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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

O. Labussière (✉)
Pacte Social Sciences Research Centre, UGA, CNRS,
Science Po Grenoble, Grenoble INP, Grenoble, France
e-mail: olivier.labussiere@umrpacte.fr

A. Nadaï
Centre International de Recherche sur l'Environnement et le Développement, CIRED-CNRS, Nogent-sur-Marne, France
e-mail: nadai@centre-cired.fr

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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 The devising of energy futures through multiple and sometimes diverging scenarios has come to be superseded by discussions about the timing, tuning and financing of long-term investments in order to develop new energy/mitigation technologies in time.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.

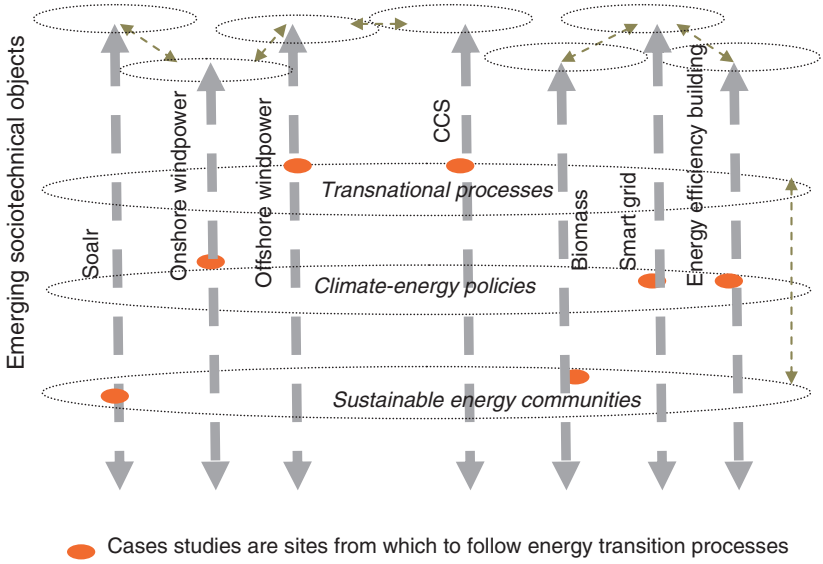

Fig. 1 Collener projects, sites/sights/(in)sight

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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