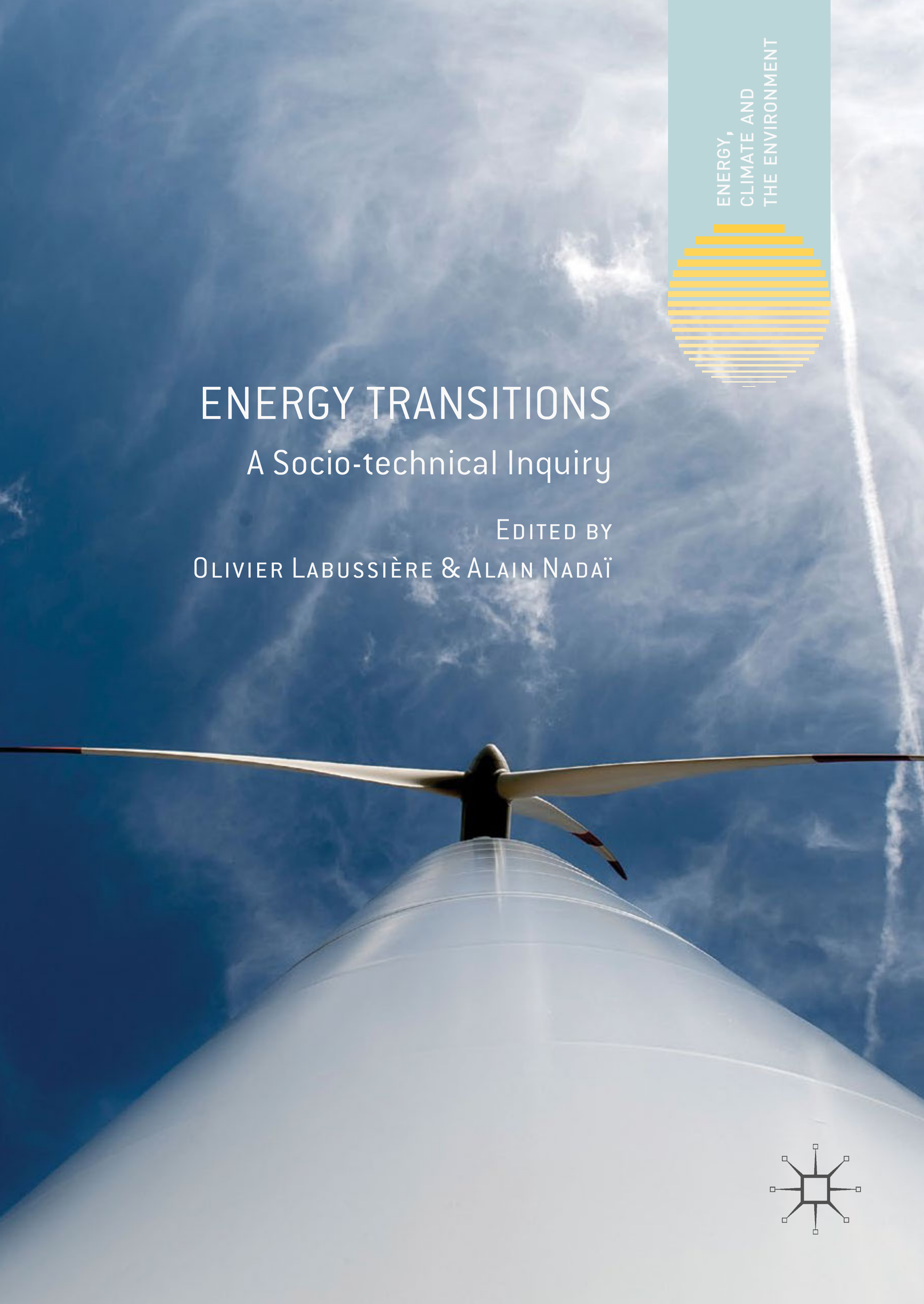

Energy, Climate and the Environment

Energy Transitions

A Socio-technical Inquiry

Edited by

Olivier Labussière & Alain Nadaï

Energy, Climate and the Environment

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The Open University
Milton Keynes, UK

"This wide-ranging exploration of the socio-political consequences of decarbonisation highlights the democratic possibilities at stake in energy transition. A rich set of case materials foreground the 'conduct' of transition to show how the progressive potential of renewable resources and low-carbon technologies cannot be assumed. Any democratic dividend from decarbonisation, the authors argue, must be worked for and achieved."

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Olivier Labussière · Alain Nadaï
Editors

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To Helene, Gala, and Lino
Alain

To Anouk, Louise, and Robin
Olivier

Preface

The approach proposed in this book emerged during a study of wind power policies and developments in several European countries (France, Germany and Portugal) between 2006 and 2010. The changes in landscapes induced by these developments enticed us to pay attention to the proliferation of sociotechnical collectives that were embarked on these processes and concerned by them. Dorle Drackle, Oliver Hinkelbein and Werner Krauss from Bremen University (Germany), and Ana Isabel Afonso and Carlos Mendes from the Universidade Nova de Lisboa (Portugal), were important research partners in this early phase of research work.

The present volume is the outcome of a research project that drew on the first phase of research and proposed to explore energy transition processes in a more systematic way, focusing on the collectives of actors (human and non-human) that were associated with these processes. The project was entitled the COLLENER ('ENERgy Transition and Sociotechnical COLLectives') Research Project (2011–2015) and was funded by the French National Research Agency (ANR) under Grant n° 2011-SOIN-003-01.

This book is a collective endeavour and the editors wish to acknowledge and thank the members of the COLLENER research team for their enthusiastic contributions, which included undertaking fieldwork, reflecting on the research framework and discussing and co-writing the chapters. They are Vincent Banos (Irstea Bordeaux), Christophe Chauvin (Irstea Grenoble), Edith Chezel (PACTE Social Sciences Research Centre), Béatrice Cointe (CIRED), Jeoffrey Dehez (Irstea Bordeaux), Michel Deshaies (LOTTER), Antoine Fontaine (PACTE Social Sciences Research Centre), Catherine Grandclément (EDF R&D), Thomas Reverdy (PACTE Social Sciences Research Centre), Laurence Rocher (EVS Lyon), Antoine Tabourdeau (Irstea Grenoble) and Eric Verdeil (EVS Lyon).

The scientific committee of the COLLENER project also played an important role in discussing our interim results. We should like to thank them for this and for having accepted our invitations to come to France and exchange their thoughts with us. They are Samir Amous (Apex Conseil, Tunisia), Marina Frolova (Universidad de Granada), Joe Szarka (University of Bath, UK) and Dan Van Der Horst (Birmingham University, Edinburgh University).

The administrative managers from the different research units engaged in the Collener Project have been key figures in making our meetings possible. We would like to thank them for their constant support and their art of making projects materialize. Eleonore Tyma (CIRED) and Nathalie Léardini (Pacte Social Sciences Research Centre), both administrative managers of the research units coordinating the Collener Project, have been particularly pivotal in this endeavour.

Zoé Ancion (administrative and scientific manager) and Jean-Marc Stébé (programme officer), both of the French National Research Agency (ANR), provided decisive assistance in their strategic attention to the successful deployment of the research project.

The editors also greatly appreciated the contributions of those invited to the concluding COLLENER conference, which was held at CIRED in Paris on November 26–27th 2015. The speakers and the discussants were Gavin Bridge (Durham University), Vanesa Castan Broto (University College London), Céline Cholez (PACTE Social Sciences

Research Centre, Grenoble), Cyria Emelianoff (Université du Maine, Le Mans), Peter Karnoe (Aalboorg University), Brice Laurent (Centre de Sociologie de l'Innovation—CNRS, Paris), Alexandre Mallard (Centre de Sociologie de l'Innovation—CNRS, Paris), Antoine Missemer (CIRED-CNRS), Sujatha Raman (University of Nottingham), Claude Rosental (Institut Marcel Mauss—CNRS, Paris), Pascale Trompette (PACTE Social Sciences Research Centre, Grenoble), Aurélie Tricoire (CSTB, Paris), Bruno Turnheim (King's College London), Dan Van der Horst (Edinburgh University), Saskia Vermeylen (Lancaster University) and Grégoire Wallenborn (Université Libre de Bruxelles).

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Finally, all our best intentions to express ourselves in clear and simple English would have amounted to little without the conscientious linguistic and proofing skills of our long-standing collaborator Jonathan Uhlaner and our first-time collaborator Paul Reeve. To both our thanks.

Grenoble, France — Olivier Labussière
Nogent-sur-Marne, France — Alain Nadaï

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How to Inquire About Energy Transition Processes?

Olivier Labussière and Alain Nadaï

List of abbreviations

ANR	French National Agency for Scientific Research
ANT	Actor-Network Theory
CCS	Carbon Capture Storage
CERPA	Centre d'Etude et de Recherche sur les Paysages
CIRED	Centre International de Recherche sur l'Environnement et le Développement
EDF	Electricité de France R&D
EVS	Environnement Ville Société
GHG	Greenhouse Gas

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IRSTEA	Institut national de recherche en sciences et technologies pour l'environnement et l'agriculture
MLP	'Multi-level Perspective' framework
OFCC	Our common Future under Climate Change conference
PACTE	Politiques publiques, ACtion politique, TErritoires
RTD	Research and Technology Development policy
STS	Sociology of Technology and Science

1 Introduction

In their concluding statement to the recent Paris scientific conference, 'Our common future under Climate Change (OFCC)' (July 2015), which preceded the CoP 21, scientists from around the world acknowledged our entrance into a new phase of climate change issues. Climate change and the 2 °C threshold are now considered (firm) scientific facts and the time has come to explore actual solutions for greenhouse gas (GHG) mitigation. The recent Paris Agreement has confirmed the advent of a time of action, of which energy transitions are part.

Our approach to these energy transitions has itself been transformed. The devising of energy futures through multiple and sometimes diverging scenarios has come to be superseded by discussions about the timing, tuning and financing of long-term investments in order to develop new energy/mitigation technologies in time. As increasing climate change casts its shadow of urgency over the negotiations, it steers our attention to 'scalable' (big) solutions. Large-scale technologies such as carbon capture and storage, nuclear or even (on- and offshore) wind power, driven by market actors, are presented as the main, if not the sole, road to success. 'Scalable' solutions, however, are contested. As such, they testify to a contemporary democratic deadlock by which the urgency of the climate issue cuts short collective negotiations on the social goals of energy transition (Stengers 2009). In many respects, social scientists are expected to find ways of alleviating what have been called 'acceptance issues', implying that the charge of resolution is in the hands of a recalcitrant public rather than in the recasting of transition projects or in a better understanding of the democratic deadlock.

1.1 A Democratic Deadlock

A large spectrum of social science approaches has been interested in issues of energy transition. Normative approaches take transition agendas as given and look for ways of surmounting barriers to their implementation (e.g. social psychology, cultural approaches; Sarrica et al. 2014). Critical approaches explore the framing behind techno-politics (Wolsink 2012, on smart grids; Aitken 2010, on wind power; Markusson et al. 2012, on carbon capture and storage; Willow and Wylie 2014, on fracking). While a large array of critical perspectives has been developed (Gailing and Moss 2016; Geels 2010), they often result in a straightforward application of an analytical framework to the object of energy transition, without necessarily entering the (messy) field of energy transition processes and reviving the type of criticisms that could be expected. Calls for more critical approaches to the democratic dimension of energy transitions are still relevant (Stirling 2014a, b), and the question of the possible effect of 'energy transition' as a field of inquiry on the social sciences remains open. Differently stated, if we assume that disciplinary framings prevent us from fully addressing the democratic deadlock we are currently facing, how can we devise our inquiry so as to explore anew the matter of energy transition processes and re-conceptualise the critical issues underlying these processes? This first displacement—from 'criticism' to the 'critical'—calls for a strategy that connects the democratic challenge to a renewed scientific inquiry.

The recent success of 'meso' approaches to technological change—the multilevel perspective (MLP) approaches to energy transition (Geels and Kemp 2007; Geels and Schot 2007)—and the debate they have triggered, illustrate the dominance of criticism. MLP has itself come under strong criticism for its lack of spatialisation and politicisation (Coenen et al. 2012) and of social and cultural dimensions (Sarrica et al. 2014, p. 3). The limits of this framework do not, however, result only from lack of openness to the work of the social sciences: Geels (2010) has argued for the potential of MLP to develop interfaces with a number of other approaches in social sciences. Rather, the limitations seem to ensue from the self-framing as a rational effort to translate transition processes into a strategic (goals/means) management issue.

The proposal for the strategic management of technologies (means) in order progressively to meet the social demands results in placing democracy in the hands of policy makers, firms and engineers. Moreover, the [related] focus on newness (innovation as the predominant issue) and the representation of the existing world as a socio-technical regime (inertia as a correlate issue) cast a shadow over both the realm of experience in which the transition is to be embedded and the consequences of technological development for this experience. Democratic issues ensue because the ways in which energy change processes are experienced and the capacity for people or milieux to take part in these processes are neither acknowledged nor represented. A 'critical field' of democratic issues builds up and lies in the midst of the dominant instrumental reasoning, as if it was concealed by it.

1.2 An Inquiry

In this book, 'inquiry' is a loaded word. It refers to a material as well as to an approach and a role for the social sciences.

First, 'inquiry' refers to a related *material.* This book is an attempt at reopening our socio-technical exploration of energy transition processes thanks to a large set of empirical case studies. This material stems from a five-year research project.[1] Five years ago in France, the phrase 'energy transition' was becoming a buzzword in both policy and academic circles. This enticed us to go back to empirical descriptions of processes of energy change, with the aim of critically addressing the performative dimension of 'energy transition'. This meant grasping energy change processes within an encompassing perspective that would allow us to capture the framing of the transition at work—for instance, what it did to the ways in which energy changes were undertaken and the social implications of this way of doing things. Returning to the field was thus a way to broaden and reopen our questioning about energy transition processes. We decided to approach these processes from different angles—local, national or transnational—and through a large set of empirical objects—seven medium-scale technologies were covered by about 30 different case studies.

Secondly, 'inquiry' points to *an approach in social sciences*. Inquiry is an idea in and a method of the social sciences that derives from the pragmatist tradition (Dewey 1939, 1946, 2008). Inquiry starts with attention to the consequences of (energy) activities for actors and entities that are affected by them but that are neither part of them nor at the origin of their undertaking. It devotes specific attention to the ways in which this often heterogeneous and unorganised set of affected actors (called a 'public') attempts, and in certain cases succeeds, in collectively articulating the interferences they experience and turning them into shared concerns that must be acknowledged. As a method, inquiry emphasises the exploration of multiple worlds and degrees of (non) implication in relation to energy change processes. It explores a 'critical' realm at the core of energy change processes, *'critical' because it plays a key role in these processes, though tenuous, hardly discussed and acknowledged*. Inquiry is also an alternative to the goal/means instrumental dialectic, since *goals (shared concerns) are seen to emerge along with processes of change*, through reflexivity and experimentation, rather than as existing prior to these processes and steering them.

This perspective assumes a scope for experimentation and a certain plasticity of the studied entities. As a sociological approach, inquiry is part of the pragmatist tradition, sometimes called 'relationism', which shares the view that things are defined by and owe their capacity to act to the relations in which they engage. Relational approaches to technology have followed various paths, including some strands that help us operationalise our approach. They explore the politics of processes that bring technologies into existence and the politics that is incorporated into the technologies and contributes to composing their social environment as they emerge (Simondon 1989, 2005; Callon 1986; Akrich 1989; Latour 1991; Mol 1999).

Thirdly, 'inquiry' indicates *a place and role for social sciences*, which has been debated since the founding of the pragmatist approach to democracy (Dewey 1946) until its most recent reinterpretation in the analysis of material participation (Marres 2012). In a nutshell, the rise and centrality of technologies in modern society has made political participation increasingly, if not essentially, problematic because of the many interferences they generate (Latour 1991; Callon Lascoumes and Barthe 2009; Pestre 2013). The problematicness of political participation has been defined as the difficulty for actors intimately affected by technological development to participate in decision-taking. The ensuing issue for these actors is to make themselves capable of influencing the course of things, an issue that has been assimilated to *ontological trouble* in the sense that this 'public' is concerned but not relevant when it comes to access to and acting in the spheres where decisions and actions are taken (Marres 2012). In this context, the sociological inquiry endorses a role that contributes to making politics of interferences explicit to actors, thus supporting the public in making itself relevant to decision and action (Zask 2008). *Ontological politics* refers to this role of social science in describing and making explicit the politics of the processes that endow different actors with different capacities for political participation (Mol 1999; Law 2004; Woolgar and Lezaun 2013).

1.3 Energy Transitions in the Making

This book aims at going beyond both the management approach to energy transition and criticisms of it. In seeking to contribute to an inquiry in the previously defined sense, it assumes that the democratic dimension of energy transition processes does not preexist the transition itself. The energy transition and its democratic dimension are jointly in the making. They are co-produced through energy transition processes.

The 'demos' under consideration is neither the *masses* (a group of individuals without a shared history or representatives, or a passive, emotional and easily manageable body) nor the *people* (a preexisting social group with a stable identity, culture, institutions and symbolic place that would resist change and innovation) (Zask 2008). The 'demos' here is a '*public*', defined as a heterogeneous collective in the making, induced by the interferences they experience and engaged in the collective articulation of their concerns so as to make them relevant to the steering of the energy transition. Exploring these publics and their singular experiences is a way to contribute to a better understanding of the current democratic deadlock.

One risk associated with this approach is to fall into particularism and restrict inquiry to microprocesses. Most of the case studies underlying this book focus on the deployment of medium-size technologies that induce large changes, new scalar assemblages, widespread processes of spatial colonisation and collective judgement. Hence the book's originality consists in adding to the contribution that relational thinking can make both in the academic arena (Stirling 2014a, b) and in policy debate.

The first part of this introduction sets forth the motivation behind the research project that underlies this book and our empirical approach to energy transition processes. The second part discusses the idea of energy transition and the approaches that the social sciences have taken to it. The third part introduces our approach to the empirical material and our conception of relationalism as a framework for analysing energy transition processes. The fourth part details the theoretical language of our inquiry. The last part shows the reader how our empirical material and inquiry is organised throughout the book.

2 A Heterogeneous Realm

As previously stated, seven years ago, when we initiated the research project behind this book, the 'Energy Transition' was emerging as a buzz word and unquestioned policy moto in France. Meso-level theories such as multilevel analysis or transition management were gaining international recognition (Geels and Schot 2007) and coming under criticism (Markard and Truffer 2008; Shove and Walker 2007; Smith et al. 2005). In the academic literature, when not borrowing to meso-level analytical frameworks, case studies tended to focus on very delimited objects of analyses (either local, or national, or transnational objects) in spite of longstanding calls in neighbouring academic fields to endorse analytical approaches that weaved together the various dimensions of environmental change (Bulkeley 2005; Shove 2003; Walker and Cass 2007).

In order to take a fresh look at how energy change followed processes that were multi-scalar in the sense of weaving together dynamics that could be local, national and transnational at the same time, we decided to observe processes of energy change from various interrelated viewpoints. This translated into a research project, initiated in 2012, aimed at following different technologies from different points of observation, considered as sites/sights (Mitchell 1996; Barry 1999). In this approach, the 'site' has a material existence (it is where processes take place) but it is also defined relationally. Through its interweaving with different networks, the 'site' not only captures an emerging reality but allows it to be brought into existence and seen (as a 'sight'). Bringing sites/sights together allows for a broader understanding of a specific situation (an '(in)sight'). Thus, the ensuing '(in)sight' does not come from nowhere: it affords the analysis a critical perspective on the energy transition that is embedded in empirical processes—a perspective that was lacking when we began our project.

Our exploration has been structured around three emerging dynamics (transnational, national and local) that are at the core of the energy transition:

- the emergence of *transnational processes* and coalitions of actors that aim at framing the political and regulatory processes of the energy transition in order to scale up the development and deployment of new energy technologies (e.g. marine strategic planning, industrial wind power);
- the emergence of *climate-energy policies* as a result of a progressive shift from energy supply policies (e.g. wind power or solar policy based on fixed tariffs) towards policies that are more territorialised (e.g. the 2009 EU Directive on renewable energies, the declension of French climate-energy policy through local and regional Climate-Energy Plans); and
- the emergence of '*renewable energy communities*' corresponding to local, collective and networked processes and projects in the climate-energy field (e.g. 'transition town' movement, 'Positive Energy Territories' network in France, 'One Hundred Per Cent Renewable Energy Regions' in Germany, cooperative renewable energy projects …).

The result was a set of case studies covering a broad range of empirical processes of energy transition processes, which afforded a well-informed view: 31 case studies covering seven energy technologies (solar, on-/off-shore wind, smart grids, biomass, low-energy building, carbon storage and capture) in three countries (France, Germany, Tunisia). Case studies were purposely conducted on multiple scales—local, national or trans-national—in order to develop a trans-scalar perspective on transition processes.

Needless to say, the result was a large set of very diverse processes, even for one and the same energy (e.g. Labussière and Nadaï 2014). Starting or end points could not capture the issues or the social recompositions at work in these processes, their innovative dimension or the course taken towards energy change. Even the idea of energy transition itself, referring to a starting/end points trajectory, sometimes seemed irrelevant in capturing the processes at work and their outcomes.

What stood out, however, were regularities in manners of framing energy transition, meaning both ways of attempting to entice the change and ways of delineating what counted in and for the change (and what did not). As commonalties and regularities stood out at the level of the conduct of the energy transition, it became important to sidestep the performative effect of the idea of energy transition—for instance, to regard the focus on quantitative trajectories (starting/end points approach) as a way of unifying processes under the 'transition' moto—and challenge the conduct of the change it brought about.

One important step in doing so was to understand better and critically assess the main approaches to the energy transition, their content and their derivations.

3 The Current Approaches to the Energy Transition

Contemporary energy transitions cannot be reduced to a 'passage' from a state A of energy production and consumption to a state B. Energy is more than just energy. Energy transition policies, because they are motivated by environmental issues and considered in a large array of countries, have the potential to support systemic, socially innovative processes. Decarbonising our economy might thus provide an opportunity to address at once societal, political and environmental challenges. Conversely, too narrow a framing of these policies might end up being counterproductive. Overlooking biodiversity, landscape or place-related challenges when developing alternative energy projects might weaken social synergies, deter individual engagement and harm ecosystems. In a word, restricting the scope of these policies may ruin the potential on which they intend to rely for addressing climate and energy challenges.

3.1 The 'Transition Management' Framework and Criticisms of It

Approaches to energy transition in social sciences have attempted to address this complexity in various ways. In what follows, we discuss briefly a few important theoretical strands in order to present our approach.

One strand is 'transition management'. This analytical framework has been developed over the past twenty years. It originates in the Twente School's quasi-evolutionary theory (Rip 1992; Schot 1992; Rip and Kemp 1998), aimed at developing a sociological understanding of evolutionary variation–selection–retention mechanisms behind technological change. It has become predominant in both the academic and policy-making fields, influencing the current devising and implementation of energy policies in various countries (e.g. the Netherlands, UK, France). Both the historical evolution and the current assumptions underlying this framework should be given consideration here. One important challenge behind the development of this theoretical strand was to understand and influence long-term changes in large socio-technical systems—changes which were called socio-technical 'transitions'. These transitions are conceived of as a process of shifting dynamic equilibria with reference to evolutionary and systemic thinking. Change in these transitions proceeds by moving from one equilibrium to another (over periods of 25–50 years). It is envisioned through a multilevel perspective (MLP) that is hierarchically structured. MLP proposes 'that transitions, which are defined as regime shifts, come about through interacting processes within and between these levels' (Geels 2010, p. 495). Each level, either 'niche', 'regime', or 'landscape', consists of specific and sometimes contradictory processes, referring to heterogeneous configurations of increasing stability. The 'niche' allows for experimenting with emergent technical options: it produces and increases variety. The 'regime' consists in the current, dominant, technological system, its rules, policy frameworks and key stakeholders: it is characterised by path dependency and inertia. The 'landscape' refers to market, politics, political ideologies and societal dynamics and desires: it exerts a selective pressure. Four configurations of change are conceived through the interweaving of these dynamics: 'transformation', 'de-alignment/re-alignment', 'technological substitution' and 'reconfiguration' (Geels and Schot 2007).

As social sciences have developed new ways of approaching the energy transition, the 'transition management' strand has faced growing criticism. As suggested in our introduction, this book draws on the distinction between 'criticisms' and the 'critical'. It aims at building on the criticisms of the MLP in order to pave the way for a (wider) perspective that could address the critical—ontological—dimension at work in transition processes.

Among the main criticisms addressed to MLP, we note three. (i) The *functionalist argument*. MLP is a functionalist (Darwinist) approach that looks at innovation through standardised and preexisting levels and functions but does not acknowledge the logics of action and their performativity (Meadowcroft 2009). Geels (2010) partly answered this criticism by defining MLP as a 'crossover middle range theory' that stages ('causal') agents having the capacity to engage in multiple modes of coordination ('causal mechanisms'). However, this answer still left uncharted the grounds or underpinnings (either objects or settings) that make these agents (choose to) engage in one or the other mode, either when innovations change 'levels' or when a new technology triggers internal displacements inside the levels (unlocking inside the regime, for instance). (ii) The *reductionist argument*. MLP has been referred to as an ex post reconstruction of processes along predefined notional categories that simplifies the processes, reads them in terms of ideas of 'path dependency' and 'technological trajectories', and ends up privileging robust technical solutions (Bijker and Law 1994; Shove and Walker 2007). Last but not least, (iii) the *spatial argument* objects to lack of an effective conceptualisation of space and local entanglements that allow the agents to access a broad range of resources, adapt institutions and manage innovation in unexpected pathways (Coenen et al. 2012).

The leading authors of transition management have produced papers to clarify their position, especially with respect to the recurrent criticism of a lack of attention to the 'agency' of actors and their political work. Different social theories have been discussed and the initial framework partly opened to include them. Mainly under the influence of Gidden's work, actors are approached as engaged in the practical work of reproducing/adapting rules of social change, which in the long run becomes a participation in revising the collective structures of society (Geels and Schot 2007). A more systematic study of the compatibility between the MLP and social theories has been proposed by Geels (2010). Through a somewhat instrumentalist take on them, Geels concludes that most social theories (i.e. interpretivism/constructivism, conflict and power theories) can be rendered compatible with MLP in order to develop 'crossover' foci on power relations, cognitive or ideological issues. Only the sociology of technology and science (STS) approach, flagged as 'relationalism', is clearly shunted aside because its 'flat ontology' would deny the usefulness of a multilevel perspective, prefer the study of micro-scale processes and refrain from developing analytical models.

3.2 Beyond Transition as a 'Management' Issue

The recent generation of MLP work clearly shows that the 'transition management' approach has privileged a 'management' lens. This, however, was not necessarily inscribed in its genes (Shove and Walker 2007; Geels 2010), a point we would like to discuss briefly here in order to overcome a simplistic opposition between the not so well integrated multi-paradigm (the MLP opened to SocSci, as advocated by Geels 2010) and 'alternatives' that mainly result in the declension of existing frameworks and their application to issues of energy (Gailing and Moss 2016).

MLP scholars (e.g. Verbong and Loorbach 2012) frequently refer to Nelson's and Winter's (1982) evolutionist approach and seminal idea of 'technological regime', according to which innovators beliefs and past experiences steer the management of new options. This perspective has been enriched to encompass different aspects of innovation (engineering practices, production process, ways of defining problems) all of which was captured under the idea of 'socio-technical landscape' (Rip and Kemp 1998). In retrospective, a striking aspect of Rip and Kemp's seminal paper, entitled 'Technological change', is that innovation was approached through a multilevel perspective in which levels were not yet standardised; standardisation came only later with Geels's works on the 'socio-technical regime' (Geels 2002, 2004). Rip's and Kemp's approach to levels was both hierarchical and relational. Levels were at the same time *perspectives on* the process of emergence of socio-technical objects and *places in which* this process could be followed. They offered a locus in which the emergence of techno-societal 'configurations that work[ed]' could be analysed in relation to their embeddedness (from the micro to the macro) into 'seamless webs'—that is, webs of very different elements (artefacts, entrepreneurs, networks, banks, regulations, users) which join together in technological developments, particularly in large technical systems, and make the evolution of technology and the evolution of society inseparable and co-evolutionary. Stated differently, Rip's and Kemp's approach wove together evolutionary and socio-technical approaches.

This analytical attempt, however, was discontinued by the authors themselves, on the grounds that socio-technical approaches overestimated technological malleability because they disregarded the constraint exerted by the socio-technical regime (vested interests, existing infrastructures) on the emergence of new technical options. The 'physical and institutional entrenchment of a technology' was, they wrote, necessary to the realisation of technology (1998, p. 378).[2] In so arguing, the authors opted for a certain (evolutionist) strain of analysis, interested in radical changes in technologies (changes in technological paradigm).

This perspective, however not irrelevant in analysing technological change in the long run, had important analytical consequences. First, it confined flexibility to a somewhat narrow interpretation. Flexibility was restricted to newness and niches, which became the only locus for it when dealing with radical technological changes. The idea of flexibility targeted the weakening of the regime rather than the changes that could ensue from the (however experimental) large-scale diffusion of mature technologies. Last but not least, the idea of flexibility prioritised a strategic management over a relational approach.

Second, in foregrounding the idea that technological change should be managed strategically, in accordance with predefined social ends, they paved the way for a progressive separation between the definition of (however multiple and disputed) ends and the (efficiency-driven) choice of means (instruments) transferred into the hands of a limited number of actors (e.g. firms, policy makers). This in turn conveyed a normative and instrumental appreciation of democratic issues. Their definition ended up being disconnected from the experiential realm of technology diffusion: the democratic challenge was reformulated in terms of innovation pathways (niche selection, regime challenging and 'barrier' overcoming) instead of referring to continuous, reflexive and contested socio-political processes.

As illustrated by the case studies in this book, new energy technologies are developed through diverse, singular assemblages. Each in its way, these assemblages are connected to and informed by a diversity of situations, objects and collectives in order to (more or less successfully) address situated issues. While these do not lead to radical breakthroughs or changes in the technological paradigm as seen through an evolutionist lens, they do contribute to addressing democratic issues and generate, in some cases, systemic effects. If we take seriously attending to the democratic dimensions of the energy transition, such variations should be regarded as significant changes in energy technologies and accounted for in our conception and vision of technological flexibility.

Such variations contribute to forming the potential—in our case, the extent to which a technology may contribute to a different energy mix—that a given technology may achieve in the transition. They contradict the well-known 'potential/barrier' view (Shove 1998): a view that conceives 'technological potential' as a given horizon and attribute of the technology (not dependent on the way in which the technology is developed) that can be tapped by merely overcoming barriers (e.g. market imperfections, environmental impacts, administrative barriers or local opposition).

While seemingly accounting for multiple dimensions (Verbruggen et al. 2010), the potential/barrier paradigm does so only superficially. In supposing the potential to be given, and not engaged in a process of taking form, it suggests that ends can be devised in complete separation from the process of deploying the technologies and denies market, social organisation and the environment any influence on their definition or the devising of solutions. It also suggests that the 'potential' of energy transition lies solely in selecting the right technological solutions to exploit energy resources. Resources, for their part, are reduced to their physical dimension (wind speed, sun radiation). They are denied the social attachments that could make their interweaving with democratic issues too complex to settle. Simplistic notions such as 'deposit' (to deal with places) or 'social acceptability' (to deal with social organisations), testify to the limits of this approach in accounting for the actual processes through which various entities—such as: market forces, social organisations and the environment—constructively contribute to energy change.

4 A Relational Approach to Energy Transition Processes

Attending to the systemic effects of the contemporary energy transition processes is a true challenge. The framework proposed by the MLP is problematic because the levels and the dynamics to be described are partly defined beforehand. The social aspects of energy transition processes are grasped along predefined functional dimensions, such as variation, inertia and selection. The transition is made sense of and rendered manageable through the reduction of its systemic effects to internal and external interactions between levels. As Geels stated it: 'The trajectories and lineages within the levels result from social (inter)actions […] Between the levels there is an evolutionary logic, with heterogeneous niche-innovations providing (radical) variety that interacts with broader selection environments (at regime and landscape levels)' (2010,

p. 505). Paradoxically, criticisms of the MLP fail to offer real alternatives to this perspective. In most cases,[3] energy transition has remained an object framed and defined in conceptual terms that largely preexisted its advent. A third way remains to be developed.

This book aims at contributing to a relational approach to contemporary energy transition processes—that is, to following the making of transition issues and their emergence as political objects, their 'issuefication' (Marres and Rogers 2005). A few scholars have made a start at a relational approach to energy transition processes, but this has been mainly with small-scale (domestic) processes (e.g. Shove and Walker 2007; Marres 2012). Developing a broader relational study of large-scale energy transition processes remains a challenge still ahead of us. This book aims at coming to grips with the challenge by exploring processes of development of medium-size energy technologies (such as wind energy, solar energy, smart grid, etc.).

In order to do this, we need to overcome the reductive assessment of STS 'flat' ontology as entrenched in the analysis of small-scale early innovation processes (as stated by Geels 2010, for instance). We, therefore, propose a relational approach that avoids predefining levels of analysis, but does not hamper treating scalable objects. Fundamental questions that then arise are: What does 'transitioning' mean exactly in the current transition processes? What entities have embarked (intentionally or not) on these processes, and do they have similar abilities to 'transition'?

4.1 Processes vs. Trajectories

These questions call for a new type of inquiry, which becomes possible only if we distance ourselves from the notions of 'trajectory' widely used in devising long-term scenarios. 'Trajectories' result from a combination of 'technological potentials', themselves defined in an essentialist manner that ignores a wide range of entities (environment, institutions, social forces) and obscures the role of these entities in the making of transition processes. A notion such as 'trajectory' fails to provide an alternative to reasoning in terms of ends and means. As we have observed (cf. §2.2), such a conception leaves the hierarchy of ends undetermined and transfers the 'strategic management' of technological means into the hands of a small number of actors, resulting in democratic deadlock.

The fieldwork observations gathered together in this book indicate how multifarious, if not indeed ambiguous, the processes of deploying a new energy technology actually are. For instance, one lesson learned from the development of wind energy in France is that renewable energy developments are not sustainable per se (Nadaï and Labussière 2017). Sustainability has to be built on a case by case basis through project processes. Outcomes in both quantity (installed capacity, productivity, cost, benefits) and quality (types of impacts, sharing of impacts and benefits) depend on the singular socio-technical assemblage that is brought together through project development. In certain cases, wind energy projects fall short of assembling the concerned parties in a manner that acknowledges the ways in which they are affected by the projects. Such projects then give rise to unstainable developments that deter local synergies and destroy the potential for further wind power developments. The direction and the intensity of such recompositions vary from one project to another and from one technology to another.

Approaching the transition as a 'process' rather than as a 'trajectory' allows us to broaden the scope of the analysis. It enables us to account for a large range of entities and for the ways in which their capacity of action, responsibility, lifestyles and material environment are affected by energy change. One key argument of our book is that this 'ontological trouble', to adopt the term coined by Noortje Marres (2012, p. 42, inspired by Woolgar 2005), should not be regarded as an external effect of energy transition processes, but as something that is constitutive of it.

4.2 Interferences and Ontological Trouble

This book approaches the energy transition as a period of 'ontological trouble'. It starts with the assumption that the status of the entities embarked on the energy transition is fundamentally unclear. The messy aspects of transition processes cannot be clarified by the use of ready-made analytical tools (as suggested by Gailing and Moss 2016).

As emphasised by Noortje Marres on a related but different issue (material participation), such processes cannot be reduced to a 'problem of demarcation'. The affecting/affected parties (individual/society, cause/consequence, etc.) and the extent to which they are affecting/-ed *cannot* be easily qualified. The challenge ahead of us is *not* just to bring them together in a joint process of settlement (Marres 2012, p. 14). The issue calls for an inquiry that follows the diverse entities and their becoming.

The inquiry proposed in this book is specific (at least for the field of energy transition analyses) in that it pays attention to the consequences of the processes of energy change for a diversity of entities, human and non-human. Our proposal is to explore the position, degree of engagement and influence of the entities that are affected by these processes, the extent to which they are concerned, impacted, implicated, or even redefined through these processes, sometimes without having a say in this, while at other times being related or even actively engaged in it.

The thought of John Dewey is an important source of inspiration for our inquiry (1939, 1946, 2008). Dewey invites us to direct our attention to the different ways in which processes 'interfere'[4] with numerous entities (landscape, animals, communities). Interference here refers to situations of maladjustment or unqualified relations between heterogeneous entities (e.g. to what extent a wind farm located in a migratory corridor is compatible with bird migration). Such situations trigger ontological issues (e.g. can bird migration become compatible with the presence of turbines, and vice versa?) that give way to ontological trouble (e.g. what then follows as to birds, their cognitive skills to fly through/under/over/to the side of rotating turbines and their qualification as (un)protected species? What as to the way in which we, as birdwatchers, conceive of them?). They open up a new potential (e.g. can wind be made shareable by birds and wind power developers if we trace the way they affect one other in a migratory corridor? Could we change the way we look at migrating birds and the politics of their protection without putting migrating birds at risk? Which settings might then allow such readjustments to come into existence?) (Nadaï and Labussière 2010).

Interferences point to these (sometimes unintended) consequences of project development and the ways in which they disturb existing continuities in individual and collective experience (e.g. the possibility of birds freely using the wind in a migratory corridor in order to migrate, individually or collectively). Interferences also indicate the interweaving of the different ways of involving or of getting others involved in energy transition processes: ways of making sense of under-articulated concerns through projects development, ways of enticing others to articulate concerns that can serve, bend, or even contradict project development. Hence, interferences point to both the consequences of project developments and the interweaving of our many attempts to channel these consequences, overcome them and give way to new and more integrative way of change.

A key issue, then, is that all entities are not equally equipped to 'transition'—in the sense of making themselves and the interferences they create/undergo acknowledged in the transition processes (for instance, were birdwatchers not following and qualifying wind power impact on bird and bird migration, wind power developers would probably not acknowledge it). Foregrounding ontological trouble associated with these interferences (suddenly, birds are considered as potentially skilled in flying through the turbines) is a way to underline that, in actual energy transition processes, entities are often approached instrumentally, without due attention to their relational existence (if we evolve the way in which we conceive of bird as a cognitive being, then what about the way in which we protect it?). Entities can find themselves unable to make the interferences they create/undergo relevant in the processes of energy transition underway.

4.3 Relations as Transition Potentials

As long as 'interferences' remain external to the processes of energy transition—for example, unacknowledged—it is impossible to bring to light both the impact of transition processes on the various entities they set in motion and the contribution of these entities to structuring these processes.

Along with the foregrounding of interferences and ontological trouble, there is thus an issue, raised and explored by this book, about offering an alternative perspective on energy transition processes that allows us to identify and qualify empirically the associated, emerging 'transition potentials'.

This cannot be accomplished by predefining the entities or the horizons of these processes, but only by attending to the relationships between the entities involved (intentionally or not) in these processes, so to characterise their (innovative or disruptive) contribution. The challenge is no longer to operationalise 'trajectories' and predefined 'technological potentials'. We do not presuppose the existence of potentials and democratic ends to be settled. Our aim is to account for the 'interferences' generated by current processes and to specify empirically the 'transition potentials' associated with them. Such a shift in analytical perspective, from '*technological potential*' to '*transition potential*', allows us to account for a wider range of material in the analysis of energy transition processes and their systemic effects.

We propose to specify the idea of 'interference' at the crossroads of different literatures. Firstly, it can be articulated by means of Gilbert Simondon's seminal work on 'individuation' (1989, 2005). As Simondon argues, things do not exist first as individual beings. Rather, operative individuals result from a process of relational adjustment. Individuation is a process that builds from and on a (pre-individual) realm in which things are mutually affected but neither relationally adjusted nor differentiated by singular capacities of action (as are wind turbines and birds in our example). Interestingly for our purpose, this pre-individual stage can be regarded as a domain of 'interferences'. Secondly, Noortje Marres work on the political construction of publics and issues is also an inspiration to press ahead with the idea of 'interference'. Marres insists that issues do not emerge separately from publics, but that rather the 'material dynamics of problematisation are constitutive of the public's formation' (2012, p. 44). Stated differently, it is in collectively formulating concerns as a shared problem and in getting this acknowledged as a problem that the public becomes structured and comes into existence.

The idea of 'public' draws on Dewey's work. It refers to actors that are affected by unintended consequences of technological developments and collectively engage in the articulation of the issues at stake for them. Analysing this process of 'issuefication' brings to light 'the tenuousness of relations, and the challenge of finding the means to establish their relevance' (Marres 2012, p. 56). Differently stated, the public is intrinsically problematic in that it faces the challenge of being concerned with certain relations while not being relevant to addressing them. The reason for this is either that these relations are tenuous and under-articulated on a collective and political level, or that the public itself as a collective formation is under-articulated and far from the arenas where relevant decisions can be made. Attending to such maladjustments, following the ways in which the protagonists progressively make sense of them and surmount them (or not), allows us to describe the collective specification of problems and identities and to shed light on the ontologies at work in the construction of transition potential.

4.4 The Reach of Relationalism

From a methodological point of view, our inquiry is a work of specification. It aims at describing: (1) how energy transition processes interfere with heterogeneous entities and disrupt their experience (disabling situations); (2) how emerging assemblages bring (or do not bring) these entities into a new relational realm and allow (or not allow) them to 'transition' (enabling processes). Thus our aim is not to clear up 'ontological trouble', but to seize it as a viewpoint: as a perspective from which to follow emerging (disabling/enabling) transition potentials.

This approach radically differs from reasoning in terms of goals and means. The objective of the process and the role of the protagonists are not defined beforehand. Instead of following pre and well-defined (and affected) individuals, the inquiry progresses from the margin (so to say). It works its way in two directions at the same time. On the one hand, it is attentive to shifting or rising *singularities*: it attends to the ways in which entities that have been ill-engaged because of ill-framed transition problems succeed or fail in progressively making themselves relevant (and active) in these processes. On the other hand, it seeks to articulate these singular adjustments with the processes of their scaling up by being attentive to the ways in which *generality* is derived from singular processes through learning, reflexivity and standardisation. Interferences are, therefore, not approached as external effects of technological development that must be internalised. They are tenuous interdependencies whose specification contributes to the exploration of new ontologies and shared values that can sustain (or fail to sustain) broader transition potential—for example, potentials that encompass a broader array of singular experiences.

5 Our Socio-technical Inquiry

The capacity of technology to trigger 'interferences' is intimately related to its socio-technical dimension. If we want to follow the idea of inquiry as a relational appraisal of energy transition processes, it is important to specify what we mean by 'socio-technical' and the way in which a 'socio-technical' inquiry allows us to develop a more politicised account of energy transition processes.

5.1 Technology as an Assemblage

A great deal has been written about technology as a relational setting, especially in the STS/Actor-network theory (ANT) tradition, though not exclusively. Technological innovation has been described as a complex process, technology as a complex system or network. Terminologies have proliferated.[5] Albeit decisive in certain cases, terms do not strictly mirror differences in appraisal, not the least because of translation issues.[6] For different reasons,[7] we have, therefore, chosen the term 'assemblage', but attach to it a meaning that borrows from the description of agencement, which we will specify.

Broadly speaking, the differences that count for us in this book are the ones that have been broached by the network approach to technology in STS, history or the philosophy of technology. Related contributions include, for instance, Akrich ('socio-technical system', 1989), Callon ('agencement', 2008), Hughes (network, seamless web, 1986), Latour ('assemblage', 2005) and Simondon (resolution, individuation, amplification, dimension) (1989, 2005). Our aim here is not to survey these fields, but to indicate what, in these characterisations of technology and technological change, matters most for our inquiry.

One basic idea is that technology is not a mere technical artefact; it is *not* some pregiven and stable physical entity. It is rather a socio-technical assemblage, in the sense of a complex articulation of social and material components, both human and non-human (hybrid) (e.g. Akrich 1989; Callon 2008; Latour 2005; Law 1992, 2002). ANT, however, has insisted on the fact that the technology is *indissociably* socio-technical, notably because it emerges as a complex web of interacting and changing entities and the work of its assembling is afterwards erased (black-boxed) (e.g. Akrich 1989; Bijker and Law 1994; Law 1987; MacKenzie and Wajcman 1985). It is then impossible to read in or through a technology the entities that have entered into its process of formation, the contribution of the object under consideration or its context. This property has been called the 'seamless web' (Hughes 1986). Thus, by implicating (Akrich et al. 2002a, b) and partly aligning (Murray Li 2007) actors and entities, and by changing their capacities and powers for action, technology transforms the world around it. In particular, emergent technologies incorporate a certain politics in the sense of important normative choices (e.g. Barthe 2009; Jasanoff 2004; Law 2000; Winner 1986).

From this understanding of technology, several consequences follow that are important for us. First, *efficient technologies are not given in advance*, because efficiency results from the success of a technological proposition (Latour 2004) in articulating the world around it. Secondly, *public participation in the emergence of a technology* is not an option; it is a precondition for innovation to work and efficient technologies to emerge (e.g. Wynne 1996; Marres 2012). Thirdly, since efficiency is a matter of alignment, it is always possible that *things could have followed another course* and endowed actors and entities with different powers and capacities for acting. Fourthly, there is thus an *issue for social sciences in analysing the politics of technological change*, that is, in following the way in which actual versions of technologies endow certain actors and not others with powers and capacities for action. Following the collectives of actors and entities at work in the emergence of a technology is a way to follow and understand the issues raised by technological change. This explains ANT/STS's interest in analysing processes and things 'in the making' such as the formation of politics through materialities (Law and Mol 2008) or of political issues around material objects (Marres and Rogers 2005), the incorporation of politics into technological artefacts (e.g. Law 2000; Akrich 1992), or their reopening through controversies (e.g. Cupples 2011).

While all these analytical strands seem important for our purpose, following collectives of actors and entities at work in energy transition processes in order to reach a more political account of these processes raises some important conceptual and practical questions as to the type of inquiry to be undertaken, a point that we should now like to discuss in more detail.

5.2 Ontologies, Materiality and the Distribution of Political Work

Debates concerning the normative implications of technological developments have been particularly interested in the ways in which we could steer the development of technologies and make it more democratic. As previously stated (see §2.2), in the 1980s, David Collingridge (1980) pointed out a dilemma consisting in ignorance of the potential impact of a technology when it is still malleable and open to re-orientation on the one hand, and becoming knowledgeable about impacts only after the technology has been developed and is no longer open to re-orientation on the other.

This dilemma somewhat overlaps, albeit in a different register, with an issue debated by the American pragmatists, namely the possibility for the public to steer technology and render it more democratic. As observed in this introductive chapter, the pragmatist approach to technological development reveals the issue of the public's relevance. Relevance has been defined as the (in)ability of a concerned public to articulate issues and have them acknowledged in the processes through which the direction of technological change and its normative properties are decided. While Lippmann (1925) defended the idea that it was impossible in (complex) technological societies for the public to take charge of its own relevance and defended the necessity of delegating this responsibility to experts, Dewey advocated the possibility for the public to construct continuities between their experience of the ways in which technology interfered in their lives or activities and the political process that steered technological development. Dewey defended a view in which these processes of building continuities played out progressively, through learning from the result of past experiences. Importantly, Dewey suggested that such learning could happen and develop in time, around the situations in which technological objects raise issues. In Dewey's view, knowledge about the interferences caused by technologies do not ensue only from informed problem framing: they also result from progressive, cumulative and imperfect processes of experiencing technological developments. In contrast with Collingridge's generic framing of the dilemma in informational terms, this suggested that the normative properties of technology could be revisited in time to allow for readjustment in steering technological development.

The social sciences have explored various options of avoiding Collingridge's dilemma and allowing for a more democratic technological development. In particular, STS scholars have suggested maintaining alternatives open; valuing diversity as a source of flexibility (Callon et al. 2009) or even as an insurance against unanticipated changes (Stirling 2011; Leach et al. 2012); valuing upstream participation to increase reflexivity (Schot and Rip 1997); and valuing socio-technical controversies as arenas for democratising technology (Callon 1981; Rip 1986). Some of these options have been criticised for being too much focused on emergent technological objects and not accounting for the broader scales and system of power and knowledge production that underlie the ontological categorisation of these objects. In particular, a 'strong' co-production programme has been advocated, aimed at fully acknowledging the joint production of social and natural orders at work in the emergence of new technologies (Jasanoff 2005). This calls for a broader viewpoint on the processes of emergence of new technologies; for instance, by an analysis that addresses multiple scales, by accounting for multiple, nested realities with different levels of conflict, by accounting for and comparing underlying legal or institutional realms and their influence on the ways in which technological objects are framed (Joly 2005).

Critics have also pointed to the need to surmount certain limits of what STS scholars have called 'flat ontology'. The term has sometimes been understood by non-STS scholars as a refusal to enter in meso-analyses and as a posture privileging small-scale, early innovation processes (Geels 2010). In fact, however, flat ontology is aimed at accounting for the fact that ontologies, and levels or scales of powers in particular, are often not given in advance (Callon and Latour 1981; Latour 2005) but are emergent in the sense that they are at stake and under (re-) construction around technological object. While institutional orders such as legal rules certainly influence the direction of technological change, notably by framing ontological definitions (Jasanoff 2005), emerging technologies also impact on and may displace the way in which we conceive what is economic or what is political (e.g. Callon 2009), or even what constitutes the working of democracy (Laurent 2016). It is, therefore, particularly important, when engaging in multi-scalar analyses, to start with a 'flat' presupposition and make clear the way in which we intend to account for the mutual relations between democratic participation and ontological orders.

One recent development in this direction has been interested in the types of political participation allowed by material devices (for environmental action, for instance) (Woolgar and Lezaun 2013; Marres 2012). Importantly, Noortje Marres (2012) has emphasised that, until recently, political participation has been only partly accounted for by STS scholars because of the way in which they locate and approach participation. To put it in a nutshell, starting with the assumption of a flat ontology, STS scholars insisted on the multiplicity of things, meaning by this that both the ontology and the capacity for things to be endowed with definite agencies depended on the settings or dispositive through which they were developed (for instance, Gomart 2002, on methadone). Multiplicity, more precisely, meant that not only could various (contradictory) versions of the same object coexist, but that they could even mutually interact and partake of one and the same realm (such as physiological and epidemiological anaemia; Mol 1999). Accounting for the politics of things in such situations then can hardly be formulated in terms of options or alternative, but may call for attending to the multiple arenas in which these ontologies and their politics are constructed and at play, so as to reveal them and their interferences. This active engagement on the part of sociologists, called 'ontological politics' (Mol 1999), relies on ontological premises that differ from classical ontology (whose epistemological premise is that things have a given, immutable essence) because it presupposes that the ontology of things is a matter of empirical processes. It has, therefore, been called 'empirical' ontology (Marres 2013). It also presupposes that the politics of technologies or things unfold through empirical processes, though somehow encapsulated in things, under the radar of agents. Hence the sociologist's role in explicating the politics of things.

Following material devices for environmental participation (e.g. an augmented teapot, eco-show homes) and the way in which they frame political participation, Marres shows that an approach attentive to the materiality of these devices allows a different locating and grasping of political participation. Indeed, a *device-centred* approach, accounting for the materiality of devices and the settings in which they are deployed, allows for grasping the type of participation they foster and the various (more or less liberal) political tropes they convey. Such devices decompose and recompose environmental action. They co-articulate daily actions with registers of environmental action: the augmented teapot allows articulating drinking tea while avoiding peak-load times; the organisation of an open show at a home energy refurbishing works allows articulating energy-saving while demonstrating climate-energy policy shortcomings. In certain cases, these devices render manifest the political tropes underlying these co-articulations; for instance by materialising and advocating an 'involvement made easy' (the augmented teapot), or on the contrary by depicting involvement and time spent as a political value ('the more involved, the more engaged', as in certain eco-show homes). In so doing, they may (or may not) endorse the task of rendering explicit the politics of this co-articulation. Importantly, Noortje Marres shows that this normative capacity of material devices is variable: it depends on the settings and situations in which they are deployed. As such, it is experimental (rather than instrumental or empirical): it *may* be successfully experimented with by actors in a situation, potentially allowing them to undertake the political work of explic(it)ation.

For our purposes, such a perspective, called 'experimental' ontology because ontologies are not only engraved in the empirical world but also arise from experimentation, has four important consequences. Firstly, it displaces our conception of and approach to spaces of political participation, because it allows these spaces to be distributed and entangled around things, technologies and their materiality. Spaces of political participation are no longer given, they are no longer patterned after predefined models (such as public debate, public inquiry): they are emergent, they can take various forms and are a matter of empirical exploration.[8] Secondly, the public issue of relevance and the associated political work is redistributed because spaces of daily action and material entanglements can become spaces of political explication and participation. Thirdly, the work of political participation is redistributed as actors and devices can themselves engage in experiments that stage and render explicit the political dimension of technology and daily action. Sociologists can take part in this work, but have no special privilege to do so. Last but not least, the type of inquiry that sociologists can undertake is broadened. While ontological politics call for a politics of revealing the politics of co-articulation located behind/below (engraved/encapsulated in) the empirical realm, experimental ontology calls for attending to the redistribution of political work as staged by and through the materiality of things.

How does all this bear on the inquiry of our book? Does the type of inquiry to be undertaken depend on the objects/devices under consideration, on their scale? Or does it depend rather on the type of ontology deployed by the analyst? Or on both? What if our case studies end up being varied as to their underlying ontologies? Can any conclusion then be derived from confronting them with specific dimensions of the energy transition such as participation and the possibility for actors to make themselves relevant?

Our book relies mainly upon and explores cases of medium-scale energy transition technologies development. It uses trans-scalar analysis to throw light on several of these processes by connecting processes that unfold around singular material objects, such as solar farms, wind farms, smart meters, wood boilers and after-storm tree stumps, with national or transnational policy devising processes. While endorsing a flat ontology (we follow processes through which new entities and new categorisations are in the making), our exploration is neither restricted to niches, early developments or emerging technologies, nor confined to local processes and ignorant of institutional developments in energy policy arena. Most case studies actually target technologies under deployment. They follow versions of these technologies as socio-technical objects: they explore the many entities and relations which are part of their shaping and describe their mutual recompositions. In developing this relational approach, all case studies have to one degree or another been interested in the extent to which and modalities through which parties that were concerned, either because they were affected in their lives and activities or because they perceived certain paths for these technological developments as more desirable, could engage in a work that made their concerns relevant and taken on board. While not endorsing a specific and unified ontological premise, case studies indicate types of political participation in energy transition processes. In certain case studies, the spaces for political participation develop around singular objects and their materiality (hence being more relevant to a type of experimental ontology at work) and often point to attempts to give these objects new political dimensions—for example, the mutualisation or territorialisation of solar or wind farms. Other case studies focus on the politics that is incorporated in technological objects or policy instruments, and are thus more relevant to a type of ontological politics: they discuss how versions of an object interfere and eventually enact potential actors—for example, how a certain figure of the electricity consumer is inscribed in the materiality of a smart meter. The first type of case studies often foregrounds an experimental dimension, sometimes (but not always) successfully leading to the emergence of new dimensions in relation to a singular setting or site. The latter foregrounds the incorporation of a definite politics into the assemblage at work, eventually detaching this politics from its context of emergence and enacting it in the course of the deployment of the socio-technical assemblage. The variety of case studies that underlies the book allows us to indicate various ways in which interferences around socio-technical assemblages are (mis-) addressed in these processes, resulting either in the emergence of new dimensions of these assemblages and new co-articulations, or in mismatches and running tensions. As a set, they thus explore the extent to which various publics succeed or fail in making themselves relevant and contributing to the steering of these medium-size technologies.

6 Case Studies as Sites for Critical (In)Sight

As mentioned above (§1), this book relies on a significant number of case studies. Wanting to make sense of our rather large amount of empirical material, we were faced with the challenge of how to organise it. Comparing our case studies early on, it occurred to us that the ways in which transition processes are framed—notably through market, policy instruments or demonstrations—is important to the capacities of the parties engaged in them (or concerned with them) to influence the course of these processes. It also seemed important in terms of how resources, space and time were mobilised—and sometimes shaped and naturalised—in these processes.

When it came to articulating this large body of material into an overall inquiry that conveyed a relational intuition more explicitly—for instance, as just developed, by highlighting the ways in which interferences trigger ontological trouble, underlying the emergence and distribution of political capacities and transition potentials—two paths seemed possible. The first solution was to pick a few of the most telling case studies. But while a number of paradigmatic case studies could have conveyed the argument, it seemed to us that the scope of our empirical material allowed for a more daring venture. Keeping the large array of case studies in sight had the advantage of engaging relationalism in a broader scale of analysis—one that some critics had faulted this approach for not attempting to cope with.

6.1 Sites/Sights/(In)Sight

The pairing of sites/sights is inspired by Andrew Barry's critical analysis of EU techno-politics, in which he proposes an articulation between situated/material and larger political action. Barry (1999) focuses on an on-site opposition movement in England in the 1990s, the opposition to the Newbury highway project, thematising the EU's difficulty in structuring spaces for the political articulation of its techno-politics. In a close analysis of the Newbury opposition, Barry shows how the demonstration rendered manifest the damage caused by the project (by materially indicating it on-site), bringing it into public existence (through artistic, press and media networks), and fostering a political visibility, in the form of 'sights', that was crucial to how Newbury was made into a political *site*.

As Michel Callon (2003) emphasises, the importance of the political spatiality of such sites has to be understood with respect to the difficult emergence of 'technological zones' in the EU, which 'does not provide any place where overflowing [of techno-science] may be publicly shown and discussed'. Barry uses the Newbury case to distinguish between two types of politics: 'politics', generically defined as the set of institutions, organisations, procedural rules, governmental techniques and practices; and the 'political', a repertory of contestation and dissension, which expands the space of politics beyond its conventional exercise (and intelligibility). Hence, the multi-scalar dimension of the Newbury site lies in its potential for becoming a political *locus*, a place in which a political sight can find spatial and material expression from which to be amplified and overflow the prevalent political frame.

This articulation between specificity and genericity as key dimensions of politicisation seemed to offer an interesting potential for our inquiry. All the same, this inquiry intended to follow socio-technical assemblages as they were both specified and amplified. Specification stems from confrontations around singular materialities (or spatialities) (sites/sights) and the requalification of entities that endows them with new capacities for action—as suggested by Marres (2012). Amplification is the process through which a critical viewpoint (an (in)sight) is derived about the way in which energy transition processes trigger or address interferences. Each is seen as complementary: specification paves the way for redefinitions and co-articulations, which both allow for enlarged compatibilities between individual experiences and collective ventures (amplification).

Turning case studies into sites, and grouping different sites of action (local, national, transnational) around different technologies in order to address the current ways of conducting the transition, struck us as a good way to bounce off Barry's pair of ideas in order to derive critical insights into the energy transition (cf. §1, and Fig. 1).

In order to capture this interplay between specification and amplification, the structure of the book echoes our initial intuition about the importance of the conduct of transition processes and the mobilisation of resources, space and time. The six chapters successively explore: the ways in which resources are engaged in energy transition processes (Chapter 2), the importance and consequences of passing through markets (Chapter 3), policy instruments (Chapter 4) and demonstration (Chapter 5) in the undertaking of energy transition processes, and the ways in which space (Chapter 6) and time (Chapter 7) are mobilised in these processes. The authors of the chapters draw on particular case studies according to their relevance, resulting in a distribution that is presented in Table 1. Certain case studies contribute to several chapters.

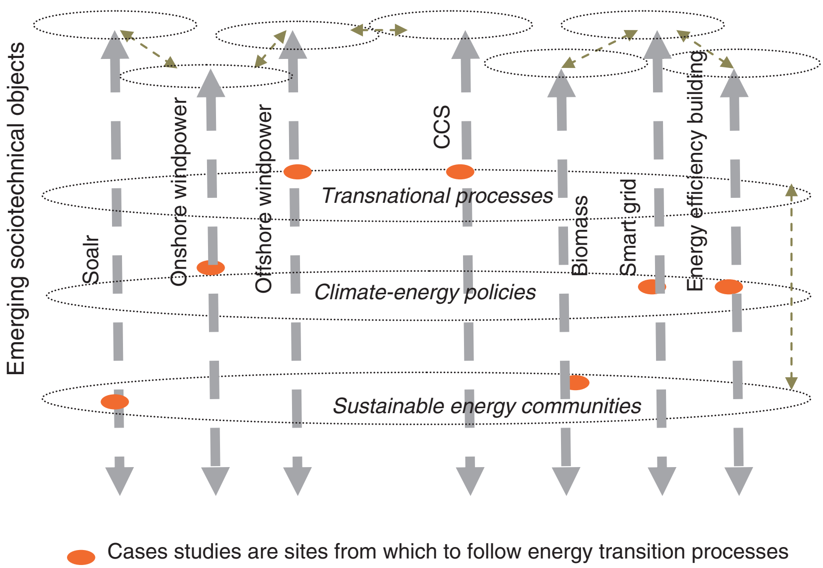

Fig. 1 Collener projects, sites/sights/(in)sight

Table 1 Distribution of chapters and case studies

	Chapter 2 Flow/Store energy	*Chapter 3* Markets	*Chapter 4* Policy instruments	*Chapter 5* Demonstration	*Chapter 6* Spatialities	*Chapter 7* Temporalities
Unconventional gas						
Unconventional futures for Lorraine bed methane gas (FR)						•
Biomass						
Biomass in Aquitaine (FR)						
Biomass in Aquitaine and the Dordogne Massif (FR)					•	
Tree stumps as biomass energy in Aquitaine (FR)	•	•			•	
Carbon capture and storage						
The contested emergence of EU CCS policy (EU)				•		
Low-energy housing						
The Caserne de Bonne (Grenoble, FR)/and the CONCERTO Programme (UE)				•		
Smart grid						
Smart grid/responsive consumers [Linky case study] (FR)		•		•		
Distributed load shedding for the electricity grid (Voltalys) (FR)	•	•				

(continued)

Table 1 (continued)

	Chapter 2 Flow/Store energy	*Chapter 3* Markets	*Chapter 4* Policy instruments	*Chapter 5* Demonstration	*Chapter 6* Spatialities	*Chapter 7* Temporalities
Solar PV						
French PV solar policy (FR)			•			
Mutualised PV solar development in Figeac (FR)	•	•	•			
Cooperative PV solar development in Rhônes-Alpes (FR)	•		•		•	
Solar PV and Thermal						
Tunisia solar [and wind power] (T)			•		•	
Wind power						
French wind power policy (FR)	•		•			
Wind power development in Aveyron (FR)					•	
Wind power development in Narbonnaise (FR)			•			
Wind power development in the Beauce (FR)						
Community wind power in Northern Friesland (D)			•			•
Weissach-im-Tal (wind and solar power) (D)			•			
Renaturing sites, empowering wind power potentials in Schipkau (Brandenburg) (D)						•

(• = case study material used for writing the chapter)

6.2 Resources as Relations

The first fact that stood out in the course of this research was that, whatever the primary resource under consideration, the definition and status of the resource had almost never been a subject of policy debate. Both at the national and the European level, the devising of new energy policies initiated in the mid-1990s has been framed by and around technological issues. Questions such as how to foster the development of new energy technologies or which policy instrument to adopt (e.g. the debate on tradable quotas vs. tariffs) have stirred debate, but the discussion has ignored issues such as the type of resources engaged, their status, qualification, ownership and becoming. Often, an abstract physical potential, reducing the resource issue to a physical dimension (wind speed, solar radiation), is used as a guide to energy change. In this way, a whole set of actual issues and messy but decisive socio-material relations involved in the development of new energy projects are not properly accounted for. So-called 'externalities' and sustainability—that is, the social and environmental consequences—involved in changing our ways of dealing with energy (or energies) are not fully addressed. Ready-made dichotomies such as 'renewable'/'non-renewable', 'non-fossil'/'fossil' energy collude in this state of affairs by suggesting that these qualifications simply mirror natural qualifications. The first category of energies ('renewable' and 'non-fossil' energies) is supposed to be sustainable, while the second ('non-renewable' and 'fossil' energies) is not.

Now, as so-called 'renewable' energy technologies and finance have been industrialised and globalised, the question of whether and under what conditions they are, or are not, sustainable has become an urgent issue. We can safely assume that resources are being framed in the new economy of energy as (inherently renewable) abstract flows so that renewability will not be seen as conditioned by the complexities of their development. It has thus become important to lay bare the web of relations, entities and transformations engaged in the making of the new energy resources, as a way of deconstructing renewability.

Chapter 2 considers a few case studies concerned with different energies. It explores the ways in which we extract, concentrate, circulate and use these energies, and the related consequences as to which entities are concerned by these developments and which are empowered to make themselves relevant in the steering of these processes.

6.3 Mediations as Relations (Market, Instruments, Demonstration)

The second fact that emerges from our case studies is the recurrence of certain mediations in the conduct of the energy transition: 'the market' (singular), policy instruments and technological demonstration are invoked and had recourse to notably by policy makers.

In the EU, this is part of a new approach to Research and Technology Development (RTD) policy, made explicit on the EU political scene during the Lisbon Summit (2000). This approach aims to move research and development (R&D) results onto an industrial scale in an effort to develop markets out of research and generate growth and employment from innovations. Important drivers in this new approach are competitiveness, market-geared policy, demonstration and public–private partnerships as key modes for devising, financing and implementing policy. This evolution went hand in hand with a redefinition of the state's role, and a repositioning of non-state actors along different dimensions of climate-energy policy.

In the field of RTD, industrialists have been repositioned as key players in the design and implementation of public policies: technological roadmaps, strategic technological agendas and public–private partnerships organised around technology **demonstration projects** have become central elements of this new policy approach.

More generally, EU authorities and national governments have come to conceive the conduct of the energy transition in close connection to **markets**. In official policy circles, conducting the energy transition through markets is assumed to mobilise all actors, ease innovation and contribute to 'fixing' energy problems. Moreover, in 'passing through' markets, the energy transition is supposed to fuel new economic growth.

The use of **policy instruments** in implementing political decisions is also part of the repositioning of the state's role and action. Policy instruments such as feed-in tariffs are thought of as incentives that can trigger investments in new energy technologies and support the deployment of these technologies. One salient characteristic of the policy instruments adopted in the field of energy transition policies is the close coordination they posit between renewable energy development, investment and market deployment. Renewable energy policy instruments are designed to support investment in renewable energies *through their markets*.

But the passage through these mediations is not neutral with respect to which actors have the power to make themselves relevant in steering energy transition processes and the outcomes that can be expected from them. Chapters 3, 4 and 5 successively explore and discuss these issues for markets, policy instruments and technology demonstration.

6.4 Time and Space as Relations

Little attention has been devoted to the **spatialities** of energy transition processes (Bridge et al. 2013). Often this spatial dimension is analysed by following networks of actors and their locations, without properly accounting for the materiality and heterogeneity that underlie their coming into existence (Coenen et al. 2012). A starting point for the inclusion of spatiality can be to account for the spatial distribution and material specificities of new energy resources: wind, solar, shale gas or coal bed methane are *diffuse* energy resources. Harnessing such resources imposes on us a renewed relationship to space. This requires attention to processes of configuring space as a manageable 'volume' in order to control energy material flows. Unlike oil, coal, or natural gas, these new diffuse energy resources need to be concentrated in order to find economic and market value, which gives rise to competition for space and the exploration of large new spaces, previously left aside in global competition. The academic literature has tackled some issues of energy spatiality under the heading of emerging 'sustainable communities', attachment to place, or inherited socio-spatial configurations. Processes of co-occupation or juxtaposition between new and old socio-technical systems—of different ages—become central, as they tend to interfere with the calculation, delineation and interconnection of new energy volumes. They call for an analytical framework allowing us to follow the processes through which space is re/dis/qualified, a challenge that

Chapter 6 attempts to address through various case studies by considering the related *politics of volume*.

Chapter 7 then turns to exploring the construction of **temporalities** in various energy transition processes. In the field of energy, time is usually approached through the modelling of technological pathways and the devising of energy scenarios. Time is conceived as a linear (chronological) entity along which abstract marks (2030, 2050) are constructed as collective horizons, in order to structure strategic discussions about our abilities to act on the future (scaling up investments, changing the energy mix, reducing carbon emissions).

As useful as it can be in coordinating action, such an understanding of time is also limited, because it does not account for the many temporalities that interfere and weave together in the construction of technological pathways. These appear clearly in fine-grained empirical and longitudinal descriptions of energy transition processes. Time is rarely external to the actors engaged in a process. Filling in certain time horizons with dedicated technological representations, or pre-empting certain possibilities of doing so, is a way to use time as a resource for steering the transition. Seizing upon the past as a resource for steering the future, if only by relying on inherited spatial or material configurations in order to develop new options, is another way of using time as a resource. It is a time that has been 'empiricised' in spatial and material configurations, as the geographer Milton Santos puts it (Santos 1997). It is a time that offers a handle for action. Once the multiplicity of time is recognised, its linear construction, however efficient, can be regarded as no more than a dominant option. Chapter 7 explores this issue by analysing the forces that enter into the construction (relational dimension) of temporalities in different case studies. It does so by emphasising the ways in which entities from different times (past, present and future) are selected, renamed and reframed in order to have them intervene in ongoing experience ('*nearness*').

The last part of the book (Chapter 8) draws lessons from the different chapters and discusses potentials for a more democratic energy transition.

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Notes

1. The Collener research project is an interdisciplinary project (economics, sociology, geography) that was aimed at following socio-technical collectives at work in the making of transition processes. It did so on different scales (transnational, national, local), different technologies (solar, wind, smart grids, biomass, low-energy building, CCS) and in different countries (France, Germany, Tunisia), and totalled up to 31 case studies. It has been founded by the French Agency for scientific research (ANR). The Collener Partners were: Centre International de Recherche sur l'Environnement et le Développement (CIRED, coordinator), Politiques publiques, ACtion politique, TErritoires (PACTE, coordinator), Electricité de France (EDF) R&D, Environnement Ville Société (EVS), IRSTEA Bordeaux (Institut national de recherche en sciences et technologies pour l'environnement et l'agriculture Bordeaux), IRSTEA Grenoble (Institut national de recherche en sciences et technologies pour l'environnement et l'agriculture Grenoble), Centre d'Etude et de Recherche sur les Paysages (CERPA, University of Lorraine).
2. This occurred in relation to the so-called 'control dilemma' debate and disagreement, in the 1980s, on the conditions for steering technological development. Collingridge (1980) argued that the 'control dilemma'—the fact that 'technology control faces an information problem (impacts cannot easily be predicted until the technology is extensively developed and widely used) and a power problem (control or change is difficult when the technology has become entrenched)' (Rip and Kemp 1998, p. 378)—could be overcome by nurturing technological flexibility; for instance, by creating technology reservoirs. Rip and Kemp argued that this proposal neglected 'the necessity of physical and institutional entrenchment of a technology: without adaptation of infrastructure (including other technologies) and without (vested) interests, there will

be no technology at all. Realization of a technology implies a measure of inflexibility' (1998, p. 378).
3. See, for instance, Gailing Ludger's and Moss Timothy's synthesis of the analytical field (2016).
4. In *The Public and its Problems* (1927), Dewey does not use the verb 'interfere': 'the public consists of all those who are affected by the indirect consequences of transactions to such an extent that it is deemed necessary to have those consequences systematically cared for' (16). The passive form (to be affected by) focuses attention on the 'public' rather than on the disruptive activities themselves. In the context of energy transition, energy projects do not only affect entities indirectly because of their development; some projects also actively grasp and reify situations, entities or collectives so as to entice them into and make them part of their socio-technical assemblage (the assemblage of the project). We use the verb 'interfere' to encompass the forces and strategies at work in energy transition and the way they interact—both the (indirectly) affected forces that eventually gather together and act as a 'public', and the direct forces which aim at framing the ways in which entities are embarked (-ing) on the project. The idea of interference allows us to elaborate in a more symmetrical way the strategies, effects and ontological recompositions at work for the different parties.
5. As for instance, 'innovation system' (Bergek et al. 2008; Lundvall 1992; Nelson 1993; Nelson et Winter, p. 198); 'technological trajectories' (Dosi 1982); 'socio-technical systems' (Hughes 1983); 'socio-technical constituencies' (Molina 1994); 'social construction of technology' (Bijker 1995; Bijker and Law 1994); 'socio-technical systems' (Akrich 1989); 'socio-technical networks' (Law and Callon 1992).
6. As in the case of 'agencement' and 'assemblage', two terms that have been distinguished from one another by certain authors (e.g. Callon 2008; Muniesa et al. 2007), or again equated in translation (De Landa 2006).
7. It seems to be more common in English and also associated with the analysis of a broader range of issues (Geiger et al. (2014) point at the use of agencement in market-related analyses; Day and Walker (2013) use it for energy precarity).
8. Incidentally, we should note that this is why approaches that proceeds from and through predefined levels of participation, such as MLP, seem to fall short of grasping issues of political participation.

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2

New Energy Resources in the Making

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List of abbreviations

kWh	kiloWatt-hour
ReN	Renewable energy
Ademe	French Environment and Energy Management Agency
DSO	(Electricity) Distribution System Operator

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TSO	(Electricity) Transportation System Operator
SAS SAES	SAS Ségala Agriculture et Energie Solaire
ERDF	French grid manager Distribution System Operator
EDF	Electricité de France
Solar PV (or PV)	Solar Photovoltaic
DLS	Distributed Load Shedding

1 Introduction

It has become usual to approach renewable energy resources as mere physical flows (e.g., of water or wind) whose (physically limited) natural reconstitution guarantees their 'renewable' status and makes them eligible vectors for energy transitions (Verbruggen et al. 2010). Renewable energies are also commonly associated to alternative political ideals—such as downscaling, distributed and more democratic energy production, energy autonomy, and so on. Such ideals partly rely on the assumption that the shift from fossil to non-fossil energies equates to a shift away from physically concentrated energies (oil, coal…) towards less concentrated, flowing energies (wind, sun, marine currents…). Such appraisals are partly flawed. For instance, some unconventional energies (e.g., shale gas, coal gas, oil shale…) are fossil energies: they are less concentrated than conventional fossil energies but are nonetheless developed by the same actors and under the same type of politics. The physical approach to renewable energy resources leaves uncharted other resources—such as land, landscape, wildlife, and local solidarities—which are commonly engaged in the development of 'renewable' energy projects. It makes these other resources harder to acknowledge, and contributes to the neglect of the rich web of socio-material relations underlying the development of renewable energy resources. In naturalising the property of 'renewability', it makes it harder to discuss the democratic dimension of their development.

As Timothy Mitchell (2011) suggested it, materiality may matter for the type of politics that is constructed around energy resources. Following the socio-material processes through which different energies take on political significance, is a way to overcome ready-made dichotomies such as 'renewable'/'non-renewable' or 'non-fossil'/'fossil'. The relevant question, then, is how matter comes to matter as energy (whatever its concentration or carbon content) and what type of politics this builds.

The question has become all the more critical for 'renewable' energies since they are industrially developed and globally financed. Many attempts have been made to understand the tensions stirred by renewable energy developments. However, they have mostly focused on reasons for opposition or on patterns of development, without necessary articulating these understandings with that of the processes through which renewable energy resources are brought to existence.[1]

This chapter attempts to do this by following renewable energy resources in their making. It builds on a set of case studies in order to explore the socio-material processes through which entities such as wind, solar radiation, energy users' practices, and wood stumps come to be assembled as renewable energy resources. In so doing, it challenges the presupposition that renewable energy resources are inherently sustainable, and argues that only concern for the social and situated dimension of their development—and due processes—can endow them with the property of sustainability.

The chapter builds on previous works and analytical strands, notably the attempt of Richardson and Weszkalnys (2014) to propose a comparative framework for analysing the materiality of resources. We share their interest in following the processes through which 'entities-that-are-there' become energy resources, and in the importance of materialities in such processes (we will return to these terms below). As energy resources are proposed and not given by nature, entities *become* energy resources. In so becoming, these entities are engaged in socio-material assemblages, which leads to changes in their properties and boundaries. In taking a process approach to these changes, it is thus important to account for the full series of transformations that unfolds from the untamed energy stock (or flows) to readily usable energy entities. We use the categories of commodity chain and commodification analyses (Hartwick 1998; Castree 2003) to operationalise our exploration. They help us focus on the transformations in processes of becoming energy resources, and connect these transformations with their political effects.

In exploring the democratic dimension of resource making, the singularities of each resource prove as decisive as the ways in which processes and resources are scaled up. We propose *pooling* as an encompassing relational notion in order to capture the ways in which differences are handled and entities are scaled up in order to assemble energy resources. The analysis opens up a discussion on the relationship between forms of pooling and the democratic dimension of energy transition processes.

The first part of the chapter presents our approach. The second part discusses a set of case studies with four different energy technologies: onshore wind power, solar photovoltaics (Solar PV), biomass energy, and distributed load shedding (DLS) in the electricity sector (demand-response). The third and final part discusses our results, emphasising the importance of accounting for the material and relational dimension of new energies in examining their potential role in a sustainable energy transition.

2 Becoming an Energy Resource

Natural resources have been approached from a variety of perspectives. Recent critical appraisals in the social sciences, particularly anthropology and human geography, share the premise that '"natural resources are not naturally resources" but the product of cultural, economic and political work' (Bridge 2010, quoting Hudson 2001). These analyses have explored various dimensions of their making.[2]

In the subfield of energy resources, these studies have mostly addressed fossil energies, with some exceptions.[3] The development of non-fossil energy resources, probably because it is more recent, has not been thoroughly covered. It has, however, stirred protest and controversy around its environmental impact[4] and social dimension.[5] Analyses of these have mostly been focused on policy framings, and have left unchallenged the (often implicit) idea that renewable energy resources are inherently more sustainable than other energy resources.[6]

This section builds on analyses of natural resources in order to set out our methodology for analysing the emergence of different energy resources. The first part introduces the idea that resources are not given.

The second underlines the importance of acknowledging materiality in describing and following the emergence of energy resources. It defines resources as a proposition (in Latour's sense) and brings together a set of notions in order to operationalise the notion. The third part proposes a stylisation of the process of becoming an energy resource and a methodology for its analysis. The fourth explains how we intend to articulate the analysis of this process to that of its political effects.

2.1 Shifting Ontologies

In their explorations of natural resources, scholars have emphasised the political and economic dimensions of these resources, as well as their shifting ontologies. For instance, Ferry (2002) has analysed the work and discourse of a Mexican silver mining cooperative in turning silver into what she terms an 'inalienable commodity', meaning a commodity that, while exchanged in market systems, 'retains a connection to incommensurate and inalienable forms of value [patrimonio]' (p. 351). Weszkalnys (2011, 2013, 2014) has analysed the socio-political and material attempts at (de)constructing the longstanding association of oil to a resource curse, in the specific case of the African Atlantic island state of São Tomé and Príncipe. Both analyses offer a good illustration of a collective attempt at changing both the way in which a resource is defined and the economic/sociopolitical potential associated with it. Such stories echo local discourses and practices of appropriation around renewable energy projects that have been observed in France (Nadaï and Debourdeau 2015), as well as attempts at differentiating and politicising the 'renewable' electricity kiloWatt-hour (kWh) in certain countries (Summerton 2004).[7]

Renewable energy resources, because they are abundant, flowing, and sometimes ubiquitous, act as recipients for moral or political ideals: they 'remind us that our electricity comes from somewhere', 'they confronts us with the responsibilities created by our demand for energy' (Pasqualetti 2000); they allow for decentralised energy production, democratic productive organisation, and energy autonomy (Scheer 2007). These visions and potentials are important, if only because they underlie innovative experiments (Seyfang et al. 2013; Nadaï et al. 2015). Nonetheless, within a few decades, renewable energies have also been scaled up as a global sector of capitalist activity. Certain descriptions of the conditions under which certain developments are currently undertaken evoke concepts such as primitive accumulation, enclaves, colonisation, and so on (as for instance in the Isthmus of Tehuantepec: see Howe and Boyer 2015)[8] and remind us that renewable energy resources are subject to diverse development paths. Setting aside cases that might be deemed extreme, scholars have pointed at the progressive fossilisation of renewable energies as they are developed by historical energy operators and adapted to fossil energy interests, institutions, and infrastructures (Evrard 2013; Raman 2013). These analyses clearly show that these new energies are poised between very different models of development which associate to them very different types of politics whose democratic reach needs to be analysed.

This should be enough for us to take leave of ready-made dichotomies (renewable/non-renewable) and try follow the hybrid and shifting ontologies of new energy resources—meaning the ways in which they are known, defined, and practised, and the potential that is attached to them. As emphasised by Richardson and Weszkalnys (2014), such ontologies can only be understood through analyses that incorporate the materiality of these resources.

2.2 Materiality and Becoming

The role of materiality has been acknowledged and conceptualised in different ways in the social sciences, only some of which concern resources. In STS, following suits with Latour proposal to overcome the separation between nature and culture (1991), the assemblage—or the agencement—of humans and non-humans has been foregrounded as a source of agency underlying the properties of things.[9,10] In anthropology, a significant body of work has taken an interest in the material dimension of social interactions, particularly exploring the role of commodities and artefacts as physical constituents of sociocultural practices (Appadurai 1986; Miller 1987, 1998). In resource geography, the becoming of natural resources—which has long been recognised (Zimmerman 1933)—was first approached from perspectives interested in the production or social construction of nature.[11] The recent penetration of STS and anthropology has, however, triggered a renewal in approaches,[12] taking things and materials as both productive assemblages (Bridge 2006, Bakker and Bridge 2006, pp. 18–19). These changes also went along with a shift in focus, from activities such as agriculture, fishing, hunting, or foraging, to resources and activities that are more common in developed economies, such as: water (e.g., Folch 2015), minerals, oil (Weszkalnys 2011, 2013, 2014), gas (Kaup 2008), forests, and biodiversity, as well as a few cases of renewable energy resources (Howe 2014 and Pinker 2018, for wind; Alexander and Reno 2014, for waste).

Energy, like many other types of resources, is extracted from milieux or vectors, such as subterranean geological formations or wind, which are often thought of as given and natural. But the limitations of this understanding become evident when we consider a broader spectrum of resources, such as biomass (woods and forests have changed through history) and DLS (which is currently under construction in the electricity sector through contracts with and the equipment of households; see below). Thus, resources are not simply given. Milieux and vectors present themselves in more or less articulated ways as energy resources. When it comes to the question of how an entity can be turned into an energy resource, the term 'materiality' takes on a particular meaning.

Matter is not indifferent. It is neither inert nor unlimitedly malleable. For instance, the capacity to stock or release oil, controlling prices, is decisive in the fight against unconventional fossil energies. So is the differential in the underground concentration of these unconventional resources, which influences—but does not determine—the cost of their extraction. Materiality in such a process can thus be regarded as a *proposition* in the sense proposed by Bruno Latour (2004). For Latour, a proposition (unlike a statement) is not true or false, but more or less articulate. Articulation is the process by which a proposition becomes sensible and comes to matter. It is an endless process which takes on board material and artificial components. It is a process of assemblage.

Importantly, Tim Ingold (2007)[13] recently called for prudence in our use of the notion of agency. In using it, he felt was projecting principles of distributed action onto a substrate matter (material) that remained inactive in the analyses. He suggested instead envisioning a 'world of materials' (as opposed to a 'material world')—'life [for both humans and non-humans][14] itself undergoes continual generation in currents of materials' he wrote (Ingold 2007, p. 32)—in order to tell the *stories* of the properties of materials. In short, he advocates engaging in the material analysis of social relations, instead of doing a sociology of the material. Cronon's following of grain in his analysis of the making of the metropolis of Chicago (1991) is for us a reference in this undertaking, even if we do not follow a historical timeline or specifically analyse the joint spatial structuring of a region.

The first attempts at drawing more systematically on these explorations of materiality in order to explore the 'resourceness' of resources are still recent (Ferry and Limbert 2008; Richardson and Weszkalnys 2014). They conceptualise resource making as a material process, meaning the 'conjunction of the material and the social, without the social swallowing the material' (Knappet 2007). They take issue with a narrow focus on commodities, a reduction of materiality to either substance or pure discursive construction. They present resource-making as a process of boundary-making, emphasise its non-linear and hybrid dimensions and call for looking at materiality at any point in this process. In other words, they argue that resources do not exist in fixed and finite states, and that their analysis should follow their transformations and circulation among multiple states of being.

2.3 Process

Building on these insights, we propose to follow the transformations of renewable energy resources from a state of heterogeneity—as they appear in their milieu—to a more homogeneous and stable state, suitable for use. Along the way, we describe the stories of the materials (their changing properties), and the strategies and rivalries through which socio-technical collectives try to take advantage of the possibilities (concentrations, accumulations, re-allocations…) offered all along these transformations.

In working from this proposal, we incorporate *three methodological propositions* in our analysis: (i) the first is the imperative to focus on transformations, that is, to follow *resources as they are transformed* from production to use; (ii) the second is to account for *materiality as relational*, that is, to approach materiality and its properties as stemming from assemblages (including artefacts, infrastructures, knowledge, discourses, practices…). As Ingold (2007) suggests, materiality can be accounted for by *telling the stories* of these properties as they emerge in the flows of materials (how they come into being). (iii) The third methodological proposition is to *follow resource ontologies*, that is, to account for the various ways in which resources are known, experienced, valued, and defined by the different actors involved in their successive transformations, the properties that are associated with these resources, and the interplay (tensions or synergies) that results from these multiple ontologies.[15]

We thus consider the process of becoming an energy resource as a set of transformations from untamed, heterogeneous, or difficult-to-access forms of energy (wind, solar radiation, marine currents, wood biomass…) to the production of energy services, possibly but not necessarily including the consumption of a standard energy commodity (kilowatt-hours, calories…). In a first approach, this process may be described in terms of six transformations, as seen in Fig. 1.

'Things-that-are-there', in their supporting environment, must be qualitatively specified as an energy deposit, and their energy potential most often quantified. For instance, in the case of wind energy, national institutions map wind speed on their territory, wind farm developers install measuring poles at the site where they plan to develop a wind farm. The corresponding entity (the wind) must also be harnessed through specific socio-technical devices (rotating blades) and operations in order to extract its energy (the kinetic energy of the wind is converted into mechanical energy through the rotation of the blades). Since this primary form of energy cannot be used directly, the potential energy contained in it must be extracted and converted (the rotation is converted into electrical energy by an alternator). This secondary

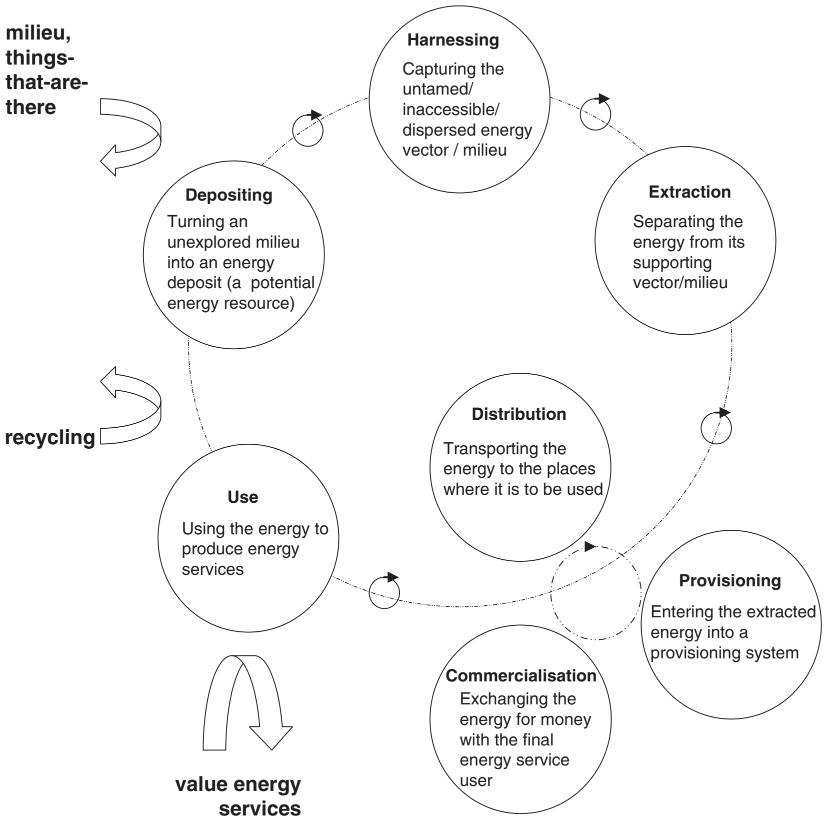

Fig. 1 The process of becoming an energy resource

energy may need to be provisioned in order to postpone its use in case of self-consumption, or to scale it up and make it potentially available for widespread uses. This can be done through physical processes (the electrical energy can be converted into chemical matter/energy through a battery) or other socio-technical devices or infrastructure (for instance, by injecting the electricity into a widely interconnected electrical grid, which makes it possible to average out variations in local production). The energy thus obtained and provisioned can then be distributed (circulated through the grid to the end users) and, possibly, commercialised (offered for sale under different commercial contracts and qualifications).

Each of these transformations involves actors (e.g., national energy agencies, wind power developers, turbine makers and insurance companies for the turbines, wind farm developers, local territories and territorial institutions, landowning farmers, grid operators, utilities…), socio-technical devices (e.g., measuring poles, paperwork, turbines, grid infrastructure, computers, software, meters…), social-natural environments (e.g., wind, birds, bats, landscapes…), know-how, etc. Their assembly must be articulated so as to allow for continuity and stability at each stage of the process and across the whole process. This has ontological consequences, as it yields a relational assemblage in which the attribution, roles, and affordances of these entities are redefined.

Figure 1 sketches this process as a loop in order to account for the possibility of recycling energy (e.g., heat recycling in co-generation processes, using 'fatal' energy…). This way of sketching the process also aims to allow for the steps in the process not being aligned in succession.[16] This figure should thus be regarded as an experimental step, a way of structuring our inquiry and learning from case studies.

2.4 Political Effects

Our interest in analysing this process is to explore its democratic dimension: that is, to acknowledge the various entities engaged in the making of energy resources, the changing properties of these entities and their resulting capacity to be recognised as relevant to this process.

To continue on with our example, wind is not the only resource engaged in converting wind into a consumable (potentially green) kWh. It is thus important to account for the resources other than wind—such as wildlife, farmers' land, landscapes, and local solidarities—that are engaged in this becoming, and to highlight the extent to which they are given room to be accounted for and become relevant in the development of wind power.

In order to specify this, we take inspiration from notion proposed by commodity chain analysis. Recent work in critical geography has

Table 1 Dimensions of the commodification process (*Source* Nadaï and Labussière, inspired by Castree, 2003)

- *Privatisation*: assigning rights to a named individual, group or institution
- *Alienability*: the possibility, for the commodity, of being physically and morally separated from its seller
- *Individuation*: the representational and physical act of separation from a supporting context (water from its environment)
- *Abstraction*: the assimilation of the qualitative specificity of a thing to the qualitative homogeneity of a broader type or process (allows, for instance, for unproblematic equivalence, as when a wetland here is made replaceable by a wetland elsewhere)
- *Valuation*: how things take on specific form of value (for instance, blindly profit-driven in capitalist society)
- *Displacement*: how something appears as other than itself (spatiotemporal separation of production and consumption, so that, for example, you cannot see the exploitation of South African workers included in Italian handmade gold jewellery)

used the notions of 'commodity' and 'commodification' to highlight that the status of commodity, rather than being intrinsic to entities, is assigned to them. Commodification,[17] the process by which commodities are constructed, can thus be regarded as a work of framing, attaching/detaching, and assembling. Capitalist commodification is broadly associated with a set of dimensions (cf. Table 1), not all of which are required (Castree 2003).[18]

These dimensions help us tease out and think through the transformations by which entities are detached from their surrounding environments and appropriated as energy resources, as well the ways in which such transformations are made legible to all, or not. It is thus important to highlight what commodity chain analysts have termed 'displacement': the fact of making the thing appear different to different actors (Hartwick 1998)[19] in order to limit widespread politicisation of issues.

In what follows, we will underline different articulations between displacement and ways of pooling energy (§4.1). We will emphasise the political effects of *pooling* and how these are smoothed by displacements, especially in the functioning of the electricity grid (§4.2). However, displacement, as understood by Marxist analysts, would not have any relevance to the analysis of political effects if resources did not change affordances and identities as the process of their becoming unfolds. Displacement thus should be regarded as a particular instance of what Mol (1999) termed multiplicity, an instance in which the multiple ontologies of something are purposefully kept separated. It contrasts with both the case of anaemia in Mol's analysis and her definition of multiplicity as a situation in which conflicting ontologies interfere and can become mutually supportive. This suggests that we should not limit our exploration to pinpointing the political effects of displacements, but try to chart the multiple ontologies at work in the processes that we explore, as well as their political implications.

As a way to test the analytical potential of our framework, we explore processes of becoming in four different resource cases: wind, solar, biomass energy, and DLS. These cases include electrical and non-electrical vectors, as well as different types of sourcing of energy production. Some appear more 'nature-like' (wind, sun, biomass), while one (distributed load shedding) has a more striking social dimension.

3 Energy Resources and Their Becoming

In what follows, we use the case of French wind power to develop our methodology and follow the transformations of wind into an energy resource in detail. The other case studies are not as detailed. We focus our exploration on dimensions that we feel are complementary in order to set the stage for a final discussion on pooling, multiplicity, and their political effects.

3.1 French Onshore Wind Power

Powering the Wind, Liberalising the Electricity Sector

In France, as in many other countries, the development of wind power has leaned on the progressive adoption of a favourable policy framework. After a period of ambivalence during the mid-nineties, this framework was marked by a decisive step in the early 2000s with the adoption of a fixed feed-in tariff, above the market price, for kWh of renewable energy.

This was part of a process of liberalisation of the electricity sector in the EU, which was gradually implemented in France and which deeply modified the country's energy sector. France unbundled its former electricity monopoly and initiated a diversification of its electricity through a series of measures, including the adoption of the feed-in tariff for renewable electricity (2001).

The feed-in tariff represents first and foremost a techno-economic framing. By granting (for 20 years) a tariff above the market price for any renewable energy (ReN) kWh, it targets private developers as economic actors and aims to trigger investments in wind power technology. This economic incentive was complemented with two important measures: Wind farms were granted the status of electricity-generating facilities (authorisation of production) as well as priority for injection into the grid. As of the year 2001, these were the only measures that had been adopted, a situation which clearly reflected French regulators' belief that economic incentives and private business alone could take charge of assembling the wind as a source of power.

Contrary to expectations, many different interests and concerns were triggered by these measures. The **electrical grid operator** expressed concern with the impact of a decentralisation of electricity production and the variability of wind power production ('intermittency') on the functioning of the grid, and in particular on short-term balancing and long-term capacity management. **Wind power developers** complained about the multiple issues they faced in developing their projects, such as considerations of landscape, fauna, and flora in impact studies, and grid connection authorisations. They continuously demanded that the state streamline procedures (Nadaï and Labussière 2009). **Local inhabitants** perceived the development of (privately owned) wind power as a radical change in the French state's approach to energy. They bemoaned both a departure from the public interest and the private appropriation of the wind, which they often claimed to be a local/collective/territorial resource. Building on the ecological political ideal associated with renewable energies, **local collectives** engaged in alternative ways of developing and appropriating wind power projects and the electricity that came out of them (Nadaï and Debourdeau 2015). Surprisingly, **legal doctrines** had left the ownership of the wind unspecified (Le Baut-Ferrarèse 2012). Both in the EU in general and in France in particular, wind power policy emerged in midstream, with a heated debate on the merits of different policy instruments (i.e. pricing, bonuses, quota certificates), setting aside, unchallenged, the status of the resource and its modes of appropriation. In many places, this contributed to making the distribution of wind power benefits problematic, for this issue had to be resolved in and around individual projects, in a context where actors' interests were already formed (some had invested funds, others had expectations).

Thus the establishment of the conditions for wind to become an energy resource—what we are calling its 'powering'—followed, in France, a path that has framed wind power as a privately developed, grid-connected, publicly supported and regulated form of energy. Along the way, this impelled actors to find ways of assembling the proliferating materiality of the wind, of the turbines and of their electrical outcomes, with other types of materiality already in place in several spheres of action, such as landscape uses/protection and the electrical grid.

A chain of transformations of energy from the wind emerged, partly inherited from the existing French electrical system. It structures a displacement of this energy, which is perceptible in the disconnection between the controversies surrounding projects development and electrical consumers' depoliticised perception of the associated kWh. In what follows we will specify the mechanism and political effects of this displacement.

Mapping the Wind, Averaging Out Turbulences, Channelling Explorations and Powers

Wind is a complex phenomenon. It is a part of local weather as well as of multi-scalar meteorological systems. Wind can be patterned on a given scale and turbulent and unpatterned on other scales. The existence of wind as an energy certainly does not date from the time of industrial wind power: wind has long allowed birds to migrate, boats to sail, and mills to grind. But the *powering* of the wind, defined as its assemblage with electricity (as an energy vector), is unprecedented. This is all the more true under feed-in tariff support of the French type, which turns the power from the wind into a grid-connected type of energy and frames the issue of averaging wind variations as a large-scale grid-related issue.[20]

In France, one of the first operations underlying the powering of the wind was the mapping of average wind speed over the entire French territory. This was jointly initiated during the 1990s by the French Environment and Energy Management Agency (Ademe) and the French regions, with a view to providing wind power developers with clues about which regions are windier. Wind mapping was also always closely articulated to grid-related issues: the question of how much wind power could be integrated into the grid without unbalancing it is central. This politicisation of the turbulence of the wind was explicit in 2005 parliamentary discussions in which ecologists foregrounded the existence of three distinct wind basins in France, advocating for the possibility of averaging out variations in production on a national level. The issue has since persisted, again featuring in a recent debate about the feasibility of 100% renewable electricity production in France. This scenario, recently issued by the Ademe, was advocated on several grounds, including a detailed, online, multi-scalar mapping of wind speeds and variations, which demonstrated that variations in wind power production can be average out on a day-to-day basis at a regional scale.[21] This spatiotemporal ordering of the turbulence of the wind not only changes how it is qualified (wind is no longer an untamed resource); it also posits regions as potential key actors in its powering.

Harnessing the Flow and Extracting and Appropriating Energy

One of the first operations in harnessing the wind is to approach its force on a finer scale, that of the siting of the turbines. Measuring poles, set up for a few months, are the usual way that developers gauge the presence and energy of the wind on a site. The pole allows a blade to be placed at a sufficient height to avoid ground-level turbulence.

It replicates the logic and design of horizontal axis turbines, the most developed technology, in harnessing the wind.

The physical encounter of the wind with the blades of the wind turbine extracts the kinetic force of the wind (individuation) and turns it into a mechanical force (rotation). It is also the point where the wind's energy is appropriated. While the legal status of the wind has remained undefined, its conversion into a mechanical force through the rotor of the machine transfers it to the machine's owner: the developer.

Displacing Energy, Scaling Up the Power of the Wind

The rotating blades drive a gear system which allows a shaft alternator (1500 rpm) to generate electricity. But the electrical grid is an assemblage that imposes standards: any electrical flow intended to circulate in the grid—to be 'injected' into it—must meet specific technical requirements. Grid injection requires a physical transformation of the electrical current that comes out of the alternator: a transformer located in the tower of the wind turbine increases the voltage up to 20 kV.

This physical transformation underpins a change in the status of the kWh. Once it has been injected into the grid, a kWh coming out of the turbine becomes part and parcel of the electrical flow, like any other kWh, renewable or not. Not only is its geographical origin (coming out of this specific wind farm) lost, but its 'renewable' origin is also physically blurred. It would be lost altogether had a system of 'guarantee of origin' not been created,[22] which allows for the circulation and trading of the 'renewable' labelling of wind power electricity. At the point of injection, this quality is detached from the physical electrical current and abstracted as an informational asset: a certificate, which is in fact a computer file. This certificate can then be traded and re-bundled with the conventional electrical current as a commercial 'green electricity' product, and offered as such to end users by some electricity producers.

The individuation of wind electricity—in Castree's sense of a separation of this electricity from its supporting environment and context—is thus at the core of this chain of operations. Importantly, this 'individuation' results in a pooling of kWhs and the loss of their singularity.

Their collective origin (as the outcome of a particular wind farm) is detached from them, re-cast as a generic attribute (renewability), and materialised by a computer file that can be traded and re-bundled with any standard kWh. This displacement is not hidden to the final electricity consumer. Commercial contracts blankly state that, by contracting green electricity, final users only contribute to the overall remuneration of renewable electricity producers to the extent of their purchase. Yet, the eligibility of a production infrastructure to the 'guarantee of origin' is ultimately[23] based on the Energy Code definition of 'renewable energy', which clearly naturalises it: the Code simply lists a few types of energies that are considered renewable, without any consideration or provision regarding the ways in which they were actually assembled as energy resources. Therefore, while the displacement that takes place in the guarantee of origin is transparent to the final consumer, its meaning—that is, the extent to which the projects remunerated through the renewable certificate were actually assembled in a sustainable way or not—cannot be traced.

Grid Electricity as a Complete Extractive Energy

Electricity (in the grid) here appears as a vector that almost completely separates the energy from its supporting environment, because it simultaneously erases both its geographical origin and its qualitative construction. The only dimension of the original resource that lingers on in grid electricity is its quantitative variations. As has been emphasised in many studies, the 'intermittency' of wind electricity is perceived as a threat to both grid management practices and the environmental performance of wind energy[24] (e.g., Howe and Boyer 2015). The remaining quantitative variability of this electrical production is mainly addressed through the development of backup capacity and the scaling-up of the grid: grid interconnection allows averaging out variations in electrical production from different areas, regions, and countries in Europe. Importantly, the way in which the variations of the wind resource are averaged out—either through depositing (see above) or through electrical organisation (backup capacities and interconnection)—is decisive for the politics of wind power, because it determines who is empowered in framing its potential (local authorities or the grid manager).

In the end, because of the grid-connected construction of wind power, the process through which wind becomes an energy resource is roughly divided into two parts (see Fig. 2).

In the *upstream* part of the process, made up of '*depositing - harnessing - extraction*', the untamed wind is turned into uneven, but appropriated, electrical energy, to be injected into the grid. On a practical level, this covers the mapping of wind deposits on various scales, the development of wind farm projects including their siting, and the extraction/conversion of the wind's kinetic energy by the turbines. This is thus the part of the chain in which territorial resources such as land, landscape, and local collectives are brought into project development and planning.

The *downstream* part is made up of '*provisioning - distribution - commercialisation*'. Here the kinetic energy of the wind, once extracted through the turbine as appropriated but uneven electrical energy (alternator), enters a genuine commodification process, including both the physical transformation of the energy (transformer, merging with the broader electrical flow) and its abstraction as an informational asset (standard kWh; certificate of guarantee) that can be separately traded and re-bundled as a marketable product ('green kWh'). As they are faced with somewhat standard commodities—this green differentiation still remains marginal in France (and in other countries)—users and uses are somewhat sidetracked in this process (this is why 'use' does not appear in Fig. 2).[25]

Previous case studies in the academic literature have emphasised the difficulties faced in attempting to assemble wind power projects in a sustainable way at the local level (Labussière and Nadaï 2014; Jolivet and Heiskane 2010; Aitken 2010a). Seen from a local perspective, these difficulties are often perceived, and have been thematised, as resulting from inadequate spatial planning (Aitken 2010b; Geraint et al. 2009). Our analysis sheds a more incisive light on these difficulties and on the role of French institutions. By dividing the chain into two parts, feed-in tariffs and guarantees of origin create a break in the articulation of sustainability and renewability. In the upstream part of the chain, the

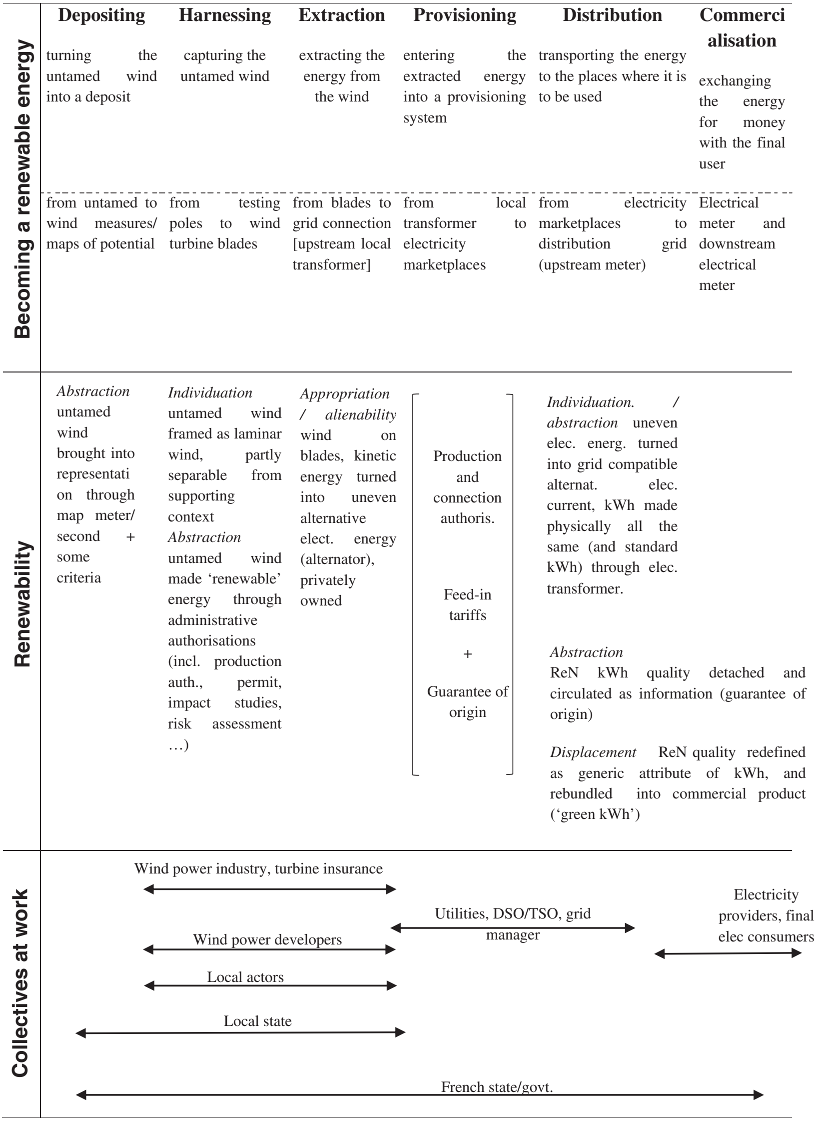

Fig. 2 Wind and the process of becoming an energy resource (*Source* Nadaï and Labussière 2017)

construction of sustainability for wind energy wrestles with the materiality of many resources. This construction often gives rise to challenges at the local level. In France, the administrative authorisation of projects establishes a distinction, and a clear-cut separation, between renewability and sustainability. Sustainability is addressed implicitly through project authorisations and is left unapparent in the downstream part of the chain. Distinctly and separately, renewability is circulated in the downstream part of the chain. It goes unchallenged partly because its reduction to a physical dimension is enshrined in the legal and regulatory environment in which the feed-in tariff is embedded (authorisation of production, Energy Code): any project using wind energy is automatically defined as 'renewable'.

Importantly, *this distinction and separation allow renewability to be detached from the material dimension of the resources and attached to the materiality of a tradable certificate (the guarantee of origin).* It paves the way for the commercial re-bundling of renewability into 'green' electricity—a more encompassing notion—and for its large-scale trading on the electricity market.

This comes on top of the support granted through the tariff. It results in an additional incentive to develop projects which does more than accelerate the pace of wind power development: it favours market-based assemblages over territorial ones. Indeed, since any project that succeeds in getting the administrative authorisations—whatever the actual sustainability of its assemblage—then stands on equal footing with other projects, those that gain these authorisations with the least work are better off.

'Aeolian Politics', Manoeuvring Through the Materiality of the Electrical Grid

Many, if not most analyses of the development of wind power have highlighted the upstream part of the chain, emphasising tensions and oppositions associated to cognate resources (land, landscape…). Howe and Boyer (2015) proposed the notion of 'aeolian politics' as a way of deconstructing wind power as a unified object, inviting us to explore the 'multiple and contingent political trajectories of the wind, as it is domesticated for electric energy'.

Although a great deal remains to be explored, following electricity from its emergence in the turbines through its transformations and circulation in the grid allowed us to highlight the centrality of powering as the socio-material operation of assembling the wind with electricity and the electrical grid. It suggests that actual aeolian politics, while multiple, as Howe and Boyer argue, is specifically a politics of manoeuvring through the materiality of the electrical grid and its scaling-up (through individuation and displacement). Aeolian politics works around and in the interstices of the grid. This manoeuvring depends on multiple factors, including the flexibility offered by the type of technology used to harnessing the energy, as we will now see it with cases in solar PV development.

3.2 Solar Photovoltaics

The powering of solar energy shares a great deal with that of wind power in the associated manoeuvring through the socio-material organisation of the electrical grid.[26] Compared to wind power, however, important differences have arisen in the case of photovoltaics because of the materiality of the technology developed to harness it, notably its modularity. Existing PV technology has been conceived and designed on the basis of modular panels, allowing projects to be developed very simply, on a variety of scales and with limited technical requirements. This allows for a certain flexibility in how projects are approached. It also makes PV development very sensitive to price changes, both in the value of the feed-in tariff and in the price of the panels sold on a global PV panel market as the PV industry develops. Accordingly, case studies on this resource reveal a greater diversity of attempts to politicise the upstream part of the chain than for wind power (even though ours is a restricted sample, which does not include any off-grid cases).

Modulating Projects, Tailoring the Resource

An example within the great variety of PV projects are three collective PV projects carried out in France: 'Les Fermes de Figeac', a mutualised PV project carried out by an agricultural cooperative in the Ségala-Limargue area, in the Lot department (southwestern France) (see Cointe 2016), and two 'Fermes Solaires' collective PV initiatives developed in the Rhône-Alpes region. Here we explore how the depositing, harnessing of the solar resource were arranged materially and collectively, and how the modularity of PV was exploited to tailor and construct the resource in ways that (more or less successfully) attached it with specific social and political objectives.

Arguably, at the beginning of the 'Fermes de Figeac', project, the resource (or the deposit) did not exist independently: the physical solar resource itself was not evaluated in detail, only estimates of mean annual solar radiation were used in the business model. Instead, the resource was constructed in relation to the territory of the project, the planned organisation and objectives of the project (selling electricity on the grid, developing a new source of revenues and activities for the territory). It was approached rooftop by rooftop, according to the particular rooftops' exposure to sunshine, the material and legal feasibility of installing PV panels on each roof, the possibility of connecting the installation to the electric grid at a reasonable cost, and the capacity of the owners of the buildings to contribute financially to the project. Rooftops that did not meet required conditions were excluded.

The Rhône-Alpes 'Fermes Solaires' PV initiatives somewhat confirms the idea that the solar resource is constructed through assembling the project. Yet, they offer a slightly more detailed perspective on this assembling and its implication for the resource. In 2010, in the Rhône-Alpes region (south-eastern France), eight pilot initiatives for the development of cooperative solar PV projects were launched. Their initiators' ambition was to develop coherent multiple-roof/multiple-roof-owner (public and private) projects. These projects were again to be based on grouped rather than isolated roofs, taking into account cognate issues such as landscape, granting access to solar benefits to all, and prioritising energy-efficient roofs. This partly came as a reaction to the then-dominant form of PV projects approached as financial assets by private developers.

As in the Fermes de Figeac case, the constitution, or depositing, of the solar resource called for the selection of a common pool of roofs, and this operation required taking into account their multiple heterogeneities (surfaces, slopes, orientations, ownership, architecture, landscape and co-visibility issues, distances to grid connection points). The way in which roofs were added or subtracted from the pool, and the dimensions that were taken into account in making these decisions, however reflected the way in which local actors took hold of the resource (Fontaine and Labussière 2015).

In the first case study, in the Regional Natural Park of Pilat (RA1), project managers started working with GIS software and datasets. They created maps of solar intensity (hours of sunshine/year) and landscape impact (underlining areas with more or less co-visibility with the future PV developments), adding factors related to the features of the roofs, such as the owner's motivations and the specific feed-in tariff category corresponding to the type of roof. The maps were then juxtaposed in order to identify promising areas and groups of roofs that matched all factors (good solar intensity, low landscape impact, good surfaces with good feed-in tariffs, roof owner's involvement). This in turn allowed the grid manager (DSO-ERDF) to assess connection costs. As the local grid architecture did not match with the most promising groups of roofs, these costs ended up being too expensive for the project, which had to adapt to the capacities of the grid. However, the logic of identifying promising groups of roofs was not abandoned and the project managers continued to use the maps to combine a large set of dimensions while meeting the constraints imposed by the grid. The same logic ruled over the final assessment and adjustment of the project's financial viability. Eventually, the project succeeded in dealing with grid constraints while maintaining a collective, innovative approach to the solar resource, one that approached it not only in terms of its physicality (solar intensity) but also of a sum of related materialities.

In the second case, in the Regional Natural Park of Massif des Bauges (RA2), local project managers also sought to assemble a collective project, but they proceeded in a different way and relied on other instruments. While the pilot site was first selected by exploring the same dimensions as in the Pilat project, they then proceeded by translating the potential of each roof into a quantitative index in order to rank them in a table and only keep those corresponding to the best lines/scores. When the grid managers reported the corresponding grid connection costs, not only did many roofs become too costly to connect, but the gap between the roofs was so wide that the owners of the most profitable ones decided to leave the collective operation and opt for individual developments. The project was then restarted within a larger perimeter, including dispersed roofs with few elements of collective coherence. Some roofs were chosen for their economic profitability in order to offset less profitable ones.

Both collectives started to produce electricity between late 2014 and early 2015, with operations pooling seven or eight roofs and producing similar amounts of power (70 and 60 kWp). However, the solar resource assembled in the two was qualitatively different, as the project in the Massif des Bauges did not incorporate the many dimensions and forms of materiality that the Pilat collective succeeded in taking on board.

In both of these projects the status of the solar resource was neither discussed per se nor agreed upon in advance. Its status and content emerged in-the-making, as the solar projects were developed. The architecture of the electric grid was a key disruptive factor, because it imposed a spatial structure, through connection costs, that did not match the solar deposit as assembled by local collectives. In this context, different approaches to project development seemed to underwrite different potentials. One logic of adding and subtracting roofs to the collective entity contributed to making heterogeneity an asset, while another made it a barrier. Such differences also underlie the resulting distribution of revenues from the project, as we will now detail in the case of the 'Fermes de Figeac'.

Tailoring the Resource, Tailoring the Politics of Redistribution

Les Fermes de Figeac' consists in a 'diffuse' PV installed on about a hundred rooftops. The PV installations on all of the roofs in project are owned and operated by a single entity, SAS Ségala Agriculture et

Energie Solaire (SAS SAES). This entity pools the solar resource and sells it to Electricité de France (EDF), the former electricity monopoly of France, which is in charge of managing the feed-in tariff, after which it proceeds downstream in the same way as any other form of electricity fed into the grid. In the case of the Fermes de Figeac, the revenues are then mutualised and distributed among the owners of the roofs on which the PV systems are installed. Here we explore how the harnessing, and extraction of the solar resource were arranged materially and collectively in this case, and how the modularity of PV was exploited to develop a mutualised project that nevertheless fits with the individual investment logic of feed-in tariffs.

To harness solar radiation and mutualise the resulting returns, the rooftops had to be collectively pooled. This required the deployment of financial, technical, and social resources in order to redefine the rooftops' status, transforming them into power plants. To this end, roofs were rented to the private entity set up for the purpose (SAS SAES), and their owners contributed 20% of the investment required to purchase and install PV panels on them. The SAS SAES then centralised all the administrative, financial, and technical procedures to install the PV park and trade the power generated. To capture as much of the dispersed solar energy as possible, the SAS SAES also established a system of collective monitoring and territorialised maintenance that aimed to increase performance. It thus made the most of its precise knowledge of both the geographical area and the group of farmers and buildings in the project to optimise maintenance and maximise its control of the resource.

The extraction of the resource then takes place 'within' the PV installations. The conversion of solar radiation into electric current is encapsulated in the photovoltaic cell, and the conversion of this direct current into alternating current virtually identical to that which circulates through the grid takes place via the balance-of-systems components of the PV installations (particularly inverters). The project is also equipped to monitor harnessing and extraction, relying on meters and on information transmitted by inverters and centralised by the SAS SAES, which operates all the installations. The maintenance system—and the collective surveillance encouraged by mutualisation, in which all lose if one panel has a problem—is designed to ensure that extraction goes well and to ensure rapid action on potential failures or accidents, but other than that the collective is not directly involved in extraction.

The modularity of PV thus allowed the cooperative to develop a project in which extraction remained dispersed, while the resource was harnessed collectively. Mutualisation, which was made possible by a combination of material, organisational, and financial displacements and negotiations, serves as the matrix for a collective and politicised pooling of the resource. The modularity of PV technologies, combined with the organisation of the downstream chain (provision, distribution, and commercialisation) around the central electricity grid, are crucial in this model, because they make possible its peculiar spatial articulation. The PV installations are dispersed across a large geographical area, and their product is 'virtually' concentrated in the possession of a single owner which then redistributes the resulting revenues.

All together, these PV case studies reflect the difficult but nonetheless possible politicisation of the socio-material construction of the PV resource around, or in the interstices of, the dominant mode of pooling the electrical resource. They also point at the decisive role of both materiality and how it is assembled (hierarchy vs. contiguity, market framing) in the becoming of solar radiation as an energy resource. Just as these factors are decisive for the pooling of the resource (depositing/harnessing), so they are for the course of policy instruments (overflowing/reframing of PV feed-in tariffs), as we will now illustrate.

Fluid Technology, Ubiquitous Resource and the Challenging of the Tariff

One striking difference between solar PV and wind power has been the rhythm and fluidity of PV development, which ended up challenging the management the PV tariff in several countries, including France (Cointe 2015). In France and many other countries, PV panels have been turned into financial products through market-based *agencements* (Debourdeau 2011). Modular design and market framing allowed a great variety of actors to benefit from feed-in tariffs, provided they developed PV as a somewhat standard market product: individual projects, individual profits, simple design (plug-and-play). This contributed to making PV development extremely sensitive to price variations (feed-in value, price of PV panels on the global market) and extremely difficult for policymakers to follow and monitor in order to dynamically adjust the feed-in tariff. The beneficiaries of this tariff were also so heterogeneous that it was very difficult for them to come together as a collective, which made collective negotiations around the tariff almost impossible. This contributed to challenging and reframing the tariff, with a brutal stop-and-go approach to policy design, in an attempt to control and regulate PV development, to limit its collective and political costs.

These elements of the uneven success of solar radiation's becoming an energy resource suggest two remarks concerning the role of materiality in such processes of becoming. First, compared to wind power, the socio-materiality of PV technology resulted in strikingly different effects. Second, the contrast between the difficulty of building a collective around a socio-economic device (feed-in tariffs) and the pooling which happened around roofs (material things) underlines the significance of the present chapter's focus on socio-materiality.

3.3 Biomass Energy, Configuring Access, Qualifying the Resource

Biomass is a *distributed* kind of thing. It presents itself in a spatially, physically, and temporally distributed manner that relates to the singular stories of vegetal entities, their implantation, their appropriation, and their temporalities (growth/harvesting cycles, becoming through exploitation or events such as storms…). Accordingly, the biomass case studies that we explore below emphasise issues of accessing distributed and often already-appropriated biomass matter and in conceiving ways of profiting from it as energy. These result in biomass energy assemblages that give certain kinds of biomass (stumps, small woods) new affordances while allocating power to certain actors. They also take part in attempts to balance material cycles (carbon), which is key in biomass energy production. Stock and flow have to be managed in accordance with the temporality and spatiality of plants' growth cycles. The management of harvesting is thus also key. The two French case studies that we will now present, in the Aquitaine (Dehez and Banos 2017) and Rhônes-Alpes regions (Tabourdeau and Chauvin 2015), illustrate contrasting assemblages and forms of energy-becoming of biomass resources.

Aquitaine is a region within the Landes de Gascogne, a large area of privately owned pine forest land on the French Southwest Atlantic coast, where the paper industry is a major presence. Recently, the establishment of a biomass energy sector in the Aquitaine region has put strains on the wood resource. Technological upscaling (installation of new boilers in the paper industry) in a post-storm context (1999) favoured the take-off of tree stump harvesting and processing (for energy). As the strain on the resource remained intense, Aquitaine paper producers began to develop control over the resource in Dordogne, a nearby forest area.

These strategies can be regarded as an attempt to balance material (carbon) cycles. The exploitation of tree stumps as an energy resource has two statuses: as an input when left to decompose on the spot; and as an output when harvested and processed for energy production. Both the work involved in processing tree stumps (grinding, calibration, drying…) and the characteristics of the energy equipment used (boiler size and capacity to process heterogeneous wood matter) are essential in adjusting the conversion of a stock of heterogeneous matter (wood stumps) into an energy resource. As part of this assemblage, ongoing issues about information concerning the resource and the access to it (its localisation and quantification) reflect active strategies used to maintain control over it.

In Rhône-Alpes (a second case study), the materiality of this access to the wood resource is managed through collective databases: these are aimed at harmonising and making more transparent the assessment of the resource coming from different actors. Information about deposits is organised in terms of two broad categorisations: heat vs. electricity, first, and collective, private, or industrial use, second. In this encoding, the socio-materiality of the wood—such as the difficulties of spatial access, the temporality of the resource (regeneration/renewability), or its pooling (negotiation of a collective contract)—is no longer readable. Undeveloped parcels are encoded as 'inaccessible', which significantly blurs the assessment of the actual wood resource.

While in the Aquitaine, spatial and physical access to tree stumps is easy and thus not an issue (flat land, lines of trees), this is not the case in Rhône-Alpes (steep slopes, bushes…). In order to fine-tune their assessment, Rhône-Alpes foresters used to describe deposits in a step-wise manner, considering (i) the 'morphology of the resource', then (ii) a 'theoretical potential' derived from a purely forestry-based vision, and finally (iii) an 'economic potential' reflecting profitability as assessed according to the current availability of the wood resource. Although this description was more sophisticated, it continued to deduce the size and the characteristics of the actual deposit from the individual assessments of private owners.

In order to reopen a potential for exploitation of the resource, foresters started to share and collectivise the available information on the resource. Sharing these data allowed them to collectively challenge the conditions of its accessibility and overcome the frequent tendency to equate 'unexploited' and 'inaccessible' biomass. A plot that could not be accessed individually (a particular plot by its individual owner and the owner's equipment) could become accessible once pooled together with other plots and owners, under conditions of collective investment. A potential that was deemed to be unexploitable could be brought into a social and material re-composition. Here, the conditions of access to the resource were re-composed, as were the related property rights: the wood had to be delivered in common, meaning that the resource only had value within a collective undertaking.

In this process, the boundaries of the common good were reconsidered. The neoclassical appraisal of the wood resource, which describes it as 'rival' and 'exclusive', was challenged by the emergence of a political and philosophical sense of shared property—a commons—co-activated by and benefiting all players. This common good was no longer approached solely in terms of its economic appraisal: it was endowed with a political dimension. This allowed for a collective undertaking in the distribution and the marketing of the resource, under the ægis of producers' groups. Pooling also enabled the targeting of new market segments such as biomass energy producers, who require regular deliveries and homogeneous quality, both of which can be maintained through the pooling of the wood resource.

These biomass case studies foreground examples of resource materiality that is distributed, and raise issues of access to these resources. They show that the way such issues are overcome can challenge the way the resource is described or classified, and lead to contrasting outcomes. Access can remain attached to pre-existing individualities which, as dominant stakeholders (such as the monopsony in Aquitaine), end up pre-empting it. In this case, the resource remains distributed. But access can also be reopened by taking advantage of flexibilities in the attachments and classifications of the resource, conferring new affordances upon it as a commons (in Rhône-Alpes). These two routes give rise to opposed forms of becoming for the resources—either mining-like and almost 'fossilised' (Aquitaine), or collective and sustainably geared (Rhône-Alpes).

Beyond this contrast, the differences between the two biomass case studies also underline the ontological dimension of a socio-material approach to the resource. Most significantly, in the Rhône-Alpes case, the biomass resource ended up becoming re-patterned and ubiquitous in that—as in the PV case studies—its potential ultimately stemmed from project development (after its re-patterning as a collective entity).

3.4 Distributed Load Shedding in the Electricity Sector (Demand-Response), Controversy around Pending Material Appropriations

Distributed load shedding (DLS) involves aggregating the load shedding actions of consumers connected to the electricity distribution networks (mainly on heating installations). This service—that is, an erased kWh—can then be sold to the grid operator in order to help it manage the real-time balance between production and consumption in the power system.

As its name suggests, DLS can be regarded as a distributed resource. It deals with individual uses of electricity, regarding them as malleable practices that afford the possibility of saving kWh (not-consuming them) in order to resell them. It thus frames people as distributed sources of potential kWh. Load shedding requires these people to be accessed in one way or another in order to categorise and sort the flexibility of their uses, and either prevent these uses or displace them in time.

The becoming of uses (as resources) is thus poised between two different key operations. The first is identifying, accessing, and contracting with a population of potential users (depositing/harnessing), allowing the installation of the required equipment in their homes and the monitoring of the electrical flux (extraction). The second is developing the shared calculative rules, devices, and agreements that allow the spared kWh to be valued as commodities on the electricity market (provisioning, distribution, commercialisation).[27]

Many different issues were raised by this activity, and it is not our aim to cover and explore them in this chapter (see Chapter 3, for a slightly more in-depth exploration, and Reverdy (2017), for a detailed presentation of the case study). Our point here is to show how the development of this resource has ended up challenging the organisation of the electrical grid, rather than merely manoeuvring through it.

Practically, load shedding operations are activated through in-home boxes that are remotely controlled by an operator. This operator contracts with final electricity consumers who agree to allow certain home appliances to be disconnected within certain timeslots, when needed by the operator. In France, this operator can offer the erased kWh on what is called the 'balancing mechanism' (BM), managed by the national transport system operator (TSO) and providing a real-time reserve of power that the TSO can use to balance the grid. Offers are remunerated on a pay-as-bid basis. The process of transforming electricity uses into an electricity resource, as we understand it, thus includes various intertwined steps, such as exploring household consumption patterns (depositing); approaching households, agreeing on potential erasing schedules, and proposing a commercial offer/contract (depositing/harnessing); installing in-home boxes to directly control certain appliances (during contracted schedules) so as to shut them off in case of grid unbalancing (harnessing); contracting with the grid operator on ways to trace back, value, and remunerate the aggregate difference between the anticipated baseline and actual consumption (provisioning/distribution/commercialisation). In commodification language, these steps abstract, individuate, value, and privatise the erased kWh.

In France, a private French firm (Voltalis) began to develop DLS in 2006, with a business model wherein the only remuneration to final consumers was through savings on electricity. As Voltalis's activity grew, controversy began to arise as to the status of the 'erased kWh' that Voltalis was selling on the BM.

The energy regulator's attempt at a market framing of Voltalis's activity—i.e. saying that Voltalis should just sell its (erased) kWh on the BM—raised endless controversy about the dimensions and perimeter of the erased kWh. Who owned these unconsumed kWh: their producer, the consumer, or their eraser Voltalis? Who should pay for them? On what grounds? In particular, other BM participants (electricity providers) argued that Voltalis should compensate them for the erased kWh because, as regular electricity providers of Voltalis's clients, they were committed to injecting the kWh into the grid, which then enabled Voltalis to (re)sell them on the BM. Of course, Voltalys disagreed.

It is not our goal here to describe this controversy (for an analysis, see Reverdy 2017). But it is interesting and relevant to note that the solution that has since been adopted is the political reframing of DLS as an emergent activity (instead of a mature market activity), worthy of state support because of its potential environmental benefits (energy savings). Eventually, DLS firms are currently supported by the French state through a tender system, but they have to compensate electricity providers for a portion of the electricity that they erase. The status of DLS has thus been dissociated from the BM, while still maintaining a relationship to it through partial compensation for the electricity on which it relies.

What seems significant for our material approach to energy resources is the fact that the Voltalis controversy directly targets the collective organisation of the grid. Unlike wind power or solar PV, Voltalis's intended business model did not play with this organisation, it challenged it. Its claim to legitimate appropriation of kWh in the flux could not help but stir controversy, since the material scaling-up of the electrical system (complete individuation and complete abstraction) relies precisely on suspending the question of the origin and appropriation of the electrons in this flux: only the inputs and outputs are appropriated, whereas the origin and material appropriation of electrons within the flux are indistinct. Hence the description above of electricity as a complete extractive energy (§3.1): asking who owns a definite electron or kWh in the grid does not make sense. Any assertion relating to either the origin or appropriation of a kWh cannot be proved or refuted on the basis of the materiality of grid electricity.[28]

As Thomas Reverdy points out (2017), while economic calculation was able to introduce some ordering into the arguments of in this controversy, it was unable to clear up appropriation issues and make DLS a full-blown resource for the electricity market. Our material analysis suggests that the limited capacity of economic calculation to overcome this controversy is precisely due to its limited ability to account for the materiality of grid electricity.[29] In other words, following materiality allows for a different, more insightful viewpoint, which connects the issues raised by DLS with the specific socio-material way in which the grid organises scaling-up, making (grid) electricity into a fully extractive form of energy.

4 Resource Materiality and the Democratic Energy Transition

Our aim in exploring the making of energy resources in this chapter was: (i) to acknowledge the role of materiality in energy transition processes in order to better understand political and democratic issues associated with these processes, such as opposition to project development, unfair wealth distribution, unfair appropriation of or privileged access to resources…; and (ii) to propose an analytical framework that could build on past analyses of natural or fossil resources in order to address cases of renewable energies, potentially in a comparative setting.

The analyses above prove that our framework works for very different types of energies, and can thus be regarded as an invitation to follow the becoming-an-energy-resource of other entities. This framework potentially allows the mapping of the full process of transformations involved, from production to commercialisation and use, and their articulations. Building on Tim Ingold's (2007) suggestion, we have followed materials (e.g., wind, electricity, biomass…) as they circulate and undergo transformations. The processes we have described can be regarded as stories that acknowledge materiality, without conjuring notions aimed at resolving the origins of actions, such as 'agency', 'inertia' or '*faire faire*'. In so doing, these stories allow us to point up some interesting singularities in the processes of resource making, and their political consequences.

It should be noted here that the reach of the chapter mirrors that of the set of case studies under consideration. Notably, as they all deal with grid-connected or industrial forms of energy production, their scaling-up of energy change is achieved through processes aimed at converting energy into market commodities. This should not be taken to mean that such a scaling-up is the only path to widespread energy change, rather it highlights the need to extend the type of analysis undertaken here to other types of transition processes (such as grassroots-led microgeneration, microgrids, self-consumption experiments…).

4.1 Pooling and the Scaling-Up of Energy Resources

As Richardson and Weszkalnys (2014) points it out: 'what makes something become a resource is its use for an end, particularly the creation of wealth'. Since all our case studies deal with grid-connected or industrial forms of energy production, this 'creation of wealth' supposes reaching a sufficient enough scale for economic activity. The case studies we have analysed display very different ways of pooling energy resources in order to scale up energy change processes. These are summarised in Fig. 3.

Pooling takes place through various means depending on the case: physical conversion, regulatory requirements and qualifications, market pooling, spatial assembly (mapping) or hierarchical ordering

	Depositing > Harnessing > Extraction > Provisioning > Distribution > Commercialisation > Use
Electricity (wind power, DLS)	**Patterning** **physical pooling** (conversion) upstream <<<< (displacement) >>>> downstream grid connection **regulatory pooling** (feed-in, guarantee of equivalence) acceleration, leeway, tensions around resources not accounted for closing access <<<< | <<<.............**market pooling**.................................. impossibility to challenge the grid organisation
PV Rhône Alpes	case RA1 **spatial pooling** **(contiguity)** << grid spatiality / connection costs < multi-dimensional reconfiguration > --- case RA2 **hierarchical pooling** **(ordering)** << grid spatiality / connection costs < incompatibilities >
PV Figeac	**collective pooling** (roofs) (mutualisation) dispersed (modularity) but learning<< sharing << coordination benefits (mutualisation)
Biomass, Aquitaine	fossilisation << monopsony << **technological pooling** (boilers)
Biomass, Rhône-Alpes	**collective informational pooling** >> reopening access, politicising the commons >>>>>>>collective marketing >>>>>>>>>>>>>>>>>>>>>>>>>>>>

Fig. 3 Forms of pooling of energy along the process of emergence of renewable energies

(table, quantification), collective assembly (mutualisation), technological pooling (around a technological solution). Ways of pooling have major effects on how and whether different entities become relevant in processes of , as well as for the outcomes of these processes.

In the Fermes de Figeac, the collective harnessing of the sun led to learning and increased collective sensitivity and reactivity to fluctuations and cycles of solar energy. In Aquitaine, the expansionist logic induced by the upscaling of the boilers (technological upscaling leading to demand for more resources) led to the development of new access to the resource (in Dordogne) through a framing as a pure stock (fossilisation). Biomass Rhône Alpes, a non-electrical case study, is an interesting case of pooling that proceeded downwards through the political construction of a resource as a commons.

The electrical case studies all together reflect the central impact of the organisation of the power grid. Apart from DLS, the assemblage of energy resources is worked out *with* and *around* the structuring of the electrical grid (feed-in tariff, guarantee of origin) and the market. This results in a partition of the process (into up- and downstream components) and in a displacement of 'renewability', preventing widespread politicisation of its content on the electricity market. With this displacement, the local tensions raised by the production of a wind, PV, or biomass kWh are not conveyed to green consumers by the so-called 'green' kWh. The tendency, at least in France, not to account for all the resources required to turn the wind into an energy resource, thus cannot be corrected by a widespread politicisation of the green kWh.

Grid electricity is a form of complete extraction of energy, which paves the way for equivalence and abstraction as it blurs the material origins of the energy. 'Erases' would be too strong of a term, because the 'intermittency' of wind power reflects the resistance of untamed wind, which lingers on in electricity provisioning.

The passing-through electricity has ambiguous consequences for the upstream part of the chain. On the one hand, the (downstream) homogenisation of materiality, its provisioning through the grid, and market *agencements* boost the volumes that can be exchanged. The associated prospects of value result in strong incentives for project development (upstream), which translate into a pressure to streamline development processes and make unconventional projects harder to carry through, as illustrated by some wind power case studies and by the Rhône-Alpes PV case study (RA2). On the other hand, the separation of the two parts of the commodity chain leaves the upstream part of the chain relatively independent of the downstream part. This allows some room for manoeuvre in terms of socio-material organisation in the upstream part, for better (as illustrated by the Figeac experience or the Rhône-Alpes RA1 case study) or for worse (as illustrated by some wind power cases).

4.2 The Political Effects of Pooling

The way in which pooling is undertaken has various political effects that induce tensions in the processes, such as transferring power to certain actors at the cost of genuine energy transition processes (biomass in Aquitaine); acceleration of project development processes at the cost of a proper acknowledgment of the materialities engaged in them (solar PV, wind power); the spurring of individual initiatives that conflict with attempts at collective endeavours (wind power); and the upstream/downstream divide (with dual effects resulting in a manoeuvring through the materiality of the grid organisation). These effects are summarised in Table 2.

Importantly, the case studies we present also suggest that different ways of pooling the resource have different relationships to appropriation. Patterning plays on a pre-individual level of the unformed thing and leaves the question of appropriation unresolved (wind and sun are not appropriated before becoming an energy resource). Ways of pooling that occur at the level of harnessing seem to be endowed with a potential to change appropriation, probably because harnessing and investment in technological artefacts (turbines, PV panels, boilers, meters) actually are the operations through which flowing energies are appropriated. Market pooling (monopsony, electrical pooling) is anchored in the ongoing, often individual, appropriation of the resource, which it plays with by aggregating greater or lesser numbers of owners, without

Table 2 The political effects of pooling and their content

Political effect	Content	Pooling (socio-material)	Case studies
Upstream/downstream divide	The energy commodity does not convey the politics of its emergence (displacement) > dual effect: power to grid incumbents (Voltalis controversy); leeway for politicisation of projects (Figeac, Pilat) > incentive to develop projects/acceleration (streamlining), recursive effects (see below, wind power)	Physical pooling (electricity as a complete extractive energy) Regulatory pooling (energy code + feed-in + guarantee of equivalence) Market pooling (electricity grid and electricity market)	All electrical case studies
Upstream chain controlled by downstream actors (extraction≫depositing, harnessing)	Technology upscaling in the downstream chain underlay a 'mining' of the resource (fossilisation of Dordogne massif) (Aquitaine biomass) > power to downstream actors over extraction	Technological pooling (upscaling) Market pooling (monopsony)	Biomass (Aquitaine)
Recursive effects (extraction≫depositing)	Conflicts in upstream part > depositing limited by conflicting strategies in harnessing	Contradictory pooling (private harnessing conflicting with collective harnessing)	Wind power

(continued)

Table 2 (continued)

Political effect	Content	Pooling (socio-material)	Case studies
Acceleration	Bringing materiality into socio-material *agencements* which ease its processing along the chain (accessing tree stumps, not accounting for all resources in wind power development) > tensions around project development (wind power, solar PV), resource (Aquitaine)	Market and regulatory pooling (> see above on upstream/downstream divide)	Wind power, Biomass (Aquitaine)
Instrument framing/instrument overflowing	Difficulty accounting for singularities and dynamics of situations in instruments and regulation > Fragility, stop-and-go (PV) > Strain on resources not accounted for (biomass, PV, wind power)	Regulatory pooling (feed-in, administrative grid connection authorisation, construction permits)	Wind power, PV solar, biomass

challenging existing patterns of ownership. These differences should be explored farther.

To a certain extent, the range of case studies analysed in this chapter does not allow a full exploration of this question, as they mostly cover electrical energy and grid-related cases. These emphasise scaling-up through large-scale socio-material organisation (grid, electrical market) rather than through the dissemination of project practices.

5 Conclusion

We opened this chapter with a discussion of the fossil vs. renewable energies distinction. We highlighted the democratic and moral ideologies associated with renewable energies, as well as the reductive physical characterisation underlying their regulatory framing.

The social sciences have foregrounded the importance of the materiality of fossil energies in the political construction of democracies. Recently they have begun to challenge the fossil vs. renewable distinction by pointing out ways in which renewable energies have been handled through the same institutions and political practices as fossil energies. Building on these developments, we have proposed to contribute to a more symmetrical analysis of the diverse forms of energy resources, attending to the materiality and political role of renewable energies.

Starting with the assumption that energy resources are not given by nature, but come into existence through socio-material processes, we have built on recent developments in critical social science and proposed a framework for following the material assemblage of various renewable energy resources. The analytical framework proposed in this chapter is its first outcome, to be developed and applied in further studies.

Our analysis also points out how integrating materiality into the analysis—i.e. following material circulations and transformations—enables a more accurate understanding of the singularities of different resources and the shaping of the power relations which emerge in their construction. The materiality of renewable energy resources is both a part of and a product of their processes of assemblage. It contributes to steering these processes, but also leaves room for them to take different courses, allowing for more or less democratic paths. In contrast to the political ideals often associated with them, renewable energies can be fossilised, to borrow a notion from Raman (2013). This can take various forms, as explained in our analyses above, such as 'mining' strategies that do not allow for a sufficient regeneration of the resource (Dordogne) or do not acknowledge the varied materialities engaged in project development (solar PV, Rhône-Alpes RA2, wind power); undue forms of appropriation (Aquitaine).

Interestingly, the course taken by these processes partly depends on the ways in which these resources are scaled up through what we term their 'pooling'. For certain resources, certain ways of scaling up the resource lead to fossilisation (e.g., market pooling, for wind). Alternatives do, however, exist (e.g., patterning the wind), which can only be highlighted through material analysis, as they are precisely rooted in ways of assembling materiality.

Pooling is certainly not specific to non-carbon energies. However, as these new forms of energy are mostly diffuse, and have in common a materiality that has not already been concentrated in space over geological time, concentrating them requires the colonisation of a diversity of milieux and operations on an unprecedented scale. Our analysis points to a variety of ways of pooling that are both material and organisational, and sheds light on some of their political effects.

Importantly, our analysis suggests that pooling can operate through different ways and that decisions about how to scale up the energy transition through resource pooling present a genuine political and democratic challenge. Sustainability and democracy thus cannot be regarded as inherent attributes of renewable energies: they are a possibility that depends on their socio-material pooling.

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Notes

1. See for instance Devine-Wright (2010), Walker and Cass (2007).
2. Such as the ways in which access to resources is achieved (primitive accumulation, enclaves, colonies… see Bridge 2010, 2014), the joint production of identities (e.g., race, Baldwin 2009) or ontologies (e.g., resources as patrimony, Ferry 2002; oil as curse, Weszkalnys 2014; fracking as a change in environment, Pearson 2016), and the role of materiality (Bakker and Bridge 2006; fluidity of oil, Mitchell 2011; electrical grids, Bennett 2005; machine and matter in pit mining, Rolston 2013; natural gas extraction, Kaup 2008).
3. See for instance Folch (2015), Bonta (2007).
4. See for instance Frolova et al. (2015), on landscape and wind power; Willow et al. (2014) on non-conventional fuels; Raman (2013) on rare earths and wind power; Willow and Wylie (2014) on local environments, ground-water resources, and fracking; Nadaï and Labussière (2010) on birds and onshore wind power; and Nadaï and Labussière (2014) on marine environments/fishing resources and offshore wind power.
5. See for instance Aitken (2010a) on benefit sharing and wind power; Aitken (2008) on power allocation and wind power; Wolsink (2012) on wind power and appropriation; and Nadaï and Labussière (2017) on landscape commons and wind power.
6. There are some noteworthy exceptions. Howe and Boyer (2015), for instance, have talked of 'aeolian politics' as a way to 'unwind "wind power" as a consolidated conceptual object' and address the manifold effects and ways of mattering of wind energy in the Isthmus of Tehuantepec (Mexico). Sujatha Raman has explored the controversy around rare earth minerals and their relationship to renewable energy development. She described this development as 'fossilised', in the sense that it is enmeshed with the same interests and politics as fossil energies (Raman 2013). Nadaï and Labussière (2017) point at the ways in which shared resources engaged in wind power projects in France, such as relational and landscape resources, have gone almost entirely unacknowledged in the development of these projects. If anything, these explorations suggest an urgent need to extend the critical analysis of the making of natural/energy resources into renewable energy resources, if we want to better understand the tensions that surround

their development and bring energy transition processes onto a more democratic path.

7. Summerton analyses the co-construction of devices, infrastructure, and consumers around electricity branding. An example of a different, more explicitly politicised model is the French cooperative electricity producer Enercoop, which refuses to use tradable certificates of (green) origin for kWh in order to ensure the genuinely renewable origin of the kWh it sells (and not a nuclear kWh cloaked in 'green' through the purchase of a green certificate). This refusal is grounded in a political line that is intended to allow Enercoop consumers to regain power over the sourcing of energy. https://www.enercoop.fr/decouvrir-enercoop/notre-projet.
8. The Corner House, a campaign group, recently issued a report, drawing on academic research, pointing at the politics of unifying energies under the broad heading of 'Energy', and arguing for an understanding of energy as a commons: http://www.thecornerhouse.org.uk/sites/thecornerhouse.org.uk/files/Energy%20Security%20For%20Whom%20For%20What.pdf.
9. The point was made in a debate with Lemonnier over the agency of human and gun (Latour 1996; Lemonnier 1996). Latour argued that neither the gun or the human was at the origin of action, but that the active agent was human-with-gun, and that any attempt at isolating either individual element was a dead end.
10. Emilie Gomart (2002), analysing the emergence of methadone as a therapeutic agent, argued that substances acquire properties through socio-technical arrangements. Michel Callon (2008) drew on developments in the sociology of markets, inspired by STS, to insist on the crucial importance of materialities for 'understanding the shaping of agencies and their competencies'. Woolgar and Lezaun (2013), in a recent discussion on a possible ontological turn in STS, discussed the relationship between the ways in which materiality is framed, the roles assigned to entities, and the emergence of distributed capacities for action. In these analyses, agency, described as both a resistance of things and a capacity to 'make [someone/something] do [something]' (*faire faire*), has been characterised as a relational and distributed capacity for action, stemming from socio-technical assemblages (or *agencements*) in which materiality is key.
11. Here we draw on Bakker and Bridge (2006). For the 'production of nature' strand, nature as a product of social relations underlies the development of capitalism. The 'social construction of nature' strand

looks at discursive constructs about nature, either to refute them or to shed light on the social significance of material world. These have been criticised for not sufficiently appreciating differences in capacities for action, notably between living and non-living entities (such as mineral matter, metals, etc.), and for dealing with them in a residually somewhat dualist way (i.e. subjects having agency, which they express 'on and through' objects).

12. Bakker and Bridge categorise them as follows: commodity chain analyses, which expand the analysis of materiality along the full chain from production to consumption (Hartwick 1998, 2000); work on corporeality, examining the materiality of texts (Kay 2000) and the relationship between identity and the bodily experience (Butler 1993); and work on hybridity, which includes investigations on multiplicity, the hybrid dimension of things, and the emergence of qualitatively different materialities (e.g., the cyborg metaphor of Haraway 1991; Law and Mol 1995 on multiplicity; Whatmore 2002 on hybrid species and spaces).
13. This was part of discussions between Tim Ingold (2007) and advocates of material culture analysis (Miller 2007).
14. Our addition.
15. As emphasised by Annemarie Mol, conflicting versions of an entity can also support one another, a phenomenon she terms 'multiplicity' and associates with a specific type of politics (ontological politics), in which we are thus faced not with exclusive alternatives, but with such co-existent interacting versions (Mol 1999).
16. For instance, the presence and importance of provisioning, commercialisation, or distribution depend on the type of process in place (e.g., commercialisation may not be part of the process in self-consumption). Depositing, harnessing, and extraction may also work together non-sequentially, with harnessing and extraction informing *ex post* the operation of depositing and allowing for learning and adjustment.
17. Commodification was first described by Marx through the concept of commodity fetishism.
18. Castree (2003) opposes the idea that 'there is or should be just one Marxian "essential" reading of capitalist commodification' (p. 274) and proposes a set of 'principal elements' that are part of commodification according to the 'work of contemporary Marxists writing about nature' (p. 278).
19. Displacement can be achieved through various means, such as physical/spatial distance, discourse framing, back-staging … As argued

by Hartwick (1998) in the case of gold, the commodity chain can be structured so as to manage discontinuities and *not* make perceptible the conditions of production at certain stages of the chain (the condition of African workers and their families in the extraction of gold) to actors active at other stages of the chain (Italian jewellery consumers).

20. The amount of kWh produced by a turbine, and hence the amount of support to production through feed-in tariffs, is measured by a meter, which materialises the frontier between the private productive entity and the publicly managed grid. Under this socio-material organisation, connection to and injection into the grid is a precondition of 'feed-in' support (as its name clearly states).
21. https://www.actu-environnement.com/ae/news/eolien-avis-ademe-maillage-territoire-foisonnement-lisser-production-26797.php4.
22. In 2006 in France, then updated (2012) and harmonised at the EU level with the adoption of the Renewable Energy Directive (2009).
23. That is, through the autorisation of production, which refers to the Energy Code.
24. Because backup capacities, working with gas or coal, have to be developed and turned on in order to offset the variability of wind power production.
25. The scenario is different, of course, in the case of off-grid wind power developments (for an example, see Pinker, 2018).
26. In France, solar PV is also supported by a feed-in tariff and guarantees of origin, and has mostly developed as a grid-connected form of energy. As in the case of wind power, these have structured a division of the chain into upstream and downstream parts.
27. For the same reasons as in the wind power case studies considered above, the stage of 'using' the energy is not foregrounded here: erased kWh and standard kWh just blend together in the electrical flow, making their origin indistinct at the stage of use.
28. To be clear, being a 'complete extractive energy' is a (socio-)material property of *grid* electricity. It is not a substantive property of electricity in general, as it certainly does not hold for off-grid electricity.
29. We could even argue that the limited ability of economic reasoning to sort out this controversy probably lies in its own denial of the material differences at issue: for economists, a grid kWh just is a grid kWh, as witnessed by the French Enercoop controversy about guarantees of origin (cf. Note 6).

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3

Transitioning Through Markets

Catherine Grandclément and Alain Nadaï

With contributions from Béatrice Cointe, Vincent Banos, Jeoffrey Dehez, Olivier Labussière, and Thomas Reverdy

List of abbreviations

EU	European Union
STS	Science and Technology Studies
PV	Photovoltaic
EDF	Electricité de France

C. Grandclément—The information and views set out in this text are those of the author only and do not reflect the official position of EDF.

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EDF-AOA	Branch of EDF in charge of purchase obligation contracts
BM	Balancing Mechanism
RTE	Réseau de Transport d'Electricité (French Transport System Operator)
kWh	kiloWatt hour
CRE	French Energy Regulator (Commission de Régulation de l'Énergie)
CURTE	Committee of electricity transport grid user-clients (Comité des clients utilisateurs de RTE)
DLS	Distributed Load Shedding

1 Introduction

The conduct of the energy transition is now associated to markets in various respects. In official policy circles, conducting the energy transition through markets is associated to numerous benefits. It is held that free markets and fair competition will provide economic actors with a 'level playing field', opening up new possibilities for individuals to act and for companies, products and services to develop. By fostering innovation, it is said, markets will 'fix' our energy problem. In setting free economic forces, markets will allow the current lock-ins and dependence on carbon-based energy sources to be overcome. The appeal of a market-based energy transition lies also in the supposed efficacy of market coordination in conducting change, in contrast to the assumed slowness of political and administrative processes. 'Passing' the energy transition through markets, on such accounts, will alleviate its costs for public budgets and make its politics easier to manage. Last but not least, a consideration closely associated to markets is the understanding that the energy transition will not threaten the living standards and norms of comfort of the Western world. Indeed, in 'passing through' markets, the energy transition may fuel new economic growth—it may create more wealth, especially in Europe.

This chapter examines the contribution of markets to the energy transition. More precisely, it examines the use of markets as an instrument to incentivise private actors to engage in energy transition processes. How do actors react to these instruments? What effects are generated? In line with the general approach in this volume, this chapter pays attention to the entities recruited into energy transition processes: here, through market-based instruments particularly. The paper examines the extent to which new 'energy transition markets' may or may not give rise to the new and unexpected. It explores the practical consequences of the close association between energy transitions and markets using analytical tools from economic sociology. Our case studies suggest that there is considerable ambiguity in what the markets may do to the energy transition. In what follows, we examine cases in which the market has to be circumvented or considerably modified to accommodate energy transition technologies, goods and services. We also look at cases in which the creation of a market relies heavily on pre-existing actors and their ability to assemble, graft and compose. In other words, as new markets capitalise on existing social and technical relationships, 'investments in forms' and market organisations, they remain very much dependent upon the pre-existing distribution of action capacities and power relationships. To varying extents, instead of markets opening up new and 'open' fields for competition, we end up with assemblages of new markets which build on and incorporate pre-existing markets and power relations.

The chapter is divided into five sections. The first section briefly sketches out EU actions towards extending markets as a policy tool in the field of environment and climate. The second and third sections present some theoretical elements drawn from economic sociology that we will use in order to discuss this policy. The fourth section critically examines the making of markets to conduct an energy transition in France through four case studies. These case studies are of the use of tree stumps as conventional fuelwood, non-residential photovoltaic (PV) production, the development of 'smart home' infrastructure and the market valuation of residential load shedding. The fifth and final section is a general discussion of the use of markets as vehicles for the energy transition.

2 Bringing About the Energy Transition in Europe Through the Market

The idea that the market may free economic forces, allow innovative activity and contribute to alleviating institutional lock-in has a long political history, and in recent years has been translated into EU and

French climate energy policy. In the EU, the close association between the market and the energy transition has become increasingly explicit since the late 1990s, as the EU began to endow energy and climate policies with an unprecedented regulatory basis (Jabko 2006; Van der Vleuten and Lagendijk 2010). In the space of just over a decade, a set of directives and texts—an EU White Paper (1997),[1] the European Climate Change Programme (2000),[2] the Renewable Electricity Directive (2001),[3] the Biofuels Directive (2003),[4] the Renewable Energy Directive (2009),[5] and the '3 × 20' Third Energy Package—marked a progressive transition away from voluntary targets and sectorial approaches to renewable energy provision and towards compulsory requirements and a more integrated approach to tackling global issues such as renewable energies and energy demand.

Even as the new targets embedded in climate policies require member states to adopt and implement stringent and innovative energy policies, the liberalisation of the energy sector (gas and electricity) (2003)[6] has been deeply modifying the ramifications of energy policies. Notions such as 'externality', 'level playing field' and 'fair competition among the different types of energies' have inspired EU energy policy. The project of liberalising energy markets while accounting for all externalities, so as to reveal the full social cost of energies through their prices, was repeatedly defended as the best way to bridge market efficiency and sustainable development. The logic of the argument was that this would allow EU policymakers to eliminate hidden subsidies to conventional energies, hence ensuring fair competition between all forms of energies and fostering the development of renewable energies. While this economic logic legitimises liberalisation in terms of sustainable development (e.g., liberalising the electricity market is good for the environment as it allows renewable energy to penetrate it; it is more democratic as it allows consumers/citizens to voice their choices through the free market, etc.), it also points to the fact that energy policy no longer can be conceived as a separate box. Foremost among the issues crossing policy domains are environmental externalities: beyond energy as such, these evolutions in the EU's approach to energy issues highlight the intersection between Europe's renewable energy policy and its regulations and aspirations to protect and improve the environment. This connection sets energy policy on course to be a multidimensional and multi-scalar process.

In gradually implementing EU regulatory frameworks and adopting its neoliberal approach, France's approach to climate and energy policy has profoundly shifted towards a market-based form of governance. In the field of electricity, since the early 2000s, the French state has progressively dismantled the former organisation of its utility as a public service monopoly in order to implement a market organisation (Reverdy 2014). It initiated a diversification of its electricity mix through market instruments by adopting a feed-in tariff for renewable electricity,[7] developing competitive tenders (biomass energy, offshore wind power generation) and by reforming its energy policy programming law.[8] The French state also launched a massive programme aimed at developing market-ready technologies for sustainability-related purposes. The programme, called 'Investments for the Future' (Investissements d'Avenir), was set up after the 2008 crisis. It funds demonstrators of technologies such as electric vehicles and charging infrastructure, smart grids, renewable energies, energy storage, fuel cell batteries, carbon capture and storage, etc. The notion of demonstrators, geared at developing market-ready technologies, marked a turn towards the commercialisation of research in France. This turn is in keeping with the 'Lisbon strategy' for research and technology at the European level (Bruno 2008). This series of reforms follows on the idea that new technologies delivered through markets are key to tackling climate change. They are the conjunction of two gospels of the contemporary era: technological optimism and neoliberalism.

3 Markets as Levers to Unlock the Energy Transition

On several counts, the use of markets to conduct the energy transition is similar to that of technologies. There is a tendency to expect that technologies and/or markets will provide a ready-made solution to problems that seem far beyond human control, or whose handling would require complex political processes. Such approaches have been criticised for the undue hope that they place on technologies. Above all, critics of such 'technological fixes' argue that technologies often do not solve actual problems, and that worse, they create others (see for instance Illich 1973; Hard and Jamison 2005). Basing the energy transition on markets present a very similar case, which we may call the 'energy transition market fix'. In conducting an energy transition through markets, governments may expect that through competition and entrepreneurship, new actors, technologies and patterns will emerge to 'unlock' what was previously locked. Markets are seen as a way to 'fix' the energy transition in a single step. This vision is quite at odds with the very idea of a transition which, notwithstanding the complex layering of temporalities involved, means at least that past and future situations are linked through a present with some form of duration.

The idea that the market fosters newness and can potentially overcome lock-in by offering a level playing field for actors to innovate has been challenged in many ways. Evolutionary economics, for instance, has shown that small events or path dependency can decide the fate of a technology, and that rather than the most efficient technology being selected, it is the technology that is selected that becomes the most efficient because it is supported (e.g., Nelson and Winter 1982; Foray and David 1995; David 1985). In economics parlance, therefore, the market can very well steer towards suboptimal choices.

The idea that the outcome of a competition is not necessarily the best possible solution is also widely shared by STS scholars working on innovation (MacKenzie and Wajcman 1985; Latour 1987; Bijker et al. 1989). Instead, the 'success' of an innovation depends on the mobilisation and alignment of allies in all sorts of realms (scientific, legal, commercial, end users, etc.) and the circumventing of adversaries. In order to retrace these processes, it is important not only to trace back the factors that led to the outcome, but also to account for the roads not taken. This important methodological principle in the sociology of innovation is sometimes summarised as avoiding doing 'Whig history', or as the 'first symmetry principle' (studying the losing sides as much as the winning one). As argued by Madeleine Akrich (1989), recomposing and qualifying both the technology and its environment is part of the process by which any socio-technical system emerges, and the work of co-constructing the environment and the technology in order to market the latter as offering superior performance is later erased in an effort to legitimate choices (by making it seem that they follow from the state of Nature). Akrich points to this as an ontological dimension of socio-technical systems, because properties that were worked out in the process of their emergence are presented ex post as being essential to the entities engaged in this process, thus supporting the idea that it is in fact the most efficient solutions that have been selected.

Finally, another line of objection to the idea of the market as a tool for developing innovative solutions to non-market problems can be found in the transition management literature. Building on the idea from economics that innovation needs niches to develop and are at risk near the point of market access (death valley), this literature has developed a (somewhat linear) model of innovation development that would only gradually expose an innovation to the destructive forces of market competition (Schot and Geels 2008). In this literature, however, once innovations are consolidated, the most efficient can be selected through confrontation on the market.

This line of discussion is not the angle we will adopt in our analysis of the use of markets as vehicles for the energy transition. Instead, we will take aim at an issue which, in a way, is 'upstream' of the question of the virtues of competition. Our interest in this chapter lies in the use of markets as policy tools. William Davies argues that the recourse to economics in public life in the form of markets or of tools that mimic markets reflects a disenchantment with politics (Davies 2014). According to his argument, if markets are tools and if politics is administered through such tools, this means that the use of markets to conduct energy transition processes is a way of depoliticising the energy transition, to take the politics out of the issue. The question that will guide our empirical inquiry here is that of the politics left, removed, or perhaps created, in energy transition markets. To do so, we will examine concrete processes of market creation. In adopting a detailed view of actual markets, we apply some important methodological principles from a particular branch of economic sociology known as 'market studies', which we present in the next section.

4 From Principles to Practices: Economic Sociology and the Empirical Study of Markets

There are many overall critiques of neoliberalism and the market, some of which have offered especially penetrating analyses (Dardot and Laval 2014; Davies 2014; Hibou 2015). But while this type of critical work is very important in making intelligible the logics and consequences of neoliberalism, in what follows we will refrain from bringing the discussion to too general a level. Our ambition in this chapter instead is to examine the particulars of the actual implementation of markets to bring about the energy transition. How is it possible in practice to transform climate care into a commercial endeavour? What kind of markets are put in place? How do they work, and with what consequences? Finally, what really becomes of the energy transition itself when it is conducted through markets? These are the questions we aim to answer through an examination of four empirical case studies, in which markets or market-based tools are used for the energy transition.

In approaching markets (plural) rather than the market (singular), we follow in a relatively recent but now well-established tradition in economic sociology, sometimes called the 'new new economic sociology' (McFall 2009), the 'performativity programme' (Fourcade 2007; Callon 2010; Cochoy et al. 2010), or 'market studies' (Geiger et al. 2015a). The origins of this tradition in science and technology studies brought a commitment to focus on moments of innovation and a penchant for the foregrounding of materials and instruments in the study of markets in the making. A distinctive trait of the 'new new economic sociology' hence lies in its attention to processes of market creation. One of its main contributions is the notion of 'market devices', and its use as a starting point in the study of markets (Callon and Muniesa 2005; Callon et al. 2007). The market devices approach offers a vocabulary to describe and analyse that all-important ingredient of economic life—markets. It does so without resorting to the vocabulary of economics, which does not simply reflect a reality out there but contributes to shaping it, as demonstrated by numerous works in the 'performativity programme' (Callon 1998b; Mitchell 1998; MacKenzie et al. 2007;

MacKenzie 2008). Instead, what constitutes the seller, the buyer, the good, the price and the general dynamics of the exchange need not be taken for granted, but instead can be the object of inquiry.

The market device literature thus breaks from a substantive vision of 'the market' as a source of power, domination and even resistance. Instead, concrete, practical, mundane and often-overlooked market devices are the primary focus of empirical and analytical investigation. This investigation often starts with an inquiry into the exchanged goods themselves, which, as Callon points out, are not given, but have to be specified in what is often a controversial and political process (Callon et al. 2002; Callon and Muniesa 2005; Callon 2007a). The result of such examination is a 'thick' rendering of markets, as opposed to the flatness of their understanding as mere mechanisms for allocation and coordination (Callon 2013). A second and interlinked feature of the literature lies in its granting of agency to all sorts of things (things that are sometimes called 'non-human') (Callon 2008; MacKenzie 2009). Markets are investigated without any prior judgment of what the market is and of what within it is social, technical, political, moral, economic, human, or other. In line with a typical ANT stance (Callon 1986a, b; Latour 2005), these are emergent categories that are sometimes but not always delineated in the course of the processes that sociologists study. Market devices are not limited to material, practical things, but encompass all sorts of things, from calculating equipment to statements pointing to the device (Callon 2007b). In other terms, what is at stake in so considering market devices as impure hybrids (rather than as perfect emanations of an economic order) is the possibility of grasping power as it is exerted in practice and political issues as they arise at the very core of markets (Callon 2007a; Cochoy et al. 2010; Marres 2012; McFall 2014). These will be the guiding principles in our empirical exploration of the making and running of four different market devices intended to fuel the energy transition.

5 Case Studies

The four case studies explored in this section span a wide range of energy transition processes, with regard both to the technologies and resources concerned—biomass energy, solar PV, smart electric meters, distributed load shedding for the electricity grid—and to their outcomes. Some apparently qualify as successes with regard to energy change and participation, some as unsuccessful, and some are mixed. Our description of each below aims to bring to light the transformation of energy transition claims into markets, and the consequences of recourse to markets for the politics of the energy transition.

5.1 Turning Tree Stumps into Biomass Electricity—A Case of Appropriation and Exclusion

The Landes de Gascogne region (on the south-western Atlantic coast of France) is among the French regions with the most highly exploited forest resources. Landes is largely covered by a major pine forest which is privately owned, and where there are a number of major pulp and paper industry installations. Two major storms in 1999 and 2009 literally wrecked this forest land, making 'available' a potential new wood resource: tree stumps. The use of tree stumps in traditional industrial processes poses a series of technical challenges. Nevertheless, in a context marked by tensions around the provision of wood products for traditional wood-based industries such as paper industries, local actors deemed it worthwhile to try to overcome these challenges. In what follows we will not explore these technical challenges (for more detailed accounts see Banos and Dehez 2017; Dehez and Banos 2017) but will instead focus on the economic processes through which actors of one specific type appropriated tree stumps for their own exclusive benefit.

Over the past decade, the availability of wood provision resources has been challenged by the emergence of what is called 'wood-energy'—as opposed to other industrial uses of wood (paper, lumber and wood panels). The development of wood energy has been driven by economic incentives in the form of tenders organised by French public authorities—through successive calls in 2004 and 2011—in order to help set up a renewable electricity production industry. In the case of wood biomass, the tender policy has been widely criticised on a number of grounds: mismatches with the distribution and availability of the resource, the gigantic scale of the projects selected through the tenders, the very low rate of actual development that ensued, and the lack of transparency and continuity in public policy. Incentives for the development of biomass-based electricity have come to threaten the wood resources used by the pulp and paper industry. The pulp and paper industry lobbies have continuously emphasised the inappropriateness of national tenders and biomass electricity production to the configuration of wood resources at both national and local levels.

In the Landes de Gascogne region, however, rather than merely criticising these tender offers, major pulp and paper producers entered bids. Here, they used national policy support in order to upgrade their industrial equipment and buy new high-pressure boilers. State support followed conveniently on a few decades of experimentation within the Landes industrial cluster. High-pressure boilers made it possible for these companies to process a broader range of biomass resources, potentially including the tree stumps that the two major storms of 1999 and 2009 had made 'available'. These boilers also enabled electricity cogeneration out of the heat from paper production. In other words, in the present case, the tender—a market-based mechanism—helped the pulp and paper industries to transition from conventional wood sources to tree stumps through a technological upgrade (high-pressure boilers) to provide for their heat needs. But what does this economic process really 'fix' here? To put it differently, what kind of problem does the process solve, and what does it not solve?

The strategy of the pulp and paper industry in the Landes region could be described as follows. They played on their market power (monopsony) as well as on the post-storm situation itself and a series of discursive manoeuvres, in order to impose low prices for stumps: stumps cannot be sold for more than a token price; stumps are only a waste product, whose economic value lies not in the stump itself but rather in soils after their removal; stump harvesting is good for phytosanitary protection, replanting and future yields. This discourse was supported by regional research bodies and other local actors. The risk of Fomes was also invoked as an additional reason for stump harvesting. Fomes is a damaging and contagious root disease (fungus) affecting softwood trees. Leaving after-storm tree stumps in the field, they argued, increased the risk of contamination. Ashes from the industry's new high-pressure boilers were tested as fertiliser and as a means of return minerals to the land. Industrialists could thus also pose as making a public contribution, rather than as pursuing their own interest in a new, cheap source of supply. Last but not least, the Landes pulp and paper industry developed a strategy aimed at colonising peripheral wood massifs in order to capture new resources (in Dordogne), following this overall objective of not competing with wood materials which are actually used in the local timber and paper supply chains.

There have been various stump pricing mechanisms (Banos and Dehez 2017; Dehez and Banos 2017). At one point in time (2010), stumps were sold by the ton for 2 euros. This price was partly based on the rental prices of land where stumps were being stocked. A few years later (2014), the local forest owners' unions promoted another higher price (10 €/ton) based on the exploitation cost of stumps. Other actors, including energy operators but also many forest owners, have argued that the prices of stumps must be based on their heat value. Nevertheless, this last proposition still does not have wide support, and the possible equivalencies with other energy substitutes (e.g., green waste, wooden pallets…) remain hard to identify.

The participation of the Landes de Gascognes pulp and paper industry in the national tenders aimed at developing biomass-based energy could be read as the result of a strategy aiming at: (1) drawing on policy support (subsidies) in order to invest and renew a business model which is ageing and under threat of international competition; (2) securing access to the pine tree resource; and (3) hampering the entry of other biomass electricity producers into the region. Clearly, the power of pulp and paper industry as an incumbent, in a position of monopsony, having a hold on regional institutions and land owners, allowed it to pre-empt the access to this biomass resource by playing on all types of know-how and relations. Pulp and paper industrialists benefit from a range of assets and know-how which allow them to manage a dominant position in biomass electricity production. These notably include technological know-how (with high-pressure boiler technologies), power relations (monopsony position in relationship to local forest stakeholders), and networking with research institutions (experimentation on harvesting, fertilisation with boiler ash…). Our point here is not to say whether what this industry did using the national scheme for biomass development is good or bad. Instead, we are emphasising how, in this case, transition and change depend heavily on what existed before, and especially upon the ability of certain actors to use resources (namely, in this case, know-how, network position and leverage based on size) and to secure access to additional resources (a new kind of biomass).

This being said, it will be noticed that the power concentrated in the hands of a few industrial stakeholders also hampers the emergence of possible potentials associated with the process of energy transition. First, it hampers the economic diversification of several other industries whose productions are developed upstream in the supply chain (i.e. forest landowners, sawmills), and which thus constitute a major input to the pulp and paper production process. This contributes to a form of 'lock out'[9] in the current regional industrial trajectory. Second, the general pressure on the availability of wood resources as well as the announced impacts on local economic activity in the timber sector (competitiveness, rural employment…) has severely limited the development of tertiary heating systems within the Landes de Gascogne area. Overall, there has been little discussion of the potential redistribution of profits and existing wood resources.

In this case, then, we have an emergent resource, tree stumps, harvested and calibrated so as to take a place in what is basically conventional biomass-based energy production, while the dominant position of the paper industry is sustained. Here, mainstream dominant actors took hold of a state-supported mechanism (calls for tenders) to retain their dominance on a market. Even more, they appropriated this new resource in a way that excludes others who might potentially also make use of it. Other, perhaps more positive effects of the traditional paper industry could appear in the longer term, however, as they strive to change and adapt their current business model.

Interestingly, the asymmetries that arose in passing the energy transition through markets in this case partly relies on the fact that public policy further empowered large actors by supporting their investment in new technologies, reinforcing their monopsony. These asymmetries also depend on the incomplete informational context, as comparing the energy content of the different options in order to price the stumps was not made possible. The articulation between market access and the energy transition thus played out (negatively) around the valuation of tree stumps: certain actors seem to have had limited access to either information about the regional resource (privatised, opaque, monopsony) or the arena where the valuation of tree stumps was devised—they did not have an opportunity to take up a place in these processes.

The turn taken by state support in this case study partly results from a default policy. This policy frames the development of biomass energy as an economic and competitive activity, without formulating political ends. It does not acknowledge the necessary work of valuation entailed in such a development, nor the differentiated ability of different actors to engage in it. This leaves incumbents, who are best placed and equipped to direct market devices in their own interests, free to do so.

5.2 Adding PV Production to the Roofs of an Agricultural Cooperative: Subverting an Individual Incentive into a Shared One

The Fermes de Figeac photovoltaic project is an economic initiative clearly driven by policies encouraging the development of markets as a means to trigger dynamics of energy transition. It was initiated as a reaction to the high feed-in tariffs that were available for building-integrated photovoltaics (BIPV) in France in 2008 (about 60 eurocents/kWh, at a time when the costs of PV systems, though still high, were on a sharp decreasing trend). Feed-in tariff policies were meant to create a safe niche for investments in photovoltaics, by ensuring their profitability, and thereby to accelerate the 'maturation' of PV markets by inducing learning effects and cost reduction dynamics. The rationale for these policies was that without them, PV would not yet be on the electricity market due to high costs and risks (Cointe 2015). The Fermes de Figeac is a cooperative PV project which responded to this financial incentive to harvest a local resource (sunshine), develop a new and mutualised source of activity and income for a territory and for the members of the cooperative, and assert itself as an entrepreneurial actor in the energy transition.

The market dimension of the project is quite straightforward (for a more detailed account of this case, see Cointe 2016). Its originality lies in the ambition to mutualise and in its articulation to a set of values promoted by the cooperative, such as collective solidarity, territorial attachment, innovation conceived as a way to maintain a local culture, a long-term vision and transmission to future generations. The objective was to harvest a territorial resource that photovoltaic technologies made exploitable and that feed-in tariffs for BIPV made profitable: namely, rooftops exposed to sunshine. To do so, the cooperative developed a business model and a business plan designed to create economic activities and profits out of these rooftops, tapping into these profits for the territory and redistributing them among farmers and other territorial actors. The initiative was largely framed by the feed-in tariffs: obtaining the highest possible level of tariffs was a condition for the project to succeed. Expected gains were calculated on the basis of the number of roofs involved, estimates of solar radiation in the region, PV installation output and the level of the feed-in tariffs. The timeframe of the project was also determined by feed-in tariffs, which are guaranteed for 20 years, while the business model and decision-making organisation were designed to ensure reactivity and efficiency, so as to be able to seize the opportunity the tariff before it was reformed out of existence.

A firm (SAS Ségala Agriculture et Energie Solaire) was created specifically for the project. Its shares were owned by roof owners willing to take part in the project (who brought in 20% of the amount needed to equip their rooftops with PV panels) and by the Fermes de Figeac cooperative, who also provided staff. The SAS would rent the rooftops, hire a firm to provide and install PV systems on them, take care of all the administrative procedures for everyone, sell the electricity produce to Electricité de France (EDF) within the framework of the feed-in tariff schemes, and pay dividends to its shareholders. The rest of the funds required were negotiated with banks. The project was expected to yield mean net profits of 20 euros per square metre of installed PV per year over 20 years (with a phase of investment, a phase for loan repayment and a phase of net profit). The resource and profits were thus mutualised: all rooftops were aggregated regardless of location or grid connection costs (though some were excluded because their bad location or high grid connection costs would reduce the project's overall profitability by too much), and costs and gains were divided according to installed surfaces (and not the actual electricity produced by each installation).

Though the project was in many ways an innovation, and involved the creation of an ad hoc firm, it did not just build on the guarantee of feed-in tariffs. On the contrary, it took firm root in the territory's resources and, mainly, on the existing capacities of the cooperative. The strength of the Fermes de Figeac was to assess and combine its existing assets quickly, and to convince partners and funders of their value in the context.

The first, most obvious assets were the rooftops themselves. For the most part, they were the roofs of agricultural buildings and sheds, and thus already had their own utility and economic value. The possibility of using them to install photovoltaics offered an opportunity to graft new sources of utility and values onto this existing capital—although it involved legal and administrative transformations (Cointe 2014, 2016).

In addition to appending itself to capital assets used for other economic activities, the project built on the Fermes de Figeac's networks, staff, know-how, expertise and capacities. The SAS Ségala Agriculture et Energie Solaire was grafted to the Fermes de Figeac in many ways (and this close interlinking required negotiations and persuasion): the majority of its shareholders were members of the cooperative; its administrative board was partly constituted of members of the Fermes de Figeac's own administrative board, and its President was that of the Fermes de Figeac; and its workforce was staff employed by the Fermes de Figeac. It was an emanation of the cooperative, designed to provide a specialised and highly reactive strike force.

These strong ties with the Fermes de Figeac provided assets that were critical for the success of the venture. It provided access to the resource: the cooperative advertised its project to its members, and farmers joined in large numbers because they trusted the cooperative, and preferred to embark on a cooperative project with a well-recognised local actor rather than engage in PV projects alone or with firms they did not know. It also benefited from less material resources. First, the cooperative had been following the evolution of renewable energy policy for over a decade, and had good knowledge of the policy landscapes and possible projects for such a rural area. This expertise was crucial in enabling it to react quickly to the feed-in tariff incentives: they were equipped to do so because they had been monitoring the relevant requirements for some time. Second, as a well-established actor in the local rural economy, the Fermes de Figeac had developed a network of connections with territorial actors and institutions, and, crucially, had obtained their trust. This clearly facilitated contact and negotiations with banks and administrations. Individual actors in the project also brought in their skills in rural development projects and collective organisation.

These assets were crucial for developing the business model, for constituting a collective form of agency to carry it forward, and for enrolling partners. However, the project also encountered barriers and challenges that were unprecedented for the cooperative. These stemmed in part from the fact that it had little experience with energy projects, and had never worked with actors such as Tenesol (the PV system provider and installer) or EDF-AOA (the branch of EDF in charge of purchase obligation contracts, with whom it was virtually impossible to establish direct working relations). But most importantly, they originated in the financial scale of the project: the total investment was over 30 million euros, and required the involvement of a syndicated loan as well as national banks. For these purposes, the assets and guarantees that the Fermes de Figeac brought forward were definitely not enough.

The cooperative had approached the banks with its project already fully designed, considering that the work of evaluating, pooling and smoothing out risks had been performed in the development of the mutualised model. Installation sites had been selected, and mutualisation was designed to guarantee that malfunction in one or another installation (e.g., payment delays, installation failure…) would, on the whole, be compensated by the rest. The banks, however, would not directly accept the mutualised project as a whole. They proposed instead to divide the project into about 100 separate projects, to be processed individually through their own risk analysis procedures. The Fermes de Figeac refused and succeeded in getting the banks to approach the initiative as a single collective project, assessing risks first individually and then globally, thereby un-pooling and then re-pooling them.

The negotiations with banks thus involved a lengthy reassessment of assets and risks, each separate installation being audited individually. The banks were largely unwilling to take mutualisation—a crucial element of the business model—into account as a guarantee in itself, and the collective project was disaggregated and re-aggregated within their risk assessment procedures.

Since the Fermes de Figeac had never worked on a project of this financial scope, or negotiated with banks at the national level, this part of the project involved a lot of learning on the go. In that sense, new capacities for economic action emerged through this attempt to harness and mutualise this solar resource that had been made profitable by feed-in tariffs. As mutualisation expanded the scope of the project and complicated the negotiations, it also to an extent led to the development of enhanced capacities. The project's success created additional assets: profits to reinvest, networks and expertise in the field of renewable energy, new competencies in negotiating large-scale projects (and, conversely, a new expertise for the bankers involved in the syndicated loan, most of whom had never worked with PV before), knowledge of the solar potential of the territory and know-how in the management and maintenance of photovoltaics… In that sense, it succeeded in bringing innovation through a market. Of special interest here is what mutualisation through the cooperative achieved. They bent banking practices, forcing banks to accept and consider mutualisation as part of a project much larger than is usual. They also modified the individual incentive of the tariff by pooling the resources (regardless of their location or grid connection costs) and sharing benefits according to installed surfaces (rather than the actual electricity production of each installation). Through this project, the Fermes de Figeac emerged as a new player in renewable energy development. But this project can also be read as a reinforcement (and renewal) of existing capacities. It strengthened the position of the Fermes de Figeac as a central actor in the area, and contributed to the revitalisation of a rural territory where agricultural activities are on the decline. The project, with all its innovative qualities, is also presented by its promoters as a means to preserve territorial economies, activities and landscapes that are threatened with disappearance if new resources are not developed. In other words, innovation here was intended to support preservation and conservation, instead of replacement and change.

In this second case study, we thus have the farm roofs of an agricultural cooperative gaining an extra role, that of collecting sunlight to transform it into photovoltaic electricity. Alternative new actors entered a field that was new to them (energy production) through a feed-in tariff. As in the first case, they capitalised on an existing network of relationships and on a state-supported mechanism. However, these actors also bent actual market practices: they forced the banks to reconsider their way of calculating risk, and insisted on modes of calculation that foreground the collective, and not the individual level. Three conditions seem to have been decisive in enabling the PV cooperative to make a traditional market actor such as a bank reconsider its usual practices, however fragile and provisional the change might be. First, the Figeac collective at work is well structured and speaks with a single voice. Second, the collective is supported by a state subsidy (feed-in tariff) that is guaranteed for an extended period, which endows it with a secure business model in the eye of the bank. Third, the arena in which the transaction with the bank is negotiated is small, and allows for the representatives of the collective to make themselves relevant. The result is that, in this case, what Çalışkan and Callon (2009, 2010) called the prosthetic *agencements* of the market—the set of ready-made available values and practices on which valuation can rely in order not to have to fully begin from scratch—are bent, and allow for the politicisation of a transition process. A transition process initially intended to proceed through mere market mechanisms thus allows for a collective concern to come to be acknowledged and to structure the process.

This case study clearly illustrates the fact that here, passing through markets in the pursuit of a political end (energy transition) succeeded because the actors concerned with these ends were empowered by the market devices that were put in place. The empowerment of these actors, however, was not a direct effect of the process of market creation. Instead, these actors were already constituted before the development of the market. However, the market supplied them with resources to extend and sustain their collective action.

5.3 Smarting the Grid: From the Responsive to the Captive Electricity Consumer

The 'consumer' is a relatively new character in the electricity sector. This character, who is closely associated to the process of market liberalisation, has become a key subject in EU energy policy in recent years. Two directives have promoted both the consumer as the key actor in energy policy and smart meters as the way to allow consumers to hold this key role (directive 2006/32/EC and directive 2009/72/EC). We choose to characterise the vision of the consumer that is put forward in these directives as one of the 'responsive consumer'. 'Responsive' echoes the term 'demand-response', which is used by actors in the electricity sector in order to point at the possibility for electricity demand—and thus for the electricity consumer—to become reactive to price signals. This reactive consumer is amenable to price incentives, to contributing to peak load sharing by shifting his/her demand and uses in time, thus taking part in the balancing of the electricity grid. 'Responsive' also echoes 'responsible', which refers to the integration of environmental concerns in the conduct of everyday life. The 'responsible' part of the responsive consumer disciplines itself to taking care of its energy consumption. The responsive consumer might thus also respond to other non-price signals such as grid congestion signals, signals for non-wind generated or polluting electricity, etc.

In the energy sector, the 'smart grid' is the key techno-economic object that supports the construction of the responsive consumer. The term designates a bidirectional grid, conveying both energy flows and real-time information in both top-down and bottom-up directions. In technical terms, this has to do with the electricity grid being rewired to incorporate a telecommunication network. On the consumer end of the grid, this can translate into devices ranging from home displays showing real-time electricity usage, electricity rates, or grid status, to fully automated smart homes whose heating and air conditioning systems, washing machines, blinds, fridges and freezers could be remotely controlled by their inhabitants or the grid operator. Governments, energy companies and manufacturers have made large investments in smart grids in both Europe and the United States.

In France, one particular episode in smart grid development resulted in 'responsive' consumers being turned into captive consumers, dependent on a smart box provider to pilot their home equipment and electricity provision. Paradoxically, the process, whose story we briefly sketch out below, was all carried out in the name of liberalisation and market choice (for a more detailed account, see Grandclément and Nadaï 2015).

A turning point in smart grid/smart home development in France was the decision to make the electricity meter the obligatory gateway of the smart home. A large-scale smart meter roll-out was announced in France in 2008, with the stated aim of installing a new meter in every French home by 2017. At first, smart home projects and smart meter roll-out proceeded independently, although possible synergies between the two were sometimes sketched out. Smart home projects were supported through 'demonstration projects' financed with public funds; calls for tenders were issued. In June 2011, at a moment of heightened criticisms of the smart meter project and while promoters of the project raced to speed decisions on its deployment, there was a new call for tenders for smart grid demonstration projects. This call included the incorporation of the smart meter as an obligatory point of passage for projects focussed on the demand side of the electricity system.

As a consequence, smart home projects now had to pass through the French smart meter. This involved a redesign of both the meter and smart home projects. While smart home projects relied on home boxes wired to the internet to communicate with home appliances, these boxes now had to physically fit into the smart meter. For technical and practical reasons, this considerably narrowed what could be done. A major limitation was that there was only one physical space inside the meter into which a device able to communicate with the grid, the energy provider and home appliances could be inserted. Intense techno-political struggles ensued over defining who would be able to put their hands on this device and for what purposes. Importantly, the device could be used either to manage home appliances (remote control function) or to carry information about grid status, electricity price and electricity usage (information carrier function) and since there is only one space inside the meter, these two functions are mutually exclusive. The arena in which this negotiation took place gathered a large set of actors including the grid operator, the energy regulator, energy providers, the energy and environment ministries, the environment agency, the energy ombudsman and other interest groups, including representatives of organisations involved in smart grid demonstration projects. One important dimension of the negotiation was the technical complexity of the issues at stake. They concerned the capacity of the meter to circulate and/or compute multiple sets of data, as well as its articulation with both the electrical grid and future intelligent home appliances (we cannot explore these negotiations in detail here due to space limitations, but see Grandclément and Nadaï 2015).

To sum up a long and intricate techno-political discussion, of the two functions of the smart meter—that of information carrier and that of remote control—the first lost and the second won. By threatening to pre-empt the one potential communicative control interface with the smart home, the information carrier function was clearly threatening downstream smart home market development possibilities. Exit then the 'responsible' part of responsive consumers, who would pay attention to the levels and timing of their electricity consumption so as to play their part in avoiding grid congestion, minimising socio-technical recourse to grey electricity and maximising recourse to green electricity.

What, then, of the other part of the responsive consumer: that is, the reactive consumer who takes advantage of market competition to choose between offers and acts according to price signals? There were two issues here. The first was the smart meter's ability to transmit real-time price signals to the smart home, so that consumers and their technical delegates can choose whether or not it is worth it to start the washing machine now. It turned out that the meter was not allowed to have prices pass through it because of the 'unbundling doctrine', which is central to the liberalisation process in the electricity sector. According to this doctrine, competitive activities (such as electricity provision) must not be mixed with non-competitive activities (such as grid operation) in order to ensure that all actors are equally able to compete. On these grounds, the French energy regulator ruled against allowing the smart meter (which belongs to the grid operator) to transmit and record actual electricity prices (which pertain to market coordination). In order to transmit prices in real time to consumers, prices had to transit through a route other than the meter. It was thus decided that energy providers should offer consumers (almost) real-time access to electricity prices, and that the meter could only be programmed with a price hierarchy: not the exact price, but an ordered list from the cheapest to the most expensive.

The second issue was the question of the hardware needed to operate a home according to real-time price signals. This issue related to the techno-economic configuration of the aforementioned device placed inside the meter that would talk both to the consumer and to the appliances while taking electricity rates into account in deciding whether or not to allow the electric oven to function. Since there was only one slot in the meter and since the device placed there only had the remote control function meant that whatever actor lodged their own device in the meter gained a de facto monopoly on the market. But this possibility was closed down with an argument, echoing the last Energy Efficiency Directive (2012/27/EU), which precisely stipulated that the smart home market had to be open to competitors. In short, smart electricity consumers—here envisioned as choosing among options on a market—should be presented with multiple offers in order to be given the chance to express their optimising potential and drive market competition towards a socially efficient configuration. Concretely, the presence of a smart home box subject to competition, supported by private business models, installed downstream from the meter and communicating with it, was thus required as a guarantee of a competitive environment.

Ultimately, and as of we conducted the fieldwork, the process ended up with the following configuration: the slot inside the meter pertains to competitive activities within the market; the device installed in that slot receives a price hierarchy from the non-market meter that it transmits in turn through a 'wave system' (to which any device, appliance or box can connect itself), downstream towards the home, to pieces of equipment such as energy management boxes that control appliances. Energy management boxes are to be developed by energy providers, home equipment industries, or telecommunications specialists. Consumers could choose on the market which one to buy. In this final configuration, in principle, consumers can choose a box and a rate separately, and programme the box so that it can decode the price hierarchy provided by the meter. In practice, however, the energy provider (who knows the prices) would be much more able to perform this assemblage of a rate and a box than either the end-user or any other intermediary.

Such an assemblage amounts to bundled offers with elaborate electricity rates, an energy management box and perhaps a 'smart' thermostat, app or display. Such a 'bundled' offer could include, for instance, a rate of this type: price A during daytimes on weekdays except from 6 to 8 pm; price B from 6 to 8 pm weekdays; price C at night on weekdays; price D in the daytime on weekends; price E at night on weekends; price F from 12 to 3 pm in summer; price G for major emergencies limited to 14 days a year; and a compatible pre-programmed box that would allow the consumer to draw the most 'benefits' from that rate.

In such elaborate service bundles, market actors can render the cost of the smart grid equipment invisible to the final user, as it is diluted in the costs of the broader smarting of the home. The provider also maintains some power over the consumer. The reactive consumer is in reality 'captated' in the sense of Trompette (2005) and Cochoy (2007)[10]—lured and held, in a manner of speaking. In other words, although it is always possible in principle for a customer to change supplier, in practice doing so is very difficult.

In the end, here the abstract economic doctrine of 'unbundling' is countered by concrete techno-material marketing efforts resulting in twists in and obvious contradictions of that doctrine. The most telling of these contradictions is that in the name of 'the' market, prices are not to be readable from the meter. The unbundling doctrine is not realistic enough to counter concrete market-making practices, which culminate in a form of 're-bundling': not of the grid and the supplier, but of the supplier and the consumer. The figure of the consumer who is inscribed within the techno-material ecosystem of the meter is of a semi-captive consumer.

In this third case, we are thus faced with an unbundled electricity system, intended to sustain a market space, which is re-bundled at a lower level, with the consequence that the consumer is 'monopolised'. There is no direct subsidy to help launch a modernised retail electricity market, but a system of 'demonstration projects' that are provided with repayable advances (see Chapter 7 on demonstration). Actors struggle to defend their own interests, but the nature of the future market is unclear. Importantly for our purposes, the arena in which the shaping of this market is debated and decided is marked by asymmetries of information and power, which clearly mirror the strategic dimension of the 'demonstration' projects and policy. The unbundling doctrine, which is supposed to grant fair and free access to the future electricity market, depends on a representation of this market as a clear-cut thing with clear boundaries. However, the boundary is not a line but a zone of struggles, devices and negotiations about where lines should be drawn. Market actors want to expand the market in order to increase the scope of their business models. They navigate with and through devices, whose technical complexities become decisive in drawing boundaries. It might also be that public actors expect smart home development to be supported by the market, so that its costs neither appear to be imposed by public administrations nor to bear on public budgets. The 'captated' consumer might not represent a deliberate end in this story, but only a kind of collateral damage. Nonetheless, the surrender of the responsive consumer speaks to the limited reach of the process with regard to both energy change and participation.

In contrast to the first two case studies, here the devising of the market was tied to a dialogical space in which the dominant actors end up being those who were supported by the very policies that call for an outside of the market in order to regulate its design. This circularity highlights the complexities involved in passing through markets for political ends: the actors placed in charge of developing these markets end up being engaged in multiple valuation processes, which can confer dominant roles on these actors and divert the markets from the ends they were initially intended to serve.

5.4 Valuing Non-consumption: Decoupling Erased kW from the Market

This case study deals with a contested attempt at developing distributed load shedding for the electricity grid in France. Load shedding consists in reducing electricity consumption at a given time in order to achieve grid balancing (and thus to avoid incidents such as brownouts or blackouts). This case study is strongly connected with the previous one, as it also deals with the development of novel ways to modulate electricity consumption according to grid or production needs. While the previous case study considers the development of business models, electricity rates and physical equipment at the home level, this case study examines the efforts of one specific actor to value load shedding on the wholesale electricity market.

Distributed load shedding involves aggregating the load shedding actions of consumers connected to the electricity distribution network (mainly cutting off electric heating installations). This service—that is, an 'erased' kWh—can then be sold to grid operators in order to help them manage the real-time balance between production and consumption in the power system. Load shedding operations are activated through in-home boxes remotely controlled by an operator. This operator contracts with final electricity consumers, who agree to allow certain home appliances to be disconnected within certain timeslots, when needed by the operator.

In France, a private firm (Voltalis) has been pursuing this business model since 2007. Voltalis started by installing devices in private homes that can interrupt electric and water heating at peak times. It did so outside of the smart meter project and without using market devices such as price signals to encourage users to increase or decrease their electricity consumption at a given time. The only compensation offered to the final consumer in its business model for load shedding is the electricity savings they obtain through the deactivation of the devices.

Voltalis is able to supply the erased kWh on what is called the 'Balancing Mechanism' (BM), managed by the national Electricity Transport Grid (Réseau de Transport d'Electricité, or RTE) operator. The BM is defined by the transport grid operator as a 'permanent and transparent system of calls for tender' or a 'market' in which kWh are sold and bought. This system operates separately from the day-ahead spot market, where producers and retailers exchange electricity in order to supply their customers. The BM provides a real-time reserve of power that the TSO can use to balance the grid, when market actors do not meet their own balancing requirements. Offers are remunerated on a pay-as-bid basis.

As Voltalis's activity expanded, controversy arose as to the status of the erased kWh that Voltalis was selling via the BM. Some participants in the mechanism argued that Voltalis should compensate the provider of the kWh that it was 'erasing'. The providers, by contracting as an electricity provider with a customer (who then contracted with Voltalis), had committed to deliver—inject into the grid—the kWh consumed by each of their customers. Electricity providers are obliged to do this by the terms of their commitment to maintaining the equilibrium of the market, and to do so prior to the moment when each kWh is expected to be consumed. In turn, while its business was dependent upon this delivery, Voltalis's activity also resulted in a net loss for its customers' regular electricity provider. In response, Voltalis argued that since this kWh had not been consumed, there was no reason for it to be compensated: asking for compensation was just a way of hampering the emergence of distributed load shedding as a genuine alternative to electricity production in the grid. Load shedding and kWh production should be considered as purely symmetric solutions from a grid balancing and a TSO viewpoint, so there was no reason for the former to compensate the latter. So went the argument.

The first move of the electricity regulator (the Commission de Régulation de l'Énergie, or CRE) as a reaction to Voltalis's activity was to apply a pure market framing to distributed load shedding, by incorporating it into the BM. However, considering that Voltalis simply sells a kWh to the BM logically implies recognising that this kWh was produced by a provider. It is not our purpose here to detail the actors involved, the process and the technicalities of the arguments (for more detail see Reverdy 2017). However, what seems important for our purposes is the course that the controversy followed. It began in a technical and regulatory arena within the CRE: highly technical discussions were organised in a grid-related expert group—the CURTE (Comité des clients utilisateurs de RTE [Committee of electricity transport grid user-clients]). It then moved on to a legal-political body, the Council of State (Conseil d'État), where the decision of the CRE and its legitimacy to arbitrate this issue were challenged. Finally, it moved into the political arena (the French parliament). In all three of these arenas, market framing categories failed to resolve the controversy and stabilise a consensual valuation framework and process. Two different market solutions were explored: the BM (short-term balancing) and the capacity market (added capacity in order to assure the balancing of demand and supply) in order to try to induce Voltalis to shoulder the full burden of its membership in the collective organisation of the power system. Both failed to provide distributed load shedding with a consensual valuation framework and a viable business model.

Eventually, an alternative approach succeeded in temporarily stabilising a framework. In 2013, under a new law, a repayment per kWh (to its provider) was imposed on Distributed Load Shedding (DLS), but DLS was also deemed worthy of subsidy 'in order to account for the advantages of distributed load shedding for society' (Loi Brottes, 2013). In this new approach, which departed from a pure market framing, the value of distributed load shedding rested on its contribution to social welfare. An assessment of the social benefits of distributed load shedding was commissioned, but the principle of the subsidy was soon contested by many actors, including other industrial load shedding operators, on grounds that it could distort competition. In 2015, in a context including new entrants, the French government reasserted a non-market approach to distributed load shedding in a new law. A national call for tenders was issued in order to support distributed load shedding 'as necessary in order to allow for its development'. Several justifications were offered in support of load shedding activities, including their contribution to reductions in electricity consumption (not only its postponement) and to consumers' management of their electricity consumption. With this change, distributed load shedding was no longer conceived as a regular market and business activity, but as an emergent solution worthy of state support because of its potential social benefits—in the same way as renewable energies had actually been conceived and regulated. Under this new framing, several incumbents in the electricity sector began their own distributed load shedding activities. While supported through a call for tenders, distributed load shedding had to compensate for the production of the kWh it erased. This mechanism was justified by treating load shedding as a type of 'reserve capacity', replacing existing peak load power.

Despite its top manager's strong connections with the French political arena, Voltalis failed to impose the total equivalence of distributed load shedding within market coordination with electricity production itself (under the BM). While it gained financial support as well as the possibility to carry on with its development, it failed in its attempts to avoid being required to compensate the producer of the kWh it erased, and to see its ideal business model—based on a recognition of a symmetry between a megawatt (producing a kWh) and a negawatt (erasing a kWh)—validated. This business model would have threatened the current organisation of the electricity market. In it, Voltalis would rely on the BM and benefit from the ongoing responsibility sharing in this market organisation (at the moment of erasing, Voltalis *counts on* the 'to-be-consumed' kWh because providers are *committed* to the collective organisation of the grid), without acknowledging this codependency and accepting to pay due contributions to this collective construction (not wanting to contribute to the cost of this granted kWh). In other words, the mega- and negawatt as framed by Voltalis were not symmetrical, because only one of them (the megawatt) recruited the full set of relationships underlying the organisation of the BM. Whether or not this set of relationships was necessary to the functioning of the electricity market was a core question that remained unaddressed. At least, it was not answered in Voltalis's vision, which thus did not represent a full-blooded alternative.

Instead, Voltalis's business model ended up being redefined as an emergent one worthy of state support, and the organisation of the BM was kept unchanged. Incumbents joined Voltalis in this emerging sector, but as it was based on a distinctive, partly isolated mode of valuation (the tender mechanism) and required compensation for erased kWh, it no longer distorted the organisation of the BM. While distributed load shedding was made part of the ongoing energy mix, it was treated as a *potential* (future) alternative to energy production.

In the end, the controversy was not resolved. There was no consensual clarification of the value that should be assigned to distributed load shedding. As emphasised by Thomas Reverdy (2017), attempts to do so have alternated between an economic valuation dominated by market pricing, economic equivalence and uncertainty about future demand, on the one hand, and a political valuation in which it is valued in terms of its benefit for society, on the other hand. Market practices and theories have contributed, through successive valuation proposals, to isolating the valuation of distributed load shedding from the existing electricity market and to clarifying the extent of financial support for it. But the present case study mostly points at the limits of markets in sustaining innovation. The institutional instability of distributed load shedding seen here resulted from the fact that its integration into the electricity market caught it up in a set of abstract economic arguments and qualifications leading to ambiguities and uncertainties, resulting in a politicisation of the surrounding debates. Importantly, we can relate the controversy about the erased kWh and their compensation (or non-compensation) to the way in which the electricity market is organised materially as a way of scaling up market exchange. All kWh are made the same when injected into the grid (see Chapter 2 on resources). Both their origin and their property status are blurred. Only computer certificates bear witness to inputs and outputs. While these inputs and the outputs are thus attributed to particular actors, the appropriation of kWh within the grid remains pending, making it all the more difficult to address compensation issues.

In this fourth case study, we are thus faced with a particularly intricate and elusive market. Here, in contrast to the previous case studies, a newcomer, who is very well-connected in high political and regulatory circles, originated an innovative proposal for passing through the market, but only partially succeeded in introducing novelty. Distributed load shedding came to be recognised and financially supported in order for its development to continue—outside the market. Market practices, organisation and categories fell short of taking charge of this novelty and promoting decreased consumption, which would be good for the energy transition in any case. In some ways, in this case study, market fought market. Voltalis's framing of the kWh was an attempt at making the BM's kWh lootable, by detaching it from the process and the web of commitments that underlay its provision on this market. In this case study, distributed load shedding and the BM fought one another for recognition as legitimate market activities. Like the previous case studies, this confirms the decisive importance of incumbents when passing through the market is used for political ends, and underlines the contrast between the widespread view of markets as a level playing field and the complex realm of market-making practices.

6 What Happens to the Energy Transition When It Passes Through Markets?

Unsurprisingly, the four cases presented here do not offer a unified view of 'the market'. Instead, they represent several types of market devices, including devices for monopolisation and a case of failure (no market can be sustained for the erased kWh within the general market organisation of the electricity sector). These case studies support the idea that there is much to gain by entering into a fine-grained analysis of actual market devices. They illustrate ways in which markets can lead to positive or negative outcomes with regard to both energy change achievements and participation in steering these changes. They confirm, if confirmation was needed, that the market alone does not have a definite orientation. Far from the ideal of a level playing field, markets can be a way to differentially empower particular actors. The way in which actors are offered access to and empowered (or disempowered) in the arenas where markets are designed is decisive for what the resulting markets can achieve. The case studies illustrate diverse configurations and reasons behind the contrasting achievements of markets in relationship to the energy transition and to who is empowered to contribute to its steering. Markets can be politicised, as in the case of Figeac, in which local actors structured themselves in order to act for the transition *and* were empowered by State support (the value of the feed-in associated with their project) in the closed arena in which they negotiated their access to credit. Market design can also rely on an asymmetric access to information about the objects to be traded (e.g., tree stumps in

Aquitaine as a biomass resource) or about the devices underlying this design (the French smart meter case study), which results in power asymmetries in market design. The way in which markets are scaled up (the way entities are made the same to be traded on a larger scale) might also impose limits on what markets can do, as illustrated by the case of distributed load shedding. Indeed, in this case, the new entrant showed political will and power in the face of incumbents, but its claim to have the right to appropriate a kWh and sell it could not be cleared up, partly because the way the electricity market is scaled up blurs the appropriation of the kWh circulating into the grid.

One conclusion that is clear from these case studies is that markets are not inherently either good or bad for the energy transition, but that their affordances are of crucial importance to what actually becomes of energy transition processes—affordances here meaning what they offer as novel possibilities for new actors to form and to act. These affordances depend on the configuration of the market devices, and it is very notable in our case studies that the state plays a central role in the processes that configure these devices. In other words, the state retains a great deal of power in devising market devices. That being said, even when the state has a definite political will, it might be that marketing strategies—defined as the sophisticated practices of market making—are stronger than generic political ambition, because they are better anchored in the actual material workings of markets (as attested by the French meter case study) and they are thus in a better position to steer them. As a consequence, while political will is a precondition for 'civilising' the market, it is not a sufficient one.

In the introduction of the book, we defined relevance as the possibility, for entities that are concerned with an issue, to succeed in being acknowledged in the processes or arenas where the issue is to be addressed. Market studies have gone further in the analysis of relevance and of markets' capacity to take charge of concerns. Drawing on several strands in market studies, Geiger et al. (2015b) point at three ways in which markets can address concerns. The first, to 'refer, relate to', is when the framing of actors and entities on which market exchange relies, as well as the underlying order of worth, are challenged and debated. These have been termed 'hot situations' (Callon 1998a; Callon et al. 2002). In these cases, the 'cut' of the market is challenged, with market-external relations intruding into the market order and setting it in motion. In the second, defined as 'affect, influence', concerns relate to the way in which hot situations are taken charge of through settings such as 'hybrid forums' (dialogical spaces where matters of concern can be identified and debated: Callon et al. 2009) or 'heterarchies' (corresponding to local settlements which allow for the articulation of multiple common goods: Stark 2011). The idea here is that markets can be civilised by incorporating concerns. The third way in which markets can be concerned is defined as 'trouble, worry', and corresponds to situations in which controversies persist and take on a political dimension. Here, actors denounce the ways in which the shaping of the market supports dominant interests, and attempts are made to concern others in order to reframe the way in which a market has been shaped.

Our case studies can be placed in this framework [arrows point to the displacement of the situation in the course of the case study] (Table 1).

Table 1 Markets and concerns in the four case studies

	Concern		
Case study	**'Refer, relate to'** ('hot situation', challenging market framings of actors and entities) - **Setting markets in motion**	**'Affect, influence'** (taking charge of 'hot situations', 'civilising' markets through dialogical spaces) - **Incorporating concerns into markets**	**'Trouble, worry'** (controversies taking on a political dimension, denunciation) - **Controversies around market framing taking on a political dimension**
Aquitaine biomass	• ———	—————	——→ •
Figeac		•	
French smart meter	• ——→	• ———	——→ •
Demand Load Shedding (Voltalis)	• ——→	• ——— ←– – –	——→ • – – –

What our case studies show is that in reality it is quite challenging to realise the alleged possibility of 'civilising' markets through dialogical spaces, as it may replicate power asymmetries present in markets, albeit for different reasons. In one case, it is because the dialogical spaces proved to be asymmetric due to the absence of genuine counter-expertise on the entities under consideration (smart meters). In this case study, in which passing through demonstration and demonstrators structured the expertise, the dialogical space somewhat replicated asymmetries present in the ongoing shaping of the market. Here, strategic information and learning was almost exclusively in the hands of actors with an interest in developing the solutions under consideration (see Chapter 5 on demonstration). In other terms, because (informational) asymmetries largely overflow the market, seeking footing outside of the market to create dialogical spaces where it can be repaired is problematic. In the other case (distributed load shedding), market shortcomings resulted from the ongoing socio-material shaping of the electricity market, which does not allow claims about the appropriation of electrons in the flux to be sorted out. While the politicisation of the issue yielded a workable status for distributed load shedding activity, this status took distributed load shedding outside of the market (rather than reframing its market). Thus, in this case again, the market was not really 'civilised'.

Both cases challenge the idea that dialogical spaces can easily constitute an exterior to markets and a form of recourse capable of correcting and civilising them. This is especially true in the current period, in which policymakers strongly believe in the virtues of the market, and tend to empower market actors in the development of new technologies, notably through demonstrators. This results in a situation in which the knowledge needed to challenge emerging markets is in the hands of those actors who have an existing interest in developing these very markets.

The role of the state in structuring such an exteriority to the market—hence making it potentially 'civilisable'—is key (Figeac PV project) but multiple. Our case studies show that the state sometimes does not formulate political ends nor acknowledge the processes of market making (tree stumps in Aquitaine); sometimes finds itself unwillingly involved in the intricacies and complexities of these processes (French load shedding); and sometimes is itself the actor that blurs the frontiers, because it sustains the emergence of the same market actors that it empowers in the dialogical spaces (French smart meter).

7 Conclusion

Our goal in this chapter was to examine the now-frequent association of markets and market shaping with the conduct of energy transition processes. We did so using a set of case studies on energy transition processes in France, which we analysed through the lens of economic sociology, paying attention, where possible, to the devices and the fine-grained working of markets.

Our case studies revealed a series of market-like devices, rather than substantive market forces. They offer a contrasting view on market-based energy transition processes—one that is perhaps hopeful, but that invites care and caution when relying on markets to pursue energy transition goals. On the one hand, conducting the energy transition through market-based valuation principles could mean a 'fossilisation' of renewable energies (Raman 2013), as well as energy accumulation instead of transition (Bonneuil and Fressoz 2013). Our case studies show that this might well be the case in certain configurations. For instance, the tree stump case study shows producers attempting to 'fossilise' the Dordogne wood resource in order to get a hold on it. On the other hand, this should not be taken as a generality: market devices can also present opportunities to act and to intervene, as illustrated by the Figeac case study.

The results of our case studies thus run counter to the widespread assimilation of markets to a 'level playing field' that can foster innovation and 'fix' our energy problem. They suggest instead that the outcomes of attempts to pass through markets are uneven with regard to both the development of new solutions for the energy transition and the extent to which these can be steered democratically. Markets per se do not exist, neither do they have a specific orientation. Their potential in relationship to the energy transition very much depends on what we attempt to achieve with them.

What also appears quite clearly in the four cases is the complicated work involved in defining and shaping market participants: buyers, sellers, goods to be exchanged and even the marketplace. It is not enough to calculate the energy content of tree stumps or the exposed surface of photovoltaics. In order for a market to take hold, these dimensions must be articulated to what already counts for the actors. This opens the door to the valuation of things other than what the market usually recognises as valuable. This underlines the complexities involved in instrumenting markets for the energy transition, and should stand as a warning against an overly instrumental take on markets. On the one hand, clear-cut cases such as Figeac or Aquitaine biomass, each in their own style, foreground the decisive importance of public policy in empowering certain actors and offering them the opportunity to bend market processes for better or worse. They suggest that there is nothing we cannot achieve with markets, if we clearly and carefully work to achieve it. On the other hand, more ambiguous cases—French smart meters and distributed load shedding—foreground the complexities involved in working with markets to achieve political ends.

The possibility has been advocated of addressing concerns and political ends through markets—'civilising' them—in various ways, such as attaching them to dialogical settings in which multiple common ends can be articulated. Our analysis suggests that this potential depends on the assumption of an exteriority and otherness to the market. Gathering and assembling such an exteriority may be difficult when institutional power, expertise, and the information required for valuation processes are in the hands of the market actors to be challenged. The possibility of 'civilising' markets requires setting up the conditions needed to assemble an otherness to a market framing (e.g., counter-expertise, access to knowledge, availability of non-market parties…).

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Notes

1. EU, 1997, Communication from the Commission, Energy for the Future: renewable sources of energy—White Paper for a Community Strategy and Action Plan, COM (97) 599 (final), 26 November 1997, Brussels.
2. EU, 2000, Commission Européenne. Communication concernant les politiques et mesures proposées par l'UE pour réduire les émissions de gaz à effet de serre: vers un programme européen sur le changement climatique (PECC).
3. EU, 2001, European Commission, Directive 2001/77/CE of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market. Official Journal of the European Communities, L 283, 33–40, 27 October 2001, Brussels.
4. EU, 2003a, European Commission, Directive 2003/30/EC of the European Parliament and of the Council of 8 May 2003 on the promotion of the use of biofuels or other renewable fuels for transport. Official Journal of the European Communities, L 123, 42–46, 17 May 2017, Brussels.
5. EU, 2009a, European Commission, Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (Text with EEA relevance), L 140, 16–62, 5 June 2009, Brussels.
6. EU, 2003b, European Commission, Directive 2003/54/EC of the European Parliament and of the Council of 26 June 2003 concerning common rules for the internal market in electricity and repealing Directive 96/92/EC—Statements made with regard to decommissioning and waste management activities, L 176, 37–56, 15 July 2003, Brussels.
7. FR, 2000, Loi n° 2000-108 du 10 février 2000 relative à la modernisation et au développement du service public de l'électricité. Paris.
8. FR, 2005, Loi n° 2005-781 du 13 juillet 2005 de programme fixant les orientations de la politique énergétique, JO n° 163 du 14 juillet 2005, p. 11570.

   FR, 2009a, Programmation pluriannuelle des investissements de production électrique. Ministère de l'Industrie. Période 2009–2020.

FR, 2009b, Circulaire du 19 mai 2009 relative à la planification du développement de l'énergie éolienne terrestre adressée par la Direction de l'énergie et du climat, Paris.

9. In the sense of preventing the entry of new actors into the sector and the development of different activities, such as the development of wood biomass products for domestic heating (small boilers).
10. Captation is a term coined by Cochoy (2007) to describe the strategies and devices deployed to influence, divert and manipulate fleeting and fluid collectives (e.g., citizens, electors, clients, consumers). It 'is a matter of having a hold over something that one does not, or rather not yet completely control' (Cochoy 2007, p. 205).

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4

The Politics of Some Policy Instruments

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With contributions from Olivier Labussière, Edith Chezel, Michel Deshaies, Antoine Fontaine, Laurence Rocher, and Eric Verdeil

List of abbreviations

ANME	Agence Nationale pour la Maîtrise de l'Énergie
BIPV	Building-Integrated Photovoltaics
EEG	Erneuerbare-Energien-Gesetz
FEE	France Énergie Éolienne
FIT	Feed-in Tariff
FNME	Fonds national de maîtrise de l'énergie

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PV Photovoltaics
STEG Société tunisienne de l'électricité et du gaz
ZDE Zone de développement de l'éolien

1 Introduction: Policy Instruments That Frame and Foster Capitalisation

Policy support has been crucial in triggering and shaping the recent development of renewable energies. Often, this support links renewable energy development closely with market deployment or investment practices, in conceptual or in practical terms.

In this chapter, we explore the role of such policy instruments in energy transition processes as it emerges in several of our case studies (in Germany, France, and Tunisia). We focus on instruments aiming to spark and direct investments. This type of instrument includes subsidies (which reduce the cost of investment), fixed tariffs (which increase and guarantee future revenues from investment) and to a certain extent tenders (which sometimes grant tariffs, but do so in a competitive setting).

In contrast with market instruments organising competition to (supposedly) promote the most efficient solutions—say, devices setting up quantitative allowances that can be traded on specific markets, such as tradable carbon certificates or energy saving certificates—the instruments we consider are directed towards investment, entrepreneurship, and investment in new technologies, or what we call capitalisation. Although they sometimes create niches protected from market competition, they are primarily aimed at fostering policy-oriented capitalisation in hand-picked technologies. The promotion of investment in renewable energy technologies enacted by these instruments is intended to contribute to broader and varying political objectives, such as reducing greenhouse gas emissions, supporting domestic industries and innovation, and market integration, in Europe; and grid stability and decreasing energy subsidies in Tunisia. The policies considered here thus seek to direct investments as a way to tackle public problems, whose management may then seem to be reduced to a question of steering finance through the appropriate design and calibration of these instruments.

This chapter looks at the workings of these instruments, what they provoke and how they are regulated, and what happens when investors are charged with the realisation of political objectives. It examines the type of politics that surrounds and participates in the development of these instruments, their implementation, and the pursuit of the political objectives to which they are intended to contribute.

1.1 Our Case Studies

We explore these questions on the basis of three national case studies and five local case studies in France, Germany, and Tunisia. France and Germany are part of the European Union and are deploying renewable energy policies in similar contexts, although their energy systems and politics differ in many respects. Tunisia is a developing country and the problems addressed by its energy policy are quite different from those in European countries, but the organisation of its energy system was largely inspired by the French example. Given the disparity of the countries and case studies, we do not offer a comparative analysis, but instead, try to give accounts of events in the three countries through the same lens.

In France and Germany, feed-in tariffs (FITs) have been a central device of renewable energy policy. FITs first appeared as voluntary schemes in Germany and Denmark in the late 1980s to accommodate increasing wind power capacities and facilitate their integration into electricity grids and markets. They were introduced in the legislation of both countries in the early 1990s, and then grew increasingly widespread and sophisticated as European renewable energy policy developed (Cointe 2014; Evrard 2010; Jacobs 2012). By the end of the 2000s, they had become the most widespread instruments for renewable energy promotion in Europe. Through the combination of a purchase obligation and a fixed price (determined politically and guaranteed by the State), FITs offer high investment security, since they guarantee a commercial outlet and sale at a price that ensures profits. Their aim is to enable the large-scale deployment of grid-connected renewable energy generation capacities. In France and Germany, FITs can be said to have succeeded in this objective, especially for wind power and PV.

Assessing and regulating them in relationship to other objectives (e.g., employment, industrial development, environmental protection), however, is less straightforward. As the French and German case studies will show at length, FITs have evolved from mere price-based mechanisms into more sophisticated policies in order to take into account their own effects and to allow for more control over the markets and technologies they support. They are now accompanied by additional regulatory instruments, such as wind power development zones and developer good practices conventions in France.

In Tunisia, solar energy is supported by investment incentives in the framework of the programmes '*Prosol résidentiel*' (set up in 2007 for residential solar heating) and '*Prosol elec*' (launched in 2010 for solar PV). In contrast to FITs, these instruments have a very well-defined scope and objectives, and target a well-defined set of actors: they are mainly targeted at households (small-scale energy users), and are meant to contribute to decreasing electricity demand and improving the stability of the electricity grid by encouraging onsite energy generation and consumption. Both programmes consist in a combination of financial incentives for purchasing solar installations: subsidies for solar systems, financial aid in the form of loans reimbursed via electricity bills, and gains from reduced electricity use after installation of the solar system. The objective of these programmes is thus not to accelerate the large-scale deployment of renewable energy generation. Instead, they are meant to encourage the small-scale development of emerging technologies and associated practices through subsidies whose total amount is directly controlled by the state and by the international lenders that support them. Contrary to French and German FITs, the *Prosol* programmes are highly controlled and designed to avoid overflows (Table 1).

1.2 Current Approaches to These Instruments

Instruments such as FITs and investment subsidies can be considered from several perspectives. We will highlight four main strands of approaches to renewable energy policy instruments in the literature. A first strand, based in the economics of innovation, emphasises that renewable energy technologies, like any other technology, are likely to traverse a so-called 'Valley of death' when they need particular financial support, before they are ready for widespread deployment (Murphy

Table 1 Case studies in this chapter

Wind power	Photovoltaics
Feed-in tariff schemes + Planning and zoning schemes	Feed-in tariff schemes Increased sophistication and refinement
Changes in national policies	Changes in national policies
Focus on Northern Friesland[a] (Germany) and Narbonnaise (France)[b]	Three projects constructed around FITs: Centrales Villageoises[c] (France) Fermes de Figeac[d] (France) The energy cooperative of Weissach-im-Tal[e] (Germany)

[a]The material presented draws on a case study undertaken by Edith Chezel (Chezel 2015; Chezel and Labussière 2017)
[b]The material presented draws on Nadaï and Labussière (2010)
[c]The material presented draws on a case study undertaken by Antoine Fontaine (2015)
[d]The material presented on this case draws on Cointe (2014, 2016)
[e]The material presented on this case draws on a case study undertaken by Michel Deshaies (2015)

and Edwards 2003; Weyant 2011). FITs have been foregrounded as the instrument for triggering such support that potential investors most prefer (Bürer and Wüstenhagen 2009). Second, there have been numerous studies focused on the classification, design, evaluation, and fine-tuning of renewable energy policy instruments (Frondel et al. 2008; Haas et al. 2004, 2007, 2011; Hvelplund 2001; Lauber 2004; Ménanteau et al. 2003; Midttun and Gautesen 2007; Mitchell et al. 2006; Timilsina et al. 2012…). Third, in a less directly policy-relevant fashion, a growing number of studies retraces the *politics* of the emergence, evolution, and fine-tuning of renewable energy policy, most often from a political science perspective (for instance, Cointe 2014, 2017, for a recent history of tariffs for PV in France; Evrard 2010 on wind power policy in France; Jacobsson and Lauber 2006, on PV policy in Germany; Lauber and Schenner 2011, on debates around EU-wide harmonisation; Debourdeau 2011, on French PV tariffs; Nadaï 2007, on wind power policy in France; Hoppmann et al. 2014, on the evolution of PV tariffs in Germany…). This literature has mostly examined national policy, with a focus on traditional policy-making arenas and debates (parliament, government, administrations, EU institutions). It also increasingly considers valuation issues, relying on economic sociology and performativity studies (Debourdeau 2011; Laurent 2015; Pallesen 2016; Cointe 2016, 2017; Silvast 2017). Finally, a broad current of literature on public policy instrumentation is heavily influenced by Foucault's work on governmentality. It strives to analyse power via the practices, devices, procedures, and rationalities of government (Foucault 2004, p. 819; Laborier and Lascoumes 2004). This literature does not address renewable energy policy per se, but it provides an interesting perspective on the workings of instruments or 'technologies of government' (Miller and Rose 1990). Breaking with a functionalist conception of public policy instruments, it stresses that instruments convey and enact political representations and format rationalities to align them with specific objectives (Miller and Rose 1990). They thus have their own agency and dynamics, and must be analysed not only in relationship to the objectives behind them, but also to what they produce (Lascoumes and Le Galès 2007; Laborier and Lascoumes 2004; Lascoumes 2004). Instruments also generate inertia, unintended effects, problems, and resistance. They thus have to adjust to or incorporate these effects. Governmentality studies have outlined the difficulties in making reality 'amenable to administration' (Miller and Rose 1990, p. 4). However, despite having pointed out the resistance of reality and the unintended effects of instruments, this literature has mostly focused on how instruments affect and format that which (and those whom) they regulate, paying limited attention to the subversion, reinterpretation, and emancipation of instruments.

1.3 Analysing These Instruments in Relation to Their Milieu

To some extent, the present chapter addresses the capacity of instruments to generate their own politics. However, it undertakes a slightly different grain of analysis in suggesting that instruments deploy along with a 'milieu'—meaning a set of actors, devices, knowledges, and practices—which is part of their functioning, and which grows with them and influences their becoming. This perspective echoes work by Dinica

(2008) emphasising the central role played by public–private partnerships in the early spread of wind power in Spain, and showing that an overly narrow perspective on instruments and their design precludes the understanding of the spread of renewable energy. This chapter thus does not begin from the assumption that a single instrument is the main driver of renewable energy development in a given country. Much to the contrary, it proposes to investigate how such instruments deploy in practice, how instruments and their milieux are coproduced, well beyond policy arenas and on different scales, and how these shape (or fail to shape) changes in energy systems.

It follows that, while instruments are at the centre of our analysis, we do not consider them as fixed technical devices, but as elements in wider assemblages of policy and capitalisation. Instruments themselves do not exist without an array of legislation, institutional arrangements, previous policies, and other, complementary instruments that can expand or restrict their scope (e.g., a FIT for building-integrated photovoltaics + rules for grid access + definitions of building integration + tax credits that make them more accessible).

As we will detail in the next section, our analysis takes its inspiration from pragmatist sociological approaches to capitalisation and (to a certain extent) markets (because the promise of value is in some cases mediated through markets). We focus on the multiple, complex relations between policy instruments and their milieux, and investigate the status of these instruments as incentives to investment from an empirical and methodological perspective. We explore how this translates into specificities in their functioning and their interactions with the milieu that unfolds around them. In doing so, we also consider the spaces for participation that are offered either around project development or around instrument design and adjustment.

1.4 Organisation of the Chapter

We start by describing how the instruments featured in the case studies work (§2), and discuss concepts from economic sociology and studies on capitalisation that can help analyse them, before detailing our approach in terms of milieux (§3). We then draw on our empirical material to highlight several reasons why it is impossible to tell the whole story if instruments are considered in isolation. We show that economic and financial elements do not suffice to account for what the instruments do: first, the financial incentives are only one part of the design and success of the projects they trigger; and second, because the instruments' effects often extend beyond the mere multiplication of new forms of transactions (§4). We then examine the government and regulation of instruments and their milieux (§5 and 6). We provide examples of the difficulties and challenges of framing investments through policy instruments, along with different strategies to address them, emphasising their iterative and experimental character. In the final section, we discuss the findings presented in the chapter in the light of the proposition of this book (§7). We show that the delegation of political objectives to instruments that operate as capitalisation *agencements*, far from depoliticising an issue, brings about its own politics. The use of policy-dependent capitalisation to address public concerns clearly does not reduce politics to issues of instrument design and calibration.

2 How These Instruments Work

Policy instruments such as FITs and subsidies have a basic structure and logic, through which they are intended to organise action in order to align it with a stated aim. Those we consider in this chapter have a common feature: they are meant to help achieve public policy objectives by encouraging the involvement of diffuse private economic actors, encouraging and directing investment towards specific systems of energy production by making them less costly and/or more profitable. How exactly do they work?

2.1 Fostering Policy-Oriented Investment

FITs force electricity suppliers to purchase the electricity produced by a set of eligible technologies (e.g., wind power, PV, bioenergy) at a fixed price and for a fixed period of time—today in France and Germany, 20 years. The list of eligible technologies, the price, and the duration of the agreement are all determined politically. In theory, tariff level and agreement duration are calculated so as to guarantee the profitability of investments; in practice, they are negotiated by actors who can be as varied as renewable energy industry representatives, utilities, grid operators, state agencies, NGOs, civil servants, and elected officials. The resulting costs are borne collectively through a levy on electricity use, also defined by law (*Contribution au Service Public de l'Electricité* in France).

The two *Prosol* programmes in Tunisia were designed to promote domestic solar energy, in the form of solar heaters and photovoltaic systems. They target individuals and industries (in the case of *Prosol Elec*, provided that they are under contract with the national electricity), reinforcing their economic capacities with investment subsidies and access to loans repaid via electricity bills (Benlalouache 2013). These programmes are financed by the national electricity provider (the Société tunisienne de l'électricité et du gaz (STEG)), the *Fonds National de la Maîtrise de l'Energie* (FNME), and international donors. Contrary to FITs, whose objective is to increase the amount of electricity from renewable energy sources fed into the grid, *Prosol* encourages onsite consumption and reductions in grid-provided electricity use. The reduction in energy bills associated with the combination of solar equipment and *Prosol* subsidies makes the investment profitable after 5–12 years. The development of markets for solar technologies is thus a means to reduce strain on the electricity grid and guarantee its stability.

German and French FITs and the Tunisian *Prosol* programmes thus work as guarantees of profitability for investments in specific energy generation equipment. They are designed to spur investments that are expected to contribute to specific policy objectives. Whether the guarantees they provide are sufficient, and whether they actually contribute to policy objectives, largely depends on their design, which to an extent makes political debates around them more technical.

2.2 Framing Market Transactions and Investments

In general, investors retain significant control over the content and organisation of renewable energy projects (Cointe 2014, Chapter 2). Nonetheless, the instruments determine conditions for access to the markets they promote, and frame transactions in a more or less strict fashion in order to entice actors to invest in a way that conforms to policy objectives.

One first thing they do is to **define eligible goods**: the electricity produced from renewable energy sources using specific technologies and fed into the grid for FITs; technologies using solar energy for onsite consumption in the case of Prosol. They also determine **who takes part in the transaction** (in particular who the purchaser will be) and under what conditions. They can do so directly, for instance, by specifying eligible recipients (only STEG clients can benefit from the Prosol Elec programme), or less directly through technical and administrative procedures required to access the incentive. For instance, in France, FITs are awarded only after purchase agreement requests and grid-connection requests, which have to be done on a project-by-project basis and following specified procedures. These instruments also contribute more or less directly to the **formulation of prices and contracts**.[1] The Prosol programmes, for instance, have fostered standardisation in the supply of solar products in order to articulate technological solutions with uses that are largely framed by economic motivations.

In doing so, these instruments contribute to foregrounding a perspective in which the **economic and financial dimensions** of current renewable energy development are framed as central: the value of renewable energy technology is framed as the value of investing in it, and in particular as the value of the revenues that can be derived from it in the future. This vision is conceived to match with that of a potential investor, a figure that has to be adopted, at least to a certain extent, by individuals or collectives interested in developing renewable energy projects.

Such instruments' framing of goods, calculative capacities, prices, and conditions of profitability also **formats its beneficiaries**. To benefit from a given incentive, investors have to conform to the model of investors performed by the instrument. For instance, they need to conceive profitability in a way that is compatible with the conception assumed by the instrument, have the financial capacities to withstand the timeframe required by the instrument, have access to technologies and to the space to install them… While Prosol targets individuals and industries willing to purchase small-scale equipment for onsite energy generation, FITs are designed for agents investing in grid-connected electricity generation capacities who are able to react quickly to incentives. As FITs leave great freedom in the design of business models and the sizing of projects, they can trigger the mobilisation of financial, human, and technical resources on a variety of scales, depending on the ambition of projects. Contrary to Prosol, they are meant to lead to the scaling-up of renewable energy development.

By framing prices and contract duration, these instruments also frame the point in time at which the investment will reach profitability. They thus confer on investments a **tempo**. In the case of wind power in Northern Friesland, for instance, the influence of the incentive structure on the timing of investments is quite clear. In this region, wind farms are exploited by 'citizen wind farm' (*Bürgerwindpark*) collectives which meet in assemblies, monitor the evolution of FITs, and discuss the corresponding opportunity to repower wind farms (i.e. replace them with more efficient or higher-capacity wind power installations) or to install new ones nearby depending on available areas.

These instruments thus frame and contribute to realising a scenario for encounters between potential investors (e.g., banks, renewable energy developers, citizens, local authorities…) and other actors (local administrations, communal authorities, electrical grid manager, electricity users…) in order for projects to be developed. They are charged with conveying a vision and ensuring that promises of future value can translate into actual money flows and revenues through appropriate devices, calculations, narratives, and encounters.

3 Capitalisation, an Inquiry from the Milieu

The two types of instruments considered here can be described as market devices designed and calibrated by public authorities in order to direct investments in the service of specific policy goals. This means that merely looking at them as market devices is not enough to understand how they work.

3.1 Market Devices That Aim to Direct Investment

The 'new new economic sociology'[2] defines market devices as devices that organise economic exchanges by framing goods exchanged, calculative agencies, market encounters, and price setting practices (Çalişkan and Callon 2009, 2010; Muniesa and Callon 2007). This perspective has two advantages for our study. First, its refinement around the concept of socio-technical *agencements* (Callon 2013; Laurent 2015) involves a conception of market devices as heterogeneous/hybrid combinations of material, social, and discursive elements that need to be carefully arranged together, a view that fits with our proposal to consider instruments along with their milieux. Second, one of its key contentions is that economic activities depend on framings that always risk being overflowed and generating matters of concern (Callon 2007). Thus, Callon (2009) has argued that a functioning market is one that is able to take the concerns it raises into account. This draws attention to the dynamics of market devices, in keeping with our ambition to consider changes in and readjustments of renewable energy policy instruments. That being said, describing FITs or investment subsidies as market devices is insufficient: they are not just any type of market device. They need to be further specified for two main reasons that resonate with current discussions in market sociology and STS.

The first reason is that they are also political instruments. While they share a great deal with other market devices, FITs and investment subsidies did not themselves emerge from market activities and actors. Instead, they were created by public authorities to facilitate, organise, and regulate investments that would not occur without them (or would remain marginal), because these investments were expected to contribute to political goals (the development of renewable energy in France and Germany, grid stability in Tunisia). Such devices that articulate political objectives and market activities have recently begun to attract scholarly attention in pragmatist studies of markets. Overdevest (2011), for instance, argued that such objects (such as food safety and environmental regulations) provide opportunities to explore changes and destabilisation in markets, and that technologies used to perform markets can also be used to perform other values. The argument has been echoed in recent works on so-called ‘concerned markets’, defined as markets to which non-economic values are attached, and which produce multiple values and social relations (Callon 2009; Geiger et al. 2014; Cochoy 2015; Krafve 2015). Building on Callon’s propositions, this literature analyses market development as an experimental process in which values and market devices are constantly re-evaluated and reshaped in attempts to take into account the various relationships and concerns that emerge from market operations.

The second reason not to restrict our framing of these instruments to their status as market devices is that they work by framing investments rather than transactions. Though market device approaches help make sense of the articulation of politics and economics in certain types of policy instruments, speaking of (concerned) markets may not be the best way to approach FITs and investment subsidies. While they can be described as market devices in a general sense, they are probably better described as an investment or capitalisation devices. They work by encouraging investments (oriented towards future profits) rather than by fostering competition in transactions of goods—as can be seen in their presentation above. It is noteworthy that the EU Commission itself has always seen the compatibility of FITs with the building of the internal electricity market as problematic, because of the potential distortion to free market functioning it may entail as a form of state aid. Recent work on capitalisation can help us take this crucial dimension into account.

3.2 Capitalisation as a Cultural Process

The above clearly shows that these instruments frame and foster investment by containing a problem—that of the value of technologies—and a solution for it along multiple dimensions. This multidimensional process of turning an object into something worth investing in—hence capitalising on it—has been named ‘capitalisation’ (Muniesa et al. 2017). Capitalisation covers the broad and collective—cultural—work of valuation, ranging from blank calculative methodologies and operations to metaphorical ways of capitalising on mundane activities (deriving future revenues from what we do). Akin to the work of the tariff, capitalisation sets a value for the thing as equal to the profits that can be derived from it in the future. It also sets the conditions for this value to be performed and become real. This includes setting up relational spaces for encounters and resolving certain issues that are usually dealt with by business models, such as demonstrating future value and revenue streams (a point decided on a political level in the case of the tariffs), qualifying goods (wind power or solar PV kWh are endowed with a renewable energy qualification by decree, and the guarantee of origin allows this quality to be traded as a certificate), and users (partly, by granting certain users priority for injection into the grid). In the language of business models, these correspond to the value proposition, the value network, and the value model. Capitalisation thus combines a vision, a scenario (narrative, actors, capacities, encounters), and devices and settings (formulation of professional practices, instruments, methodologies…) to perform the value that it foregrounds.

This pragmatic approach to capitalisation processes is relevant in the analysis of policy instruments because it strongly suggests that they do not exist and perform in a vacuum. Visions and values are enacted in various configurations through the combined actions of the instruments' promoters and users.[3] While capitalisation theory enlarges the range of modes of analysis of policy instruments, it has not yet been much applied to renewable energy policies. As we showed in the introduction to this chapter, existing analyses of these instruments have not acknowledged the full dimensionality of their deployment. While the financial dimension is, in fact, a central part of current renewable energy development, one key question is how this financial approach is actually incorporated into renewable energy deployment, and what type of politics around these instruments is fostered as a result.

A renewable energy project incorporates and articulates different dimensions together through the siting of material devices (solar thermal or PV panels, wind turbines). It has a multiple existences as an economic and financial entity, but also as a social, technical, territorial, legal, and regulatory one. A successful project articulates capitalisation along several different dimensions. While capitalisation carries the promise of an encompassing approach, this strand of analyses is a recent development, and has mostly been focused on the economic, management, and financial dimensions of capitalisation.[4] In what follows, we would like to analyse the politics that surround the development of policy instruments by proposing a mostly non-financial exploration of their functioning as devices for policy-driven capitalisation.

In doing so, we regard these instruments as socio-technical *agencements* defined and calibrated by public authorities. *Agencements* consist in combinations of material and discursive elements that organise transactions, and notably investments in new energy technologies, by framing economic goods, agents, prices, and encounters. *Agencements* point to the distributed and dynamic character of (economic) agency: by providing a frame for action, they also trigger potential overflows and transformations (Callon 2013; Laurent 2015).

3.3 Teasing Out the Role and Dynamics of the Milieu

While framing instruments as *agencements*, we would like to (somewhat redundantly) tease out the role of the hybrid network that grows along with their development, and its role in the politics that develops around them. Taking inspiration from the work of Gilbert Simondon (1989) on the genesis of technical objects, we analyse this network in terms of the notion of '*milieu*'. Purposefully, foregrounding these policy instruments' milieux enables us to analyse how instruments build on territorial, social, or political dimensions in order to foster policy-driven capitalisation.

Simondon holds that technologies do not exist separately from their environment, but progressively emerge while producing their own (associated) milieu. In this process, the technical object is a 'mediation' of a specific type, as it engages things in a completely new relational reality. Instruments, by setting incentives, set-ups, and devices, act as mediators in bringing actors and entities into a new relational realm, which grows as they are implemented, and constitutes a Simondonian milieu: it becomes part and parcel of the instruments' own realm.

In what follows, we explore the relationship between instruments and their milieux by **looking at the concrete arrangements through which instruments and their milieux deploy and evolve**. The empirical material that we draw on allows us to consider two interacting aspects of the arrangements through which instruments make a difference. First, our empirical material offers a view on **how policy instruments are made operational, regulated, and reconfigured** according to evolutions in their effects and/or objectives. We thus look at the careers of FITs for PV and wind power in France and Germany, as well as the two Prosol programmes in Tunisia. In analysing these national careers, local case studies—wind power in Northern Friesland (Germany) and in Narbonnaise (southwestern France)—provide insights on how the emergence of these instruments reinforced pre-existing interests in wind power development, and structured collectives that had to be taken into account in changes made to these instruments at the national level.

Second, the empirical material provides **insights on how policy instruments are actually seized and activated by collectives of actors on the local level**. The case of Northern Friesland provides a historical perspective on the development of wind power in a region, and on how various actors, institutions, and territories arranged to seize FITs and, later, to devise zoning plans. The case of Narbonnaise, in southwestern France, shows how multiple values, including concerns for bird protection, can be woven together with environmental and economic logics in seizing the tariff for wind power. Three project-focused case studies make visible the work involved in using FITs for PV as a basis for developing or renewing collective involvement in renewable energy. The energy cooperative of Weissach-Im-Tal (Baden-Württemberg, Germany), the Sicaseli-Fermes de Figeac cooperative (Lot, France), and the Centrales Villageoises (Rhône-Alpes, France) all initiated photovoltaic projects built around FITs. In different ways, they all articulated various logics and values to the market incentive provided by the instrument and, to varying extents, turned it into something else.

4 Why a Focus on Policy Instruments Cannot Tell the Whole Story

Arguably, economic incentives do work. The impacts of FITs levels and reforms can be seen in the pace of renewable energy deployment. But renewable energy support schemes cannot be reduced to their status as economic incentives. Building a project around an economic incentive requires the (re)arrangement of capacities—which are not only economic or financial—in a way that is compatible with the framing proposed by the instrument. To function, an instrument relies not only on the occurrence of financial and market operations, but on the emergence and arrangement of collectives that bring markets to life and drive them forward by constituting new capacities and relationships.

4.1 Incentives Do Not Act Alone

Analysis of projects articulated around FITs for PV shows that while the incentive does act as an initiator, this effect is far from immediate. FIT-supported PV are particularly interesting in this respect. The combination of strong incentives (high FITs) with technologies that are flexible, modular, and relatively easy to handle favours the rapid development of a wide diversity of small- or large-scale socio-technical arrangements. The contrast between the projects of the energy cooperative of Weissch-im-Tal in Baden-Württemberg and the Centrales Villageoises in the Rhône-Alpes regional natural parks sheds light on the potentialities and challenges of the process of arrangement by and around instruments.

The Need for a Collective Venture

The case of Weissach-im-Tal (Baden-Württemberg, Germany) focuses on an energy cooperative set up by the city council to install photovoltaic systems on the roofs of public buildings. FITs were critical in the decision to start the project, but they were only one of the elements that enabled the municipality to invest in PV. Weissach's energy cooperative was created in 2008 by the city council, following requests from citizens. It brings together about 250 people, and has financed a dozen photovoltaic installations on the roofs of public buildings made available by the city council. Most of its members have long been involved in the promotion of renewable energy as an alternative to nuclear and fossil resources. In particular, its leaders were first active members of the local solar association Rems Murr, which has existed informally since the 1980s, and officially since 1994. Rems Murr has acted as a venue for reflection and experimentation and as a platform for learning and exchange among local renewable energy initiatives, thus contributing to the emergence of a local milieu favourable to renewable energy projects.

The cooperative has also taken advantage of a favourable historical and institutional context. In Germany, energy cooperatives benefit from a number of legal and financial privileges (exemption from the obligation to publish financial statements since 2004, no cap on the amount of subscriptions or the number of members). In 2006, the creation and functioning of cooperatives were simplified, reviving this form of organisation in the energy sector, and particularly in renewable energy: the number of energy cooperatives multiplied by 10 between 2006 and 2013, and the Weissach cooperative is part of this wave. This model is a renewal of the model of the electricity cooperatives that played a key role in the electrification of rural Germany in the first half of the twentieth century. It also reproduces the model of agricultural cooperatives such as the Raiffeisen-type systems that were established in southern Germany in the nineteenth century in collaboration with small local cooperative banks, the *Raiffeisenbanks*.

Finally, in the case of Weissach-im-Tal, the cooperative's project built on certain characteristics of PV technologies. The FIT was also available for other technologies, but PV had the advantage of being relatively easy to install, and of rapidly making the results of investments visible. The availability of public rooftops then became a determining parameter for the viability of the project, as much as, if not more than, the level of FITs. After three years, the stock of non-equipped public roofs in the city ran out, while the decrease in the level of FITs for PV-generated electricity reduced the financial attractiveness of investment in PVs, threatening the cooperative's future. However, the capacities that had been structured to carry out this project did not disappear: they have eventually been rearranged around a new support scheme for another technology: the Land's *Windenergiewende*, which eliminated wind power-free zones in Baden-Württemberg to support wind power development.

The Centrales Villageoises projects in the Rhône-Alpes region also built on an environment and set of capacities whose engagement with renewable energy predated the creation of FITs. In this case, however, tuning these capacities to the logic of FITs turned out to be quite challenging. The project was initiated by the Vercors Regional Natural Park and the regional energy agency, Rhône-Alpes Energie Environnement. Both have been involved in the development of renewable energy in the area for several decades. They had collaborated before in the context of European programmes. While their experience and networks were assets for the project, they had emerged during projects that focused on the territorialisation of energy issues, and mobilised technologies other than those now promoted by FITs. FITs, in contrast, were designed to facilitate investment without particular consideration for the territorial or social dimensions of projects: building a project around FITs thus implied a reconfiguration and updating of their expertise.

Here again, the incentive provided by FITs acted as a trigger. In this case, however, building projects on the basis of FITs turned out to be challenging for several reasons. First, the Centrales Villageoises projects are driven by territorial concerns and by an ambition to develop solar energy as a local resource; they seek to exploit solar potentials collectively and locally. By contrast, FITs foreground the economic dimension of the solar resource and gear actors' attention towards individual profitability. Second, given their territorial ambition, the Centrales Villageoises projects seek to associate local actors in all their heterogeneity. They were too busy assembling these heterogeneous collectives to act in time to reap the incentive at its highest point and maximise return on investment. In turn, contrary to the projects of Weissach-im-Tal or the Fermes de Figeac (detailed below), this has not been a key objective of the project.

Seizing FITs, in this case, is all the more difficult that it is difficult to gather diverse types of photovoltaic installations within a single project within the FIT framework. Following the 2011 reform of FITs for PV-generated electricity in France, the Centrales Villageoises project developers found themselves chasing after FITs that kept changing (in both levels and categories such as individual/commercial, roof-integrated or not) and constantly re-evaluating what the FIT scheme did and did not allow at a given time—in particular, when it came to putting together different types of PV installations that did not all fall within the same tariff category. The Centrales Villageoises collectives found it extremely difficult to articulate their project around FITs. To overcome these difficulties, they tried to resort to direct political lobbying, attempting to convince public authorities to take into account the specificities of their project, and particularly their non-economic value, but failed to carry enough weight as a political force for ministers to heed their concerns.

Collectives That Articulate Multiple Values

Access to the incentives provided by renewable energy policy instruments depends on the capacity to conform (at least to an extent) to the investment model and rationale that instruments convey. This capacity, however, is far from relying solely on economic and financial resources. Collectively conforming to the instrument's framing requires articulating the multiple values to which the various members of the collectives hold, in one way or another.

In the cases of Weissach-im-Tal and of the Centrales Villageoises, it is clear that transactions around photovoltaic electricity were not the only reason for the existence of the socio-technical collectives that the FIT incentive set in motion. They drew on technical, legal, and social capacities and resources, some of which predated the incentives and were renewed by it. It follows that the effects of these instruments cannot be reduced to the realisation of economic transactions and investments that would not have taken place without them. **Since they rely on multiple resources, the collectives that emerge with the incentive are not merely economic entities: while organising to seize the incentive, they can transform territories, create new associations, emerge as political actors**… These multiple dimensions are crucial to assessing the political impacts of instruments, especially when there are uncertainties regarding their durability. Not only will those who are able to organise quickly to react to incentives benefit the most from them, they will also largely shape the future trajectory of renewable energy development and the policies that support it, potentially creating lock-ins.

Some projects explicitly rely on the economic incentives provided by policy instruments to serve other objectives, for instance turning them into a tool for territorial development or a catalyst to bring together heterogeneous actors. This is clearly the ambition of the Centrales Villageoises, but, as we have just shown, in their case this ambition partly clashed with the FIT framework. Whilst FITs were critical for the success and viability of the Centrales Villageoises, the projects were not articulated with FITs as their backbone. Instead, the project developers attempted to keep up with changes in the FIT scheme. This created difficulties for them in emerging as a political and territorial player through, and beyond, FITs.

By contrast, the mutualised photovoltaic project carried out by the Fermes de Figeac cooperative was articulated around FITs from the outset. It clearly aimed to use them to make a profitable investment, but this was never the only objective. From its infancy, the project relied on the cooperative's skills, interests, and values to tightly articulate financial investment, territorial innovation, and mutualisation. Its business model was designed to make the most of FITs as a financial device that can turn the local solar resources into a source of profits, enabling the territory in all its diversity to benefit. Territorial innovation, renewable energy development, and mutualisation are central objectives of the project, but they depend upon the successful exploitation of a financial opportunity (Cointe 2017). The alignment of non-market objectives with a financial operation took a lot of work, especially when it came to negotiating with bankers. The business model of the Fermes de Figeac relied on the mutualisation of PV installations of various sizes, locations, and forms of ownership as a guarantee, insofar as it had been construed to smooth out and dilute risks. But the banks involved in the funding of the project were not ready to accept this mutualisation (which assembled heterogeneous individual projects) as a financial guarantee: they had to reassess risks for each installation individually and ask for additional guarantees to ensure that mutualisation was financially sound. In the end, this reinforced the interdependence of the mutualised and territorial character of the project and its financial viability, as it validated it from a bankers' perspective.

Milieux That Predate Incentives and Live on

The milieux that are associated to and grow with the development of instruments often predate them. The first wind power projects in Northern Friesland emerged in the 1980s from the conjunction of individual initiatives driven by anti-nuclear mobilisations with the first federal RD support for renewable energy. The FITs set up in 1991 and reinforced in 2000 acted as a catalyst for a process that had already been launched.

In the Fermes de Figeac, the successful articulation of heterogeneous sources of value was partly allowed by the trust that farmers already had in the existing local agricultural cooperative, which developed the project. The collective that grew out of the PV project also had impacts far beyond the financial profits and immediate economic activity it generated. As a matter of fact, it equipped an agricultural supply cooperative with the expertise, the network, and the human, technical, and financial resources to become an actor in the field of renewable energy. More broadly, it enabled the cooperative to emerge as a representative of a specific political project centred on a territorial and mutualised conception of renewable energy development. Interestingly, it is because the project complied with the logic and temporality of the FITs that it could take them forward and make a financial device into the basis for building capacities in the field of territorial renewable energy.

In the case of the Narbonnaise Regional Natural Park (France), the milieu which allowed the repowering of a wind power project also predated the process and lives on in various ways. This case study displays a definite articulation between the financial capitalisation of a wind power project, which was triggered by the French FIT, and other types of non-financial capitalisation which underpinned the possibility of its development.

The case study is located at the border between France and Spain, on the east side of the Pyrennees. As a very windy area, Narbonnaise hosted the first industrial wind power project in France in the early 1990s, which could then be considered for repowering (dismantling the wind farm in order to set up a new one) twenty years later (2010).[5]

Importantly, as a windy place, the small coastal plain of Narbonnaise is also a stop on one of two migratory routes for birds on their way from Africa to Eastern Europe and back. Narbonnaise has a strong political history in birdwatching. It was one of the important places in France where birdwatchers met and set up 'migration camps' in the 1970s, counting the population of birds passing by in order to attract the attention of European and French state authorities to the need for regulatory protection.

As the wind power site is located within a major migration corridor, birds became an important project adjuster in the repowering process. The project's design and siting proposal involved a collaboration between the wind power developer and the local branch of the French bird protection organisation (LPO), in which birdwatchers used the existing wind farm as a lab-site to monitor individual birds in their flight through the turbines. Focusing on individual trajectories allowed birdwatchers to understand and assess birds' cognitive and strategic capacities in crossing the turbines—knowledge which could then be translated into a proposal for siting the turbines that were felt to be compatible with migration. The project thus ventured into changing the politics of bird protection in the same area where migration camps had politicised it in the seventies. With this project and this experimentation, the developer and the LPO opened up access to spaces that were protected because of bird migration movements, turning them into energy-producing spaces.

Thus, in various ways, the milieu that grew with the project and allowed this capitalisation on wind energy predated the instrument, and lives on. Capitalisation was triggered by the wind power tariff, without which the developer would never have been interested in developing a wind farm, but it was not restricted to finance. Financial capitalisation was underpinned by other types of capitalisation, such as making more out of past knowledge and political and network structures around bird protection and environmental compensation.

4.2 Investment Is Not the Only End

Economic transactions and financial investments are an important aspect of the emergence and articulation of the collectives and action capacities that support instruments help bring into being. However, they do not tell the whole story. We have shown that the ability to seize an instrument and benefit from the incentive it provides is not immediate, and that it can be constituted with the explicit objective of going beyond the market framing proposed by policy instruments. In many cases, financial and economic objectives (i.e. investments and transactions) are only one element in the elaboration of projects. The instrument then produces more than financial flows. Regulation that only takes into account market effects is likely to fail.

Sometimes, however, especially when incentives are high, policy instruments act purely as financial devices: that is, they are used only to ensure financial profits. Between 2008 and 2010, the high level of French FITs for PV-generated electricity guaranteed extremely high rates of return. These attracted a multitude of economic agents with financial, if not speculative, aims (Debourdeau 2011). A specific milieu, oriented towards profit maximisation, thus emerged around FITs: PV developers proliferated, and some market actors combined multiple financial vehicles with public subsidies to turn PV into a financial product whose material characteristics mattered only insofar as they translated into added expected profits (Debourdeau 2011).[6] The FIT scheme did not withstand this proliferation: public support for a programme with an impact on electricity bills could no longer be justified if it had no other effect than to drive a surge in financial investments and speculation.

Thus, it turns out that policy instruments do not stand when they are used only as vehicles to enable profitable economic transactions: their objectives do *not* boil down to developing and multiplying economic transactions and investments. Through support to market creation, these policy instruments, in fact, aim to create more than markets.[7]

As soon as policy instruments foster more than mere market transactions, they cannot be governed simply by tinkering with market framings. Cutting incentives is not enough to make the collectives that grew out of them disappear, because they tend to fight back. Nevertheless, it can scare away those motivated only by financial profits, and thus contribute to market regulation.

As Capitalisation Grows, Milieux Evolve and Challenge Instruments

The effects of renewable energy policy instruments cannot be reduced to their economic and market dimensions, such as the multiplication of new kinds of transactions, increased investment in technologies that were previously financially unattractive, and growth in installed renewable energy generation capacities. Variables such as technologies, prices, installation costs, number of projects, and expected and accumulated installed capacities and electricity generation are used to monitor and calibrate such policy instruments, but give only a partial account of the transformation induced by policy support. The qualities of renewable energy projects that develop in the context of economic support also depend on the types of collectives that mobilise around them, their motivations for doing so; physical, geographical, and administrative constraints; the material and administrative organisation of existing energy infrastructure; the material and industrial characteristics of technologies, etc. As of today, dimensions such as the ambitions and objectives of projects, types of business models, and the territorial and political impacts of instruments are not systematically monitored. This is perhaps in part because they are harder (if not impossible) to assess quantitatively. And yet regulation via instrument design and technical parameters can only act upon whatever the instrument in place is equipped to take into account.

It follows that **political action mediated by policy instruments only allows for limited regulation of renewable energy development. The effects of these instruments can thus easily challenge the associated frame**, not only because these effects can extend beyond the associated objectives, but also in the sense that instruments do not always provide the means to channel their effects.

The Challenging Management of PV Deployment

Overflows have been especially striking in the case of PV. Despite frequent readjustments and increasing sophistication, FIT schemes struggle to take into account the specificities and dynamics of the photovoltaic sector. As modular technologies, PV are very different from the technologies for which FITs were initially devised, chiefly wind power. Compared to wind turbines, PV modules are relatively easy to handle, and they can be assembled into installations of very diverse forms and scales. PV can thus deploy in varied, potentially very diffuse forms, which makes their development difficult to control. In Germany and France, channelling the development of PV in the context of FIT support schemes has proven extremely challenging.

In Germany, the 2004 FITs for PV-generated electricity, combined with the drop in global PV module prices in the late 2000s, triggered a surge in PV installations. To control this surge and redirect investments, the FIT scheme was revised four times (in 2009, 2011, 2012, and 2014). The failure of these revisions to effectively contain the development of PV stems from several factors. Given the rapid rate of change in the PV sector (globalisation, decreasing PV system prices), it is virtually impossible to incorporate reliable monitoring devices into a FIT scheme, or to keep track of and consolidate reliable data on future cost trends in order to adjust FIT levels.

These technical difficulties related to instrument calibration contributed to the incapacity of the FIT scheme to both contain the quantitative increase in PV projects and to direct PV development towards particular types of projects, actors, and landscapes. Until the 2012 revision, each decrease in FIT levels, in fact, accelerated the increase in installed capacity instead of halting it. Announcements of upcoming reforms triggered waves of investment (windfall effects) which accelerated the development of large-scale ground-mounted PV plants instead of promoting the decentralised diffusion of small-scale residential installations: firms used FITs as a financial vehicle for risk-free profits.[8]

Finally, the control of PV development in Germany was further hindered by a lack of consistency in the objectives of FITs. Apart from the goal of increasing investments in PV, these objectives were never clearly defined. Throughout the 2000s, they oscillated between the development of substitutes for fossil fuels and support for the domestic PV-cell production industry. For instance, the increase in the cap on PV capacities eligible for FITs and the very attractive FITs for PV-generated electricity set in 2004 was aimed at providing market outlets for PV-cells manufacturing companies. This objective faded in 2011–2012, after most German PV manufacturing firms went bankrupt. These objectives tend to become increasingly variable as the success of FITs creates new problems, such as the management of the increasing share of intermittent electricity in the electricity grid (Hoppmann et al. 2014), or the increase in electricity bills caused by FITs.

In France, PV support provoked a similar surge, which was exacerbated by the design of FITs (which were high, static, and polyvalent) and by the lack of adaptation of the support scheme to evolutions in expectations. The FIT scheme set up in 2006 had very modest ambitions and provided no mechanisms for monitoring or readjustment. Market overflows were thus managed in a context of urgency: a series of ad hoc reforms in 2010 created windfall effects and accelerated the surge, as was the case in Germany. In order to discourage speculation and to direct investment towards specific types of PV installations, the government attempted to differentiate FITs—notably with the category of 'Building-integrated photovoltaics' (BIPV)—and introduced targeted decreases in FIT levels. BIPV was supposed to restrict access to the more attractive FIT it offered and be used as a proxy to differentiate between desirable and undesirable PV projects. It, however, was impossible to define 'building integration' in an exhaustive way and the category did not allow to contain the proliferation and diversity of roof-mounted PV, nor to control large-scale roof-mounted PV projects (the biggest share of installed capacity). In the end, its use greatly complicated the French FIT scheme, and the inability of the FIT scheme to actually frame the development of PV it had sparked led the market to explode and the instrument to implode.

The series of reforms in 2010 ended with a three-month moratorium on FITs which were then renegotiated and redesigned, along with their objectives.

Wind Power and the Landscape Challenge

Though they led to very different problems, French FITs for wind power also proved ill-equipped to manage their own effects, particularly in relationship to planning and territorial policy. They were adopted in 2001, without additional framing devices. In contrast to German policy, they were not associated with priority access to the grid for wind power. The financial incentive combined with the prospect of a possible limitation of access triggered a race to develop projects. The number of projects submitted for authorisation rose dramatically, especially in windy regions, and soon raised local opposition. In the absence of a coordinating framework, these contestations were initially dealt with on a case by case basis, and ad hoc institutions, rules, and regulations piled up at different levels of government: administrative and legal acts, voluntary regional schemes for wind power development, codes of good practices, wind power committees, etc. (Labussière and Nadaï 2015). In 2005, the *Loi de programmation énergétique* established 'Wind power development zones' (ZDE in French): landscape issues and local opposition were invoked to justify the need for state coordination and planning tools. But wind power development zones were not tailor-made to deal with siting issues, since their design essentially resulted from a political struggle over the decentralisation of energy policy (Nadaï 2007). This shift was accompanied by increases in litigation and in administrative constraints on wind power projects. Wind power development zones were eventually eliminated in 2013 (loi Brottes), leaving the issue of the collective and territorial construction of wind power unaddressed. Since then, there have been attempts to address this issue through the creation of a wind power development charter which was co-signed by a federation of wind power developers and an association of local authorities (FEE-Amorce). Overall, the case of French wind power shows that the regulation of FITs is difficult to stabilise owing to the divisions created by the fact that FITs reduce wind power to its economic dimension. These divisions have repeatedly prompted the development of strategies to contest and weaken the successive regulatory devices in the domain.

5 The Co-dependence of Instruments and Their Milieux

Policy instruments and those who benefit from them depend on each other. The collectives and milieux that arrange through and around a specific policy instrument generate their own political needs, in the strong sense of 'political' proposed by Barry (2001, 2002): that is, as something that cannot be channelled through the ordinary course of politics. These collectives and milieux have to be taken into account, dealt with, and sustained in further policy development. They can resist when the instrument they depend upon is threatened. Instruments need to be constantly adjusted, and the effects of these iterative changes need to be followed in order to govern the changes.

5.1 Sustaining a Milieu

The case of Prosol Elec in Tunisia illustrates the tensions that arise when a policy arrangement is too focused on end-transactions and fails to sustain the network of intermediaries without which these transactions cannot take place. Difficulties with managing Prosol Elec did not stem from the surge in PV installations so much as from the jamming effects that ensued. The incentives for households to install PV systems opened an unprecedented market for solar technologies, triggering the configuration of economic and entrepreneurial activities directed towards the supply and installation of solar systems. This 'boom' involved actors of highly diverse scope and strategies: subsidiaries of foreign firms, local businesses specialising in solar energy, firms seeking to diversify or reorient their activities. But the design of the Prosol Elec system did not make it easy for these businesses to develop, because it was almost exclusively focused on its recipients (chiefly, households). To prevent households from having to pay an advance on the cost of installations, the Agence Nationale pour la Maîtrise de l'Énergie (ANME) (National Energy Agency) directly transferred the amount of subsidies to the firms that supplied and installed PV systems.

The concrete consequence of this system was that firms had to bear installation costs themselves until the ANME paid them. Meanwhile, the ANME and the STEG, in charge of managing Prosol, lacked the financial and human resources needed to cope with the programme's success. Additional tensions stemmed from the limitations of extra-budgetary support instruments and from the low-level of international funds (which play a determinant role in the calibration of Prosol subsidies). This generated delays in payment, as the ANME was unable to process subsidy requests and make timely payments. PV system installers and suppliers thus faced delays that many were unable to bear. This led to bankruptcies and to a narrowing down of the sector around those best able to absorb the shock (for instance because their activities were more diversified or because they had greater financial capacities or more backup from banks), casting a shadow on the success of an instrument that benefited from strong legitimacy and the enthusiasm of its recipients.

5.2 Resisting the Milieu

In France, the mutual dependency of FITs and their milieux, and the resistance of these milieux to reforms, were abruptly revealed by the moratorium on FITs for PV-generated electricity in December 2010. The moratorium was perceived as a shock by the PV sector. It triggered intense political reactions, which translated into an extremely tense climate in the following months and the creation of diverse, more or less durable associations to represent and defend the interests of the various PV sector actors. Until then, they had felt no need to structure themselves politically, since the FIT scheme left room for everyone; but because it threatened their very existence, the moratorium pushed them to do so. The consultation of PV actors that took place during the moratorium enacted the politicisation of PV: by providing a stage for the expression of grievances and debate, it made visible the diversity of actors and interests related to FITs for PV. Moreover, the moratorium forced these actors to organise in order to constitute representatives and appear as legitimate voices in political arenas. Although many of these actors and organisations disappeared shortly after the moratorium, the vehement reactions to the suspension and renegotiation of FITs and the political moment that they initiated suggest that tinkering with a policy instrument after it has started acting can never be neutral. The issue is not simply to regulate and cleanse a policy-dependent market, but rather to constitute reliable representatives and negotiate with diverging interests that assert themselves politically when they are threatened.

In Germany, the reform of the Erneuerbare-Energien-Gesetz (EEG) that came into force in August 2014 had similar effects. This reform clearly aimed to stall the uncontrolled development of PV, and the measure it introduced restrained it significantly (annual cap on new installed capacity, reduction in and quarterly adjustment of FITs, the introduction of tenders for ground-mounted PV). It thus triggered heated contestations from the sector (which had not been the case of previous EEG revisions).

5.3 Augmenting the Instrument

The instruments considered here work by providing market framings and financial incentives, but we have shown how neither their effects nor their objectives are limited to creating new markets. The calibration and adjustment of technical parameters are thus not enough to govern the dynamics that policy instruments initiate. In our case studies, specific strategies for regulation and steering take shape along the way, with more or less success. They need to take into account the dynamics and temporality of policy instruments, their multiple impacts, and the mutual interdependence of instruments and their recipients.

The support schemes studied here are characterised by iterative evolutions that constitute so many attempts to take additional criteria and effects into account. These evolutions either translate into increases in the sophistication of the policy instrument itself, which grows in complexity as it is equipped to adjust to its 'milieu', or into the addition of other instruments to the scheme. Often this process makes support schemes simultaneously more technical and more political: while the instruments grow in complexity, they also grow more contested.

Wind Power: Regulation Through Addition

The case of wind power in France is a good example of regulation by addition of instruments and devices. As detailed above, after five years of adding layer upon layer of ad hoc regulations, FITs were supplemented with devices for territorial planning: wind power development zones. These spurred increasing contestation, which eventually led to their demise in 2013. However, the issue (territorial planning and coordination) has not been resolved, and new strategies are being developed to address it, such as the current attempt to elaborate a convention between developers and local authorities. In Germany as well, wind power was regulated through the gradual introduction of zoning tools at different scales, but this led to very different modes of governing the territorial impacts of wind power. For instance, in Schleswig-Holstein and particularly in Northern Friesland, procedures for concerted zoning were developed (though they were not without their own problems, see §6.3).

Photovoltaics: Regulation Through Sophistication

In contrast to French wind power, the case of FITs for PV-generated electricity is emblematic of policy evolution through increases in the sophistication of instruments. When they appeared in Europe in the 1990s, FITs were relatively simple price-based instruments: they secured priority access to the grid, imposed a purchase obligation, and fixed a purchase price, usually on the basis of the avoided cost of electricity generation. In 2000, the German EEG introduced more sophisticated FITs that were more finely tuned to the characteristics of technologies. First, they were technology-specific, and their level was determined according to technology costs, and not avoided costs.[9] Second, they were set to decrease on a regular basis to follow the decreases in technology costs that they were expected to trigger. From 2003 onward, an additional distinction was introduced between roof-mounted and ground-mounted PV, so as to favour the former (Jacobs 2012).

By the late 2000s, as the need to control the development of PV became more pressing, FITs were made more sophisticated through the addition of mechanisms to control quantities. In Germany, a 'corridor' system for FIT adjustment was introduced in 2009: the evolution of FIT rates was indexed to the annual quantity of PV projects in order to follow a desired growth pathway. Similarly, in France, FITs were made 'self-adjusting' in 2011: the evolution of FIT rates was indexed to the pace of PV development, it was calculated on a quarterly basis according to predetermined formulas calibrated to a cap on yearly new PV installed capacity.

FIT schemes have further grown in complexity to allow for qualitative steering of PV development, notably with the introduction of a BIPV category intended to direct investments towards residential PV (see §4.2 'The challenging management of PV deployment'). The growing sophistication of FIT schemes, and their frequent adjustments, highlights the will to refine FITs as much as possible, as well as the difficulties of accounting for the multiple dimensions of PV within the frame of a single instrument.

Paradoxically, though this process has intensified the technical nature of these instruments, it has also tended to re-politicise them (even when the aim was the opposite). On the one hand, instruments become less transparent as they grow in complexity. The space for political negotiation narrows down, since political choices are tentatively delegated to instruments that are designed to adjust automatically. At the same time, the ambition to consider an increasing number of non-economic criteria in the design of instruments also requires more choices. In the end, price adjustment does not depend on market dynamics as much as it does on political negotiation processes that can be more or less open.

Furthermore, over the course of such evolutions, instruments come to assemble increasingly heterogeneous considerations—such as aesthetics, redistribution issues, equity, political constraints…—and become vulnerable to a wider range of contestations. The frequent renegotiations of FITs for PV-generated electricity in France and Germany emphasise the failures of de-politicisation through instruments, and the inability of policy instruments to channel renewable energy development wholly through markets.

6 Monitoring and Negotiating Change

A major challenge for market-oriented renewable energy policies is to adapt support instruments to their unintended effects, or in other words to bring the overflows of policy-dependent markets and investment dynamics back into the frame. These support schemes need not only to create renewable energy markets, but also to civilise them (Callon 2009). This generates tensions between the market, economic, or financial dimensions of instruments—which are pointless if they do not constitute economic incentives—and their political content—their objectives evolve along the way, and are not limited to profit-making and market creation.

In turn, what is at stake in the establishment of such means to monitor and represent the consequences of policy instruments is the capacity to hold support schemes together with the objectives that justify them. As the policy instruments that we consider here tie the achievement of political objectives to the successful development of market and investment activities, keeping them in line with their purpose requires the conciliation of the (often diverging) private interests of the collectives that arrange around them and keep them alive with the (often fluctuating) public concerns that justify their existence. This alignment of economic and non-economic values is an experimental, iterative process: as we show here, the development of market capacities that follows the adoption of instruments produces multiple new relationships, values, and concerns that are then fed back to the policy process. These emerging and multiple relationships, values, and concerns need to be represented and negotiated for the instrument to evolve. The cases studied in this paper display the variety of the arrangements set up to govern instruments and their consequences: that is, to represent them *and* act on them, with more or less success.

6.1 Representing and Documenting Multiple Effects

The challenge is then to devise means for representing and piloting the effects of policy instruments so as to bring back into the policy frame those elements that threaten it because they extend beyond it. This holds true for economic framings (e.g., changes in technology costs over time) and political pacification (e.g., governing emerging socio-technical collectives).

The first challenge is to **represent and document the multiple effects** of policy instruments—and specifically, those that overflow policy instruments. Stabilising means to represent these effects requires reaching agreement on what elements should be considered relevant, and the development of devices to track and represent them. When it comes to policy instruments, especially those that are expected to produce something new, this process cannot be separated from regulation, or indeed from politics. Monitoring the effects of instruments requires discussions around what should be taken into account, how, and through what devices and representatives, but also around the extent to which effects should be attributed to instruments, and whether or not they are desirable. It is thus about stabilising the assemblages of means of representation that will contribute to the organisation of both the relevant markets and the associated political processes—what Brice Laurent calls 'constitutional orders' (Laurent 2013). Sometimes, these very arrangements are unstable and contested (as opposed to situations in which they are stabilised and institute specific forms of scientific objectivity and political legitimacy that channel the management of an issue).

For instance, the lack of established modes of representation and monitoring of FITs and their effects was at the heart of the French PV crisis in 2010. The lack of human, technical, institutional, and statistical resources to track the evolution of the PV sector largely contributed to the government's inability to readjust FIT levels in a timely fashion. The PV sector was comprised of economic actors of very diverse origins and interests (large utilities, local construction firms, actors from the finance sector, farmers, start-ups, etc.), all of whom benefited from very high FITs. In that context, there existed no reliable statistical, institutional, or political channels to, first, establish a picture of these actors and interests, and second, obtain robust data on the evolution of PV installation costs, which were crucial to FIT assessment and adjustment. There was also a lack of visibility on the number of PV projects that would be carried out: grid operators were overwhelmed and the rate of speculative projects was unknown, making it even harder to get a clear view of the sector. The consultation that took place in 2011 brought these uncertainties, controversies, and divergences into light, and was made particularly difficult by the absence of legitimate spokespersons for the sector. As a matter of fact, it did not prove able to produce a representation of the PV sector that was considered reliable enough by public authorities (Cointe 2017). This collective inability to arrange the representation of PV and of the impacts of FITs was one of the reasons for limiting policy support for PV and restricting the scope of FITs in 2011. For instance, the introduction of tenders for medium- and large-scale PV installations allowed for more direct control over the sector, especially insofar as it forced project developers to provide standardised information. It made it possible to identify and list project developers, and to consolidate information on project costs (one of the calls for tenders was based on price as the only criterion, encouraging candidates to state their lowest price).

6.2 Keeping Flows of Money Running

In Tunisia, the solar sector does not appear to be very structured: two trade unions claim to represent the sector (the *Chambre syndicale des énergies renouvelables* and the *Chambre des industries électriques et des énergies renouvelables*), but neither seems to really play this role either in their relationship to firms or as an interface with public authorities. However, the difficulties encountered by Prosol Elec triggered vigorous debates in the press, revealing a confrontation between the *Chambre syndicale des énergies renouvelables*, the ANME, and the STEG. The ANME was thus challenged in its regulatory role. In the current arrangement of the Prosol programme, economic activity is heavily reliant on the capacities of administrative actors who appear unable to keep up with their tasks. Following this saturation of the instrument, the Tunisian PV sector has been developing new strategies to emancipate itself from subsidies and from public regulation. The jamming of Prosol Elec may thus hint at a rearrangement of PV activities.

6.3 Articulating Spatiality

With wind power development, the issue lays not so much in the representation of the effects of FITs as in the arrangement and stabilisation of ways of addressing one of their most visible, material effects: the geographical dispersion of wind turbines and wind farms. FITs schemes in Germany and France did not consider territorial or landscape issues at all, and, contrary to FITs for PV, there have been no attempts to adapt them to do so. Instead, a variety of strategies for planning, negotiating, and coordinating zones open to wind power development emerged, in tension between local and national politics and between economic and territorial concerns. The regulation of the territorial impacts of FITs for wind power has followed contrasting trajectories in Germany and France.

In the case of Northern Friesland, a rural district (a *Kreis*, totalling up to 133 rural towns) from the region (*Land*) of Schleswig-Holstein in northern Germany, the issue of the instrumentation and regulation of support for wind power has travelled across federal, regional, and municipal scales to be rearranged in a number of arenas. Its evolution has been shaped by tensions between attempts at regulating the effects of FITs and the interests and collectives arranged around them.

FITs for wind power were instituted at the federal (national) level without consideration of the spatial dimension of wind power development. Planning emerged gradually at the regional or municipal levels to regulate the impacts of FITs on territories and landscapes *a posteriori*. In 1991, immediately after the establishment of FITs, the number of authorisation requests for wind power projects surged.[10] Local town authorities encouraged project developers to group together in order to facilitate the planning of the projects. In 1992, the rural district of Northern Friesland started mapping both the landscapes to be preserved and the first zones 'suited for wind power development'. The latter emerged around existing wind farms. In 2000, Schleswig-Holstein followed a similar concentration policy and asked all its *Kreise* to negotiate with their town authorities and to suggest about 1000 ha suited for wind power development. Building on its longstanding interest in wind power, the *Kreis* of Northern Friesland involved all local wind power actors (pioneers, citizen parks, and developers) as well as its 133 towns. It ended up proposing a surface that largely exceeded the threshold: it was first cut down under the direction of the *Land* of Schleswig-Holstein, before being raised again after the 2012 reform of the federal renewable energy policy (EEG).

In this process, the regulation of wind power development proceeded through a succession and superposition of several levels of decision-making and negotiations—individual-town, town-collective, town-*Kreis, Kreis-Land, Kreis*-town, and town-*Kreis*—with the federal government retaining power to trigger shifts in regulation that the Land had to take into account. The articulation of spatiality remains challenging. The result of the combination of FITs and the planning tool was that only a portion of the towns were allowed to develop wind farms, which then raised a distributive issue between towns with and without wind farms. This has led to legal recourses against the zoning plan, and threatens all regional planning in Germany since 2000.

The regulation of wind power development in France took shape through quite different arrangements. As mentioned above (cf. §4.2 'Wind Power and the Landscape Challenge'), 'wind power development zones' were established in 2005, five years after FITs, to regulate local opposition to wind power in a context of political ambiguity regarding wind power and the decentralisation of energy policy (Nadaï 2007). Moreover, this planning instrument established that wind power development zones would be devised by local authorities but validated by prefects (i.e. representatives of the state). The state thus maintained control over wind power development, and wind power development zones were immediately contested by the wind power sector, who pointed out that they constituted an additional barrier to wind power development. This triggered a proliferation of legal cases: developers have contested zoning that threatened ongoing projects, and, more recently, anti-wind power networks have contested the chosen zones in order to trigger reconsideration of projects under development (or even already developed) in these zones. In 2009, the planning of wind power development was regionalised—meaning that zones suited for the development of wind power were re-examined and consolidated on a regional level by regional administrations. In this process, the political work that had been carried out by local authorities before the regionalisation was still very unevenly taken into account. This led to additional frustration and contestations, which added to the ongoing judicialisation of wind power development zones, and resulted in the eventual elimination of this planning device in 2013. The contested career of wind power development zones reflects the challenges of assembling diverging interests around an instrument for territorial planning that failed to develop in interaction with territorial issues, actors, and configurations.

7 Instruments, Concerns, and Relevance

The use of instruments or markets to pursue political ends is often considered to move issues away from the domain of political debates and negotiations, entrusting them instead to technical adjustments in instrument design or to economic activities coordinated through market operations, respectively. The cases studied in this chapter present us with a more complex picture, because despite (or perhaps due to) the crucial role that market activities and policy instruments play in them, all of the cases studied are rife with engaged collectives, conflicting interests, heated political debates, and attempts to configure arenas for the confrontation and conciliation of differences.

Our case studies show that the economic processes framed by policy instruments—either market or investment encounters—are ‘concerned’ (Geiger et al. 2014). They deal in multiple values and lead to policy reforms, or even crises, when they are only informed by economic and financial logics. Moreover, the potential of instruments to bring about changes in energy systems depends not just on their design, calibration, or inclusion in wider policy frameworks, but also on the constitution and arrangement of capacities and collectives able to react to policy incentives. Instruments grow with and within what we have called their milieux. These milieux are heterogeneous and dynamic, and the need to take them into account leads to the iterative development of regulatory strategies that can take very diverse forms (and of which we have highlighted only a few examples).

With some exceptions, the literature on the policy instruments considered in this chapter has focused on their design and their fine-tuning in the political arena. It has not acknowledged the milieux that develop around them and the way in which these milieux shape the politics around them. When it has done so, it was either to explore the role of intermediaries in relationship to project development (Agterbosch et al. 2009) or to analyse the extent to which instruments succeeded in making certain realms and people governable (governmentality literature; cf. the introduction to this chapter).

Our analysis suggests that instrumentation and economisation do not necessarily lead to the de-politicisation of public issues. Indeed, they can be political (in the strong sense of producing effects that cannot be readily addressed through established procedures and institutions) in many ways. At any rate, they do not eliminate the need for collective and political negotiations, although they configure such negotiations in new ways. In that sense, this chapter completes previous studies in STS that emphasise the potentially destabilising effects of practices usually considered to 'cool things down', such as calculations (Barry 2001, 2002) or benchmarking (Overdevest 2011).

The cases related here also outline the multiple collectives, concerns and values that grow out of and sustain policy instruments (and the markets they frame). These appear to be crucial for the analysis of renewable energy policy, and for renewable energy deployment more broadly.

Policy instruments are often meant to initiate the deployment of specific forms of energy production. But in fact, the projects and collectives that build on these instruments, as well as the arrangements that are set up to regulate and govern them, continuously shape the trajectories and potentials of renewable energy. These arrangements can be more or less open—that is, more or less equipped to address the heterogeneous impacts, interests, and concerns that arise around them. It should also be noted that their openness or lack thereof may as easily result from explicit and concerted political choices as from the contingency of accompanying ad hoc changes.

The processes by which instruments are deployed cannot be reduced to the negotiation of a design. In triggering the formation of collectives and coalitions as well as the articulation of shared values, they are part and parcel of the emergence of political ends, beyond those that are foregrounded by instruments.

The deployment and continuous adjustment of these policy instruments are thus moments in which democratic issues are at stake in the articulation of these shared values. What our analysis shows is that it most often builds on pre-existing political structures at various levels and scales, and triggers the structuring of new and persistent collectives and practices. In certain cases, it enables the emergence of participatory spaces (e.g., Figeac, Northern Friesland).

The articulation of instruments and their milieux thus plays on multiple levels, both around projects and in larger, national policy arenas. Far from merely depoliticising the conception and deployment of public policies, as has been argued in some analyses of the 'instrumentation' of public policies (Lascoumes and Le Galès 2005), the co-dependence and co-evolution of these instruments and their milieux gives rise to its own politics. These are not restricted to the offices of institutional politics and civil service, a feature made visible by the difficulties in controlling the effects of incentives to invest in renewable energy production in the three countries considered.

As capitalisation *agencements*, the policy instruments examined in this chapter convey a vision that is centred around economics and that, in certain cases, makes it difficult to capitalise projects along dimensions that are not aligned with this vision. The case studies, however, reflect a diversity of developments, and the articulation of multiple values seems to be all the more successful when it predates the deployment of these instruments. In some of our case studies, collective ventures capitalised as much on previously existing political structures as on the financial dimension of the tariff.

8 Conclusion

This chapter started from an interrogation of the role of policy instruments, especially those that are investment-oriented, in shaping changes in energy systems. Bringing together relatively recent developments in STS on 'concerned markets' and 'capitalisation' allowed us to examine the politics of policy instruments from an angle that differs from those taken in the existing academic literature, and to suggest several insights on the relations between politics, policy instruments, investment, and markets.

Here, we sought to develop a detailed, empirical sociological perspective on renewable energy policies in three countries (France, Germany, and Tunisia), addressing cases of instruments that were meant to achieve political objectives through markets, by both fostering *and* regulating investments in new energy technologies.

Despite their economic framing, these instruments trigger processes that deal with multiple values and that sustain the emergence of collectives concerned with their effects: what we called their 'milieu'. The need to articulate these instruments with their milieu leads to iterative adjustments and developments that carry with them their own politics, far beyond conventional issues of design. The processes by which instruments are deployed are thus part and parcel of the emergence of political ends beyond those directly foregrounded by these instruments. These instruments prove to be very unevenly equipped to address the heterogeneous impacts, interests, and concerns that arise, not to speak of cases where concerted political interests deliberately contribute to their being overlooked.

Echoing the introduction of this book, the deployment of policy instruments can thus be regarded as a moment of ontological trouble, in which actors and entities are embarked in energy change processes and faced with changing identities and capacities to act. The extent to which the different actors who are called for in these processes can make their concerns relevant is variable and needs to be explored further.

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Notes

1. For a detailed description of the framings created by FITs for PV in France, see Cointe (2014, pp. 90–98).
2. See, for instance, Chapter 3 in this book for a characterisation of this strand of analyses.
3. Sometimes, instruments do not have the desired effect precisely because they are not combined with the (institutional, legal, technical, informational) equipment that would make them operational, and thus fail to be seized and appropriated. For instance, in 2002, the first FIT for PV in France had a very little impact, not because of bad design, but because it was not connected to the realities of PV and was, it could be argued, an instrument 'without a milieu'.
4. See Muniesa et al. (2017) on capitalisation on Powerpoints, scientific research, and time.
5. Under the French FIT, 20 years is commonly considered by wind power developers as the time lag after which turbines can be dismantled and replaced.
6. Though they emerged around the same instrument, this milieu and those that developed in the Centrales Villageoises and the Figeac can be understood as diametrically opposed. On the one hand, actors in the financial ecosystem that developed to reap the benefits of FITs for PV strove to dematerialise PV: what counted for them was the ability of PV technology to produce a good that secured high return on investment. On the other hand, in Figeac and Rhône-Alpes, the objective was to entangle PV—and profits from PV—in specific territories and collectives.
7. In that sense, the transactions framed by policy instruments contrast with 'traditional' market transactions, which purchaser and seller leave without further mutual obligation, and the traded good is largely disentangled from the seller's world and entangled in the purchaser's world. Here, what the transaction provokes outside the exchange matters and has to be taken into account, because the transaction is not the ultimate objective of the instrument.
8. Most large ground-mounted PV plants were developed in the new *Länder* by developers and funding societies based in western Germany.
9. The 'technology cost' approach consists in setting the tariff on the basis of cost of the energy technology (PV in this case); the 'avoided cost'

approach consists in supporting the new technology on the basis of the costs (capacity investment, environmental damage…) avoided by virtue of its development.

10. In January 1991, 130 wind turbines were already in service in Northern Friesland, and 200 authorisation requests were pending; in August 1991, 500 additional requests were recorded.

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5

Technological Demonstration at the Core of the Energy Transition

Alain Nadaï and Olivier Labussière

With the contribution from Catherine Grandclément

List of abbreviations

CCS	Carbon Capture and Storage
CO_2	Carbon Dioxide
DG-TREN	Directorate-General for Mobility and Transport, at the EU Commission

C. Grandclément—The information and views set out in this text are those of the author only and do not reflect the official position of EDF.

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DSO	Distribution System Operator
ETP	European Technology Platform
ETS	EU Emissions Trading System
EU	European Union
ERDF	Electricité Réseau Distribution France
EDF	Electricité de France
FDMD	French 'Downstream Meter' Demonstration Project
FP	Framework Programme
GDP	Gross Domestic Product
GHG	Greenhouse gas
IA	Investissements d'Avenir
IPCC	Intergovernmental Panel on Climate Change
JRC	Joint Research Centre
JTI	Joint Technology Initiative
MW	MegaWatt
NER 300	New Entrants' Reserve
NGO	Non-Governmental Organisation
R&D	Research and Development
ReN	Renewable Energy
REX	Return on Experience
RTD	Research and Technology Development
SACS	Saline Aquifer CO_2 Storage (project)
SET-Plan	Strategic Energy Technology Plan
SGTF	Smart Grids Task Force
STS	Science and Technology Studies
TSO	Transport System Operator
ZEP	European Technology Platform for Zero Emission Fossil Fuel Power Plants

1 Introduction

The steering of technological change is key for the conduct of energy transition processes. As Science and Technology Studies (STS) scholars have emphasised, emergent technologies incorporate a politics that is scripted into them, black-boxed, and that gets enacted as they get developed (Akrich 1989, 1992). Following and understanding the forces which drive their emergence is thus critical if we are interested in the democratic dimension of energy transition processes.

This chapter is an attempt at addressing the role of an increasingly important setting for technological innovation in the field of low carbon technologies: demonstration projects and policy. Demonstration projects gather research and industry actors around projects and organisational settings—'demonstrators', or 'demonstration programmes'—which are aimed at developing new technologies (sometimes in the form of prototypes) and accelerating innovation.[1]

The use of demonstration projects as part of research and technology development (RTD) policy is not new,[2] but it has recently become central to the conduct of energy transition processes in many countries. In the European Union (EU), it is part of a strategy which found political expression at the Lisbon summit (2000), and which is aimed at using research to develop markets in order to generate growth and employment. A European Commission report explained the motivation for this new strategy as 'a number of paradoxes which prevent [the EU] from realising its full potential, namely an inability to convert inventions into new products, patents and jobs'.[3] It came along with a redefinition of states' role in the field of RTD policy as well as a repositioning of non-state actors—mainly industrial—as key players in the design and implementation of RTD policies.

While there is evidence of an absolute increase in the number of demonstration projects—driven by energy transition activities and reflected in policy rhetoric, in quantitative data (Brown and Hendry 2009) and in the academic literature (Bossink 2015)—it is not easy to circumscribe demonstration as a research object and to frame the issues it raises from a democratic standpoint, for multiple reasons.

One reason is that there are many different types of demonstration projects, which fulfil many different functions in the conduct of technological change. Demonstration projects gather a consortium of private, and sometimes public, actors around a specific technological project in order to experiment with it. Most often, the project aims to assemble a version of the technology at scale one, in a real-size environment—on-site, in the home, etc.—in order to monitor its performance and the conditions required for it to perform efficiently. And yet demonstration projects vary along several dimensions. First, their *number* may vary to a great extent for a given type of technology.

For instance, in the EU, about 12 demonstrators had been planned on carbon capture and storage technology, whereas about 350 smart grid demonstrators were in place a few years ago. Demonstration projects also vary with regard to the intensity of the controversies they raise. These controversies may bear on various dimensions of the corresponding technologies—such as the uncertainty they contribute to energy transition processes, the extent to which they lock us into given existing technological or political trajectories, or the type of risk involved in developing them. Most of the strategic energy technologies currently on the table are complex, if not systemic, assemblages of bits of existing technologies. They may include critical technical parts that have never been subjected to out-of-lab development and real-scale experimentation. And yet for many of these technologies, scale-one assembly and functioning in a real-size environment are precisely what is critical. Accordingly, the ways in which demonstration projects are approached, framed, and managed by EU policymakers differ widely. Notably, these may privilege either singularity and tailor-made relations or collective approaches, categorisation, and ranking. Such variations are not neutral, especially if we consider the room that the different protagonists are given to influence the course of the demonstration.

Another reason is that demonstration projects are part of larger technological systems, which makes it difficult to delineate them and to assess their functioning and outcomes. It is thus important to be clear on the reason for our interest in demonstration projects and what we will look for in order to frame our object. This includes questions such as whether to look at one or several demonstration projects, a set of similar ones or an array of different ones, and whether we focus on their outcomes, their functioning, or the articulation of the two.

As emphasised in the introduction of this book, our inquiry is driven by a concern for the democratic dimension of energy transition processes. In this chapter, we will thus explore questions such as: How do demonstration and demonstrators frame issues deemed relevant to the energy transition? What parties are involved in the definition of these issues? Do actors who feel concerned with the changes at work in the demonstration projects have a role in defining these issues? Are these actors associated with the conduct of change? And how?

We will explore these questions on the basis of three case studies, chosen here because of the striking differences between them and the issues they have raised. They are: the emergence of the EU's Carbon Capture and Storage (CCS) demonstration programme and policy; the demonstration of smart grids and the French smart meter; and the Caserne de Bonne low carbon neighbourhood demonstration project (France) funded by the EU CONCERTO initiative (Framework Programme 6). These case studies differ in terms of size, the intensity of the controversy they raise, and the type of management on which they rest (cf. Table 1).

Our goal in examining these cases side by side is not to derive grand generalities about demonstration projects and the use of demonstration. Instead, it is to foreground problematic dimensions of these projects with regard to the conduct of the energy transition. In doing so, we also aim to challenge both a dominant framing of these objects in the academic literature as mere socio-technical/innovative arrangements (e.g. Hekkert et al. 2007) and an emerging view that they are unproblematic incubators of social (democratic) values aimed at underpinning innovation and the development of markets for low carbon energy (Huguenin and Jeannerat 2017). Our approach builds on work in STS on demonstration (Rosental 2013; Reno 2011) and on political representation (Laurent 2011).

The first part of the paper presents the recent rise of demonstration and demonstration projects in EU climate energy policy and introduces our three case studies. The second part briefly surveys current approaches to demonstration in the academic literature and details how we propose to approach demonstration and demonstration projects as technologies of democracy. Each of parts 3–5 presents one of our case studies, examining the ways in which demonstration constructs its object, its publics, and the political principles on which it relies. In the sixth and final part, we discuss our results on the role of demonstration and demonstration projects in energy transition processes and sketch out a future research agenda, before concluding.

Table 1 Size, controversy, and management in the three case studies

	Size/nb of demonstration projects	Controversy	Management
EU CCS demonstration	*Small* A few demonstration projects (12)	*Highly controversial* Highly controversial option, decisive choice for the course of the energy transition (with or without fossil energies) High investment, uncertain outcome ("leaks") Strategic R&D (potential international market), complex technology (assemblage of existing technologies for capture, unknown geological underground storage capacity)	*Key role of a small collective of industrial actors* (EU Zero Emissions Platform, ZEP) *Key role of EU policy and politics* Demonstrating CCS with a few cases
Smart grid EU/ France	*Large* Several hundred (EU) to a few (France) demonstration projects	*Controversial* The option is not controversial, but its implementation and the design of technical objects are (meter, business model, privacy) Strategic R&D (potential international market), complex technology (protocols, systemic dimension)	*Key role of national state* *Key role of a small collective of industrial actors* Large scale EU support for demonstration Qualitative REX compiled into statistics (EU Joint Research Centre) Technological deployment underway (France)

(continued)

Table 1 (continued)

	Size/nb of demonstration projects	Controversy	Management
Caserne de Bonne demonstration project (France)—EU CONCERTO programme (Energy efficient housing)	*Medium* (CONCERTO: 58 communities, 3000 residences, Smart Cities:71 cities)	*Not very controversial* The option is not controversial Assemblage of existing technologies, finding a business model, scaling up International competition on green building (label, products, services)	*Key role of decentralised initiatives* EU bringing local initiatives into comparison and benchmarking (databases, ranking/benchmarking…)

2 Demonstrating Low Carbon Technologies in the EU

In a recent paper and special issue of *Research Policy*, Foray et al. (2012) analysed what they call 'mission research and development (R&D) programmes'—that is, R&D programmes aimed at addressing current global challenges such as climate change, for which 'market forces alone cannot induce all of the R&D investment that is needed […] [and] government programmes to aid in the development and deployment of the relevant technologies are needed' (p. 1697). In a set of case studies on such contemporary programmes in different fields, including energy, the authors point out that they differ from traditional government R&D programmes because addressing contemporary complex problems calls for involving many actors, some of whom co-finance the programmes, and because these programmes are often geared towards market development and government is not the final user of the resulting innovations (unlike traditional programmes such as the Manhattan Project and Project Apollo in the US).

Demonstration projects are part of these mission R&D programmes. Their number has significantly increased over recent decades, and they have become a key dimension of government action in the field of RTD policy (Brown and Hendry 2009).

In the EU, the practice of demonstration emerged in the policy arena in the mid-90s, with the rise of information and communication technologies (Rosental 1998). It was progressively placed at the core of the construction of the European Research Area, before being inscribed in the proposed EU Constitution in 2005 (Rosental 2007, 2013). The Lisbon Summit (2000) and its follow-up meetings have been political milestones, where heads of state have adopted the quantitative goal of attaining 3% of GDP investment in R&D,[4] sharpened the political vision for an 'Innovative Europe', calling for 'a new social structure', a 'paradigm shift going well beyond the narrow domain of R&D and innovation policy'.[5]

In the field of energy and low carbon technologies, the Framework Programmes (FP5 to H2020), the Strategic Energy Technology Plan (SET-Plan; 2007), the European Technology Platforms (ETPs; 2004 onwards), the Joint Technology Initiatives (JTI; 2005 onwards),[6] and the development of public–private partnerships (2005 onwards)[7] are all part of this new approach to RTD policy.

A major shift that occurred during this process was the repositioning of industry's role in both devising and financing research and development policy. Technological roadmaps and strategic technological agendas devised by industrial players, as well as public–private partnerships organised around technology demonstrators, have become key elements in this new policy approach.

European Technological Platforms (ETPs) are illustrative of the new role conferred to industry in RTD policy development. These industry-led arenas, progressively established by the Commission since the beginning of the 2000s, have been put in charge of bringing expertise to the Commission and devising technological visions and strategic agendas in different fields. ETPs thus give industrial actors the opportunity to impact the allocation of new funding and create occasions for developing the demonstration that they envision. More than 40 ETPs were already in place by the end of the 2000s[8] despite their lack of formal status as EU institutions.[9] The Commission actively networked the actors involved in these platforms with banking partners in order to facilitate the implementation of large industrial initiatives and public–private partnerships in various domains. Four such partnerships were already established under the Seventh Framework Programme (FP7) and six European Industrial Initiatives were set up under the SET-Plan, a programme aimed at supporting industry in the pursuit of the objectives of the EU Climate Energy Plan. Eventually, the status of ETPs was institutionalised in 2013,[10] as part of the broader adoption of series of regulatory texts aimed at facilitating public–private financing of innovations within Europe 2020.

This process took place as the construction of the European Research Area, initiated in the early 2000s,[11] was under way. It notably consisted in setting up an 'internal market' in research designed to strengthen cooperation, stimulate competition, and optimise resource allocation. The restructuring of the European research fabric with the aim of developing a European research policy that could cover all aspects of other national and European research policies was also part of this agenda. As has been emphasised by Bruno and Nowotny, these changes challenged the traditional public dimension of scientific research by intensifying competition within academic research and between national research policies, and by contributing to an increase in the private share of the financing of scientific research (Bruno 2008; Nowotny et al. 2005).

These changes reflect profound change in the articulation of innovation, economic power, and society. In the climate energy domain, they have resulted in an increased role for industrial players in the financing, definition, and implementation of strategic research agendas. Demonstration projects play an important role in the implementation of these agendas: accelerating innovation, gaining global market share, and contributing to growth and employment in the EU. This strategy has been critically assessed in relationship to these purported objectives (Birch 2014), but there has as yet been no discussion of its relationship to the democratic dimension of the steering of technological change for the energy transition.

3 Demonstration *Agencements* as Technologies of Democracy

The demonstration projects that we consider in this chapter are not an easy object to frame and analyse. In addition to the forms of variability underlined in the introduction to this chapter (size, controversy, management), they are difficult to analyse because they are part of larger socio-technical systems (Bossink 2015; Harborne et al. 2007; Markusson et al. 2011) and they fulfil many functions in the articulation of industrial research, policymaking, and politics (Rosental 2013). It is thus important not to restrict the inquiry to the demonstration projects themselves, but to follow the issues they raise and that matter for us, which may imply a broader angle of analysis. However, in expanding the scope of analysis we may be faced with the fact that these demonstration projects do not necessarily have one single public. In playing multiple functions, they may be addressed to different publics in different arenas, and we may have to choose and prioritise which ones we want to follow.

It is also important to keep in mind that these demonstration projects are not necessarily unified objects. As industrial consortia, they bring together actors who are engaged in a mix of cooperation and competition: these actors co-operate around a technology, but they each have a different input into it as well as partly convergent, partly divergent interests. These result in strategic interactions, within demonstration projects as well as with the outside, which are a source of opacity and do not necessarily allow protagonists to foresee the course that the project that they are engaged in may take. Front- and back-staging of certain dimensions of the demonstration are used strategically to present clear and unified outcomes to the outside (Rosental 2007; Neri O'Neill 2015; Neri O'Neill and Nadaï 2012), but they can also be used internally in order to manage internal tensions or to steer the demonstration in directions that are desirable to certain parties.

Another source of uncertainty is what we might call framing and otherness. Any demonstration project defines itself by a purpose, a structure, and a potential for learning that reflect the social and political context within which the technology is to be developed. For instance, the purpose may be to develop electricity consumer demand-response in order to improve the efficiency of the grid and better integrate ReN electricity. Framing consists in tacit principles of selection, emphasis, and presentation which serve to define what exists and what matters in the demonstration. Framing is necessary to learning, as it delimits the learning domain and steers exploration (Markusson 2011). And yet it also contributes to leaving certain dimensions of the process that is under demonstration unaccounted for. This otherness—in the sense of these dimensions that are not acknowledged by the participants in the demonstration—can unexpectedly make its way back into the demonstration process and complicate, if not challenge, its outcomes. Such ex ante uncertainty is added to the ex post difficulty of assessing the actual outcomes of demonstration projects which is due to the fact that innovation results from systemic interactions and repeated attempts at demonstration (Harborne et al. 2007).

Not only are returns from experience uncertain, they also have a dual fate (Labussière 2014). On the one hand, they are learnings and, as such, they can be encouraging, but also disappointing. On the other hand, when they are communicated to the outside—and especially to policymakers in charge of demonstration programmes—learnings can be recycled by them and circulated as signs of policy success. As part of the policy success rhetoric, learnings can be detached from their often complex and ambiguous, albeit formative, context of emergence. In the end, learnings can thus be used strategically both by policymakers as evidence of policy success, and by industry to entice policymakers to provide additional funding.

All these imbrications show that demonstration projects are not just clear-cut projects: they are demonstrating *agencements*, in the sense that they bring together a diversity of actors, cognitive and material devices which all together acquire the collective capacity to demonstrate a technology and ground with materiality, realism and (possibly) success, the visions and expectations of those who support or develop them. We are thus interested in the democratic dimension of these *agencements*, meaning what or whom they allow to take part in the steering of energy transition processes, and how.

The academic literature on demonstration has taken various directions. A large strand of analyses, whose first papers date from the 1970s, is interested in demonstration projects of the types we want to analyse in this paper: projects aimed at demonstrating new industrial technologies. Some focus on new energy technologies such as wind power and PV solar technologies, synthetic fuels produced from gasified biomass, etc.[12] Most of these papers are interested in innovation, the management of innovation, and the related policy issues. They often try to analyse demonstration projects' degree of success, or the conditions for their success, along dimensions such as learning (Markusson et al. 2011), reducing uncertainties (Frishammar et al. 2015), and the marketing of new technologies or products (Hendry 2010). Apart from providing quantitative data about the development of demonstration projects (Harborne and Hendry 2009),[13] these analyses also point at the systemic and socio-technical dimensions of demonstration. They show that demonstration projects provide ""temporary protected spaces" or "incubator rooms" where radical new technologies can be developed, nurtured and tested' (Harborne et al. 2007, p. 169), that they are places where participants build a shared body of knowledge (Frishammar et al. 2015), and that demonstration projects can offer opportunities for new entrants to make inroads in an industrial sector (Mosgaard et al. 2016, on energy efficient maritime technologies). They emphasise the importance of the relationship between R&D and demonstration projects and the importance of test centres (Hendry 2010), the complementarity of different types of demonstration projects (technical, organisational, market: Bossink 2015), and the fact that demonstration only produces outcomes after iterative and recursive attempts in which 'technically focused [demonstration projects] and R&D often follow the opening up of markets […] and "failed" technology is revived' (Hendry et al. 2010). Last but not least, they discuss policy challenges and options for policy design (Hellsmark and Jacobsson 2012).

This large strand of analyses[14] thus combines varied foci of analysis, ranging from innovation management to innovation policy and socio-technical appraisals of technological change (for instance the analyses of national innovation systems, Hekkert et al. 2007) or multilevel framings of technological change in which demonstration projects are equated with niches (Geels 2010). Recently some researchers have attempted to broaden this 'innovation' lens and build on the pragmatist approach to valuation (i.e. Dewey 1946, 2011; Muniesa 2011; Callon et al. 2007) in order to analyse demonstration projects as incubators of *social* values. As argued by Huguenin and Jeannerat (2017): 'In line with pragmatic theories of socio-economic value and market construction […] value creation is not the result or byproduct of innovation […] Value creation is about inquiring into new values in society, translating them into social and technological solutions and making them valuable in markets. In this perspective, pilot and demonstration projects in current transition policies can be interpreted as fundamental inceptions of new values that are not predetermined by innovation but actuated through complex processes of value co-creation in society and markets […] By focusing on the purpose behind the sustainability transition rather than the factors that contribute to it, a valuation policy approach offers new insights for future research and policy' (p. 624).

In framing demonstration projects as arenas in which processes of production of shared values take place, this proposal shares a good deal with our aim in this chapter, and it partly draws on a similar theoretical framing (pragmatism, valuation). However, while aiming to depart from innovation frameworks, it remains attached to them in its maintenance of a linear, somewhat functional patterning of the process of valuation: *social* values which stem from demonstration projects are 'actuated' in *socio-technical* innovations that assign *economic values* to the markets. In the end, an analysis which sought inspiration from the pragmatist approach to valuation retains very little of its critical potential. The discussion of value-making in few case studies that have been presented has to some extent kept innovation as an implicit benchmark—i.e. the emphasis in the analysis the production of *new* values—rather than venturing into discussing the ways and the extent to which these values are shared or contested and by whom. We will come back to this point later in this chapter, but it is important to note here that Huguenin and Jeannerat do not really retain the critical dimension of the pragmatic strand on which they build their analysis of demonstration projects.

A third strand of academic analyses attends to 'public demonstration'—demonstrations performed in public, a category that includes phenomena as varied as experimental proofs, academic lectures, performances by salespeople, and street protests. This literature does explore one of the critical dimensions of this type of demonstration: its capacity to construct both its public and its objects, hence raising issues of the truth and construction of shared knowledge. As emphasised by Rosental (2013), these appraisals of demonstrative practices have been undertaken in a disconnected fashion, consisting in isolated case studies 'with public demonstrations themselves not always the focus of the analysis'. Nonetheless, they have underlined some dimensions of demonstration practices which are of interest to us in analysing those practices' relationship to democracy. Here we would like to briefly focus on these dimensions before presenting our analytical framework.

One dimension concerns the asymmetrical power of experts in demonstrative practices. A number of authors see demonstrative practices as tools of persuasion and rhetorical devices, and analyse the structural, material dimension of this rhetorical power (Latour 1983;

Rosental 2005; Stark and Paravel 2008). A second dimension of demonstration practices that have been foregrounded pertains to ways of collectively knowing in order to make collective choices: in such analyses, demonstration practices are presented as institutionalised practices by which members of a given society test knowledge claims—what Jasanoff calls 'civic epistemologies' (Jasanoff 2005). A third dimension is the relationship of demonstration practices to politics, and particularly to spaces for politics: these analyses show how demonstration practices either serve centralised power (the technological demonstration of Louis XIV through the Versailles gardens, Mukerji 1997) or offer otherwise marginalised actors arenas to stage issues that are not acknowledged in current politics and the opportunity to weigh in on the management of public affairs (the demonstration to oppose the Newbury highway project in the UK, Barry 2001). Last but not least, a large array of approaches has built on Ervin Goffman's ethnomethodology to analyse demonstration practices as dramas (Goffman 1974), closely examining interactions and evidential roles in order to uncover social dynamics. Importantly, work in this line has shown how the audiences of public demonstrations did not simply exist 'ready-made', but were stirred in response to performances, and how persuasion implied constructing the public (Ezrahi 1990; Hilgartner 2000; Jasanoff 2005). Claude Rosental (2013) proposed a 'sociology of demonstration', acknowledging the many roles of demonstrations and attempting to bridge the gap between detailed dramaturgical analyses of face-to-face demonstrative practices and the politics of demonstration (Rosental 2007). His critical analysis points out the power to steer funding and capitalise on science that demonstrators have derived from demonstration practices in certain domains—what he termed a 'demo-cracy'.

All of these dimensions seem important to keep in mind when analysing the democratic dimension of demonstration projects. However, these projects differ from 'public demonstrations' in the sense of this literature. While they do have a public dimension—as we underline above, their outcomes are important to policymakers and the energy transition—they do not necessarily perform publicly. Public demonstration may be part of certain steps in the management of demonstration projects, especially when communicating on project outcomes.

However, most action on these projects is not public but confidential, if only because they deal with strategic matters. Even more, communication on project outcomes generally takes more convoluted pathways than do public demonstrations of the type just mentioned. Thus, 'demonstration' in our case points to the production of a type of technological evidence—learning, organisational, or market outcomes—that entails the construction of knowledge and of a public in order to underpin collective choices (the steering of energy change), but that is not necessarily always enacted in a face-to-face interaction.

In order to capture these critical dimensions of demonstration projects—the construction of a public, collective problem, and the production of knowledge that underpins this construction—and leave room for their sometimes systemic embedding in socio-technical systems, we propose to use the notion of a *technology of democracy*. This notion was proposed by Brice Laurent (2011), who wrote that 'technologies of democracy are instruments based on material apparatus, social practices and expert knowledge that organise the participation of various publics in the definition and treatment of public problems'. Thus, technologies of democracy organise the 'conduct of democratic life'. Importantly, this definition can point at *agencements* that 'might be independent from the issue to which they are applied (e.g., electoral system)' or at others that 'on the contrary, might be intimately tied to it', such as the demonstration projects we examine here. As Laurent underlined, the force of this notion is 'to displace the question of the normative evaluation of public engagement' (p. 650) in two ways. First, because it does not presuppose a given domain of public engagement but considers 'within the same analytical gaze' instruments that are labelled and thought of as participatory and *agencements* that are not but that nonetheless contribute to the definition of collective problems. Second, because the notion seeks to make explicit the political construction that technologies of democracy enact, instead of proposing a ready-made framework for the evaluation of participatory procedures.

Demonstration is one of the technologies of democracy that Laurent addresses (along with experiments). On a methodological level, the analysis of technologies of democracy does not differ from that of other hybrid *agencements* in scientific, technical, or market domains (Latour

1988; Akrich 1992; Callon et al. 2007). According to Laurent (2011), it 'leads the analyst to describe the investments these technologies need, the voices they must silence, the alternative constructions they face, and the political order they produce'. Thus, framing demonstration projects as technologies of democracy means analysing the material and cognitive investments that they draw on in producing public's and collective problems, while highlighting their controversial constructions and the possibilities for alternatives that emerge in and around these constructions.

In what follows, we will thus successively analyse three demonstration projects as technologies of democracy. In each case study, we will point out the public's and collective problems that are constructed, and the controversies that emerge in these constructions as well as the political principles that underwrite their stabilisation. We will also underline the shifts that occur in these constructions as demonstration projects are developed.

4 Tracking Carbon Dioxide, Side-Tracking Policy Contestation (EU CCS)

CCS combines technologies in order to capture carbon dioxide (CO_2) from industrial and power plant installations, transport, and store it in geological reservoirs in order to reduce greenhouse gas (GHG) emissions.[15] The concept of CCS was devised by researchers in the 1970s, and has garnered wide international attention since the early 1990s. Since the mid-2000s, the EU has committed to a CCS policy, including a demonstration programme which aimed at the development of 12 industrial-scale on-site demonstrators by 2015. The emergence of this policy was marked by intense debate about CCS technologies' maturity, costs, associated risks, and the adequacy of the CCS option as a response to the climate energy challenge. This process was also marked by intense conflicts around the development of on-site projects. There are now industrial-scale projects in several countries, most associated with enhanced oil recovery (EOR—the CO_2 is injected into old oil wells in order to push out oil, enhancing extraction) or natural gas installations (CO_2 is captured from the natural gas in order to purify it to commercial quality).

In 2002, at a moment when scientific programmes and institutional networks were exploring the feasibility of the concept of CCS, the IPCC decided to launch a scoping process to produce a special report on CCS. The publication of this report (SRCCS) (IPCC 2005) was a major landmark. It concluded that CCS technologies have the potential to mitigate GHG emissions and that the technology urgently needed to be demonstrated through on-site demonstration projects. Importantly, the SRCCS's rationale for supporting the CCS option was that institutional lock-in made the use of CCS necessary to bridge the gap between the fossil fuel economy and a future non-carbon economy. Greenpeace, in contrast, continuously sought to challenge this statement and to demonstrate the urgent need to take radical steps in the direction of a non-carbon economy. Notably, in 2005, it contested the conclusions of the SRCCS report, to which it contributed. In 2007, it issued a no CCS, no nuclear scenario for the EU. In 2008, it published a report pointing out the risks and uncertainties associated with CCS and the vested interests of the fossil fuel industry. A growing collective of NGOs progressively rallied to Greenpeace's position, in the absence of any arena at the EU level where their concerns could be discussed and the controversy addressed. Quite the contrary: the European Council used the SRCCS's rationale to justify an EU investment in a demonstration policy and programme. The European Commission followed up and operationalised the Council's recommendation. It was then advised by the European Technology Platform for Zero Emission Fossil Fuel Power Plants (ZEP), a collective of (mostly) industrial actors set up in 2005 by the European Commission in order to devise a vision, a strategic agenda, and a CCS 'flagship project'. This project ended up taking the form of an EU CCS demonstration programme comprising 12 demonstration projects, which was adopted in December 2009 under the EU CCS directive. The ZEP also decided to finance this programme through one of the world's largest funding programmes for innovative low carbon energy demonstration projects (CCS and renewable energy projects): the New Entrants' Reserve (NER 300), consisting in the proceeds of a sale of 300 million emission allowances from the EU

Emissions Trading System (ETS). NER 300 was designed by a small collective of industrial actors within the ZEP, who also successfully lobbied for its inclusion in the ETS Directive in 2011. In 2009, at the time of the adoption of the EU CCS Directive, local opposition to the first on-site CCS projects already grew stronger and some important projects (Claye-Soully, France 2009; Barendrecht, Netherlands 2010) were stopped. The withdrawal of the Barendrecht project was a milestone, propelling the issue of social acceptance to the top of the CCS agenda.

Space does not allow us to enter into the minutiae of this process in this chapter. In what follows, we would, however, like to emphasise a few dimensions that we find important for the discussion of the democratic dimension of demonstration and demonstration projects.

A decisive aspect of this case study is the intense controversy around the technology as an option for the energy transition. Not only is CCS technology associated with technical uncertainties concerning costs, performance, and risks (Nykvist 2013) but the choice of whether or not to invest has an important political dimension in relationship to the energy transition. Investing, even only in the demonstration of CCS, implies significant spending, as well as setting up a legal framework that allocates rights and powers to certain actors. As emphasised in the literature on demonstration projects in general (see above), outcomes from these projects are difficult to assess, if only because they do not necessarily occur on a single-project basis. For instance, we might end up being trapped in climate change by spending our money on CCS and not detecting poor performance and CO_2 leaks in time. As much as institutional lock-in may not allow for a rapid transition to a non-carbon economy, investing in CCS might reinforce lock-in into a carbon economy. This explains the controversy around this technology—a controversy that calls for due process if we want to allow for a genuinely collective choice.

The second salient dimension in the EU CCS process is that the overall institutional setting clearly did not offer space for debate about the political dimension of CCS. Despite its intense activity and highly structured nature, opposition to CCS has been sidetracked. To be clear, it was not that NGOs were not accepted in certain arenas for debate: Greenpeace did contribute to the IPCC SRCCS, and it was invited to participate in the ZEP. However, expert appraisal has remained prioritised in the institutional framing behind these processes, in such a way that the terms under which participation was considered relevant were to be aligned with it. To some extent, this enticed Greenpeace to draw on the scientific arsenal (by producing a quantified scenario and publishing a scientific paper), but neither the outcomes nor the political rationale behind Greenpeace's position were incorporated in the framing of the discussions. Hence Greenpeace's final contestation of the SRCCS conclusions in spite of its participation in the report.

Third, in this context, demonstration and demonstration projects have been given a decisive, but ambivalent role. Most actors in favour of CCS demonstration argued that only technological demonstration can provide a factual basis for answering the questions of this technology's cost, performance, and associated risks. Answering these questions was equated to grounding the collective choice between CCS (and the prorogation of the fossil fuel economy) and a (necessarily radical) turn towards a non-fossil fuel economy. The policy rhetoric of ZEP and the EU both evolved over the course of the process in order to respond to and incorporate the alternative. As was made explicit in a ZEP video entitled 'hard facts,' CCS was posited as part of the arsenal (energy efficiency + renewables + CCS) that would allow us to transition to a non-carbon economy. Demonstration thus played a strategic, but ambivalent role. On the one hand, it was posited as (just) a terrain for knowledge making. On the other hand, this terrain required setting up laws and investment vehicles which further empowered the actors of the fossil fuel economy. Greenpeace ceaselessly emphasised the ambiguity and risks involved in empowering these actors in the steering of the energy transition.

Demonstration also played on another level: that of the communication of specific demonstration projects. In particular, one[16] on-site CCS process—the Sleipner/SACS project, in Norway—became a symbol of CCS's potential in the early part of the process, at the time of the drafting of the IPCC SRCCS. Starting in 1996, the CO_2 captured from the Sleipner natural gas platform (240 km off the North Sea coast) began to be stored in the Utsira deep saline formation, underground, under the North Sea. Funding from the EU (FP4 1994–1998, FP5

1998–2002) had supported the Sleipner industrial consortium in developing two research projects (SACS Saline Aquifer CO_2 Storage, and SACS 2) aimed at tracking this CO_2 and visualising its underground movements through seismography. The first results, and in particular the images of the CO_2 'plume', which visualised the underground movement of CO_2 over three years, had a dramatic impact. These results were taken up by the media, published in scientific journals, and presented at international conferences in the industrial sector (oil, gas, electricity).[17] The project became a symbol of the industrial and scientific success of CCS. A capitalisation on the Sleipner demonstration was clearly at work in the SACS 2 project (April 2000–April 2002), aimed at confirming the results and stabilising a consensus around CCS. All together SACS and SACS 2 led the researchers to conclude that any significant leak would have been detected, albeit without any ability to predict the behaviour of CO_2 in the long term. In many respects, however, the Sleipner/SACS results had the effect of marking the entrance of CCS into the era of risk management. The possibility of following the CO_2 implied that of potentially (in)validating the modelling of its behaviour in the underground. As Utsira, the geological formation into which the Sleipner CO_2 was injected, is a major worldwide geological formation, this contributed to more than the Sleipner project: it underlay SRCCS's support for CCS demonstration and the European Council's subsequent approval of the development of an EU demonstration programme. In 2008, Greenpeace[18] brought international attention to a StatoilHydro note attesting the presence of oily water on the sea-surface of the Sleipner gas field. The event revived the controversy on the feasibility of CCS and triggered scientific debates[19] attempting to elucidate the cause of the spills. They progressively pointed to the importance of the geological specificities of the site,[20] which 'provid[ed] potential routes for CO_2 to leak from sub-seabed reservoirs'.[21] While no signs of such leakage had been detected, were it to be confirmed, such a perspective would certainly have threatened public support for CCS in the EU, according to an article in *Nature*.[22] Our point here is not to analyse the controversy, but to point out the pace of learning in this process. Of course, the leaks and the explorations they triggered were posterior to the adoption of the EU regulation, and it would be misplaced to read ex post the process in the light of the leaking. And yet the pressure to rapidly demonstrate, in the context of an ongoing policy process involving unprecedented amounts of 'carbon' funding, presents puzzles as to both its pace and the political processing of learning from demonstration.

Last but not least, a fourth important dimension of the case study is the key role played by a limited group of the most active players within the ZEP. The framing and assembly of the EU demonstration programme was conceived by a small pool of high-level executives, even if its detailed technological description was undertaken in coordination with a wider network of industrial experts. As discussions and negotiations went on, notably about the financing of the demonstration programme, ZEP's role vis-à-vis of the European Commission changed dramatically. In the first year (2005), ZEP members defined themselves as an advisory body and showed concern about ZEP's representativeness in terms of plural expertise and its distinction from traditional Brussels 'interest groups' (lobbyists). In 2008 and 2009, however, the ZEP board conceived the idea of the NER 300 with the help of a member of the European Parliament, and operationalised it through direct parliamentary lobbying, with the active support of the Commission.

The role played by the ZEP appears all the more problematic if we consider the internal divergences of interest between its members. Discussions within the ZEP reflected clear divergences of interest between two groups of actors, with slightly shifting borders depending on the subjects: oil producers and engineering companies on one side, electricity producers on the other side. For the former, CCS is a potential revenue source, either by offering underground storage capacity (on top of enhanced oil recovery, for oil producers) or in developing CO_2 capture technologies (engineering companies). For electricity producers, CCS is a cost centre, not a profit centre, unless CO_2 prices rise to very high level, which was then perceived as unlikely in the short term. There were salient divergences on some issues, such as the inclusion of energy efficiency measures in thermal power plants within the scope of ZEP, a subject of interest for electricity producers (energy efficiency can reduce their costs of production and CO_2 mitigation), but one that oil producers did not want to cover (they saw it as a missed opportunity for profits). After heated discussions in 2006, the subject was mentioned in the strategic agenda, but not developed as part of ZEP's activities.

The dimensioning of CCS demonstration programmes and projects—was also a subject of internal dissensions, which were carefully quieted in interactions with the outside and discussions of public funding. CCS combines three components: capture, transport, and storage. While capture can be tested on a smaller scale, this makes little sense for transport and particularly storage, where it may be important to test the possibility of injecting large amounts of CO_2 underground. However, no clear technical reasons imposed a specific size of demonstration project for that purpose. Eventually, the decision to define the full-demonstration project as a 250 MW unit (and not a 100 MW one, as was discussed internally) was as much political as technical, and betokened a will to accelerate CCS upscaling (O'Neill 2015, p. 168). For electricity producers, CCS development is strategic despite cost uncertainties, as it potentially allows for the replacement of ageing thermal plants; a portion of them thus joined oil producers in aiming at the rapid development of CCS technology, supported by public funds.

In the end, this case study displays: (i) the clear construction of the public of the demonstration through a framing that prioritised expert appraisal; (ii) the construction of CCS as a collective problem that progressively shifted its definition from reducing CO_2 emission (including possibly leaving carbon resources underground) to limiting the risks associated with CCS as the mitigation option, with technological demonstration becoming a privileged route to risk assessment; and (iii) scientific democracy—defined as the conditioning of the possibility of debate on the scientific nature of arguments—as a prevailing political principle.

5 Unbundling the 'Smart', Re-bundling the Consumer (French Smart Meter)

Smart grid technologies have been developed through nationally and/or EU co-funded R&D, demonstration, and deployment projects (eight FP5 projects; six FP6 projects; 23 FP7 projects), which started to increase steadily in number after 2007 and peaked in 2010, reaching about 220 demonstration projects (JRC, 2011). Distribution system operators (DSOs) have been the major actors behind these projects. Since 2007, joined by energy companies, transport system operators (TSOs), and universities.

EU Smart grid policy has emerged at the crossroads of successive energy efficiency plans (2000, 2006, 2011) and the post-Lisbon public–private approach to RTD policy.[23] Energy efficiency, which in the 1990s was portrayed as a constraint and a necessary effort, has progressively been reframed as an opportunity for growth and employment. In 2009, the EU directive on the liberalisation of the electricity market recommended that member states encourage the modernisation of distribution networks through the introduction of a smart grid. In 2011, the Commission issued a communication on the deployment of smart grids that marked the beginning of a period of devising of standards (meters, interoperability) and good practices.

In developing this smart grid policy the European Commission set up various advisory bodies, such as the Smart Grids European Technological Platform (ETP SmartGrids[24]) and a Smart Grids Task Force (SGTF)—including industrial actors, DSOs, and TSOs—in charge of devising visions (roadmaps), strategic agendas, and recommendations. The production of methods allowing for a quantitative, EU-wide comparison of developments, experiments, and benefit assessments has also been an important dimension of the Commission's activity, undertaken by the Joint Research Centre (JRC). The culture of 'lessons learned' or 'return on experience' (REX) and strategic roadmaps has been present since the start of this policy. The first REX from smart grid demonstration projects was derived by DG research in 2005, on the basis of the FP5 results. The JRC followed up with two reports in 2011 and 2013.[25]

In France, the culture of roadmaps and demonstration has emerged through various channels, including the participation of French experts in EU demonstration arenas such as ETPs and the SET-Plan. This resulted in a colossal 50-billions euro fund in 2010, 'Investissements d'Avenir' (investments for the future; IA), including 250 million euros for smart grids demonstration projects. The language and vision behind this programme were close to that of EU RTD policy: RTD projects were no longer 'funded' but 'supported' through repayable advances; 'market demonstration projects' took over from 'research demonstration projects'.

In 2008, the French DSO, ERDF, had already announced a 'revolution' in the electric meter. Every French household was to receive a new modern meter by 2017. This French smart meter had been conceived and developed quite independently of roadmaps and demonstration programmes. Born and conceived within the DSO organisation and from its perspective, it soon created a public controversy concerning its ability to serve both the liberalisation of the electricity market and the greening of individual behaviours. In 2011, when a second IA call for smart grid demonstration projects was announced, a political decision imposed the integration of this meter as an obligatory brick in any downstream (meter) demonstration projects. The inclusion of the meter in these projects positioned it as a central device. It also transformed the demonstration process into a political space with the French meter at its centre.

First confined to expert and policy arenas (2006–2009), the controversy became public during the spring of 2010. It developed within several interrelated arenas, including policy development arenas, the main French 'downstream meter' demonstration project (FDMD), and the ERDF-EDF R&D department.[26] The points under debate have been numerous, among them: the cost of the meter, its computing and communication capacities and potential lock-into sub-optimal technology, and the possibility for users to actually access real-time price and consumption data. Among other things, this meter had been promoted as a tool to modernise consumption, thanks to accurate, real-time information on household electricity usage. However, given its very small screen (3 LCD lines) and the frequent positioning of meters outside homes or in technical spaces out of reach for users, in reality users regularly checking their meters was unlikely.

The question of whether or not to add a remote in-home display to every meter was debated within a work group over the course of the controversy, and remains very contentious. In these discussions, the role of the FDMD 'community'—as they called themselves, meaning the partners in the main downstream meter demonstration consortia—became central as only they, and especially EDF, were up to date on technical aspects of the meter. The discussions progressively shed light on the strategic importance of a slot in the meter into which a radio module could be plugged in order to communicate with home appliances in situations where a wired connection was not available. The discussions also betrayed the conflicting interests of various FDMD participants in gaining exclusive access to this slot in order to construct it as an exclusive point of access to the downstream meter: in short, the smart home market.

Eventually, the project was closed down on the basis of an anti-monopoly argument.[27] As discussed in Chapter 3 of the present volume, the discussion also raised the issue of whether or not the consumer would be able to access electricity data—prices and quantities, in real time—through the meter. Part of the participants in the work group argued, that this was impossible, on two grounds. One was the 'unbundling doctrine', which is central to the liberalisation process in the electricity sector and states that competitive activities (such as electricity provision) should remain independent from non-competitive activities (such as grid operation) in order to ensure that all actors are equally able to compete. The other reason was technical aspects of the meter that allegedly rendered it unable to manage multiple, dynamic flows of data. Eventually, it was decided that price and quantity data would not be supplied through the meter but through an Internet website.

The presence of an in-competition smart home box, supported by private business models, installed downstream from the meter and communicating with it, was required as a guarantee of a competitive environment. It was also decided that data (prices, quantities) would be provided through a website. This also redefined the position of the consumer, from a behavioural energy saver (rationally managing private energy consumption on the basis of real-time data) to a somewhat 'captated' consumer (energy consumption is optimised by the box provider) kept under the control of a provider of elaborate bundles of services.

Some dimensions of this case study are particularly relevant to our discussion. First, it should be underlined that smart grids, despite being an important element of energy transition processes in many countries, are not widely contested as an option for the energy transition. In contrast to CCS, there is debate concerning the ways in which they are developed, but not regarding their status as an option for the energy transition. Thus, they are much less controversial, for instance, than CCS.

Second, and importantly, the initial policy justification for developing smart grids pointed to the joint construction of an electricity consumer. At both the French and EU levels, policy rhetoric revolved around the idea of empowering the consumer. The figure was that of *prosumers*: consumers who are actively involved in energy matters, who at the same time are able to take charge of producing part of their own energy, and who are concerned with collective energy-related issues such as energy savings and the state of the electrical grid.

Third, in France, the development of the smart grid is embedded in a political and socio-technical environment inherited from a former monopolistic situation. This has led to an institutional culture in which a single actor is empowered and knowledgeable with respect to managing the unity of the grid and its socio-technical artefacts. EDF is also still the main shareholder of ERDF, the grid operator. The development of the smart grid through a single 'national' type of meter is thus an expression of this inheritance.

Fourth, the enmeshment of smart grid demonstration projects in this inherited structuring of interests led to a demonstrating 'downstream meter community'—as they called themselves—whose members' interests were partly cooperative (in inter-compatibility with and around the French meter) and partly rival (all wanting the highest possible share of the smart home market). They also shared a privileged, albeit differentiated, access to knowledge about the technical aspects of the meter and of what they called its 'ecosystem' (the smart home under demonstration). The technicalities involved in the discussion of the working group on the in-home display clearly provided a terrain on which this knowledge became strategic, in determining the configuration of future modes of access to energy consumption data and the smart home market.

The fifth dimension derives from the shared interest of industrial actors and a portion of state actors[28] in having market actors take charge of the issue. For industry, it offered a stronger basis for developing business models; for policymakers and ERDF, the market vehicle reduced the visibility of the costs incurred. The process thus resulted in energy data being conveyed to consumers in an indirect and mediated way (through Internet and the energy provider), depriving them of the direct relationship to their own energy consumption initially promised by the figure of the 'prosumer'.

In the end, this case of smart demonstration reflects: (i) a clear shift in the construction of its public, from the promise of empowering 'prosumers' to the scripting of ('captated'—enticed and captured) consumers whose management of their energy uses remains in the hands of a smart home provider. This shift partly relies on the joint empowerment of a community of industrial demonstrators; (ii) a reformulation of the collective problem addressed by smart grids in the course of the process, from saving energy to offering business models a broad enough market basis to develop the smart home market; and (iii) a shift in the political principles overarching the construction of smart grids. The initial objective was enabling political participation in environmental and electrical commons by way of distinct materialities: the idea of engagement and involvement is central to the figure of the 'prosumer'. Later this objective was replaced with that of ensuring fair competition (unbundling) and developing market opportunities that mediate and ease the realisation of energy savings (captated consumer).

6 Upscaling Community Approaches, Benchmarking 'Real Life' Experiments (Low Energy Housing)

This last case study[29] follows the changing articulation between a local experience—the Eco-district project of the Caserne de Bonne in Grenoble (France)—and the European CONCERTO initiative, a demonstration programme aimed at upscaling local experiences in the field of renewable energy and energy efficiency by involving communities in mutual learning.

The CONCERTO initiative is a demonstration programme managed by the Directorate-General for Mobility and Transport at the EU Commission (DG-TREN). It is part of the 'Sustainable Energy Systems' axis of the 6th European Research Framework Programme (FP6), an axis whose goals were stated as follows: 'to pave the way for the introduction of innovative and cost competitive renewable and energy efficiency technologies into the market as quickly as possible through demonstration and other research actions aiming at the market'.[30]

Contrary to past sectoral funding, the CONCERTO fund aimed to support emerging innovative communities at the local level (named 'CONCERTO communities') in order to learn about full-scale experiments combining both renewable energies and energy efficiency actions. In doing so, it enacted an emerging economic rationality aimed at optimising costs and energy performance by upscaling community approaches, from the scale of the building to a broader urban scale.

In Grenoble, a Green-Socialist political alliance won the local elections in 2001. The deputy mayor for environment and planning had the ambition to turn a former military district—the Caserne de Bonne—into an (energy efficient) eco-district. This would be a first in France. To this end, the municipal team decided to set up a multi-competence committee and apply for CONCERTO initiative funding. Largely influenced by an experienced energy efficiency expert, the committee set targets two times more stringent than the then-applicable French national energy efficiency standards.

In 2005, their submission to the CONCERTO programme was selected for funding. This funding (8 million euros) was conditioned on the implementation of a binding framework including quantitative objectives, an obligation of performance, and a two-year monitoring of the buildings included in the project. In doing so, CONCERTO broke with the habitual way that city planners managed real estate operators (obligation of means without quantitative objectives). Although the tight schedule did not allow consultation of these operators, a public–private collaboration was made possible by the promising real estate market and the advantageous location of the eco-district. The CONCERTO framework required the systematic use of dynamic thermal simulations of buildings during the design process. In order to ensure rigorous implementation, the same energy efficiency expert was commissioned to monitor all the buildings in the eco-district: a rather unusual role of orchestra conductor in energy performance.

Simultaneously, DG-TREN initiated a lobbying strategy at the European level. First, DG-TREN organised various side-events, for instance during the third EU Sustainable Energy Week, in January 2008: 'The CONCERTO communities all over Europe are "real life" experiences: people actually live and work in this environment and can thus provide the experts with a first-hand feedback on the advantages and challenges'.[31]

As a complement to these meetings, DG-TREN mandated an Austrian private research group (Arsenal Research) to benchmark the local initiatives supported within the CONCERTO programme. DG-TREN suggested a set of, largely quantitative, criteria as methodological guidelines. All the local leaders of CONCERTO projects were invited to workshops in Brussels (in July 2006, December 2008 and May 2010) to share experiences and co-define benchmarking criteria. The process resulted in the private group issuing normative policy reports, setting out the requirements for 'high energy performance' buildings, and developing a multi-criteria database. This new informational environment enabled DG-TREN to translate local initiatives into quantitative reviews and to lobby other EU institutions, as it did by issuing a position paper during the redrafting of the Energy Performance Building Directive.[32] This position paper drew on the CONCERTO initiatives to demonstrate the key role of local authorities in work towards a 'zero-energy Europe'.

In the meantime, the French Ministry of the Environment, considering that France lagged behind in this domain that was mostly led by northern European countries, created the national grand prize for eco-districts (*Grand Prix national ÉcoQuartier*). In November 2009, the very first of these prizes was awarded to the Grenoble eco-district, before the project had been completed. At the time, the buildings had just been delivered. As required by the CONCERTO programme, a two-year monitoring process was about to being. One year after the publication of the monitoring results, the De Bonne eco-district was widely criticised in national and regional newspapers, which argued that the national award-winning eco-district had not kept its promises. After its initial fame, the Grenoble project was shamed.

This case study stresses the fact that demonstration policies generate reputational effects before they end, which can then be difficult to manage politically when real learnings emerge.

Several dimensions are of salient interest for our study of demonstration projects as technologies of democracy. First and foremost, in this case a local innovative initiative was significantly reframed by European demonstration funding. In conditioning its support on the implementation of a binding framework (quantitative objectives, performance obligation, measurements), the CONCERTO Programme allowed this initiative to be translated into quantitative data and benchmarked. Furthermore, the policymakers in charge of the programme used the new informational environment to increase their institutional power.

Second, this reframing induced a tension in learning around the Caserne De Bonne demonstration project. This case study points at multiscalar dynamics around the project. Here, the local, French, and European scales became interwoven with: ongoing learning in the demonstration project; France's attempts to catch up with eco-district initiatives elsewhere; and a renewal of technological policies that the Lisbon Strategy aims to introduce in the building sector. The process resulted in the reframing of an experimental, collective way of introducing dynamic thermodynamic simulation into the design process of collective housing in the Grenoble project—and therefore not just as a performance measurement tool, but as part of a collective design process. This attempt at collective learning was revised and processed by the managers of the CONCERTO programme, within a post-Lisbon programme management style based on quantification, ranking, and competition (Bruno 2008, 2009). For the CONCERTO programme managers, this represented an attempt at accelerating learning by creating a bandwagon effect and new collectives that could draw attention to the possibility of adopting new energy performance standards. The Caserne de Bonne project was perceived as a frontrunner, invited to communicate outcomes in the course of its development, learning, and monitoring, and praised in the national media for its exemplarity.

But when monitoring results were published and appeared not to be up to the new standards—although they were still of interest for the project and the associated learning processes—it was then criticised, even dismissed.

Third, demonstration in this case study was thus a multiscalar phenomenon (from EU to local, local to EU, and EU and local to national) whose political management was difficult. It articulated multiple processes which interacted and generated political opportunities for France to catch up with other countries, on the national level, as well as unruly effects of faming/shaming.

This case study thus reflects multiple shifts: (i) a shift in the definition and construction of the public of the demonstration, from innovative local communities which were to learn from each other to EU institutions needing to be convinced by quantitative outcomes; (ii) a shift in the definition of the collective problem at issue, from an initial concern with ways of supporting the bottom-up emergence of 'sustainable energy systems' and upscaling community approaches (from the scale of the building to a broader urban scale), to a concern with informational translation and quantitative benchmarking; and (iii) finally, a shift in the political principles overarching action, from mutual/collective learning to benchmarking and competition.

7 Hectic Politics, Hectic Learning

In 1984, about three decades ago, Stephen R. Lefevre (1984) wrote in a major journal of public management: 'Demonstration programmes attempt to shorten the time within which a specific technology makes its way from development and prototype to widespread availability and adoption by industrial and commercial users. The value of demonstrations, both in energy and other technological areas, is disputed [….] It is now timely to ask if demonstration projects are effective vehicles for refashioning domestic patterns of energy production and consumption. Despite a decade of experience, surprisingly little is known about energy demonstrations and about whether the sceptics of "technology forcing" are correct' (pp. 483–484).

Lefevre was echoing a debate about whether, in civilian research and development, innovations should be ‘pulled’ into the marketplace or ‘pushed’ by the US federal government. His main concern was the innovative efficiency of demonstration programmes.

As underlined by Foray et al. (2012) today demonstration projects are part of new mission-oriented R&D programmes. These differ from past R&D programmes in that they involve many parties as well as both public and private financing. As our analysis has just shown, they also have effects beyond that of generating technological learning and new technologies. Demonstration projects also have a political and democratic dimension, as they contribute to the joint construction of collective problems, publics, and the political principles that hold these problems and publics together. This justifies the approach to them as technologies of democracy developed in this chapter.

However, demonstration projects do not contribute to this joint construction of publics and issues in isolation. They work because they are embedded in socio-technical systems where, over time, this joint construction brings rewards to those who support the projects’ development: either because it helps create the conditions for further funding, or because it contributes to establishing new markets for new technologies. Just as their technological and learning outcomes cannot be assessed exclusively by considering demonstration projects in isolation (Hendry et al. 2010), the same is true of their political effects, making the analysis of these effects similarly difficult.

A few studies have addressed the democratic dimension of demonstration projects from perspectives which have attempted to articulate ethno-methodological approaches to demonstration practices with an examination of the political dimension of demonstration—either scientific capitalism (demo-cracy, Rosental 2007) or techno-environmental politics (Reno 2011). As we pointed out earlier in this chapter, the most recent analysis of demonstration projects by Huguenin and Jeannerat (2017) focusing on their dimension as incubators of social values seems too linear and functionalist to genuinely address their democratic dimension.

The case studies analysed in this chapter suggest a very different realm (Table 2). Demonstration projects are incubators of social values

Table 2 The construction of public, collective problems, and political principles in the three case studies

	CCS	Smart grid	CONCERTO/Caserne de Bonne
Public	Expert framing	*From* 'prosumer' *To* 'captated' consumer	*From* innovative and mutually learning local communities *To* convincing EU institutions through quantitative outcomes
Collective problem	*From* reducing CO_2 emissions (including possibly leaving carbon resources in the ground) *To* limiting the risks associated with CCS as the mitigation option, with technological demonstration becoming a privileged route to risk assessment	*From* saving energy *To* offering business models a broad enough market basis for developing the smart home market	*From* upscaling community approaches *To* quantitative benchmarking

(continued)

Table 2 (continued)

	CCS	Smart grid	CONCERTO/Caserne de Bonne
Political principle	Scientific democracy—defined as the conditioning of the possibility of debating on the scientific nature of arguments	*From* Material engagement (enabling political participation in environmental and electrical commons through materialities) *To* Involvement made easy (ensuring fair competition and developing market opportunities that mediate and ease the realisation of energy savings)	*From* mutual/collective learning *To* benchmarking and competition

to the extent that they produce publics, collective problems, and political principles. Their democratic character, however, is questionable. In the three case studies considered here, parties concerned by the ongoing demonstration—environmentalists, electricity consumers, Caserne de Bonne project developers—did not succeed in making their concerns relevant to the course taken by the demonstration and its effects. There were no genuine spaces for political participation, or if there were, they did not really allow for different voices to be heard or to enter learning processes that made them relevant within these processes. Expert framing, knowledge asymmetries and technicalities, or the pace of the process hampered balanced political participation and adversarial processes.

In two of the case studies (CCS and smart grids), market development was also prioritised in the aim of fostering growth and employment through technological development. Meanwhile, political issues were raised by collectives of actors.

In several regards, this situation with respect to RTD echoes issues that were raised in the 1990s about the ways in which the public dimension of science was challenged and under threat, because of new private modes of financing scientific research (Nowotny et al. 2005). The change in funding modes for science was combined with a rhetoric of accountability that Nowotny interpreted as positing citizens as final consumers of science, potentially entitled to impose demands on science as they do on markets (Nowotny 2005). This new articulation, it was argued, was progressively taking over from traditional modes of legitimation of science (relationship to a public, collective ownership of the knowledge produced, claim to autonomy). Accountability issues also stemmed from repeated controversies about technological outcomes in which the public nature of science was contested 'because it does not sufficiently take the public interest into account as articulated and represented through the public that is engaged in the controversy' (Nowotny et al. 2005, p. 16). The role of scientific experts was challenged, and the issue raised of how governing institutions could renew rules of political engagement to allow for wider inclusion and engagement with science and technology.

In raising these issues anew, technological demonstrations and demonstration projects, because of their purpose of generating innovation, also foreground issues of learning. As we underlined above (§2), it is common to discuss demonstration projects in efficiency-related terms, such as innovation management, actual innovation outcomes, and the intensity and types of learning which take place in projects. In these approaches, learning is only considered from the standpoint of technological innovation. Huguenin and Jeannerat (2017), as mentioned above, recently proposed to broaden this scope. They build on the pragmatist tradition in order to frame demonstration projects as incubators of new social values, which underlie the development of socio-technical systems as well as the production of economic values on markets.

However, this approach remains linear and instrumental: social values are supposed to impact socio-technical systems, which in turn are supposed to underlie the construction of markets and the production of economic values, seen as the ultimate outcome of the chain. It thus does not do justice to the critical and political potential of the pragmatist approach, as it lures us away from the motivation behind this type of analysis. In a nutshell, one of the key motivations of pragmatist analysis is to address the many political and democratic interferences generated by the rising centrality of technologies in modern society (Latour 1991; Callon et al. 2007; Pestre 2013). This includes the ensuing challenge, for the actors who are concerned by a technological development (called a 'public', Dewey 1946), to make themselves relevant to the processes through which these developments are steered—for instance, by becoming able to access and act in the spheres where decisions are made. This issue has been described as 'ontological trouble' because this 'public' is concerned, but their concern is not necessarily acknowledged—the public is not made 'relevant' to the process—and because ontological redefinitions and redistributions of political capacities are at work in these processes (Marres 2012).

Pragmatist sociology thus starts by paying attention to the consequences of activities for actors and entities. It directs specific attention to the processes and the work through which actors collectively attempt (in some cases successfully) to articulate the consequences that they experience and turn them into a shared concern that can be acknowledged in policy processes (Marres 2007). The term 'issue' points to the indistinct status of a concern when ongoing practices, categories, or codes (economic, political, scientific) fall short of taking responsibility for it. Importantly, the process by which an issue emerges (as a shared concern) is a political one: it is the moment at which a 'public' comes into being (Dewey 1946). The public is thus inseparable from the issue and from its formulation as a collective 'problem'. It is a collective of people concerned with this issue and attempting to articulate it as a 'problem' in order to make it public. Noortje Marres (2007) emphasises that the construction of a 'problem' requires a collective and collective work.

Pragmatist sociology thus emphasises several dimensions of the process of turning individual experiences into collective problems, the bypassing of which perverts its critical potential: (i) this process relies on collective work, including sharing experiences, turning them into a shared concern, and formulating this concern as a (collective/public) problem; (ii) this process has an ontological dimension in the sense that both the object under consideration and the actors/entities that engage with it are redefined and associated with new potentials for political participation; and (iii) very importantly, this process is marked by contingency. Its success certainly depends on the quality of the spaces that are offered for political participation, but neither the emergence of these spaces nor the course of the processes can be predicted. John Dewey (2011) emphasised the key role of learning in these processes, as well as the reciprocal relationship and mutual formation of means and ends. While 'ends in view' are needed to develop action, the outcomes of action and learning serve to reformulate new 'ends in view'. Ends serve the formation of means, which serve the emergence of new provisional ends, and so on. The continuity of learning becomes key in turning heterogeneous concerns into collective problems, through: sharing heterogeneous concerns; identifying shared values that are behind these concerns, which allow the concerns to be turned into an issue; and identifying as a collective (a 'public') around these shared values in order to structure action and formulate the issue as a collective problem relevant to policy formulation (Dewey 2011).

None of the three case studies under consideration in this chapter satisfies such conditions of learning and continuity. Either the framing of the debate privileged certain forms of experience and formulations of issues, or there were significant asymmetries in access to and mastery of decisive information, or the pace of the process simply did not allow learning to develop. These case studies also show that the circulation of learning can be multiple and take different modes. Outcomes from demonstration projects are detached from their processes of emergence and are circulated in different arenas, with differences in the way they are presented. Notably, they are quickly taken as signs of success, either by policymakers or by demonstrating participants themselves. This nurtures a certain acceleration of innovation and policy processes, which is not without risks, as it may disturb learning or lead to premature translation into policy decisions. There is, in various ways, a tension running through each of these case studies between the ongoing and unsettled character of things in the making in the demonstration project and their translation and communication to the outside.

These case studies suggest that it is necessary to address the democratic dimension of demonstration projects. They also show that this requires not approaching these projects in isolation and not restricting their analysis to the way innovation unfolds within them. Our understanding of learning in this context also cannot be limited to its technical dimension. We must analyse demonstration projects in relationship to the social forces that challenge their ends and to the broader institutional environment that gives them a central role in energy transition processes. And we must broaden our appraisal of learning to include the emergence of issues and collective problems.

In the EU, we have seen that such a broadening means including the recent turn to Innovation 2020, and the overall positioning of industry at the centre of the financing and steering of RTD policy. This broadening must thus include ETP, strategic agendas, the SET-Plan, and Joint Technological Initiatives. A more detailed and diverse analysis of demonstration projects and policies is needed in order to challenge them for what they actually are—i.e. settings that contribute to jointly defining collective problems, their publics, and the political principles that overarch these joint definitions.

8 Conclusion

This chapter aimed to address the role and the democratic dimension of demonstration projects, which are increasingly central to RTD policy for contemporary energy transitions, especially in the EU.

Demonstration *projects* have mostly been analysed in terms of their innovation potential, looking at their management, their internal practices of innovation and learning, and their technological outcomes. Demonstration *practices* have been analysed in terms of the detailed interactions which underpin the joint construction of their objects and their public. Few analyses have attempted to articulate the minutiae of these analyses with the politics of RTD policy.

In this chapter, we have analysed three cases of technological demonstration—CCS, smart grids, and low carbon communities—focusing on the ways in which these demonstrations jointly constructed their public, their object, and the political principles that hold these together.

Our results show that there were significant democratic issues with each of these projects, because in each case collectives that were concerned by these technological developments did not succeed in having their concerns acknowledged in these processes.

Our results contrast with those of recent analyses that praise demonstration projects as hybrid forums incubating social values, which then underlie the development of new socio-technical systems and markets. We conclude instead that demonstration projects should be analysed in relationship to the social forces that challenge their ends, and to the broader institutional environment that gives them a central role in energy transition processes.

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Notes

1. 'One of the key roles of the Commission is to use its programmes to encourage the sharing of experience amongst organisations in the EU Member States, and to ensure that lessons are learned as quickly and efficiently as possible' (Gillett et al. 2001, p. 2), quoted by Hendry et al. (2010, p. 4518). Gillett, W., Gambi, R., Obled, C., Ossenbrink, H., Perujo, A., Scholz, H., 2001, Results from PV Demonstration Projects in Europe. In: Proceedings of the 17th, European PV Solar Energy Conference, Munich.
2. They were used, for instance, during the oil shocks in the US in order to foster the development of nuclear energy (Lefevre 1984).
3. EU, 2006a, "An Innovation-Friendly, Modern Europe," Communication from the Commission to the European Council, COM (2006) 589 final, 12 October 2006, Brussels.
4. EU, 2002, More Research for Europe Towards 3% of GDP—Communication from the Commission, COM (2002) 499 final, 11 September 2002, Brussels.
5. EU, 2006b, "Creating an Innovative Europe," Report of the Independent Expert Group on R&D and Innovation appointed following the Hampton Court Summit and chaired by Mr. Esko Aho, Brussels. http://ec.europa.eu/invest-in-research/pdf/download_en/aho_report.pdf.
6. ETPs are industry-led arenas which were established by the Commission in order to bring expertise to the Commission, and to devise technological visions and strategic agendas in different technological domains. JTIs are large industry-led technological projects.
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Specific Programmes—Report of the 2005 External Panel," August 2005, Brussels.

10. EU, 2013b, "Strategy for European Technology Platforms: ETP 2020," SWD (2013) 272 final, 12 July 2013, Brussels.
11. EU, 2000, "Towards a European Research Area," Communication from the Commission to the Council, the European Parliament, The Economic and Social Committee and the Committee of Regions, COM (2000) 6 final, 18 January 2000, Brussels.
12. For a review, see Bossink (2015).
13. For instance, Harborne and Hendry (2009) identify 148 demonstration programmes and projects for wind power between 1974 and 2004—a total of 577 sites covering Europe (199), Japan (201) and the USA (177).
14. Bossink (2015) points at ten different fields and issues: (1) Experimentation: developing measurement methods and methods, (2) Innovation adoption and diffusion, (3) Demonstration project management, (4) Public clean energy policy, (5) Strategic niche management, (6) National systems of innovation, (7) Financial and life cycle analysis, (8) Knowledge and technology transfer, (9) Learning, (10) New organisational forms.
15. This part and all the material and analysis about CCS are based on Neri O'Neill (2015) and Neri O'Neill and Nadaï (2012).
16. For the sake of clarity, we purposely leave here aside the role played by other important projects, such as the Hawaii and Weyburn projects.
17. Torp Tore A., and Gale John, 2002, "Demonstrating Storage of CO_2 in Geological Reservoirs: The Sleipner and SACS Projects," paper presented at GHGT-6, Kyoto, Japan.

    Torp, Tore A., and John Gale. "Demonstrating Storage of CO_2 in Geological Reservoirs: The Sleipner and SACS Projects." *Energy* 29 (2004): 1361–1369.

    For a recent use of an artist representation of CO_2 plume in the underground that was released by Statoil at that time, see figure 1. In: Chadwick, R. Andrew, Benjamin P. Marchant, Gareth A. Williams. "CO_2 Storage Monitoring: Leakage Detection and Measurement in Subsurface Volumes from 3D Seismic Data at Sleipner." *Energy Procedia* 63 (2014): 4224–4239.
18. Greenpeace, 2008, "Leakages in the Utsira Formation and their Consequences for CCS policy, Briefing," consulted 30 November 2011, http://static.greenpeace.org/int/pdf/081201BRUtsira.pdf.
19. In journals such as *Energy Procedia*, for instance.

20. Eiken, Ola, Philip Ringrose, Christian Hermanrud, Bamshad Nazarian, Tore A. Torp, and Lars Høier. "Lessons learned from 14 years of CCS operations: Sleipner, in Salah and Snøhvit." *Energy Procedia* 4 (2011): 5541–5548.
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22. By Monsterky, idem.
23. This part and all the material and analysis about smart grids is based on Granclément and Nadai (2015).
24. https://www.earpa.eu/earpa/39/etp_smartgrids.html.
25. JRC, 2011, Giordano, Vincenzo, Flavia Gangale, Gianluca Fulli, Manuel Sánchez Jiménez, Ijeoma Onyeji, Alexandru Colta, Ioulia Papaioannou, Anna Mengolini, Corina Alecu, and Tauno Ojala. 2011. "Smart Grid Projects in Europe: Lessons Learned and Current Developments." Joint Research Centre Reference Reports, sy 8. http://www.fvu-center.dk/sites/default/files/smart_grid_projects_in_europe.pdf.

    JRC, 2013, Mengolini, Anna, and Julija Vasiljevska. 2013. "The Social Dimension of Smart Grids: Consumer, Community, Society." Joint Research Centre. https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/social-dimension-smart-grids-consumer-community-society.
26. Electricité de France (EDF) is the current main electricity provider. It was the former electricity monopoly, and is currently the main shareholder of the distribution grid manager ERDF (recently renamed 'Enedis').
27. Recently restated in the last Energy Efficiency Directive, precisely to prevent this type of monopolisation (Directive 2012/27/EU on Energy Efficiency—Article 18).
28. For more details about these actors, see Chapter 3, §4.3.
29. This case study is based on Labussière, 2014.
30. EU, 2005, European Commission Community Research, SP1-Priority 6-1, 6.1 Sustainable energy systems, Work Programme, Revision 4 for the TREN-4 Call, June 2005, p. 3. http://cordis.europa.eu/pub/fp6/docs/wp/sp1/f1_wp_200216_en.pdf.
31. CONCERTO, 2008, CONCERTO newsletter, issue 5, July 2008, p. 8.
32. CONCERTO, 2008, Position Paper on the Recasting of the Directive 2002/91/EC of 16 December 2002 on the Energy Performance of Buildings, 7 p.

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6

The Spatialities of Energy Transition Processes

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With contributions from Jeoffrey Dehez, Laurence Rocher, and Antoine Tabourdeau

List of abbreviations

ADEME	Agence Française de l'Energie et de la Maîtrise de l'Environnement
AMORCE	Association de collectivités, gestion des déchets, réseaux de chaleurs, gestion locale de l'énergie
ANME	National Tunisian Agency for Energy Efficiency
CRE	French Commission for Energy Regulation

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EGL	European Gas Limited
FNCOFOR	Fédération nationale des communes forestières
GIZ	German Cooperation Fund/Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
RAEE	Rhône Alpes Energie Environnement
RNPGC	Regional Natural Park of the Grands Causses
STEG	Tunisian National Electricity and Gas Utility
WPDZ	Wind Power Development Zone

1 Introduction

Energy transition is fundamentally acknowledged as a geographical process that happens in particular places, transforms landscape features, produces uneven development and, more generally, entails reconfiguring current spatial patterns of economic and social activities. The way in which spatial processes shape new energy technologies and influence their capacity for transformation, however, has rarely been a focus of analyses (Coenen et al. 2012; Hansen and Coenen 2014; Lawhon and Murphy 2012; Bridge et al. 2013). The strong technological dimension of energy transition has sometimes led researchers even to shunt aside the importance of the spatial dimension.

The deployment of new energy technologies is an important focus of the 'transition studies' (see the Introduction of this book). Both the 'technological innovation systems' and the 'multi-level perspective' have produced conceptual frameworks to explain technological change and

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system innovations over time. Both of these approaches have conceptualised socio-technical systems as interrelated sets of actors, networks institutions and technologies/artefacts. But the spatial dimension (i.e. materiality, relationality, heterogeneity) that may influence the way these emerging constellations of actors come into existence has usually been neglected. The 'multi-level perspective' (Geels 2002; Geels and Schot 2007) has provided a conceptual framework to analyse systemic socio-technical transformations in relation to pre-constituted scales—'niche', 'regime' and 'landscape'. But these scalar metaphors refer to the institutional structures and the maturity of socio-technological systems rather than their spatial dimensions and issues (Coenen et al. 2012; Lawhon and Murphy 2012). In other words, place has by and large been taken for granted by transition researchers, understood implicitly as a spatial container wherein socio-technical systems are located and innovations emerge (Murphy 2015; Gailing and Moss 2016).

By seizing spatial categories as given and reducing space to a container function, transition studies fail to grasp the socio-political dimensions of energy transitions (Gailing and Moss 2016). The diffusion and territorialisation of new energy technologies are not processes free of power relations and power struggles. Their diffusion goes along with the political construction of sustainable and desirable futures, which regularly proves to be a highly conflictual and divisive process (Meadowcroft 2009) and occurs at various institutional and geographical scales. In an early conceptual contribution, Shove and Walker (2007) noted the importance of the institutional embeddedness of socio-technical development processes within specific places. Following them, geographers have maintained that future research on the geography of energy transitions should investigate more systematically how place-specificity and scale influence transitions processes (Truffer and Coenen 2012; Hansen and Coenen 2014).

To investigate further the role of space in the energy transition, this chapter proposes to take into account the diffuse materiality of renewable energy resources. Our aim is to contribute to an emerging agenda about the spatialities of energy resources and their political issues at the crossroad of materiality and space. The chapter is divided into four sections. The first briefly presents the field of the geography of energy resources and explains the approach of renewable energy resources as a 'turbulent' materiality. The second proposes theoretical elements inspired by works on the vertical dimension of space to study the processes through which space is configured as a manageable 'volume' for controlling energy material flows. The third examines five case studies from France, Germany and Tunisia. Finally, a discussion about emerging politics of 'volume' in the energy transition aims at providing a critical geographical appraisal of the current development of renewable energies.

2 Spatiality, Materiality and Renewable Energy Resources: Setting the Stage

2.1 Geography of Energy Resources

The deployment of new energy technologies goes hand in hand with the valorisation of new energy materiality flows (wind, solar, tide, biomass and so on) and their construction as energy resources (see Chapter 1). Relatively few contributions deal explicitly with the importance of renewable energy resource endowments for sustainability transitions (Hansen and Coenen 2014), perhaps because these 'natural' resources (wind, solar, biomass) seem better distributed and accessible than fossil resources. Yet we have known since FitzSimmons (1989) made an appeal to place the 'matter of nature' squarely within the sights of a politically engaged human geography that resources are not 'external things', discovered by science and technology and to be extracted and transformed into useful commodities. In the 1990s and 2000s, the literature of political ecology gave particular attention to the political and economic dynamics surrounding control and struggles (material and discursive) over access to environmental resources (Blaikie 1999; Robbins 2004). Rather than 'being', resources 'become and what counts as a resource depends on the interaction between biophysical heterogeneity and social networks' (Bakker and Bridge 2006). This invites us to consider the relational becoming of energy materiality flows and whether or not their configuration as an energy resource is 'renewable'.

If the revitalised 'resource geography'[1] (Bridge 2009, 2011, 2014; Bakker and Bridge 2006) is clearly built on rich traditions of research such as 'commodity stories' of resource production (Peluso 2012), this thinking is also influenced by works on hybridity, which have turned their attention to documenting the ways in which heterogeneous entities (human and non-human) are churned together. The significance of work on hybridity for resource geography lies in the relational and distributed view of materiality. This approach shows how the competencies and capacities of 'things' are not intrinsic but derive from association (Bakker and Bridge 2006). A key component of this resource-making process entails calculation and measurement, practices which define 'things' in particular ways and defend them against other claims. The process of resource management, on this view, is both material and discursive: It emphasises the 'social and institutional practices through which resources are not only allocated but also defined—discursive, social, material practices through which resources come to be constituted' (Bridge 2009). Supporting assemblage thinking (Anderson et al. 2012; De Landa 2006), Bakker and Bridge (2008) claim that resource space is rather a precarious achievement, 'a temporary stabilisation at the nexus of political, economic and technical relations that is always potentially subject to dissolution and challenge'.

Assemblage thinking is all the more important because the energy materialities studied in this chapter are diffuse. Indeed, in contrast with the resources consumed for centuries (oil, gas, coal), these energy materialities have to be 'concentrated'—that is, their flow harnessed and their turbulences tamed to allow a regular and predictable production of energy. As the 'concentration' of these diffuse and sometimes fluctuating materialities is not bounded in space, it can give rise to invasive technological developments in fragile environments (e.g. large-scale wind or solar farms) and a competition for space between different users and visions. The occupation of broad new areas is also very important because these new energy technologies are modular and need some support and technical requirements to be developed. These observations suggest the importance of a specific questioning about the materialities and spatialities of renewable energies.

2.2 Which Ontology for Turbulent Materialities?

As pointed out by Castree (2003) (see Chapter 1), the commodification of 'nature' into a resource implies that a thing is progressively separated from the socio-ecosystem in which it is initially embedded. Things are turned into 'discrete ontological entities' while being individuated, specified by new qualities, a monetary price attached to them, and finally made tradable. Castree has insisted on the different 'natures' the process of commodification is rooted in. What is called 'nature' is usually known as environmental externalities (e.g. pollution). Castree has distinguished this external 'nature' from an internal one in which things are entirely commodified—for instance, seeds and chickens in capitalist agriculture. The internal/external distinction is precisely something this chapter wants to reformulate. It insists that the process of commodification comprises practices of framing things and of the various material adventures that may disrupt their categorisation.

As set forth in the Introduction, we approach the energy transition as a period of 'ontological trouble' that calls for an inquiry about the emerging properties of the materiality in relation to specific socio-technical assemblages. Our assumption is that the process of commodification 'interferes' in many ways and at various degrees with environmental entities that do not find a clear status in the process. This aspect is not ignored by Castree, who refers to ecological means that are sometimes only partially detached from the place they belong to or inadequately valuated and exchanged. But he understands this type of 'incomplete commodification' as the expression of an 'external nature'. Beyond the internal/external divide, the issue is to look at materiality as something more complex than a stable or unstable thing. An 'interference' is not an interaction between two things that pre-exist the process. An interference enacts the world in multiple ways as it generates new entities and adds new properties to their existing ones (Latour 1999).

Setting materiality in motion and taking control of a flow of energy is a process that triggers many interferences prior to the stabilisation of a socio-technical assemblage. Following Cresswell and Martin (2012), we approach materiality as something fundamentally 'turbulent'—that is, in emergence and uncertain. A long tradition of works positions the idea of 'turbulence' negatively, as the opposite of order and stability. Cresswell and Martin have rejected this preconception based on the predilection of classical science for a governable and predictable materiality—that is, the model of laminar flow. Thus, beyond the order/disorder distinction, they invite us to look at the material adventures of things in terms of 'event'—in our terminology, of 'interferences' that induce uncertain but sometimes creative becoming, and of 'transitory ordering' understood as phase of stability. This approach to materiality strongly echoes the issues raised by the commodification of diffuse and fluid energy resources.

3 Configuring Space as a Manageable 'Volume' to Control Energy Material Flows

3.1 From Energy Materiality to 'Spaces of Resource': Dynamics, Interferences and the Political

The making of 'spaces of energy resource' invites us to study how space is configured to channel and control turbulent materialities (e.g. wind, solar and so on). This configuration of space is approached as political engineering, for it aims at managing the materiality of energy resources in relation to numerous others entities (landscape, local uses), through practices of displacement,[2] differentiation and concentration in space. We assume that these spatialities of control over energy resources 'interfere' dynamically with other pre-existing spatialities. This has always been studied in the case of carbon energy resources. For instance, in the Appalachian mountains the deeper coal extraction goes the more it devaluates surrounding land outside the mine and fosters its horizontal extension (Hass 2008). These spatial dynamics, their interferences and their politicisation, must also to be studied in the case of renewable energy resources.

To do so, the idea of space has to be revised and adjusted to the turbulent and diffuse materialities we are looking at. Energy resources such as wind, sun or biomass question both the horizontal and vertical dimensions of space. For example, sharing the wind in the form of siting wind turbines that fit in with bird migrations is not the same political work as sharing the subsoil in the form of exploiting timber resources in a way that avoids weakening the carbon storage capacities of the forest (biomass, subsoil). Among the spatial dynamics at work in the contemporary energy transition is the disconnection between the vertical and horizontal dimensions of space. This is the case when, through the development of renewable energies, land ceases to be treated as a land and is narrowly approached as a surface. The disconnection of horizontal (land, property rights, local knowledge) and vertical (aerial/surface/subsurface resources) dimensions is one of the contemporary expressions of a capitalist appetite for space, as, for instance, more specifically studied by Chouquer (2012) in the case of land grabbing by international agricultural companies in southern countries. Is renewable development, by taking over surface or subsoil, therefore a de facto challenge to ongoing articulations between the horizontal and the vertical dimensions of space? Is this issue being taken into account within the processes of energy transition, and if so, how?

The vertical dimension of space has not been much studied, especially with respect to the energy transition (Lehman 2013; Grundy-Warr et al. 2014). Braun (2000) insisted on the construction of the underground as vertical 'geological' territories through scientific practices of collecting, comparing and combining things from disparate places. Elden (2013) developed the idea of 'vertical geopolitics' as the capacity of controlling flows (of persons, market goods) in a volume, taking the case of Israel's border with Lebanon. Following Elden, Bridge (2013) suggested that the idea of 'volume' may help to explore the practices of calculation and visualisation that configure the underground and lead to the commodification of oil. The idea of 'volume' usefully addresses issues concerning underground resources. Within the scope of the present chapter, we want to avail ourselves of this literature to look more systematically and analytically at the dynamic formation of the 'space of energy resource', since we assume that the space of a resource is specifically arranged according to its materiality in both its horizontal and vertical dimensions.

3.2 Politics of 'Volume': Calculation, Navigation and Dis/Connection

The 'deposit' of an energy resource does not exist beforehand. We propose the idea of a 'space of resource' as an intermediary term between materiality and space. It focuses attention on the diverse mediations needed to explore the materiality of an energy resource and the different spaces and scales of which it is part. The making of a 'space of resource' calls for specific operations: calculating a volume, navigating within it, controlling a material flow (Bridge 2013; Labussière 2017). The volume is not predefined and does not pre-exist these operations, since all three actively contribute to configure an incoming manageable and predictable volume.

Calculation: the deployment of new energy technologies is conditioned by the availability (quantity, quality) of an energy resource. The assessment of this energy potential relies on operations of calculating its intensity (wind speed, solar intensity, biomass density) and its recoverable part (in accordance with specific technologies). This occurs in different places and environments, but also in relation to different types of energy materiality. The calculation of an energy potential aims at sizing a tradable volume of energy (kWh/hours, calorie). As we have observed, this 'volume' of recoverable energy is deeply linked to the way a 'deposit' is built and spatially configured, horizontally as well as vertically. In this chapter, we are interested in what makes calculation spatially, socially and technically possible. In particular, we assume that calculation is a capacity that relies on the way space is configured as a manageable volume, that is, a volume in which a flow of energy is under control and which allows a capacity for predictability. Thus, calculation is not reducible to the application of a formula, but calls for explicit and pragmatic statements, as suggested by Muniesa and Linhardt (2011) about what a thing is and what it can do in a specific situation. Numerous questions arise in relation to the calculation of a volume: Does the materiality of a resource influence the way it is valuated (instruments, categories of quality)? How is the activity of calculation influenced by the configuration of places?

Navigation: the 'space of energy resource' is also configured by the devices set up to visualise the resource and navigate within a volume (see for instance Scott 1998, on the making of nature and nation through visualisation). Depending on the different energy materialities, this work proceeds in different ways. It depends on the way space is relationally (re)defined by determining reference points, limits, borders, areas, strata in relation to a new energy technology. This spatial vocabulary emerges from the confrontation of technology with its surroundings. For instance, in the case of a wind power unit it is a matter of discovering the relationships between the wind turbines and others entities, such as the landscape (visual), birds (migrations) and local populations (land uses). These different issues give rise to a new geometrisation of space and a new allocation of powers—that is, capacity to have a voice or not in the process of siting the project. On this basis, the 'space of energy resource' is progressively differentiated and brought into visualisation. This process makes (or does not make) the volume shareable and negotiable. Questions that then arise are 'How is space geometrised through the development of a new energy technology?' 'How is this geometrisation brought to visualisation?' 'How does this visualisation allow collective capacities of navigation and exploration of the energy volume?'

Dis/connection: as previously stated, a 'space of energy resource' constitutes a transitory ordering of things around an energy materiality flow. This spatiality is not clear-cut but looks more like an assemblage that interferes with others assemblages (as suggested by the work of De Landa 2006). We assume that the making of a 'space of energy resource' consists in identifying singular elements, attributing to them a function and then bringing them into a net (a seminal work on spatial technoscience topologies is Law and Mol 2001). For instance, the development of a community-based solar project may connect differently the roofs of private and public buildings depending on the priority given to economic profitability or the building of a local renewable community. This networking is not accomplished once and for all but is experimentally developed so as to optimise the recovery and the concentration of energy flow. The experimental activity generates many interferences because it consists precisely in catching and releasing things, playing with their functions and progressively revising their properties in an operative unit. Taking control of a material flow (from solar rays to photovoltaic kWh) presupposes the management of political issues that may emerge from these interferences.

4 Spatial Dynamics and Relations of Power in Energy Transition

Five case studies out of the 36 explored in the Collener programme have been chosen (3 in France, and 1 in Tunisia). These empirical inquiries allow us to study the processes through which space is configured as a manageable 'volume' to control energy material flows.

4.1 Colonising Periphery, Developing Fuelwood: Biomass Development in Aquitaine

As a major consumer of wood and energy, the pulp and paper industry has been under pressure from the EU climate and energy policy package. While requirements to reduce carbon emissions challenges its manufacturing process, fuelwood policies impact on its wood resources endowment.[3] This issue is all the more important to the paper mills of the Landes de Gascogne massif (southwestern France) because the cultivated forest,[4] primarily composed of maritime pine, was identified as an attractive biomass deposit in the mid-2000s by the French national resource inventory (Banos and Dehez 2015). But these transnational and well-established firms are able to resist any change threatening their interests. With their strong institutional backing and their monopsonistic position, they have tried to lock the supply chain through means such as (1) preventing market entry of energy competitors, and (2) avoidance of the 'withdrawal' (Galis and Lee 2014) of the usual partners who could see fuelwood as an opportunity to break dependency relationship (forest owners, sawmills). Thus, local pulp and paper industries presented fuelwood as a shared challenge (competitiveness, employment, sustainable forest management) and called on public authorities to keep the Landes de Gascogne forest area clear of biomass energy projects (Banos and Dehez 2017).

The strategy of the pulp and paper industry also consisted, however, in transforming the energy transition into new opportunities for their rooted business model. To do so, they started a struggle over the 'volume' of fuelwood needed at different levels. (1) Since forestry resources are abundant at the national level, the French Commission for Energy Regulation (CRE) has organised since 2003 tenders to increase the production of electricity obtained from biomass by supporting industrial investment in large wood boilers. (2) In response, the pulp and paper industry developed a powerful lobby at the European and French national levels to give priority to cogeneration technologies (simultaneous power and heat production) for improving the energy efficiency of the projects selected (Montouroy and Sergent 2014). This approach favours paper mills that traditionally use steam in manufacturing processes and, unlike energy companies, already control the entire supply chain. (3) At the French national level, industrial sectors (chemistry, energy) and NGOs agreed on the 'cascade' principle as a means to protect the forest while opening its resources to the energy transition (i.e. a hierarchy of woods ranked according to their priority uses: lumber, paper, wood panel and finally heat energy). All this means that the paper industry is better positioned than its competitors to respond to CRE projects. In 2012, two cogeneration plants were being developed in the Landes de Gascogne forest area and both were backed by paper mills. One of them was the most powerful in France (69 MW) at the time. How did the paper industry manage simultaneously to emphasise the scarcity of wood resources to foreclose access to the Landes de Gascogne massif and to ask for an increase of wood mobilisation to supply their new cogeneration plants[5]?

The storms 'Martin' and 'Klaus' (1999 and 2009, respectively) turned out to be powerful allies for resizing the 'space of resource'. In 2010 storm damages convinced regional public authorities to support the 'closure' of the 'Landes de Gascogne' region to new wood energy projects—by cutting the associated subsidies: 'With data and simulations, it appears that an implementation of biomass projects on the maritime pine resource is not possible' (Regional Biomass observatory,[6] in Banos and Dehez 2017). Even this spectre of scarcity (Bridge and Wood 2010) is based on questionable supply and demand projections (e.g. forest management options, pulpwood and fuelwood consumption); it also allows the major operators of the massif to push vigorously for an ontological and spatial extension of the resource. Priority has been given to two paths long proposed by the Gascon pulp and paper industry. The first objective has been to turn pine maritime stumps, historically defined as a forest waste, into a valuable resource.[7] This has led to an adjustment of an inherited socio-technical assemblage devoted to the exploitation of trunks, branches and twigs to a new wood 'volume' situated underground: learning how to harvest the stumps, make piles to let it dry, allow rain to wash off adhering sand, find an adequate means of transport and supply industrial wood boilers with residual sand as far as this does not affect their performances. This process extended the wood 'volume' because it provided new technologies and practices for exploiting a forest area disturbed by natural hazards. It progressively turned a ‘radical otherness’ (the stump), usually abandoned in the ground, into an emerging commodity. Nevertheless, the paper industry resisted its full marketisation, for it did not want to pay for using stumps. They argued that stump harvesting constituted a new service to the forest owners because this method would reduce cost of forest regeneration and help to prevent the spread of the butt rot (*Heterobasidion annosum*) that causes decay in conifers. But removing stumps could also disrupt the carbon cycle and the fertility of the soil, since it could affect its calcium, potassium and phosphorus content (Walmsley and Godbold 2010). Still, such interferences and emerging issues did not actually trigger public concern (Banos and Dehez 2017).

The second road to increase wood mobilisation and secure the Gascon industrial fabric consisted in the enlargement of the supply basins towards neighbouring areas. Dordogne and Pyrenees forest areas were progressively treated as ‘peripheral massifs’. These were targeted for immediate harvest and for the further extension of maritime pine afforestation through the use of energy transition and climate change arguments (Hautdidier et al., forthcoming). It resembles a process of spatial and economic colonisation that consisted in replacing ‘declining’ broadleaf forest by maritime pine. In Dordogne, a former ‘space of resource’ had been organised for fifteen years around a chestnut coppice: The needed ‘volume’ of wood was low, small boilers were supplied by a network of local farmers, and this network helped rural social housing to access low-cost heat. Nevertheless, these projects were highly vulnerable as they reached their financial stability only thanks to the support of the French ADEME and the Dordogne Council. The priority given nationally to large boilers for improving energy and the economic efficiencies of fuelwood policy redirected the ADEME subsidies and opened the area to new industrial players. In 2011, many rural institutions and NGOs specialised in the development of local biomass projects tried to politicise the question at the national level, but without success (Banos and Dehez 2015). In the Landes de Gascogne region, it was the paper industry’s takeover of the evaluation of wood stock and the absence of a shared database about this that stifled the possibility of political negotiation about the spectre of scarcity and the need (calculation of the volume, navigation outside the Landes Massifs) for the paper industry to harvest stumps and colonise the ‘peripheral massifs’. In this case, the practices that underpinned the making of new wood volumes participated in ‘fossilizing’ a potentially renewable materiality (as proposed by Raman 2013), following the rules of an industrial extractivist model.

4.2 Wind Power Beyond Zoning: Towards Politics of Massif in Aveyron

Aveyron (South-West France) is one of the French departments with the best wind potential. But the rush to exploit the potential after 1999 was confronted by a stop-and-go process. Planning attempts first tackled issues of landscape but failed to take into consideration many local interests and the evolution of wind towers. After 2005, another more integrated attempt at the level of the massif encountered pressure from municipalities and developers pushing for profits and from the opposition of increasingly reluctant inhabitants.

Wind power development started in Aveyron in 1999. No wind power planning action whatever was in place at the time. In order to cope with the increasing number of projects submitted by private developers for approval, the local administration decided to set up an inter-services platform (in 2000) and to start devising a planning scheme. At that time, the Regional Natural Park of the Grands Causses (RNPGC), a non-state actor, had suggested approaching wind power planning on the scale of the massifs. Contrary to the usual assessment of wind potential (limited to the speed measures of the wind), this offered the possibility of calculating a wind power ‘volume’ that encompassed massif configurations, including related landscape and environmental issues. These massif entities offered as such a framework that was more compatible with collective negotiation at the local level. In 2000, however, the idea was discarded by the prefecture as being too complicated because massifs overlapped administrative divides. The local administration set aside this territorial approach because of the lack of landscape analysis capable of objectifying massifs entities.

The outcome was a first wind power planning scheme issued in 2005. The approach translated wind power issues into zoning through several operations such as the definition of landscape 'types' based on morphology and heritage values, the mapping of regulatory constraints and the addition of buffer zones to compensate for regulatory insufficiencies in the face of the exceptionally far-reaching co-visibilities imposed by industrial wind turbines. The gradual shift from a qualitative landscape issue to a zoning logic (favourable, unfavourable or negative) certainly answered to the need of administrative instructors for rationality and objectivity in the face of pressure from wind power developers (Nadaï and Labussière 2009). It was supposed to provide navigation in the in-between of the wind power zones, conceived by the administration as spaces not visible from the most touristic and daily frequented parts of the territory. But this logic appeared inappropriate for controlling wind power 'volume', since the development inside the favourable zones was left unplanned. The concentration of wind turbines inside the favourable zones rapidly exploded and soon interfered with the daily landscapes and land uses.

As the local administration was unused to communicate figures about projects under consideration (accepted, ongoing applications, refused), inhabitants of a hamlet in the Massif of Lévezou developed a grassroots mode of calculating the 'space of resource'. Taking advantage of local solidarity, they went from door-to-door in order to cross-reference information. They quantified more than two hundred wind turbines under study. This mode of calculating contributed to joining private concerns to a network covering the Lévezou, and hence to putting the massif on a new political scale. In order to structure resistance against wind power, the inhabitants formed a league ('Levezou in Peril') to tie together threads (heritage, proximity, landscape) that were kept separate by the administration. They politicised massifs in the centre and the south of Aveyron and progressively obliged the administration to scale up its approach of wind power deployment and revise its techniques of control over it. At the same time, landscape protection was coming up against the limits of the first wind power plan (e.g. co-visibilities between protected and authorised zones, obsolescence of landscape choices in the face of the rapid technological development of wind energy).

In 2006, the Wind Power Development Zone (WPDZ), a new legal instrument for planning wind developments, had just been implemented at the national level and provided the local administration with a justification for revising the existing power plan. The Aveyron prefect was replaced. The new prefect imposed a temporary moratorium on wind power permits until all WPDZ came into effect under the action of intercommunalities. The WPDZ offered a window to change the approach of calculating the wind power volume, based on the existing wind power farms and their future deployment at the scale of the massifs. Massifs, considered as landscape entities, were thus endowed with a political and relational existence. This allowed for collective explorations of what the 'space of resource' was, navigating among protected and ordinary landscapes, and revising their visualisation. For instance, local mayors pointed out that the situation of highlands (former commons used for grazing during the nineteenth century) at the other end of the massifs limits the co-visibilities between the wind farms and their villages. Their status made it easier for communities to share the financial benefits from wind power.

In this process, the RNPGC supported intercommunalities through funding and the aid of a landscape architect, on the condition that the different local mayors would follow shared good practices in devising WPDZ (e.g. coordination on a massif scale, concerted decision process with local inhabitants). Nevertheless, this innovative approach failed. It interfered with the interests of private developers and mayors already engaged in a myriad of wind power projects scattered across South Aveyron. This aggregation of private interests hampered the reopening of the planning process on the regional scale. Even more important, this private approach to wind power exacerbated social tensions and induced processes that exhausted local synergies and solidarities, rendering wind power more an exhaustible energy than a sustainable one. This shows that an emerging 'space of resource', even when engaged in a local process of trial-and-error, is not entirely reversible in the face of individualistic and privately-based types of wind power development.

4.3 Aggregating Roofs, Commonising the Sun: Village Solar Plants in Rhône-Alpes

The magnitude of photovoltaic feed-in tariffs in France between 2008 and 2010 induced a large and rapid growth of the photovoltaic sector. Rural areas with their large fields and large agricultural facilities roofs progressively became prime targets for private solar developers. These developments, steered by the quest for the highest private profitability and the lack of a local regulatory scheme, gave rise to waves of local resistance. One of these movements formed in the regional natural park of Vercors where a massive solar project threatened to interfere with local landscapes and uses (massive forest cutting, unequal accesses to solar energy outcomes, problematic co-visibilities).

As an alternative, the Regional Natural Park of Vercors and Rhône-Alpes Energie Environnement (RAEE), a regional NGO that benefited from former experiences with renewable energy development, promoted the idea of small local energy cooperatives ('centrales villageoises solaires') using PV technology (100–250 kWp). Eight cooperatives, financed and managed locally, arose from this initiative in five different regional natural parks. To explore and build the 'space of resource', these cooperatives proceeded by basically joining together the roofs of the interested owners to provide first solar capacities. While embracing the same alternative vision, the cooperatives aggregated their roofs, but did it differently one from each other and with varying degrees of success (Fontaine and Labussière 2015).

In the Pilat Regional Natural Park (south of Lyon), project developers wanted to generate a solar operation concentrated in space, connecting the roofs of buildings close to each other. After a round of public meetings in the area, four municipalities were selected on the basis of their inhabitants' motivations to join the collective solar project. For each municipality, local technicians did fieldwork to evaluate the roofs' solar intensities and their landscape co-visibilities. These observations, along with others (roof surfaces, roof feed-in tariff category), were aggregated into a database managed by a geographical information system. This in turn led to first aggregates of roofs, which became surfaces/solar intensity on a map and allowed calculating first volumes of solar electricity. The geometrisation of space was based on the roofs, the buildings and their relative proximity. This exploratory step led to the selection of the village of Les Haies as the pilot site of the programme.

Using these promising aggregates produced with a GIS, the natural park's landscape architect began exploring the landscape and architecture-related issues. She returned to fieldwork to visualise in situ the roofs (incline, orientation, presence of chimneys, antennas and windows) on various scales (building, village, landscape). This other type of exploring and navigating within the estimated solar volume significantly changed the way it was looked at. Two scenarios of development emerged: (i) an alignment of houses along the main street that would underline the smooth rising of a hill in the distance; (ii) two coherent gatherings in the old and new parts of the village. These allowed refinement of what the 'space of the resource' would become, dealing more precisely with the materiality of things and providing them with a new internal coherence.

The political value of the process appeared when the project leaders asked for cost estimates from the electric grid manager. He looked at the project not as a whole but as a sum of roofs that can be divided into individual units. He therefore calculated the electricity produced by each panel, identified the panels sharing the same substation and answered the question whether a given substation would support these new connections. The 'space of resource' was normatively indexed to the available capacities of the existing grid segments. According to their situation in the network, some roofs would require grid reinforcement and generate unacceptable additional costs. In every case, this situation obliged the solar projects to reduce their size and revise the initial ambition of a qualitative development. In some cases, the heterogeneity of the costs, benefits and individual profits made a community-based solar project impossible (e.g. the Natural Regional Park of Les Bauges). At Les Haies, the leaders envisioned reducing the scope of the project by detaching roofs from the initial assemblage without excluding their owners from the project. To do so, they paid less attention to economic profitability and focused more on qualitative criteria (landscape and architecture coherence) so as to choose which roofs could be taken out of the assemblage. The project maintained its high ambitions of proceeding collectively, even though it was quantitatively downsized.

The Pilat case looked at roofs in relation to buildings and their surroundings, which offered a view of roofs in terms of scales and relations (architecture, landscape). The aggregation of roofs was an operation that went beyond adding together roof surfaces. It was a matter of creating a collective 'space of solar resource' that allowed communising the sun. The case demonstrates how two socio-technical systems in one place and from different ages (the grid as a centralised infrastructure; decentralised solar projects) interfere with each another and the capacities permitted by the relational appraisal of materiality to modulate a project in a constrained situation, technically and economically.

4.4 Recovering Sovereignty Over Renewable Resources: The Electric Grid and the Colonisation of Space in Tunisia

In Tunisia, the national electricity and gas utility (STEG) was created in 1962, in the aftermath of independence. Over the years, STEG has been the right arm of the Tunisian state in unifying the emerging nation, both socially and territorially, through development (symbolised by light). STEG can be labelled, using Nadai's and Labussière's phrase, 'an energy common' (Nadaï and Labussière 2015). Electricity in Tunisia has largely been produced by thermal technologies (95%) until now.

In Europe, the quantitative objectives adopted at the beginning of the 2000s for the development of renewable energy triggered transnational visions of energy production across the Mediterranean basin. In particular, the Desertech initiative, a gathering of private firms, was launched in 2006. Desertech's vision was that renewable energy units located in the Sahara and operated by European firms could break the carbon lock-in and supply up to 90% of the demand in Europe and by 2050. Their vision was to create new connections between the two continents thanks to high direct voltage lines to be built under the seafloor. In the same decade, different European countries were engaged into a race to promote and benefit from renewable North African energy resources. In 2008, France struggled to form a Mediterranean Union, and promoted with others countries the Solar Mediterranean Plan. These large-scale initiatives tended to approach the 'space of resource' of North African countries in a narrow way, through the calculation of deterritorialised solar potentials. In the case of Tunisia, the massive arrival of private renewable energy developers would have 'interfered' with the national energy policies and the traditional centralised management of electric utilities (Rocher and Verdeil 2015).

Established in 1985, the National Tunisian Agency for Energy Efficiency (ANME) has pushed for renewable energy-based electricity generation only in recent years. The framework of the Tunisian Solar Plan was adopted in 2009. As the name of the plan clearly indicates, it was a response to large-scale European initiatives. Still, despite ambitious objectives of diversifying energy and encouraging private investments, the Tunisian Solar Plan initially aimed at reinforcing the monopoly of STEG on energy generation and distribution. In this decade, STEG firmly rejected any attempt to open the electricity generation market to private producers, under the pretence of its legal monopoly and of its ability to master these technologies. In 2009, the renewable law allowed only power self-producers to sell electricity on the grid, with a limit of 30% on their output, which in practice prevented large investments in renewable energy. First wind farms were developed by STEG in 2009 (Hawariyah) and 2011 (Bizerte Hills).

The opening of Tunisia to renewable energies was amplified by the Tunisian Revolution (2010–2011). The rise in hydrocarbon prices since 2008 was so great that it made adjustments in electricity tariffs politically unfeasible. STEG also became subject to many criticisms, both because of embezzlement cases with members of the Ben Ali family and mismanagement of the Bizerte Hills wind farms. This prompted a coalition of ANME engineers, local industrialists and local and international energy investors, backed by the German cooperation Fund (GIZ) and other foreign money lenders, to make a stern call for a new renewable energy framework, including a feed-in tariff mechanism for private electricity generation projects and even the possibility of direct export. This group received strong national political support.[8]

Through the negotiation of a new Renewable Energy Law, STEG attempted to promote a gradual lock-out of the electricity system that weakens the Tunisian centralised model. The new law was promulgated in May 2015, after many delays. A first version was annulled by the Constitutional Court because the law failed to comply with a new constitutional article adopted in October 2013 that introduced the principle of the Tunisian people's sovereignty over national resources. This article also expressed concern about the colonisation of the Tunisian space of solar resources by companies like Desertech and Tunur. The new legislative framework endowed the electricity network with a political dimension because it extended, and also conditioned, the rights to connect renewable energies to this national infrastructure in different ways. First, residential or corporate self-producers can consume their own electricity and sell the remainder to the grid, but without a feed-in tariff. This mechanism aims at preventing the boom of solar panels and the unforeseen problems faced by many European countries. Second, the law supports the development of renewable electricity by private developers by means of a feed-in tariff. Nevertheless, the licenses will be adjusted to a yearly national plan determining the amount of generating capacity to be added by big regions and abiding by STEG's regulations and terms of reference for connection and transport. Third, to export electricity, private firms are supposed to finance and build a new grid, technically independent of the former one. This grid will progressively become the formal property of STEG, but will be operated by private companies.

This case study illustrates how an inherited infrastructure has been constituted to be a political means of revising the rules of navigating (gradual opening of regions' renewable energy resource) and controlling (rights of connecting, selling and exporting electricity by the grid) the space of resource. STEG has thus counteracted 'big' transnational solutions based on a politically damaging calculation of the resource, which would have threatened the regional development, the grid's stability and STEG's historical monopoly of energy. In recent years, however, with the stagnated electricity demand and the rise of renewable capacities, European countries have been reluctant to open their market to Tunisian and other Maghrebian electricity imports.

5 Politics of Volume: A Critical Geographical Appraisal of Renewable Energies

As proposed in the Introduction, we approach the energy transition as a period of 'ontological trouble'. It interferes with many human and non-human entities which are mobilised to make new energy technologies come true, but which are not clearly identified and empowered to influence these developments. In this chapter, we have enlarged our inquiry to the transformation of space through contemporary processes of energy transition. We assume that energy transition is 'spatial' not only in the sense that new energy technologies are widely scattered through space. The energy transition is also spatial because the increasing interest in new and more diffused energy materialities (wind, sun, biomass) fundamentally changes the practices of acting with space to bring alternative 'energy resources' into existence. The impact of this material turn on energy transition goes far beyond the attention paid to the deployment of energy technologies themselves (wind turbine, solar panel, boiler).

Following inspiring works (Bridge 2013), we have intertwined materiality and space in an encompassing questioning focused on the idea of volume. A major challenge of the energy transition is to manage energy materiality to steer its flowing through different geographical environments. The capacity to turn this geographical environment into a manageable volume in which a material flow is under control is hard work. The control over a volume is nevertheless a fundamental step in giving investors confidence, ensuring a predictable production and market energy capacities. Our analysis has been intentionally focused upstream to the commodification of energy resources (i.e. basically before the connection to the grid), at a point where energy materialities are still 'turbulent', the race for the biggest volumes extremely competitive, and the 'flowing' through a volume potentially open to negotiation. This approach aims at contributing to the analysis of emerging 'spaces of resource' (as a result of a perspective joining materiality and space) in the contemporary energy transition.

To guide our inquiry, we have considered three practical operations of making a volume through specific geographical environments and controlling energy materiality flows. (i) calculation is the process of 'valuating' the volume both in the extension of space and in terms of recoverable energy; (ii) navigation is the practical capacity of bringing the volume into visualisation and moving within it; and (iii) dis/connection is the capacity to reshape the net of entities (e.g. birds, wind turbines, landscapes and local uses in the case of wind power) that allows a flow to circulate adequately within a volume. The originality of this approach is to propose a shift from energy materiality in general (e.g. biomass as a slowly renewable resource) to a specification of energy materiality within its geographical environment (e.g. the stump of maritime pine in the Landes massif), and then to propose an analysis of the interferences and political issues related to these practices of calculation, navigation and dis/connection. Consistent with our pragmatist framework (see the Introduction), this approach insists on the idea of experimenting with the geographical environment to stabilise new volumes of recoverable energy.

The table below summarises the results of the case studies according to three main dimensions: (i) energy materiality in its geographical environment; (ii) the making of a 'space of resource'; and (iii) the interferences and types of politicisation at work (Fig. 1).

The discussion below focuses on different processes of making energy volumes that are often singular but also bear witness to key political issues at the heart of the contemporary energy transition. How is an energy volume calculated, delineated and controlled? How to value, share and live together within a volume? How is a volume (re)configured when being connected to a former and larger socio-technical assemblage? Giving some answers to these questions allow us to specify a step forward politics of volume that emerge at the crossroad of new energy materialities (fuel wood, solar and wind energies) and emerging energy spatialities.

5.1 Bonded Volumes: Instrumental Use of Scarcity and the Colonisation of Space

The calculation of an energy volume, its delineation and control can be undertaken as a question in tension between two fundamental issues,

Cases	From materiality (emerging properties)	To space of resource (emerging spaces)	Interferences / politicization
Aquitaine Biomass; hierarchy of uses; dispute over the volume (scarcity); finding new volumes by resizing the space of resource	Stump (rooted, sandy, struck by hurricanes, messy woods), turning waste into a resource. Chestnuts (unused coppices, unmanaged and scattered, rapid growth); preserving maritime pine and paper industry	Cleaning the woods, adjusting technologies to remove stumps, rock, wash and pile them, supplying industrial boilers. Colonizing peripheral massifs, facing costs related to distance and chestnuts woods fragmentation.	(Interference) fertility of soil, potential lack of minerals; carbon cycle and sequestration; not object of public concern (Interference) inherited network of small boilers (Dordogne); FNCOFOR, AMORCE's attempt at politicization; the wood volume is not negotiable.
Aveyron Wind; planning processes stop-and-go; difficulty in opening the wind volume to landscape and environment issues	Wind massifs (based on landscapes entities) Wind zoning (result of landscape heritages and wind speeds) Wind spaces of resistance (based on local solidarities) Wind power development zone [un/sustainable]	Scale of massifs, related to landscape and environment issues Zoning approach, to make wind turbines invisible, to navigate in intermediary wind power areas Door-to-door network covering the Lévezou massif, new political scale Expansion negotiated inside WPDZ, few places 'exhausted' by wind power development	(Interference) local administration's desire for objectivity (Interference) heritages and ordinary landscape; development inside the favourable zones unplanned (Interference) heritages and ordinary landscapes; lack of public discussion/democracy (Interference) interests of private developers and inhabitants; failure of collective attempt to reopen the space of resource
Rhône-Alpes Solar; community-based solar development; decreasing without destroying the solar volume	Solar aggregates (owners, buildings, roofs) Solar connectivity (electric grid, quantitative potential) Solar commons (network of habitants, roofs sharing)	From quantitative space (surf. / solar intensity ratio) to qualitative solar landscapes (architecture, co-visibilities) Available capacities of existing grid segments, geography of electric substations Setting roofs aside without excluding owners, preserving collective landscape values	 (Interference) community-based solar project, some roofs require grid reinforcement, high costs (Interference) community-based solar project (pace, profitability) but prevents group from being split up
Tunisia Solar; national sovereignty over resources	Transnational solar visions (solar estimated capacity) Solar connectivity (national electric grid, new REN law)	Solar Mediterranean Plan, Desertech, colonization of North African countries Limited solar dvpt. by region, electricity export conditioned by the building of a new grid by the private operators	(Interference) Tunisian sovereignty over renewable resources, STEG centralized management of energy

Fig. 1 From materiality to space of resource: Presentation of the case studies

situations of scarcity or abundance. In some cases, both issues are even combined and give rise to a complex entanglement of volumes and logics, that has to be discussed a step further. The Landes de Gascogne is case in point combining two different activities, an inherited forest industry and an emerging renewable wood fuel potential. In what follows we investigate the types of volume that ensue from this situation and their strategic combination in space.

For decades, the pulp and paper industry strategically controlled the wood resources while arguing for the existence of a regional scarcity. The volume of wood said to be consumed lacked fundamental transparency and was rarely discussed openly (complexity of the wood supply chain, monopsonistic position of the paper mills). The storms Martin and Klaus strengthened this rule of silence by helping to translate the scarcity claim from the field of political economy into an inevitable 'law of nature' (Bridge and Wood 2010; Bettini and Karaliotas 2013). As suggested by these authors, the reference to nature helps to reduce materiality to its physics and diffuse the idea of a rigid and a finite volume (e.g. as peak oil, inviting us to look at the underground as an 'empty barrel', following Bridge's metaphor). In our case, wood, is approached by the paper industry as fossilised stock. The instrumental use of 'scarcity' hinders the possibility of a public debate about forest uses and fuelwood development at the regional level.

Paradoxically, the storms Martin and Klaus also generated a situation of abundance of wood that resulted in new politics of volume focused on fuelwood. The paper industry plugged more fluid and invasive types of spatial explorations into its traditional economic model (framed by the organisation of their supply chain and their standards of wood). The industry combined strategies of spatial control (of the Landes massif) and spatial proliferation beneath (underground) and out of the massif (its 'periphery'). Our analysis of this emerging fuelwood supply chains (timber, branches, twigs, stumps, industrial wastes) has pointed out its opportunistic and variable character. Large-scale boilers (fluidised bed boilers) allowed burning a great variability of wood quality. What emerged is a sort of fluid volume complementary to the rigid stock claimed by the paper industry. This gave rise to geographical extensions to the former productive forest (the Landes de Gascogne massif), developing opportunistic connections with its soil (maritime pine stumps) and its now so-called 'periphery' (chestnuts coppices). What emerged is a sort of fluid volume complementary to the rigid volume and stock claimed by the paper industry.

One can notice that these volumes depend one of the other, and jointly contribute to extend further the monopoly of the paper industry on the forest. These volumes are 'bonded', in the sense of a situation of heavy depends on the interests of this industry. Such a situation has major consequences. First, the use of maritime pine stumps in the Landes de Gascogne massif interferes with the soil fertility and the long-run capacity of the forest to sequestrate carbon. This did not emerge as a public issue and mainly remained confined to the scientific field. Out of the recoverable volume of energy, the thing went back to the laboratory and found no political career. Second, developing these additional volumes of wood allows the paper industry to develop in the field of wood energy and to increase its power over the forest and the relevant actors. Third, this case provides us with a perspective that complements the idea of carbon lock-in as proposed by Unruh (2000, 2002). Classically, the notion of carbon lock-in refers to the capacity of fuel industries to resist any change that threatens their interests and to hamper the development of renewable energies. Different from this, in the Aquitaine case study, the carbon lock-in results from the strategy of a monopolistic industry in taking advantage of the development renewable energy, and not in opposing it.

The deregulation and the opening of forest to energy companies ends up preventing competitors from accessing usual wood volumes, reinforcing the power of paper mills on forest resources and allowing its extension to peripheral forests. The politics of bonded volumes results in a form of spatial colonisation which imposes an industrial extractivist mode. This occurs at the expense of other ways of exploiting biomass in the region and leaves other renewable energy assemblages out in the cold.

5.2 Shareable Volumes: Seeing Like a State, Living Together Within a Massif

The 'volume', as we define it in this chapter, shall not be restricted to an amount of energy to be recovered in a given space. While quantification and calculation are important to its delineation, as we saw it in the above, the 'volume' also refers to the way in which space is valued and configured by different human and non-human actors so as to share it and live together within it.

The Aveyron case study illustrates how such a collective dimension can intervene in the search for new transition potentials, along the way in which space is geometrised and visualised. It displays a modern state, relying a two-dimensional geometrisation of space in order to manage a territory, and being challenged by emerging (wind power) volumes issues.

Initially, the local administration actively developed a wind power plan based on a zoning approach. Areas supposedly hidden from other areas devoted to tourism and urban daily life were clearly assigned to wind power development. This old-fashioned functionalist approach to the land is based on the separation of activities aimed at preserving sites of great interest. From the point of view of the administration, this should have endowed the emerging wind power landscape with a shared dimension, as a state landscape—that is, the historical and scenic landscape, legally identified and protected, was taken into account. This clear-cut boundary-making also appeared as a method of calculation for private developers to agree on volumes of electricity produced by wind turbines in different favourable areas. Still, the two-dimensional space failed to manage the relational issues induced by wind turbines in the field (co-visibilities in the distance, migratory birds, densification of turbines in a given area). The unplanned wind power development inside favourable zones provoked these issues and the local administration had in fact to deal with the untamed volume. This unravelled the spatial hierarchies in use by the administration (centre/periphery, visible/invisible) and brought about new entities which wind power development interfered with (e.g. unprotected landscapes).

Instead of setting on the two-dimensional approach (seeing like a state) against a three-dimensional one, which can be all the more normative, the question could be interestingly considered as the practical challenge of finding a common ground to discuss emerging energy (wind power) volumes. How to make the wind shareable among private developers, inhabitants, birds and bats? Harnessing the wind generates so many interferences between aerial and terrestrial spaces that this calls for experimental spatialities. A major political struggle in Averyon has consisted in upscaling the approach of the local environment to define collectively sustainable wind power capacities. In the Lévezou, this had been done by the networking of the inhabitants who were affected by a massive wind power development in the massif. In others areas, the regional natural park provided the local intercommunalities with a subsidy to support collective agreements on a coherent wind power development inside different massifs. This obliged the administrative officers to move from a one-by-one project authorisation to a more integrated approach. The planning scheme was progressively revised to take into account the massifs as coherent landscape entities in such negotiations. Massifs helped locally to deal with (wind power) volumes while avoiding enclosing them within controversial borders. They provided a more relational approach to space, bringing together the protected as well as the ordinary landscapes. This clearly changed the calculation of the wind power volume and the way of exploring its potentialities with territorial heritages (opportunistic areas for wind power such as the 'highlands'), connecting different environmental issues (biodiversity, landscape) with specific geographical sites.

These spaces of experiment (massifs) around wind power development remain vulnerable. Thus, and again with reference to Unruh (2000, 2002), if renewable unlocking processes could generate redistributive effects (of power, wealth, environment), they sometimes also led to processes oriented towards private interests, even towards an unequal appropriation of resources. This observation reinforces the idea of a new generation of 'renewable lock-in' induced by large scale technological developments. In Aveyron, attempts to revise the first wind power plan on a new political scale (massifs) were rejected in the interests of projects already in the pipeline. This in turn intensified conflict locally among residents, families, NGOs and local representatives, and generated long-term negative effects on local solidarities (Nadaï and Labussière 2017). Such misplanned wind power volumes exhausted local social forces and paradoxically generated unsustainable renewable developments.

5.3 Connectable Volumes: Power Struggles Around the Electric Grid

Another key process of energy transition is the translation of new energy volumes into grid capacities, and the need to adjust dynamically the one to the other. This draws attention to the key issue for electric renewable energy projects of accessing the grid and renegotiating the modalities of its connectivity in both technical and political terms.

The community-based solar experiments in Rhône-Alpes illustrate the importance of this dynamic management of volume. In the case studied, the solar project was not the result of an 'addition' of surfaces (of roofs) but rather of the 'aggregation' of heterogeneous materialities brought together to support quantitative as well as qualitative scenarios of solar development. The practice of calculating a solar volume was relational. It focused on the multiple ways heterogeneous entities (sun, roof, buildings, landscape) related to the project and their progressive entanglement in a coherent solar volume. The connection of the community-based solar project to the grid clearly disrupted this logic. The grid manager divided the first solar aggregate into a sum of individual roof surfaces and quantified the available electric capacities by substation. This division of the solar volume was fundamentally individualistic, quantitative and ignorant of local issues. To avoid the failure of the project, the local group of shareholders succeeded in downsizing its quantitative objective while maintaining its qualitative ambition. They did this by playing with materiality (roofs, buildings, area) in order to reassemble a smaller number of roofs around collective relational principles (landscape, architecture). In others words, they strategically managed the growth of a solar volume in order to prevent its splitting up by discontinuous strategies: private interests (individual profitability), usual governance (compartmentalised space) and electric heritage (individual connectivity).

Tunisia faced an exponential growth of the solar volume through the transnational initiatives led by European private firms and countries (e.g. Desertech). As an answer to what was perceived to be a process of colonisation, STEG, the centralised Tunisian administration for gas and electricity, endowed the national electric grid with a new economic and political dimension. The electric grid became the infrastructure that physically defined a politically acceptable volume of renewable electricity development. This was implemented by adopting regional quotas of renewable energy each year. Then, through the new renewable energy law, STEG put a price on discontinuity (renewable energy developments outside the volume) by requiring private firms to finance and build a new grid in keeping with their plan of exporting electricity to Europe. While we consider the Tunisian case study as showing the resistance of the national grid manager to transnational firms, we consider the action of the French grid manager as disruptive of the community-based solar experiments. What could be understood as a bias of analysis (small-scale projects would be 'better' than huge ones) has to be understood precisely in terms of the politics of volume. In the French case, the grid manager refused to adapt his expertise to allow the connection of collective solar projects, and in so doing denied the 'common' nature of the grid: The volume was systematically reframed by a conception of the grid as a network of electric individualities. In Tunisia, the grid manager was faced by transnational solar projects that intended to develop the volume of energy, regardless of the spatiality of the network and its available capacities. These 'unbounded' solar volumes would have dramatically impacted on the management of a national infrastructure and the future opportunities of structuring local development along these lines.

6 Conclusion

The aim of this chapter is to contribute to the analysis of the role of space in the energy transition. It approaches renewable energy resources (wood fuel, wind, solar) not as a given but as turbulent materialities of diffuse and changing character. We have assumed that space is part of different operations for channelling and controlling these material flows and turning them into energy resources. Inspired by previous work (Bridge 2013), we have interwoven materiality and space in an encompassing questioning focused on the idea of volume—understood as the spatial operations undertaken to control a material flow, ensure a predictable production and market energy capacities. We have looked specifically at three operations: calculation (valuation of a volume), navigation (within a volume to explore its potential) and dis/connection (with heterogeneous entities to stabilise a volume in the long run). This allowed us to acknowledge a great range of spatial dynamics associated with energy volumes in rapid expansion, collectively negotiated, split up into individualistic adventures, strategically decreasing, or aligned to inherited infrastructures to ensure their control.

Facing such a diversity of processes, our analysis has first contributed to propose a questioning specific to emerging politics of volumes in the context of energy transitions. How is an energy volume calculated, delineated and controlled? How to value, share and live together within a volume? How is a volume (re)configured when it is being connected to a former and larger socio-technical assemblage (electric grid)? Through this lens, the chapter has provided the reader with a renewed understanding of the strategic combinations of energy and non-energy volumes ('bonded volumes'), the political issue associated with moving from a zoning to a relational approach of the visualisation of space in debating about the volume as a common ('shareable volume') and the quest for a negotiable connection to the grid that do not hamper the emergence of fair energy volumes ('connectable volumes').

Second, as proposed by Lehman (2013), considerations of volumes go beyond volumetrics, understood as a matter of quantification in which things are enlisted. Contrary to a materiality reduced to its physics (and easily turned into a volumetrics), this approach consists in looking at materiality and volumes as untamed entities, always singular and place-related. In our case studies, energy volumes weave together a great range of qualitative dimensions that are often hard to catch and value (architecture, landscape, local uses), but, however, play a role in the construction of more collective and democratic approaches to renewable energies. The notion of volume is thus itself relevant to challenging static, bordered and linear framings, to bringing together things usually kept apart (protected/not-protected landscapes, transnational/local development) and to discussing them jointly.

Third, another lesson of our work is the importance of local heritages in finding ways of collectively agreeing on sustainable energy volumes. Heritages, when not reduced to a patrimony to be left untouched, afford such means. For instance, the landscape organisation of a massif (with its strata from valley, hills to plateau), or the way the buildings of a village are densely packed (and provide the surroundings with the coherence of a singular strata in a broader landscape), introduce local inhabitants, developers and NGOs to the verticality of space. We have seen that these spatialities may remain informal and have in some countries, such as France, lately been taken into account by local administrations to revise their way of visualising space.

At last, the widely spread notion of carbon lock-in (Unruh 2000, 2002) suggests a distinction between fossil and renewable energies distributed on each side of a 'carbon' line, as negative and positive polarities. From this ensues a one-way interpretation of what filling the gap should be, that is, overcoming the 'barriers' to technological innovation. Our case studies invite us to acknowledge more diverse pathways and sometimes generate other kinds of lock-in, such as renewable lock-in, whereby dominant capitalist actors take over new energy technologies (fuelwood, wind power) and develop them in ways in which they end up 'fossilising' the associated resources.

Our analysis of the spatiality of these energy material flows brings to light the often overlooked volumetric character of their development, the difficult understanding of their actual spatial and environmental issues, and the related deficit of institutional regulation. This also contributes to specifying the spatial issues associated with energy transitions and involved in the wider debate on land grabbing (Scheidel and Sorman 2012).

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Notes

1. For instance, it includes work on oil (Bridge 2011; Mitchell 2011), forestry (Prudham 2005), water (Bakker 2005) and fisheries (Mansfield 2004).
2. The idea of 'displacement' refers to practices of reopening, reprocessing and sometimes disrupting the relationships through which entities take place in a local environment, so as to qualify them as a 'means' and make them part of an emerging energy production process.
3. 'Fuelwood energy is an administered economy. No unit is built without public subsidies. This is clearly the distortion of competition with

other uses. It is all the more inadequate because the paper and energy industries use the same resources: forest and sawmills residues' (Pulp and paper industrialist 2012).

4. The Landes de Gascogne massif is often described as the largest cultivated private forest in Europe (1.5 Mha).
5. 'The industrialists employ a doublespeak: they have always claimed they were opposed [to the development of fuelwood] since it would take too much of a toll on the resource… but who was it applied for the CRE' projects? You bet you, the large paper mills' (Forest owner 2012).
6. These regional agencies have been established within French energy programmes to supervise competition for access to forest resources.
7. Currently, only cogeneration technologies (fluidised bed boilers) of paper mills are able to use stumps.
8. From Mehdi Jomaa, successively Minister of Industry in charge of Energy, and Prime Minister, and from Nidhal Ouerfalli, his Secretary of State for Energy and formerly economist at the French National Agency for the Management of Nuclear Wastes (ANDRA).

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7

The Temporalities of Energy Transition Processes

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With the contributions from Edith Chezel and Michel Deshaies

List of abbreviations

EGL	European Gas Limited
FWLK	Friedrich-Wilhelm-Lübke-Koog
GPS	Global Positioning System
HSW	Husum shipyard
IBA	International Bauausstellung (IBA) Fürst Pückler Land
LMBV	Lausitzer und Mitteldeutsche Bergbauverwalttungsgesellschaft mbH

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1 Introduction

The policies of energy transition are driven largely by scenarios of an energy future that result from modelling future technological pathways. This scenario-based approach, and the 'technological potentials' these visions of the future are embedded in, tend to capture normatively the different entities engaged in the processes of energy transition (the 'market', the 'environment', the 'social'). These are presented as 'barriers' to be overcome so as to reach pre-defined amounts of renewable energy production and avoid carbon emissions. From this approach ensues an oversimplified representation of time. Time is represented as a line punctuated by abstract dates (2030, 2050) and used as a collectively shared horizon to engage in strategic debates. While this partitioning provides energy transition debates with shared temporal references for harnessing strategic discussions (about levels of carbon emission, required amounts of investment), the question of whether or not it represents collectively shared horizons remains entirely open.

The aim of this chapter is to provide a critical enquiry in the processes of time-making and of agreeing upon collective horizons of energy transition. These collective horizons, when approached at the level of energy projects, are not given beforehand. Their framing results from a process of change that is confronted with a multiplicity of issues embedded in the development of new energy technologies. To state this more graphically, we do not approach the energy transition as a generic path from 'A' to 'B', but as an experimental process of grasping and assembling 'A' and 'B' altogether. Thus a preliminary but key assertion in this research is that time is not a factor independent and exterior to actors, but a relational factor, configured differently according to emerging sociotechnical assemblages.

Nevertheless, the relationality of time and the importance of a multi-temporal perspective are not self-evident. Decades of academic and disciplinary debates in history, anthropology, geography and sociology have focused on the past through categories (for instance, 'patrimony', 'identity', 'memory') that tend to freeze outcomes and insist on nostalgic evocations of cultures, technical objects and places (for a good analysis of this, see Jackson 1994; Nora 1997; Lowenthal 2015). Another reason an alternative conception of time is not self-evident is the academic and post-structuralist literature that often introduced 'relational' thinking exclusively focused on the 'event' (for instance in geography: Doel 1999; Thrift 2000; Dewsburry 2000) and neglected its ties to history. Thus the ambition of this chapter is to explore the possibility of a relational approach that allows us to study how the distant and recent past, and the near and the distant future, can be taken up into a process of change in the context of energy transition.

The chapter is structured in four sections. First, proceeding on the assumption that a broad range of academic literature looks at the energy transition solely as a 'matter of timing' (historical drivers, pace of the transition), it engages in a re-problematisation of the question of time. To do so, it takes advantage of two research agendas, respectively focused on the 'future present' and 'nearness'. In the second section, it develops a conceptual framework embedded in pragmatic thinking (John Dewey) that focuses on the ideas of 'experience', 'nearness' and 'duration'. This section aims to displace the way we look at the energy transition from being an interval, a gap to be bridged, to being a process of change in which new assemblages and new durations are performed and become disputed. In the third section, it inquires into three case studies: one in France (Lorraine) and two in Germany (Klettwitz/Schipkau and Northern Friesland). The analysis asks how 'nearness' becomes an issue in energy transition, through which mediations it is connected to entities from different time scales, and the extent to which these scales partake in configuring emerging sociotechnical assemblages. The last section discusses the idea of 'nearness', its ties with material intensities, and the political dimension of 'duration' in the steering of energy transition.

2 Problematizing the Temporal Dimension of the Energy Transition

2.1 Energy Transition: A 'Matter of Timing'?

A first insight into the works about energy transition suggests that the question of time is largely dealt with from two classical perspectives: an historical approach drawing on past energy transitions, and more theoretical efforts to conceptualize the contemporary dynamics of sociotechnical innovation. Our goal is not to provide the reader with a complete overview of these fields, but to initiate on the basis of its main discussions our questioning about the temporal dimension of energy transition.

Evolutions of energy in human history are analysed on different timescales, sometimes interrelated, ranging from micro-scale evolutions to global changes. The academic literature used to combine them so as to relate a linear history proceeding from one state of civilization to another. This history generally moves from traditional agriculture to the preindustrial stage, then from the Industrial Revolution to the emergence of a globalised fossil-fuelled civilization (Debeir et al. 2013; Smil 1994; Crosby 2006). The global timescale provides a useful perspective for discovering some of the major energy trends and non-energy factors (technical innovation, emergence of mass markets, social practices) that participate in the changes of our relationship to energy. Nevertheless, it also offers a perspective that is open to dispute for various reasons. First, the focus on global tendencies (demography, energy consumption) over centuries tends to universalise occidental energy uses through history, neglecting the role of specific cultures and places in the development of societies, even though more contextualized works exist (for instance, works about national trajectories by Nye 1998, in the case of United-States; by Wrigley 2010, in the case of United-Kingdom). Second, such historical works hardly bear witness to troubled situations, interwoven interests, and emerging actors as they are observed in ongoing processes of energy transition. Historical records provide finely selected data, but time remains external to actors and situations. Time is (re-) constructed a posteriori, but not defined relationally. Third, such global and linear approaches induce a peculiar perspective on what is called a 'transition'. In the light of long-term perspectives, 'transitions' mean key shifts from one energy source to another, as was the case from wood and charcoal to coal and then to hydrocarbons, followed by 'transitions' to a higher share of primary energy consumed in a secondary form as electricity (Smil 2010). This conveys the idea that time is a line that could be divided between periods of stability and change, and by extension that a transition is the time that elapses between two patterns of energy use. Historical approaches share a common research agenda focused on the characterisation of the factors that drive historical change. Different and numerous assumptions exist to give shape to this question. For instance, Melosi (2006) insists on the idea that evolutionary changes could explain revolutionary ones in the field of energy. Other attempts (Friedrichs 2013) stress the idea that, in the face of imminent civilizational collapses (in the current case, climate change and energy scarcity), a transition could be envisioned more radically as a break with former industrial conditions.

A second field in which the temporal dimension of the energy transition is conceptualized is works about technological change and processes of technological innovation. As summarized by Sovacool (2016), these works share a common inquiry about the timing of energy transition: How long does it take for an energy transition to occur? A series of concepts (phases, path dependency, lock-in) developed by a constellation of authors are enlisted to explain this—most often, in terms of why it takes so much time. For instance, Grubler's work (1996) has stressed factors that highlight how innovation spreads in time and space, and the necessary 'phases' of its scaling-up. Focusing on the development of electrification, Hugues (1983) has distinguished 'phases' (invention, technology transfer, system growth, large expansion, spatial differentiation) that explain why it took decades to build city lightning infrastructures, and the 'path dependency' it generated. More recently, and to counteract the idea that large technological systems can hardly be changed, the multi-level perspective (Geels and Schot 2007) has proposed an encompassing framework that approaches change as the effect of complex alterations at different levels and the interactions between them. These authors suggest a different timing for the development of energy transition (substitution, transformation, reconfiguration, re-alignment).

The brief overview of these fields emphasizes the fact that the energy transition used to be approached in the academic literature as what might be called a 'matter of timing': what factors have historically driven energy transitions? How long does it take for an energy transition to occur? The research agendas these questions belong to present different limits for those who want to investigate ongoing energy transition processes. First, the conception of time at their core is almost linear and abstractly partitioned between past, present and future. These dimensions of time are studied separately (for instance, historical works focus on past transitions, the technical innovation approach on the ambition to influence the steering of contemporary processes), while the issues related to their articulation and political entanglement remain neglected. These approaches still lack a common theoretical basis to investigate temporal processes and issues of energy transition. Second, the conceptualisation of energy transition as a 'matter of timing' can be seen as an expression of a managerial turn, notoriously fleshed out by the multi-level framework. This tends to narrow down the temporal issues of energy transition to few questions, such as the pace of the transition and the means to foster the scaling-up of decarbonized technologies. The narrowing down is accomplished through ideas (levels, barriers, technological potential) that normatively capture the entities engaged in energy transition (for instance, is the landscape a 'barrier' to wind power development?) and underestimate their contribution to stabilizing these temporal issues (does the landscape offer inherited configurations that could help regulate locally the pace of the wind power development?) (Labussière and Nadaï 2014). By extension, this treatment also minimizes the importance of others issues (for instance, the becoming of local heritages, or the life cycles of biodiversity). Third, as discussed in the introduction of the book, the values and ends associated with visions of energy futures are usually not explicit. They remain in the shadow of technological promises. Thus revising the conception of time is both a theoretical and a democratic challenge. Time is put in the hands of innovators, industrialists and policy makers so as to ensure the control over emerging energy futures. This does not sufficiently acknowledge the power relationships at the heart of energy transition and their importance for giving shape to values and means that do not pre-exist the development of new technologies of energy.

2.2 Re-problematizing Time (1): The Future Present

An increasing number of works from the social sciences (Granjou et al. 2017; Poli 2017) develop a research agenda about living towards and governing futures. Compared with mainstream academic literature in the field of energy (see previous section), these works offer new theoretical insights into the interactions between heterogeneous temporalities. Some of these are briefly presented here because their approaches and questions are of interest for our inquiry.

As a starting point, we shall take advantage of the anthropological work of Barbara Adam (2010), with Chris Groves (2007), devoted to the history and the transformations of the future. The idea of the future understood as a predestined fate, a time in the hands of the gods, has been progressively abandoned during the modern era. Faith in science and progress imposed a new framework. The future became a new territory to colonize, plan and steer in specific directions. It has thus progressively shifted from a 'gift of God' to a 'commodity'. 'The future was transmuted into an abstract, empty and quantifiable entity available for free unrestricted use and exploitation' (Adam 2010, p. 365). Mainly interested in the consequences of this revolution, Adam proposes a distinction between processes of 'future-taking', in which the future is envisioned as a free resource for present use, and those of 'future-present', which consist in an ethical and relational questioning of our choices about the future: 'What are we doing to the future?', 'the perspective of future present […] places us in a relation of indebtedness with not-yet existent others'. (Adam 2010, p. 370) A step forward allowed by this questioning is the relational conceptualisation of time, basically summarized here by the alternative between an instrumental or an ethical relationship to the future.

When enquiring into specific processes such big questions have to be contextualized and operationalized through methodological mediations. Other works from the field of 'future studies' develop such mediations by following the multiform presences of the future in our contemporary societies and the politics of anticipation related to it.

The work of Ben Anderson (2010) focuses on regimes of anticipation associated with potentially catastrophic futures, such as climate change, chemical terrorism or pandemic diseases. All these threats turn the question of governing futures into a matter of risk management. To characterize the regimes of anticipation related to futures, Anderson distinguishes 'styles' (statements about the future and its relations to past and present), 'practices' (acts of performing, calculating and imagining to appreciate these eventualities) and 'logics' (programmatic actions that aim to prevent, mitigate, adapt to, prepare for or pre-empt specific futures). The value of this framework is manifold. It provides us with a lens to analyse how the future is performed through a diversity of anticipatory practices (modelling, planning, simulations, games, etc.). Through them the future appears imbricated with a plurality of perspectives and relations of power. This clearly broadens the scope of the inquiry. It is now 'to attend to how futures appear and disappear; to describe how present futures are intensified, blurred, repressed, erased, circulated or dampened; and to understand how the experience of the futures relates to the materiality of the medium through which it is made present' (Anderson 2010, p. 793).

We should like to draw on preliminary observations from our own fieldwork to introduce the question of energy transition and situate its problematisation relative to these works. First, and compared for instance with the politics of anticipation studied by Anderson, the processes of energy transition investigated do not have a positive or negative meaning a priori. Energy futures are not already present as a threat or as a ready-made 'solution'. If energy transition is presented as an answer to climate change, the development of new energy technologies in the field is fundamentally uncertain. The emergence of a technological object is conditioned by the constitution and the stabilization of a network of heterogeneous entities. This work gives rise to new questions, obliges us to define new values and to regulate emerging interests. Thus energy transition potentials that are brought into existence may be major sources of interruption, rupture and breakdown for local territories as well as an opportunity to redistribute wealth, power and impacts on the environment. Their temporal dimension is entangled in a myriad of experiences, practices and situations. Second, our fieldwork, while dealing with temporalities that are uncertain, disputed, fluctuating because related to emerging technological assemblages, does not connect present situations with very distant futures. The relationship to the future is not a matter of anticipation as it usually is in 'future studies'. More pragmatically, the challenge is to find the means to reengage a situated experience constantly in a continuous but innovative development that avoids major interruptions. This invites us to problematize the energy transition as a situated experience of time, in which the situation, referring to materialities, embodied durations and inherited spatialities, should play a major role in relationally exploring and rearranging past, present and future.

An interesting work by Christopher Groves (2017) about the politics of environmental anticipation carries forth the idea that anticipations are not free-floating cultural representations but are rather embedded in multiple realities (representational, technical, biophysical, emotional). Groves distinguishes different 'styles' of anticipation in tension, called 'abstract', 'empty' and 'lived' futures. The study of a conflictual case of siting an energy infrastructure allows him to elaborate them. The first two styles refer respectively to forecasting energy demand ('a disembodied view') and planning governance. As Groves puts it, this second style deals with (and actively 'empties') the future by 'direct[ing] attention towards a restricted set of system variables' (Groves 2017, p. 34). By contrast, the 'lived future', introduced with reference to the work of Tim Ingold, is defined by the connection and attachment of a community to its everyday environment. These relations enable local people to 'reflect on potential futures in relation to particular pasts, and then […] interpret the past through possible future outcomes' (ibid., p. 35). This interestingly draws attention to the level of experience and its connections to places and heritages. It also suggests that, between the immediate everyday experience and the long-term forecasting, both struggle to get a grip on a sort of particularly strategic and disputed temporal zone—the same one which has been planned and is controversially 'empty' in Groves's study.

We now propose to problematize the temporal challenge of energy transition more frankly with reference to this 'near future', envisioned as a sort of common ground between short and long-term perspectives.

2.3 Re-problematizing Time (2): Near the Now

The relationship to the future and the effect of this relation in the present is a major issue for energy transition, and it has been discussed under the figure of the distant and unpredictable future. Here we should like to make a new start in dealing with the future, and more globally the question of time, by drawing upon a paper that triggered numerous discussions in anthropology a decade ago.

Two years after an address at the annual meeting of the American Ethnological Society, Jane Guyer published a paper 'Prophecy and the near future' (2007) that problematized in a substantially different way the question of our relationship to the future. Basing the discussion on her own experience, the author observed that the temporal frame in which she grew up in post-war Britain was strongly organized by the near past and the near future. Since then, she argues, the near future has thinned out because people are more and more focused on the immediate present and the very distant future. 'The shift in temporal framing has involved a double move, towards both very short and very long sightedness, with a symmetrical evacuation of the near past and the near future' (Guyer 2007, p. 410). Discussions and cross-observations in anthropology from different social and cultural contexts progressively corroborated the assumption of the disappearance of 'nearness' (the recent past and the near future), making it into a full object of inquiry. Questions arose about the temporal bricolage that was specific to this temporal frame, for, until now, it has lacked theoretical elaboration and empirical characterisation.

This temporal frame, according to Guyer, was characterized by doctrines and programmes that directly shaped experience and generated durational social process. 'I suggested that […] the "near future" was disappearing, as referring to a manageable range of rational planning and of the postwar, 5-year-plan kind, with its confident expectation of making life better within a definite time frame' (Guyer 2017, p. 2). Guyer provides illustrations, including from monetary theory, to describe the disappearance of this specific near future. For instance, the regulation by the state of the value of money offered a viable, long-run working horizon for a planned economy following theoretical stages of growth. This has been progressively replaced by the model of a free market based on the combination of rational choice in the very short run and growth in the very long run. According to the author's analysis, the near future has not disappeared, but has been differently articulated and arranged. Mainly it has been compressed and associated with economic functions, almost impossible for the ordinary citizen or the consumer to handle or to relate to. In this way, the near future is 'unhitched' from the present and the distant future, and is made workable for the benefit of more specific people or actions.

Thus 'enduring time' has been progressively replaced by 'punctuated time'. According to Guyer, the latter refers to a new sort of 'near' future. This is a regime of time organized around some predictable dates for some people, but merging into turbulences and unpredictability. Direct action is less easily inserted in the long run; it constantly faces the gap between an instantaneous present and a very different distant future. With this new time regime, the visions of and the attitudes to the future have shifted from prediction—from before, from anticipation—to being prepared for. The author's conception of 'punctuated time' is closely associated with the idea of emergence and event. 'The time frame that used to be "near", as a visible horizon towards which we plan our moves, is now more commonly referred to as "next" and "emergent", in open and indeterminate mode' (Guyer 2017, p. 7). This near future has no visible logical sequence; each date is lived as an event, and its horizon is never definitively shaped.

In its recent developments, Guyer's approach contributes to exploring an 'anthropology of the contemporary' (Faubion 2016) inspired by the works of Paul Rabinow. According to Rabinow, 'the contemporary is a moving ratio of modernity, moving through the recent past and near future in a (nonlinear) space that gauges modernity as an ethos already becoming historical' (Rabinow 2007, p. 2). Drawing on this work, we want to stress the idea in the current chapter that 'nearness' is a temporal bricolage, a relational framework which questions the combination of the near past and the near future in an era of deep indeterminacy. Nearness has not disappeared, but it has become a disputed field where at least different relational combinations of the recent past and the near future are in competition. Interestingly for the coming analysis, Rabinow's reflection pays attention to the work of John Dewey: the making of the 'contemporary' is approached as problem-driven enterprise that consists in creating new mediations between heterogeneous temporalities. Guyer for her part does not emphasize Dewey's influence. We think that Dewey's theory of the inquiry as a transactive process could offer a promising framework to approach experiences of transitioning-towards emerging futures of energy transition. It could also help us investigate the political dimensions of these processes.

3 From the 'Transition' to 'Transitioning-Towards': A Pragmatic Approach

To support an integrative perspective on time we should like to avail ourselves of pragmatic thought. Pragmatic thought is sometimes said to deal primarily with the future, since it emphasizes human being's ability to shape the emergent. While there are different pragmatic perspectives (Peirce, Royce, James), we have assumed that the one proposed by Dewey allows us to consider a critical distance to the past and, as such, open a genuine relationship to inherited forms that support emancipatory practices. This leads us to conceive of experience as first and foremost an affair of transitions between past, present and future. Transition means not a displacement from one (present) world to another (future one), but rather a transition from one relational state of the reality to another. From this perspective, past, present and future are contemporaneous with each other and interwoven differently according to situated processes of change. This conception enables us to inquire into processes of transition in-the-making from an insider perspective.

3.1 Experience, Transactions and the Continuity of Life

It is of course not possible here to give an extended presentation of John Dewey's thought. Instead, we stress three ideas at the core of Dewey's approach: experience, transactions and the continuity of life. The idea of experience does not refer to Dewey's work to a subjective perspective on the world. It cuts through dualisms of object and subject, person and environment. Experience is first a relational adventure; it begins with the discovery of being constantly associated with and affected by. 'Association in the sense of connection and combination is a "law" of everything known to exist […] the action of everything is along with the action of other things. The "along with" is of such a kind that the behaviour of each is modified by its connection with others' (Dewey 1927, pp. 22–23). Thus the relational dimension of the experience forms what Dewey call a 'situation'. If living in association is a common condition of whatever exists (seeds, trees, humans, etc.), Dewey draws attention to man's capacity to play with associations in a given situation to produce expected consequences that perform an improved situation. This is what makes specifically human associations in contrast with many others—'assemblies of electrons, unions of trees in forests, swarms of insects, herds of sheep, and constellations of stars' (Dewey 1927, pp. 23–24).

From this point of view, experience is not only deploying 'along with' in a situation, but also fully engaged in transforming its relations with others and, thus, transforming the conditions of experience itself. This brings us to another key idea, that of 'transaction'. At the end of his life, Dewey insisted on the idea that experience took place not only through 'interactions' with 'objects' that resulted from stabilized and enduring situations, but also through 'transactions' with 'elements' that were actively questioned, selected and specified within a changing situation (Dewey and Bentley 1949, p. 121). 'The "transaction", as an object among and along with other objects, is to be understood as 'unfractured observation' (i.e. "just as it stands […] with respect to the observer, the observing, and the observed". The transactional activity is the relational mode that supports the inquiry. It is oriented towards the re-determination and the renaming of objects that present themselves in a subject matter so as to provide them with new potential to keep the experience running on. Through 'transactions', things enter in action, and action is made collectively negotiable through the activity of valuing things.

From the point of view of experience, 'situation' and 'transactions' are not separate from one other. We live in a series of situations and this is what allows our life to be continuously performed and re-invented, in extension and in duration. 'Different situations succeed one another. But because of the principle of continuity something is carried over from the earlier to the later ones. As an individual passes from one situation to another, his world, his environment, expands or contracts. He does not find himself living in another world but in a different part or aspect of one and the same world. What he has learned in the way of knowledge and skill in one situation becomes an instrument of understanding and dealing effectively with the situations which follow' (Dewey 1997, p. 44). This long quotation puts us in possession of the focal point of inquiry, the temporally continuous aspect of experience. Complementary to this perspective, Dewey acknowledges aspects that interfere with experience and hamper its full continuation.

Using this framework, we want to propose the following structuring idea for the study of temporalities of energy transition: first, experience provides us with a perspective on the world as constantly transitioning, engaged in 'qualitative-transformation-towards' (Dewey 1906, p. 254); second, the idea stressed in our introduction that energy transition processes 'interfere' with experiences without providing them with an agency and a political status could be approached using Dewey's idea of treating situations interactionally rather than transactionally.

3.2 The Continuum of Ends-Means

Without leaving the level of experience, we should now like to introduce the reader to the continuum of ends and means, since it provides us with a valuable understanding of the relationships between past, present and future.

As seen before, experience is engaged from one situation to another in a transactional activity that consists in re-engaging existing things in a new world of meaning and action. Things are inquired into and valuated according to a changing situation and according to new ends. This conception was developed by Dewey in his theory of valuation (Dewey 1939). According to this theory, 'ends-in-themselves' do not exist. There are no ends that pre-exist a current situation, beyond what is experienced, but only transitory ends, called by Dewey 'ends-in-view'. An end-in-view arises from and is oriented towards a qualitative change within a situation. For this reason, ends-in-view are not superior to means. They proceed from the same relational realm. The relationship between the two is not mechanistic but rather experimental. An end-in-view is a methodological proposal that aims at testing new relations between things. It allows us to access new experiences and new appreciations about a better way to carry on in a given situation.

The concept of continuum is important, for it stresses the fact that ends-in-view and means are engaged in a process of constant and mutual definition. This is illustrated by Dewey's motto that experience is guided by the attitude of 'taking care of consequences'. Thinking oriented to action from the perspective of consequences is all the most important because (past) consequences constitute the ground in which the current experience is rooted in and (the not yet present) consequences express the hope for improved conditions of life. Thus 'caring for' offers a multi-temporal perspective on experience. '"Care" signifies two quite different things: fret, worry and anxiety, and cherishing attention to that in whose potentialities we are interested. These two meanings represent different poles of reactive behaviour to a present having a future which is ambiguous' (Dewey 1930, p. 215). This invites the thought that caring is oriented towards the exploration of situations that matter and towards the past events that would be at the origin of these situations in the form of renewed attention to things and transformative potentialities.

The attitude of 'caring for' finds a methodological translation in Dewey's theory of valuation through three different operations: valuing, evaluation and valuation (Bidet et al. 2011). The first is an immediate appreciation of a thing in the present of experience (for example, liking/disliking what is experienced); the second consists in appreciating the thing relative to former situations of appreciation (for example, providing our judgment with a series of similar experiences); and the last encompasses the first two operations and is oriented towards the production of a transformative point of view (that is, an end-in-view) in a given situation. This in turn lets us see more finely the extent to which Dewey's concept of experience encompasses the past, the present and the future, and engages them in the search for continuity or, as we shall say in the following, a 'duration' adequate to experience. 'Aforetime man employed the results of his prior experience only to form customs that henceforth had to be blindly followed or blindly broken. Now, old experience is used to suggest aims and methods for developing a new and improved experience […]. We use our past experiences to construct new and better ones in the future' (Dewey 1920, p. 94). Clearly, Dewey rejects the idea of time as a passive accumulation of experiences and the blind continuation of customs. Time is not an abstract thing, but a thing that matters for experimenting with new enactments of the world of experience.

3.3 Duration That Matters, Matters That Endure

Drawing on the previous observations, we should now like to propose a few guidelines for the following study of the temporalities of energy transition.

Dewey's thought has often been presented as a philosophy of the future (Lachs 2003; Koopman 2006), that is, a philosophy which cuts off its ties to the past compared with more traditional approaches to time. This characterisation seems to us questionable. Dewey's philosophy is probably better described as a philosophy for the future, in the sense that it does not exclude the past but rather proposes an experimental and organic perspective for approaching the question of time. Let us explain this more precisely.

A concrete illustration can help figure forth such abstract questions. A striking example comes from Dewey's core attention to education. In Dewey's view, the purpose of education is not to train tomorrow's citizens, since we don't know what 'tomorrow' will bring. It is to provide children with educative experiences that will allow them to deal with situations which might change radically in future. Education is a process of living and not a preparation for future living. 'The process is a slow and arduous one. It is a matter of growth, and there are many obstacles which tend to obstruct growth and to deflect it into wrong lines' (Dewey 1997, p. 30). Thus it is to provide a person with 'educative experiences'—that is, experiences which will enable him to contribute to life as it occurs in association, in society. This draws our attention to the fact that Dewey's approach to time is not split into three distinct phases. Time is not beyond experience but defined relative and according to various situations and issues. Thus, within experience, time is embedded in and problematized through specific processes of 'growth'. Time matters in education because the capacity of an adult to adapt to emerging problems is grounded in 'educative experiences' lived through during childhood. In the same way, time matters especially in a democracy, for the reform of institutions requires new 'publics' able to emerge from previously scattered situations. In sum, Dewey's thought provides us with three important analytical directions.

- First, the continuity of experience is a matter of 'growth'. We would reformulate this idea stressing the issue of engaging experience with human and non-human associations that allow it to endure despite obstacles. Here is a touchstone for the connection between the ideas of time and materiality, that is, for 'duration' in the sense of a continued existence in time, and for 'endurance' in the sense of something that resists over time. Thus the idea of growth offers a stimulating research perspective on duration and materiality, even if it is not fully problematized by Dewey.
- Second, the continuity of experience requires temporal mediations. This refers directly to the transactional activity previously discussed. Experience is constituted not only by 'interactions' with things that reveal usefulness in the present, but also by 'transactions' with things so as to engage them differently than they were or are in the near future. Transactions define a relational mode of inquiring into the experience. Transactions are the practices thanks to which things are

renamed, reframed and entered into action. Dewey does not describe these practices in detail, but we propose to look at them as emerging temporal mediations—that is, mediations which change our attachment to things, and in consequence our relationship to time.

- Third, these temporal mediations impact the way 'nearness' is configured. It seems to us that it is of fundamental importance to introduce the Dewey's philosophy not as a thought of the future (abstract, in general) but of the 'near future', and by looking at the continuum of ends-means of 'nearness'. 'Nearness' is not a temporal metrics, as we might speak of a 'five years plan'. It is an uncertain and plastic zone, where the effects of our actions take place–an aspect that echoes the pragmatist conceptualization of place proposed by Malcom Cutchin (2008). 'Nearness' is a proposal of 'duration' to be articulated. It can be shut down and interrupt an experience, be imperfectly configured and hamper the continuance of an experience, or enact the experience in multiple ways and amplify its potential.

These three points offer a perspective on time that is closely linked to the concept of experience as a process, as emerging mediations of entities from various temporalities (distant or recent past, present, near and distant future), and as the creation of new spatialized and material durations, while seeing these entities within a process of energy transition.

3.4 'Transitioning-Towards': The Strategic Configuration of Nearness

Contrary to the idea that only distant futures (visions, scenarios) and anticipatory attitudes drive energy transition, we assume that 'nearness' is a real battlefield. We make this assumption because energy transition 'potentials' are fundamentally uncertain. Taking control of the future requires intensive practices of selecting, renaming and reassembling things in order to bring values and interests into an enduring process of change.

In the following analysis, we therefore focus on and approach 'nearness' (past and future) as a strategic and disputed zone in the context of energy transition. 'Nearness' is not given beforehand, as if the future were endless. We shall therefore analyse the process of its configuring.

Our research agenda consists of the following questions: how does 'nearness' become an issue and problematized in the processes of energy transition? How are the mediations between emerging issues and entities elaborated from the point of view of various temporalities? How is the near future transformed into duration, and through what material assemblages? How do these assemblages enable or disable the different stakeholders to engage with the energy transition?

4 Exploring the 'Nearness' of the Energy Transition: Entangled Temporalities and the Making of Capacities for Change

4.1 Capturing the Past, Pre-empting an Unconventional Future: Coal Bed Methane Exploration in Lorraine (France)

This case study is located in Lorraine, north-eastern France, at the border with Germany (Labussière 2017). Here is one of the largest coal basins in Europe. The coal industry in this place has a long history running over a century and half. After the Second World War, the French state nationalized the mining industry and created the national company Charbonnages de France. The exploitation of coal went on until 2000. When the mines shut down after 2000, the mining area was opened to newcomers.

At that time, Kimberley Oil, a junior Australian company, was ambitious to become a major player in coal bed methane in Europe. Lorraine is strategically located at the heart of Europe, in a very large coal basin, served by an international gas network and close to places of high energy demand. The activity of a junior company is orientated towards the exploration of underground gas potential. The main challenge is to clear a gas field of its financial risks and geological uncertainty so as to stabilize a manageable near future that will be sold to, capitalized and developed by a gas provider. In what follows, we analyse the practices of assembling different temporalities to generate such an unconventional 'near' future.

As the underground and its resources belong to the French state, Kimberly Oil had to obtain in 2004 a mining permit to start drilling operations. Just arrived from Australia, it knew nothing about the geology of Lorraine. In 2006, it contacted a recently retired director of a mine, who formerly worked for Charbonnages de France, to profit from his knowledge and experience. In practice, the company got much more than expected, since the former director spent six months collecting the archives that belonged to the French National mining company. These cover the knowledge accumulated for a century and half about the geology of Lorraine and its gas. Making copies and scans, the Australian company captured for free thousands of documents (maps of mines, stratigraphic sections, location of six hundred drill holes, etc.). Capturing the past was strategic to fostering the siting of drilling operations and reducing uncertainty about the depth and the geometry of underground coal seams. Inherited knowledge, cut off from the mining experiences it was attached to, was translated into standardized data, positioned in space by GPS coordinates, and compiled into a database with more recent geological results.

The opening of drilling operations to inherited knowledge, however, was put to a hard test by the materiality of gas in Lorraine. In the near past—that is, in the post-mining era—Charbonnages de France stopped pumping the water table, an operation necessary to accessing and exploiting the coal. The coal seams progressively recovered their natural water content. The temporality of this natural cycle interfered with and complicated the operations of drilling. The first drilling exploration occurred in Folschiviller in a part of a mine that had remained largely untapped. In 2007 another retired French mining engineer, experienced in drilling in the Lorraine basin, was employed by Kimberly Oil to direct the operations. At that time, the drilling concept was to make a horizontal well so as to cross a faulted coal seam and access a large amount of gas. When the well entered the fault, the latter was flooded with water. Geologists progressively realized that the well was connected to the groundwater table and that the amount of water might be endless. 'We were pumping the ocean', said an engineer. The ability of the team to direct the drilling was limited by their lack of experience.

Kimberly Oil, now renamed European Gas Limited (EGL), then hired Canadians engineers from Alberta, specialized in coal bed methane production. At the same site, the Canadians used a new drill with the idea of placing three drains in three different seams to extract as much gas as possible. This procedure is technically very complicated. They succeeded in positioning the drains, but as these were shorter than expected, the amount of gas remained restricted. A new testing site was necessary. In 2014, EGL opened a new site at Tritteling. The drilling concept had slightly changed: this time it was a horizontal well with multiple drains, but all the drains were located in the same seam. The hope was to develop longer drains. Six drains were successfully positioned. A pump was placed at the crossroad of the six drains and was expected to suck water and then gas. But new problems arose during the production test. The downward pressure of gas in solution is like a bottle of champagne. When the gas moves upward, it progressively generates bubbles inside the well. The pump, moving water and gas very rapidly, produces a mixture that cannot easily escape. 'We've got a column of water and gas moving up and down! And when the bouncing is hard, it has serious effects on the pump', said one of the Canadian drillers. A row of six broken rigs was displayed on a shelf in his office.

The description of the successive drilling concepts shows different assumptions about ordering general skills, knowledge, cutting head, pump, coal seams, water and gas. Ordering these entities in an operative unit is an experimental process. It consists in stabilizing relationships between these entities and making them participate in the construction of a new common duration. This duration results from a relational but uncertain arrangement that aims at detaching the molecules of methane from the coal seams, allowing them to circulate underground and then bringing them together in a new, stable entity. The idea of duration usefully expresses that this arrangement has both a temporal and a relational nature: the challenge is to stabilize and generate enduring relationships so as to bring a regular flow of concentrated gas free from water to the surface. Thus the construction of a manageable 'near future' oriented towards the production of gas in Lorraine was made up of heterogonous temporalities and materialities.

The case suggests that this emerging 'near future' was also entangled with another temporal frame focused on the relationship between the immediate present and the distant future. While the exploration in the field was progressing by trial and error, EGL launched an advertising campaign in a French national newspaper. The advertising represented typically French jars of jam full of unconventional gas, as if the gas was already a stable commodity. At the same time, EGL was being listed on the stock market. The strategic issue for EGL was to inspire confidence in its private investors and to become part of a renewed gas market, including unconventional gas, which has assumed a larger and larger role in some visions of an energy future (Shell 2013)[1] as a key step towards a decarbonized economy. If the 'near future' is the transformative zone where heterogeneous entities and temporalities are rearranged, this zone is almost inaccessible to emerging 'publics'. What happens underground is not accessible to ordinary experience, and the capture of local knowledge hampered the possibility of a counter-expertise in the long term.

4.2 Repowering and Renaturing: New Renewable Energy Landscapes Embedded in Inherited Browlands and Its Otherness (Lusatia, Germany)

Our second case is located in the former German Democratic Republic, in Lusatia, halfway between Berlin and Dresden (Deshaies 2015). This area is known for the extensive open-cast lignite mining that shaped the landscape from the nineteenth to the end of the twentieth century. Lignite was the prime fuel source for East Germany, but with changed priorities in energy supply after reunification (1989–1990), the majority of mines closed abruptly. High unemployment and outmigration were results of this economic shock. What remained was a devastated countryside, full of huge holes and slag heaps.

Immediately after reunification, there was no comprehensive development strategy to steer rehabilitation of this vast area (Lintz et al. 2012). Two processes were taking place. First, by switching off the mines' drainage pumps, the ground water table began to rise again over the years, causing the creation of a number of lakes in the holes created by the mines. Second, according to the Unification Treaty, the Federal Republic of Germany was responsible for rehabilitating the devastated areas and boosting their economic future. To this end, it created a state-owned rehabilitation company, the Lausitzer und Mitteldeutsche Bergbauverwaltungsgesellschaft mbH (LMBV). To foster the development of the area, LMBV entered into a partnership in 1999 with the International Bauausstellung Ilse-Park (IBA) to elaborate with the federal states and the districts a new landscape concept. IBA does not execute schemes itself but rather creates networks, attracts investors and coordinates operations. In what follows, focusing on the municipality (Gemeinde) of Klettwitz/Schipkau in the centre of this area, we analyse how renewable energy development, the emerging waterscape and the IBA's landscape concept have been progressively interwoven to transition-towards successive generations of energy landscapes.

At the end of the 1990s, the large available spaces around Klettwitz/Schipkau attracted private wind power developers. These post-mining areas were easy to explore since the dilapidated industrial landscapes and the low level of biodiversity presented no constraints for the siting of wind farms. The best sites were the upper part of the plateau made of detrital material. This induced the development of new technical solutions (implementation of specially developed combined pile-raft foundations) to turn the loose tipping ground of a former open-cast coal mine into manageable ground capable of anchoring wind turbines. From our own analytical perspective, we want to stress the importance of these technical mediations that allow for rearrangement of an inherited and muddled past, providing it with a new endurance and duration.

From 2000 to 2010, the IBA Fürst-Pückler-Land concept was launched. It consisted in opening nine 'landscape islands' (IBA 2010).[2] These were experimental sites intended to test principles of renaturation that could inspire post-mining regions all over the world. The development of renewable energies was in line with this strategy of economic and environmental reconversion. As a guideline, the IBA Director, Rulf Kuhn, envisioned a middle line between a complete reconversion, which would have erased the past and turned the territory into a recreational area, and just leaving the landscape to its own devices as a wilderness (Mead 2005). 'Island 2', one of the four experimental sites near Klettwitz/Schipkau (in Lauchhammer-Klettwitz), is a good illustration of this middle strategy. The pit of the mine of Bergheider was flooded from 2001 to 2014. New forests and crops were planted on its surroundings. It allowed the flourishing of a new biodiversity, especially thousands of migratory birds (for example, wild geese, storks), beginning in 2007. Industrial relics and landmarks, such as the F60 conveyor bridge that excavated the coal seams, survived to be part of a new tourist destination about the industrial heritage. At the margins of this site, 100 MW of wind power capacities were installed between 1999 and 2006. On a broader scale, the region became one of the most important in Germany for electricity production (wind farms, solar panels, biomass), with 85% of electricity needs met by renewable resources. These developments flesh out the idea that transitioning-towards is not making a future vision come true, but rather engaging actions along with a diversity of physical, biological, economic temporalities, all joined together in a project of repowering (that is the end-in-view). Experimenting at the same time in all these directions is of course rare if not unique, but it lets us see how the 'near future' can be arranged in a 'transformative zone'.

Pursuing the case a step further, we see how, as suggested by Dewey's approach to experience, a transformed situation enacts experience in multiple ways, or, in others words, how a 'transition potential' emerges from successive adaptations to a changing situation. This is visible in the case of Klettwitz/Schipkau when the first wind farm was being repowered from 2012 to 2015. The potential 'interferences' between bigger wind turbines and this new nature became a public issue. The building of new wind towers had to take into consideration the deep onsite renewal of the fauna and the flora. This did not hamper the project, since the studies concluded that the impact on the fauna and the vegetation would be limited. Two wind turbines formerly envisaged have been removed so that birds have a larger migratory corridor to access the Bergheider See. The soil also had to be taken into account to make sure it could accommodate the new and heavier wind towers. The implementation of specially developed combined pile-raft foundations allowed stabilization of those in water-saturated and rolling dump soils. The new, bigger wind turbines were also sited a little farther from villages to limit co-visibilities with surrounding villages. Working in concert with the population has been easy for the wind farms, which are now widely accepted and considered part of the landscape.

The case shows how brownlands that might have supported an almost opportunistic and quantitative energy transition have progressively been endowed with a political dimension supported by environmental concerns. A first generation of wind power projects participated in a process of redesigning the land and strengthened local capacities for developing new environmental requirements. The second generation of wind power (repowering) opened a window for actively negotiating post-mining nature and managing its new multiplicity (birds, landscapes, visual qualities) with respect to energy transition. From this point of view, the short life cycle of wind power farms (twenty years of production) contributed to fostering the interweaving of different entities (lakes, forests, migratory birds) and joining their respective life cycles into a common 'near future'.

4.3 Amplifying Collective Experiences to Up-Scale Wind Power: The Continuous Growth of Citizen Assemblies and Wind Power Parks in Northern Friesland (Germany)

Our last case is located in Northern Friesland, an administrative district in Germany, on the border with Denmark, on the shores of the Wadden Sea. Its landscape consists of islands, outlands, wetlands and polders. In 2016, it had 162,000 inhabitants and more than 800 wind turbines (with a total capacity of about 1800 MW) installed on 90 wind farms, 77% of which belong to 'citizen wind park' inhabitants. Prior to wind power, agriculture had been the dominant economic activity, including mainly sheep breeding and cow and wheat farming, and despite some tourist attractions, the population was declining.

Compared with the two others case studies, which were about one to two decades long, this one covers four decades of wind power development, between 1976 and 2014 (Chezel and Labussière 2017). It aims at exploring how ‘nearness’, understood as a ‘transformative zone’ where past and future are rearranged, can be configured to connect to manifold experiences and support successive generations of increasing wind power capacities. Thus, in contrast to standardized technological pathways, the case allows us to observe how citizens problematized the up-scaling of wind power as ‘growth’ that both included and questioned their experiences.

As a starting point of this long wind power history, we can usefully consider the German federal pilot project GROWIAN, implemented in the neighbouring district of Dithmarschen in 1980. The Federal Research Ministry handed it over to the Jülich Institute for Nuclear Research. A 3 MW turbine with a hub height of about 100 m had been designed, and the project was intended to test the feasibility of a large-scale wind turbine that would provide Germany with the technical foundation to develop an ambitious wind power policy. This oversized device, with an excessively heavy rotor, never reached its full run. The pioneering megaproject was supposed to provide Germany with a large-scale alternative to nuclear power. This vision came up short, since ‘present’ experience, not related to former wind power experiments at smaller scales, could not reach such a ‘distant future’ in the abstract. Reducing wind power development to small-scale projects could be interpreted as a political way of putting wind energy to one side, but this interpretation would fail to take into consideration the “Danish way”.

The spatial diffusion around the border has certainly played a role in the advent of small wind turbines in Northern Friesland. It inspired not only individuals but also private firms. A well-known company from Schleswig-Holstein, the Husum shipyard (HSW), whose nautical activity was in decline, shifted to the construction of wind turbines in 1987. It first began producing a prototype, the HSW-200 (200 kW), by using its traditional know-how in the shipyard, the same employees and with financial support from the district and the federal state of Schleswig-Holstein. The turbine had been tested onsite, right behind the company’s workshop. Promising results led HSW to envision the production of a range of bigger (HSW-250, 750) and smaller wind turbines (HSW 30) to be exported to isolated regions or developing countries. In 1989, HSW decided to build the biggest park in Europe (13 MW) in the polder of Friedrich-Wilhelm-Lübke-Koog (FWLK) with mixed financial support from the community, the district, the state of Schleswig-Holstein and investors from Munich. Lack of internal skills led the company to revise the project and to settle for smaller turbines.

This first line of wind turbines nevertheless inspired the polder's farmers. Looking at the foundations, the erecting of the turbines, the material and its management, some of them realized in situ that wind energy could be produced on their lands with local wind and local technologies. Three different farmers asked the mayor of FWLK whether they could build a wind turbine on their diked land. He asked them to come up with a common wind farm in order to avoid a dispersion of wind turbines in the polder. More than a piece of land free from any infrastructure, the polder has strong collective land management—dewatering, dike construction and conservation—historically anchored in inherited practices of collective management. The polder offered a spatial pattern that could match a collective wind power perspective and optimize the occupation of the land when siting the turbines along the dike. The three farmers decided to invite people from the whole polder to join the project. In 1991, they organized a meeting every week of the year. In the end, 44 inhabitants (one-third of the polder) participated in the project and, following a request from the bank, also mortgaged their land to hedge against the risk of a project failure. In 1992, they received authorisation to build 22 wind turbines (6.6 MW) along the dike. There were similar stories in Bredstedt-Land in 1991, and Bohmstedt in 1993, and many other citizen wind parks. The first law promoting and financing the selling of electricity produced from wind energy was adopted in 1991 and fostered these developments.

At the end of the 1990s, wind power development became contested at the national level, especially owing to landscape changes perceived as the result of uncontrolled growth. Because of its early wind power history, Northern Friesland was a crucial district for devising and testing innovative planning solutions. In 1993, its administration started to standardize approval of the new wind power projects. It also produced the first maps of the wind power development and established wind power development zones. The administration worked closely with municipalities, associations and citizen wind parks. The emerging landscape policy was therefore informed by the inhabitants and their political experience of sharing the land. In contrast to an abstract vision, this wind power plan represented a political compromise able to steer wind power development towards the 'near future'—that is, without cutting off the ongoing dynamic from its grass roots and its transformative potential. In practice, this consisted in agreeing upon the creation of wind power basins with high densities of wind turbines and breathing spaces where the Frisian landscape could be preserved.

Another emergent issue was that the development of citizen wind farms quickly became dependent on expanding the grid. This is ordinarily not manageable at the scale of a single wind farm. In 2009, wind farmers decided to network and create a new assembly based in Breklum (Northern Friesland), ARGE NETZ (that is, 220 windfarms and 9000 partners) around emerging concerns on the regional level. ARGE NETZ created a financial pool with contributions from the wind parks to mutualize investments in the electrical grid and develop the existing transformer stations—two sensitive issues in achieving large-scale wind power development. It also created a firm, the Breitbandnetzgesellschaft, whose goal is to turn Northern Friesland into a 'broadband country', that is, a region equipped with fibre-optic cables to support the remote management of wind farms and optimize the production of electricity. This development has created facilities that also benefit villages without wind turbines. It became obvious that the ways the landscape was turned into a political and negotiable entity through wind power development could in turn offer possibilities of regional development to everyone in the region. ARGE NETZ is also eyeing the possibility of political lobbying, mainly focused on the role of citizen projects in the 'Energiewende' (German energy transition policy), and opened an office in Berlin in 2014. A striking aspect of this case study is that the making of enduring citizen assemblies, continuously adjusted and enlarged to support new wind power end-in-views, allowed the scaling-up of wind power parks in a way that did not ignore the lessons learned from previous wind power development at a smaller scale nor the challenging effects induced by the proliferation of biggest wind turbines. This points out the idea that the scaling-up of new technologies of energy is not a matter of moving from 'niches' to 'regimes', but a matter of producing a duration that allows the different entities to endure in the process, and have a say on its steering.

5 From 'Nearness' to Enduring Processes of the Energy Transition: Coping with Heritages and Material Intensities

To begin the discussion, we go back to the assumption proposed by Guyer (2007): 'nearness', understood as the temporal frame in which experience is embedded, has thinned out in the last sixty years. The temporal frame inherited from the post-war period, strongly concatenated to the recent past and the near future, has progressively been replaced by a new one, focused on the immediate present and the very distant future. According to Guyer, 'nearness' has not totally disappeared—a position that differs from more radical perspectives (Jameson 2002)—but its management has become more and more an individual affair, without any reference to a defined collective future.

Energy transition is an especially stimulating field of inquiry for questioning this proposal. At first sight, Guyer's observation seems very well established if we consider that many energy policies are driven by long-term scenarios of energy futures (by 2030, 2050), which exhort us to act urgently. Delayed investments in policies of attenuation and adaptation make us enter a more uncertain and risky world, and confront us with unbearable costs to manage the consequences of an untamed planet. While not denying the pertinence of this economic reasoning to foster collective concern for ambitious climate and energy policies, its logic of time is questionable. For instance, its opening to democratic issues is limited. As was asserted during the recent scientific conference that preceded the CoP 21 in Paris, anthropogenic climate change is now well established and we are entering the 'time of solutions'. This means that the 'technological solutions' are known; many are common to different scenarios and it is felt they have to be imposed urgently even if implementation neglects the regular democratic interplay. Such assertions urge us to reopen the temporal dimension of the energy transition and to analyse the political issues that ensue upon its elaboration.

The temporal frame depicted by Guyer usefully develops some of the tensions at work in the contemporary energy transition. Nevertheless, 'nearness' in the sense proposed in this chapter should also be considered with attention to the level of energy projects. Through this lens, 'nearness' does not entirely disappear but is invested and rearranged differently according to emerging technologies and issues of energy transition. In this direction, our assumption is that 'nearness' constitutes a strategic and disputed zone for taking control of emerging energy futures. Drawing on our case studies, we propose several points of discussion to test this idea.

Our first point pertains to the different media through which past, present and future entities come into 'nearness'. Existing analyses—for instance that of Anderson (2010) of the future present—have always usefully suggested that these mediations could take different shapes such as calculative practices, narratives or embodied performances. Our pragmatic framework invites us to look at these mediations as 'transactions'—understood, following Dewey, as relations that rename, reframe and specify things to endow them with a new agency in a process of change. What are these mediations? How do they take completely different times in a process? And how do they configure 'nearness'?

- The case of Lorraine covers over fifteen years: the distant past was captured—that is, a century and a half of archives was cut off from former mining experiences, standardized into data and compiled into a database to reduce uncertainty about where to site drilling operations and inspire confidence in private investors about the amount of recoverable gas; the recent past was enlisted—that is, former mining engineers were hired by the private company to direct the operations of drilling in the field; 'nearness' was configured as a restricted zone to develop interactions with a declining coal mining activity (and benefit from past experiences), but avoiding any relationships of reciprocity with miners, their memory or post-mining environmental concerns; and in the 'nearness' drilling experiments remained hidden and interferences between the exploration of coal and the water table failed to become a subject for investigation. Thus, transitioning-towards was the process through which 'nearness' was configured to exclude the public from the issues and foster (from exploration to market) an unconventional medium-term future.

- The case Klettwitz/Schipkau covers over 25 years: the distant past (man-made topography, huge holes, slag heaps) and the recent past (water table recovering its natural level) were approached abruptly after German reunification without any comprehensive plan, and 'nearness' was configured as a field of experiment (the 'islands' introduced by the landscape concept) to develop transactions with the past that did not erase their own dynamics. In the 'nearness', soils made of detrital materials were consolidated to support wind turbines and processes of renaturation were engaged to enable plants and animals to colonize the 'islands'. Thus, transitioning-towards was the process through which 'nearness' was opened and connected to various (physical, biological, economical) cycles to intensify transformative effects and crossed influences inside, between and outside the 'islands'. On the basis of this 'transition potential', local concerns for sustainable energy landscape emerged and participated in repowering wind turbines.
- The case of Northern Friesland covers over 40 years: the distant past (polder, strong collective land management of the dikes) continue to influence current activities in the land—even if romantic nationalism of the nineteenth century and national socialism from 1933 to 1945 can be seen as a rupture in Frisian solidarities; the recent past (the Danish adventures of small wind power) was easy to visit and a natural source of inspiration, since it took place in a neighbouring area, sharing strong geographical and cultural patterns also due to porous frontiers until 1920; and 'nearness' was configured as a zone of experiencing and sharing know-how among inhabitants (that is, an 'assembly'). In the 'nearness' inhabitants took advantage of the polder pattern and their custom of land management to engage with and gather around wind power. In the 'nearness' a wind power plan was elaborated to cope with the proliferation of wind turbines and design

> principles of growth for the 'near future' inspired by grass roots collective experiences. In the nearness, a network of wind power assemblies arose to tackle problems issuing from increasing wind power capacities (that is, the reinforcement of the electric grid) and support more widely regional development. Thus transitioning-towards was the process through which (wind power) assemblies were successively brought to higher level of commonisation to up-scale wind power without cutting-off its grass roots and its transformative potential.

Our second point originates in the observation that these experiences are embedded in more multiple and various temporal scales (distant past, recent past, present, near-future, medium-term future) than has been noticed in the literature about 'futurity' and 'nearness'. This clearly shows that 'nearness' in the context of energy transition is not reducible to the influences of the 'immediate present' and the 'distant future'. It also suggests that energy transition processes induce spatial re-compositions as well as underestimated temporal re-orderings. 'Transitioning-towards' is an operation that takes both materiality and time in a process of change. It makes time matter, it endows time with a renewed materiality. This echoes what the Brazilian geographer Milton Santos (1997) called the 'empiricisation' of time. According to Santos, a sociotechnical system produces historically dated types of human organizations and settlements because it reconfigures human activities (work, cooperation, financial flows). Over the course of history, the juxtaposition of sociotechnical systems from different ages in a place generates a complex interplay of materialized temporalities. While this formulation places technology at the core, it also suggests a layered approach of time that limits our ability to understand more dynamic processes of change. On its own, the idea of 'nearness' draws attention to how heterogeneous elements are taken up in an enduring assemblage that engages people and things in a new relationship to time, a new duration. Thus 'enduring', giving consistency and robustness to a sociotechnical assemblage, is a condition for, and the 'duration' an outcome of, transitioning-towards. This offers a perspective different from the one introduced by Guyer's work (2007, 2017). According to Guyer, we have shifted from an 'enduring time' to a 'punctuated time', or to put it more simply, from plan to event. The plan is supposed to be endowed with a duration defined by advance, while the event focuses on the continual adaptation of a person to a changing world. Both bypass the question of how things participate directly in making a specific duration when taken up in a process of change.

This leads to our third point of discussion, the political dimension of time-making in energy transition. If transitioning-towards is different from a 'matter of timing', this is because all the dimensions of time, as embedded in a multiplicity of experiences and material processes, are not present in a process of change with the same intensity. In others words, some are intentionally selected and defined along with the ongoing experience, while others constitute a 'surplus', a 'margin' of the experience (Dewey 1906), but can 'interfere' with it. Thus the question of time in energy transition is both relational and intensive. Our case studies have specifically brought the attention on the role of heritages and environmental processes in the configuring of the nearness. But it is clear that the temporal mediations are multiple and manifold. Thus, 'transitioning-towards' can be defined as the political work that consists in defining and specifying the relevance/irrelevance of temporal associations in performing an 'enduring' sociotechnical assemblage. This consists in including/excluding experiences or material processes according to their capacity to foster or to slow down a process of change. For instance, it can be seen in the processes of configuring 'nearness' along with heritages and environmental intensities.

'Nearness' emerges from the case studies as being configured in three ways: a 'restricted zone' (Lorraine), a 'field of experiments' (Klettwitz/Schipkau), a 'zone of experiencing in common' (Northern Friesland). In the three case studies, emerging sociotechnical systems are clearly and intentionally embedded in heritages. These heritages provide each process studied with different relational and intensive contributions. In Lorraine, the appropriation of local knowledge and skills aimed at accelerating the drilling operations by taming geological uncertainty. It severed ties to heritages with the former mining activity and engaged the exploration of the subterranean in a different direction, changing from coal mining to coal bed methane. In Klettwitz/Schipkau, heritages (post-mine landscape) did not propose a clear direction of change but provided the stakeholders with an enormous potential to experiment in very different directions. In Northern Friesland, heritages (spatial configurations, customs/habits of collective land management) differed from the precedent cases since they were embedded in a vivid custom of landscape management. This made visible that 'nearness' does not cope with the same problematisation of change in both cases, Klettwitz/Schipkau (managing discontinuity) and Northern Friesland (managing continuity).

'Nearness' is also politically configured in the way it copes with material intensities, often unexpected and untamed, which question the best way to challenge the means of steering change and open a collective discussion about its consequences in the near future. In our three cases, these materials intensities erupt into experience in the following statements: 'too much water', 'too many birds', 'too many wind turbines'. These things are issuing, but do not become collective concerns in the same way. In Lorraine, when the horizontal drilling interfered with the water table, pumping became endless. This confronted the operation with such a huge environmental intensity—the circulation of water underground—that the drilling concept had to be revised. No 'duration' could be performed from this assemblage. 'Nearness' dissolved in the earth's own temporality. As the interferences between drilling operations and water remained hidden underground, no one 'public' emerged from this adventurous management of water and gas. In Klettwitz/Schipkau, on the contrary, physical, biological and economic cycles were revitalized by switching off the pumping of the table water, planting forests and crops, settling wind turbines and developing tourist activities. These processes progressively interfered with each other, strengthening new environmental concerns such as those for the cohabitation between wind turbines and migratory birds. Here local inhabitants constituted themselves as 'publics' (that is, groups affected by the issues resulting from this post-mine nature), participated in open 'nearness' as formerly embedded in a 'network' (that is, a scientific and technical assemblage of heterogeneous pieces) of new environmental processes (here migratory birds, since flooded pits offered them new resting places). Renaturing offered unexpected lines (birds' migrations) to repower the turbines, and repowering advanced this new nature a step further with a more enduring assemblage. Thus the 'publics' helped turn random 'interferences' into well-specified 'transactions' among the entities (local inhabitants, mines, turbines, lakes, migratory birds) of an emerging sustainable energy landscape. Finally, in Northern Friesland, the increasing number of wind turbines in the countryside interfered with the landscape and generated political concerns about its becoming. These 'interferences' nevertheless issued from a wind power development strongly embedded in an inherited transactive pattern (collective management of the polder, wind power assembly). The challenge was to move these transactions from the scale of local wind power assemblies to the scale of a region, so as to agree on the pace and the extension of the wind power development in the near future. Wind power raised the question whether or not the wind power landscape could be directed as a regional commons. The devising of an innovative wind power plan opened to grass roots experiences helped in reaching agreement about new landscape intensities ('breathing spaces' and 'wind power basins') on a new scale.

These examples stress the fact that 'nearness' is a strategic and disputed zone for two chief reasons. First, 'nearness' was systematically connected to all or some of the heritages that were selected and reconfigured according to emerging issues of energy transition. Second, 'nearness' was continually challenged by emerging 'interferences' and became (or did not become) the object of new investigations aimed at translating their quantitative effects ('too much water, too many birds or wind turbines') into a qualitative 'duration'. Each 'duration'—that is, the way successive generations of experiences were taken up into a process—specified the identity of an energy transition 'potential'.

It is worth noting that here an 'interference', contrary to what may seem to be the main assumption of this book, need not as such be negative. The elements with which the processes of energy transition interfere are called into a process of change and may contribute to its configuring according to their own temporality (circulation of water underground, cycles of bird migrations, expansion of wind power). Thus 'nearness' develops in the tension between temporalities that are intentionally captured, enlisted, observed or celebrated, and the others that erupt into experience but can be harnessed, defined along with experience. This tension illustrates how 'transitioning-towards' is a political process. It goes from manifold experiences of time (that issue and interfere) to the formulation of new ends-in-view which include or exclude entities attached to these experiences.

6 Conclusion

The aim of this chapter is to provide a critical inquiry into the processes of time-making and of agreeing upon collective horizons of energy transition. Contrary to the idea that energy transition is driven only by distant futures (visions, scenarios) and anticipatory attitudes, we have argued that 'nearness' (recent past and near future) has a major influence on steering processes of energy transition. This is so because energy transition 'potentials' are fundamentally uncertain. Taking control of the future requires intensive practices of selecting, renaming and reassembling things to bring values and interests into an enduring process of change. In this way, our pragmatist framework has insisted on the idea that we are 'transitioning-towards'. This displaces the way we look at energy 'transition' from being an interval, a gap to be bridged, to being a process of change in which new assemblages and new durations are performed.

We now sum up the main outcomes of our study as follows.

First, drawing on the pragmatic heritage of John Dewey, we have proposed a relational approach to time, defined along the lines of 'experience', 'transaction' and 'duration'. Experience is constituted not only by 'interactions' with things that reveal themselves to be useful in the present but also by 'transactions' with things that engage them differently from how they were or will be in the near future. Transactions define a relational mode of inquiring into the experience. 'Nearness' is defined relative to this transactive pattern. It is the operation of selecting, renaming and reframing entities from different times (past, present and future) to make them intervene in the ongoing experience. 'Nearness' offers a new perspective on 'duration', which is thus approached as the processes of engaging experience in associations that allow it to endure despite obstacles.

Second, this problematisation of 'nearness' allows us to analyse the entanglement of past and future temporalities and to reassess them as at the heart of the processes of energy transition. Our case studies have shown that these processes appear to be more embedded in multiple and various temporal scales (distant past, recent past, present, near-future, medium-term future) than has been noticed in the literature about 'futurity' and 'nearness' (immediate present/distant future). This has drawn attention to how heterogeneous elements are taken up in an enduring sociotechnical assemblage that engages people and things in a new relationship to time, a new 'duration'. This in turn allows us to define the idea of 'duration' more precisely from a relational and material perspective. 'Enduring', giving consistency and robustness to a sociotechnical assemblage, is a condition for, and 'duration' an outcome of, transitioning-towards-a-qualitative-change. Hence this suggests that the way in which 'nearness' is configured, and by extension the way in which a 'duration' is performed, is both a material and a political enterprise.

Third, our work has defined the political effects that ensue from the configuration of 'nearness'. The pragmatic approach allows us to understand that all the dimensions of time—as embedded in a multiplicity of experiences and material processes—are not present in a process of change with the same intensity. Some are intentionally selected and defined along with the ongoing experience, while others constitute a 'surplus', a 'margin' of the experience, yet can 'interfere' with it. This points to a difference between energy transition approached as 'matter of timing', in which time is treated within a unified but abstract framework, and energy transition as a 'matter of experiencing new durations' ('transitioning-towards'), in which time is multiple and intervenes in mainly two empirical ways, as heritages and as material intensities. 'Nearness' appears most often intentionally associated with heritages (knowledge, skills, spatial patterns) according to their capacity to foster or to slow down a process of change. At the same time, 'nearness' is continually challenged by material temporalities (circulation of water underground, cycles of bird migrations, expansion of wind power). These untamed intensities question the coherence of an assemblage and give rise to new objects of investigations and new 'publics', translating quantitative effects into a qualitative 'duration'. Thus the 'duration'—that is, the way successive generations of experiences are taken up in a process—specifies the political dimension of an energy transition 'potential'.

From this perspective, 'nearness' is a strategic and disputed zone for steering the processes of energy transition. It is a zone in which the definition and the specification of relevant associations between material intensities and temporalities become a political issue. It is the plastic zone where an energy future becomes a proposition of 'duration', which has to be articulated in relation with the things located where it takes place.

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Notes

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2. IBA, *Bergbau Folge Landschaft (Post-Mining-Landscape)*. Berlin, Jovis, 2010. See also: http://www.iba-see2010.de/en/verstehen/projekte/neun-inseln.html.

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8

Energy Transitions and Potentials for Democratic Change

Olivier Labussière and Alain Nadaï

List of abbreviation

PV Photovoltaics
MLP Multi-level perspective

Our inquiry in this book started with the assumption that the current conduct of the energy transition raises democratic issues, because it does not offer people or their milieux a genuine chance to take part in these processes and ensure that their concerns are represented within them. We justified this claim with an account of the domination of an

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instrumental form of reasoning which separates the definition of the ends of the energy transition from that of its means. This reasoning locates these ends out of the reach of the actors and entities who are engaged in the processes of energy change. This is achieved by various means such as: creating large-scale visions for long-term horizons, framing the transition as an A-to-B trajectory rather than a process in which ends can be adjusted with learning, targeting large-scale technologies, attaching 'potentials' to the technology…

In this book we set ourselves the task not to focus on criticising this approach, but to address this democratic issue through a fresh exploration of energy transition processes, and a re-conceptualisation of the critical issues underlying these processes—what we called a displacement from 'criticism' (of the management approach to the energy transition) to the 'critical'.

Throughout the book, we emphasised the importance of the ontological dimension of energy transition processes. This refers to the fact that the entities that are engaged in these processes find themselves, their environments, and their capacities for action modified, without proper acknowledgment of these changes or the resulting tensions, and without their being handled in spaces suited to political participation. We spoke of *ontological trouble*, pointing at the problematic dimension of this becoming, and pointed out the need to further explore the consequences of new energy project developments and the interweaving of the many attempts to channel these consequences—what we called *interferences.*

In defining our approach, we drew from pragmatism and pragmatist sociology in outlining what we called our *inquiry*. We defined this inquiry as a relationship to *material* (reopening the exploration of energy transition processes through a large set of empirical case studies), *method* (attending to the consequences of energy change processes for actors and entities that are affected by them and that attempt to collectively articulate their concerns by organising themselves as a 'public'), and a *role* for the social sciences (contributing to making the politics of interferences explicit to actors, thus supporting the public in making itself relevant to decisions and actions).

This endeavour was also charged with the ambition of adding to the contribution that *relational* thinking (in which ontologies are not given once for all, but derive from relations and are thus a matter for empirical inquiry and experimentation) can make both in the academic arena and in policy debates about how to conduct energy transition processes. We notably challenged recent criticisms of relational approaches arguing that they confine themselves to the appraisal of small-scale processes such as niche innovation, and are unwilling or unable to address broader systemic challenges.

This ambition was made possible by the scope of our empirical material—about 30 case studies from three different countries as well as transnational cases, addressing the deployment of seven different medium-scale technologies. Doing so required us to conceive of an inquiry that could handle this large array of case studies together while doing justice to their particular complexities and multi-scalar dimension. The emergence of ontological trouble and its handling through political participation often simultaneously weaves together dynamics that are local, national, and transnational. All the same, as the aim of the inquiry, was to address the current conduct of energy transition processes, it seemed appropriate to organise it in terms of the categories of action that are currently foregrounded by this conduct—markets, economic instruments, and technological demonstration. At the same time we sought to challenge what might be called its compass: that is, the set of unchallenged ('natural') categories underlying the structuring of this conduct: resources ('renewable' energy resources), spatiality ('scale') and temporality ('horizon(s)'). This methodological stance turned cases endowed with material existence into 'sites' (where processes take place) that were also defined relationally: Their interweaving with other case studies allowed us to derive a broader understanding of (an 'in-sight' into) the specific situation, the conduct of the energy transition, and how we might better conceive it.

1 From 'Sites' to 'In-sights': Transitioning Revisited

A first insight that our inquiry allows us to derive is in revisiting the current 'compass' of the conduct of the energy transition on the basis of our empirical material.

Renewable energy resources are part of this compass. They have often been associated with de-carbonized, progressive, alternative, democratic political ideals. At the same time, their expert/policy framing has stabilised their categorisation by reducing it to their physical dimension: non-carbon energy obtained from continuing or repetitive currents of energy occurring in the natural environment. Such ready-made characterisations seemed unproblematic until the large-scale industrialisation of renewable energy technologies. Our inquiry into the material dimension of how elements of our environment—such as wind, solar radiation, biomass, or energy usages—are being turned into renewable energy resources, however, shows that none of these characterisations can currently capture the political dimension of the processes of resource making. In building the promise of value associated with the making of energy resources, the possibility of scaling up their use—what we called the *pooling* of the resource—appears decisive (especially for electrical grid-connected type of resources). Our case studies show that ways of pooling have major effects on how and whether different entities become relevant in the process of constructing the resources, as well as on the outcomes of these processes. In certain cases, the collective depositing or harnessing of the resource allows a shared politics to become central (mutualisation in the Fermes de Figeac PV, commons in Rhône-Alpes biomass). In other cases, private interests take over the framing of the resource, either hampering a collective harnessing of the resource (Aveyron wind power in its early phase) or leading to its framing as a pure stock (fossilisation). The democratic dimension of the making of renewable energy resources—hence, their sustainability, including appropriation and distributive issues—thus require further analysis. This is all the more important given that the case studies show that the organisation of this making does not always allow for a genuine politicisation of the issues they raise.

As resources are not simply given as such by nature, the questions of scale and temporal horizon, which are both central to any formulation and implementation of 'the' energy transition, cannot be considered as given and devoid of politics. Our case studies show that energy transition processes construct their *spatiality*. While these build on inherited configurations that are both social and spatial, they are also constructed through a *politics of volumes*. Volume here is defined as a socio-material, relational notion. It is the three-dimensional space in which an untamed energy materiality is progressively valued, managed and controlled. The notion of volume goes beyond the matter of producing energy. It questions the way we value, share and live together within new energy spatialities. The chapter has shown that renewable energies give rise to new activities of boundary-making ('[dis-]placement'), which entails the construction of spatial hierarchies (spaces/resources that count, spaces/resources that do not count as part of spatiality) and power relations, with contrasting effects. Through this lens, the chapter has provided the reader with a renewed understanding of the strategic combinations of energy and non-energy volumes ('bonded volumes'), the political issue associated with moving from a zoning to a relational approach of the visualisation of space in debating about the volume as a common ('shareable volume') and the quest for a negotiable connection to the grid that do not hamper the emergence of fair energy volumes ('connectable volumes').

Temporality is another dimension of the compass. Close examination of this issue through case studies allowed us to challenge the frequent framing of the energy transition as a 'matter of timing' (historical drivers, pace of the transition) along pre-defined temporal horizons (2020, 2030, 2050…). This creates a shift from an approach that regards the transition as a gap to be bridged (from A to B), to one that frames it as a process of change in which new, potentially enduring assemblages are performed and disputed. This shift foregrounds *nearness*—a near future—as a duration in which multiple temporalities are woven together (distant past, recent past, present, near-future, medium-term future). Importantly, these temporalities are materially mediated (heritage, environment), potentially allowing the concerned parties to experience interferences and engage in selecting, renaming, reassembling things in order to bring values and interests into an enduring process of change. As a disputed duration, nearness can be configured in ways that allow for varied forms of political participation, from foreclosing access to the construction of nearness ('restricted zone', unconventional gas in Lorraine), to setting up a 'field of experiments' (post-mining wind power in Klettwitz/Schipkau) and space for 'experiencing in common' (wind power in Northern Friesland).

The other dimensions of the compass that we explored are three key mediations that are regularly invoked in the current conduct of energy transitions, namely: markets, demonstration, and economic instruments.

Official policy circles almost unanimously invoke the numerous benefits associated to conducting the energy transition through '*the*' market, in the singular. 'The market' represents the promise of a 'level playing field', in which free competition, free innovation, and efficient coordination will unleash economic forces, thereby allowing the current lock-ins and dependence on carbon-based energy sources to be overcome. Our examination of the fine-grained workings of different cases of market-based energy transition processes suggests that the outcomes of attempts to pass through markets are uneven, with regard both to the development of new solutions for the energy transition and to the extent to which these can be democratically steered. 'The market' as such neither exists, nor does it have a specific orientation. Unsurprisingly, our case studies reveal instead a series of market-like devices, and foreground the complicated work involved in shaping market participants, tradable energy goods, and a marketplace, while articulating these to what already counts for the actors. The case studies emphasise the decisive importance of public policy in empowering certain actors and offering them the opportunity to bend market processes for better (solar PV in the Fermes de Figeac) or worse (Aquitaine biomass). But they also foreground the complexities involved in setting up markets for the energy transition, because this opens the door to the valuation of things other than what the market usually recognises as valuable (smart meters and distributed load shedding in France). This should warn us against an overly instrumental take on markets for the energy transition. Furthermore, while the possibility has been advocated of addressing concerns and political ends through markets—'civilising' them by attaching them to dialogical settings in which multiple common ends can be articulated—our analysis suggests that this potential depends on the assumption of an exteriority and otherness to the market. Gathering and assembling such an exteriority may be difficult when institutional power, expertise, and the information required for valuation processes are in the hands of the market actors who are to be challenged. The possibility of 'civilising' markets thus critically depends on setting up the conditions needed to assemble an otherness to a market framing (e.g., counter-expertise, access to knowledge, availability of information to non-market parties…).

This result is all the more critical in a context in which technological *demonstration* is increasingly used in the conduct of energy transitions, if only because technological demonstration may impact the overall production and distribution of strategic knowledge about new energy technologies. Demonstration projects gather research and industry actors around technological innovations in order to accelerate them and, by consequence, the energy transition. As emphasised in this book, the rise of demonstration projects in the European Union has been contemporaneous with a repositioning of industry as a central actor in devising and financing research and development policy. In the face of this, scholarly analyses of demonstration have remained split. On the one hand, they have analysed the management, learning, and innovation potential of demonstration *projects*. On the other hand, and as a separate strand of analyses, they have detailed the ways in which demonstration *practices* underpin the joint construction of objects and publics in various domains of action. Very few analyses have attempted to articulate the minutiae of demonstration practices with the broader politics of RTD policy. Among those which have recently done so, some have tended to praise demonstration projects as hybrid forums where social values are incubated, which then underlie the development of new socio-technical systems and markets. Our analysis of three cases of technological demonstration (CCS, smart grids, and low-carbon communities) in France and the EU shows that demonstration projects are incubators of social values to the extent that they produce publics, collective problems, and the political principles that hold these together. While they should thus also be regarded as technologies of democracy, their democratic character, however, is questionable. In the three case studies considered, parties that were concerned by the ongoing demonstration did not succeed in making their concerns relevant to the course taken by the demonstration and its effects. There were no genuine spaces for political participation, or if there were, they did not really allow for different voices to be heard or to enter into learning processes that made them relevant within the demonstration processes. Expert framing (CCS, French smart meter), knowledge asymmetries and technicalities (French smart meter), or the pace of the process (acceleration: low-carbon communities) got in the way of balanced political participation and adversarial processes, with one case even illustrating the empowerment of a demonstrating consortium at the core of market framing (hence, no exterior to the market at all).

Last but not least, recourse to *economic instruments* is an essential component of the conduct of the energy transition. This is often justified by the need to support and steer the transition using economic incentives, conceived as a conceptual and practical articulation between renewable energy development, market deployment, and investment practices. And indeed, policy support has been crucial in triggering and shaping the recent development of renewable energies. Approaches to these instruments have mostly focused on the design, evaluation, and politics of their emergence. Their use to pursue political ends has also been blamed for moving issues away from the domain of political debates and entrusting them instead to technical adjustments in instrument design. Closely examining the workings of instruments aimed at sparking and directing investments (subsidies, fixed tariffs, tenders) in three different countries (Germany, France, and Tunisia), our case studies present us with a more complex picture. All of the cases studied are rife with engaged collectives, conflicting interests, and heated political debates. The processes by which instruments are deployed cannot be reduced to the negotiation of a design. They build on pre-existing political structures at various levels and scales; they trigger the structuring of new and persistent collectives as well as the articulation of shared values that are part and parcel of the emergence of political ends, beyond those that are foregrounded by these instruments. The potential of instruments to bring about changes in energy systems thus critically depends on the arrangement of collectives able to react to policy incentives—what we have called their 'milieu'. In certain cases, such arrangements underlie the emergence of spaces for genuine political participation (solar PV in Figeac, wind power in Northern Friesland). Just as in the case of markets, this should alert us against an overly instrumental take on such policy instruments, and invites us to pay increased attention to the role of inherited and emergent collectives in their functioning.

All together, our results bring out a new picture of what it is *to transition*—as an experimental process embedded in multiple experiences, by contrast with *the transition*, conceived as the substantive vision consisting simply of two (pre)defined patterns of energy use separated blankly by an interval of time. *First*, the unchallenged categories underlying the current conduct of the energy transition—'renewable energy', 'scale', 'horizon(s)'—are no longer given. The construction of these categories is part of the work of transitioning. It is disputed, weaves together multiple dimensions (material, temporal, and spatial), into an assemblage with a durable political existence. *Second*, the set of mediations (markets, economic instruments, demonstration) that are central to that same conduct cannot be regarded as mere means to an end. Recourse to them triggers processes that are not linear, induces multiple valuations, and empowers collectives of actors who become unavoidable parties to confront or to count with in any further change. *Third*, ends are reconfigured and shifted in the course of these processes so that there is a reciprocal, formative relation between means and ends. *Fourth*, these complex webs of relations lead to contrasted forms of becoming with regard to both the energy dimension and the democratic dimension of the energy transition. Inertia and lock-in into ways of 'fossilising' renewable energies—that is, exploiting them in a non-sustainable way—can result from failure to acknowledge these relations. The converse also holds: acknowledging these relations can help ensure recognition of the distributed capacity to contribute to a more democratic energy transition and establish the conditions for it to happen.

This portrait suggests that the current approach to the energy transition(s) does not allow us to properly acknowledge the complex set of relations that it brings forth. It also suggests that a relational approach to energy transition processes, because it has the potential to shed light on these relations, can help us acknowledge, understand, and address their effects.

2 The Reach of Relationalism

This set of results in itself demonstrates the usefulness of a relational approach for the conduct of the energy transition. However, we would like to insist in this conclusion on the type of contribution that the relational analysis set out in this book brings to the understanding of the energy transition.

As stated in the book's introduction, science and technology studies are often associated to micro-scale analysis, and sometimes dismissed as incapable of inquiring into and revealing power relationships and political tensions. This is the line taken notably by certain tenants of the MLP approach, in a quite instrumental assessment of the different contributions from the social sciences, where they argue that the analytical potential of STS thinking is limited to what happens at the level of niches (Geels 2010). Following suit, our reader might be tempted, in the end, to regard the case studies presented in this book as no more than a succession of niche explorations, and to bypass the book's invitation to consider them as 'sites'. What, then, *is* the difference between a 'local' case study and a 'site' for inquiry? Why does this matter so much? How does this relate to a relational take on energy transition processes? And what are the implications for the reach of our results?

Among the numerous case studies analysed within the Collener research project at the origin of this book, some stood out in our collective discussions as particularly interesting. They highlighted entanglements between processes, actors, and scales that seemed critical. These also were entanglements from the perspective of which we could understand more about the energy transition and its political dimensions. Read along these lines, the case studies offered new 'in-sights' into this transition and its current conduct. This justified considering them as 'sites' for (understanding) a broader set of relations. Considering them in this way was not just a play on words. While they actually were the sites where a certain set of relations was made readable, making them so also meant reading the case studies from certain trans-scalar perspectives, and considering that one and the same case study, particularly intensive, could be read along different lines of transitioning. The pair of notions 'site'/'in-sight' thus conveyed a worthwhile conceptual displacement, allowing us to address systemic dimensions of the energy transition without delineating the system and its parts in advance. This left space for them to change, be displaced, develop, and for us to follow the changing relations and ontologies. Rather than being fixed and charted in advance, the system called for an inquiry that followed ongoing relations and, in the end, allowed us to derive a truly systemic and critical understanding of the energy transition.

Attached to this inquiry is a notion of system that is not functionalist: elements of the system are not allocated definite functions and capacities to interact in advance. While interactions are central to the analysis, the inquiry is not interested in charting reality in its entirety (the whole set of relations), but instead focuses on aspects and phases of the reality that directly serve a project (Dewey 1906)—in our case is a change in ways of producing and using energy. However, and importantly, the elements that are not directly considered and included in this logic of action are not discarded or suppressed. They remain active because they compose the background of actors' experience as part of the effective ground in which the development of energy transition projects is tested. Hence, 'systemic' in our approach means that actors' experience and capacity to interact gets built in constant relationship with the object of the inquiry *as well as* with the background that affords the condition of its testing.

From this perspective, the founding categories (renewable energy, scale, horizon) and mediations (market, economic instruments, demonstration…) used to approach and steer the current energy transition can be said to provide us with a *half-view* on the relationships they bring forth and their wide-ranging consequences. Our analytical strategy has precisely consisted in (sidestepping these categories and) following relations in order to discover the 'other' half of these processes. As our results show (see above), this allowed us to shed light on how these categories and mediations operate in reality, and how they are enacted (and contested) by the multiple entities they interfere with. We were able to point out essential interactions and systemic dimensions, and follow ontological changes which a prior charting and delineation of the system would never have allowed.

Hence, far from being restricted to micro-scale analysis, a relational inquiry offers the possibility of gathering together the fragmented parts of the picture and analysing their mutual relationships. It is also relevant to engagement with political issues, as it is most often from the margins of the processes that their effects and consequences become perceptible. In engaging with these issues, it not only points out consequences, but offers a way to thematise the different ways in which energy transition processes involve actors and entities, and how to reconceive the potential for change.

3 Ways of Being Involved, from 'Interferences' to 'Transactions'

A key assumption that we made in the introduction of this book was that the processes of energy transition 'interfere' with many entities (knowledge, heritage, skills, places, environments…) without assigning them a clear status and role. This leads to what, drawing on Marres (2012), we called 'ontological trouble'. In this introduction, the term 'interferences' referred to situations of maladjustment, of unqualified relations between heterogeneous entities due to different ways of getting others involved in energy transition processes, but also to the interweaving of our many attempts to channel these consequences, overcome them, and set in motion new and more integrative ways of change. The importance given to interferences was justified by the idea that when entities are taken up in a process of change in which they remain ill-named and ill-related, they cannot intervene in its steering: they remain external to the energy transition.

Drawing on a vast set of observations, this book offers privileged access to these ill-relations, as well as a categorisation thereof. It makes clear that processes of energy transition interact ambiguously with the situations out of and/or within which they arise. It also makes clear that such ambiguities arise because: (i) these processes do not acknowledge the inherited resources or the different entities with which they interact, and which they engage in a process of change; (ii) they do not acknowledge these resources' or entities' entanglements; or (iii) they do not consider the effects they will produce in the wake of their implementation, and which sometimes challenge their own coherence.

As analysed in the different chapters and shown by our results, these ill-relations are caused by approaches (to resources, space, time, markets, economic instruments, and technological innovation) that are normative, and whose combination restricts plans and initiatives for change to marketable, carbon-free, large-scale, and long-term solutions. From this perspective, the energy transition is a matter of bridging a gap between A (the present) and B (the large-scale and long-term future), with the necessary continuity of social interactions underlying the process of change being overlooked. Recovering the possibility of acknowledging and understanding this process requires changing our definition, our approach, and the grain of our analysis of what it is *to* transition, which results in a different ontology. Indeed, as our results show, this implies setting aside these (ready-made) founding normative categories and reintroducing the whole set of entities, practices, and networks that take part in the process of energy change into the analysis. These include notably the making of resources, spatialities, temporalities, market exchange, instrument-driven capitalisation, and technological innovations. Doing this implies undertaking the analysis at the level, and in the sites, where transitioning is experienced by the participants in the process.

Seen from there, the different dimensions of transitioning become interwoven. For instance, 'civilising' a market for the energy transition may critically depend on how we organise innovation for the energy transition; and the way in which temporalities emerge and endure cannot be separated from the ways in which spatialities are defined and engaged in a process of change. Actors and entities also acquire a more active role in transitioning processes. For instance, while the successful implementation of economic instruments rests on inherited spatial and political structuration, this implementation also triggers new spatial and political structures ('milieux'), which struggle to make change out of these instruments. They, in turn, become integral to the functioning of these instruments. Thus, innovative practices aimed at selecting, renaming, and reassembling things in order to account for previously relegated values or interests become central to the more democratic steering of change. As long as statuses and capacities for action come to be negotiated and reconfigured, these interactions reach beyond mere interferences: They amount to 'transactions' by which conditions for engagement can also be more actively experimented or more symmetrically negotiated (Schipkau wind power, Figeac PV, Northern Friesland wind power, Rhône-Alpes biomass, Tunisia Desertec and Tunur).

4 Ways of Steering Energy Change, from 'Technological Potential' to 'Transition Potential'

Along with the foregrounding of interferences and ontological trouble, this book proposed a shift in analytical perspective—from 'technological potential' to 'transition potential'—and announced its aim of offering an empirical grounding of the latter.

As the different chapters show, the changes achieved in the various cases studied do not depend primarily on the technology under consideration or on the physicality of the resource—which also proved not to be given, as in the case of the wind's turbulence. For one and the same resource or technology, very different outcomes have been achieved, both qualitatively (fossilisation of biomass energy in Dordogne vs. emergence of a sustainable potential for biomass energy in Rhône-Alpes) and quantitatively (wind power in Northern Friesland as compared to other rural districts in Schleswig-Holstein), depending on how processes of change are framed and steered. Such results ultimately challenge the relevance of conceiving the potential for change as attached to a given technology or resource. Evidently, technologies and resources have different potentials to contribute to the energy transition because of their readiness to be developed or their abundance. But the case studies presented in this book prove, if proof was necessary, that the ways in which they are developed and the politics they incorporate in their development matter as much or even more.

Herein lies a critical issue in changing our way of conceiving the potential for change: detaching it from its exclusive association with the physicality of the resource and of technological artefacts and reattaching it to the diverse arenas in which the potential for change is assembled. The case of demonstration projects analysed in Chapter 5 may seem paradigmatic: They remain mostly characterised and analysed as artefact-centred devices even when they have acquired a central role as technologies of democracy in the steering of the energy transition. The change in perspective proposed in Chapter 5—i.e. analysing mediations as technologies of democracy—should be generalised, as the other chapters in this book do, albeit in a less explicit way, to all dimensions of the energy transition. The 'transition potential', then, can be defined as *the potential of a situation, or process, to jointly assemble and redefine its public, its objects, and the political principles that hold them together, in a manner that acknowledges all the interferences at work and allows for the necessary transactions to take place.*

In adopting such a definition, the idea is to allow for processes in which it is possible for both ends and means to be brought into debate, so as to allow for a continuity in learning (through time, among the parties in presence) and reciprocal formation of ends and means through time. The idea is to account for the fact that—as we saw, for instance, in the case of capitalisation-driven instruments or technological demonstration—ends evolve. The challenge, then, is no longer to predefine 'technological potentials' and to operationalize 'technological trajectories', but to acknowledge 'interferences' generated by current processes and to allow for the relevant transactions to proceed. As illustrated by our case studies, such transactions can occur in a variety of formats and through a variety of mediations—material, temporal, and spatial.

Our results suggest that a steering of the energy transitions based on transition potentials should attend to: (i) all of the inherited resources and different entities with which energy transition processes interact and which they engage in a process of change; (ii) acknowledge all of the entanglements of these resources or entities; or (iii) attend to all of the effects that they produce in the wake of their implementation. Renewable energy resources should not simply be equated to non-fossil energies, but attention should be paid to the ways in which these resources are defined as such, and the resulting allocation of power in energy transition processes. Markets should not be approached as a unified category, but as a process and a constructed realm, whose potential to incorporate both democratic and energy transition concerns also depends on who is empowered to act and negotiate in the arenas in which markets are shaped. Economic instruments should not be conceived as a pure economic incentive, but as a mediation that builds on past political structuration and sets a milieu in motion wherein both the ends and the means of the energy transitions are devised. Technological demonstration should not be equated with fine-tuning a technical artefact, but approached as a political process that jointly formulates a collective problem, brings forth the collective concerned by it, and devises the political principles in charge of holding them together. Scale should neither be considered as given nor as entirely malleable, but as a spatiality that weaves together inherited configurations that are social and spatial, and that is constructed so as to incorporate a definite politics. The same holds for temporal horizons, which do not reflect an external timeline, but whose construction weaves multiple temporalities together (distant past, recent past, present, near-future, medium-term future) and enacts a politics of transitioning. These are but a few dimensions of our transition potential, which needs to be further explored and characterised so as to make the energy transition a more comprehensive and democratic one.

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