How to inquire about energy transition processes?

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Chapter 1 : « How to inquire about energy transition processes?

Energy transition, a sociotechnical inquiry

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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 have acknowledged our entrance into a new phase as regards to climate change issues. Climate Change and the 2°C threshold are now considered as part of (stabilized) scientific facts and the time has come to exploring actual solutions to GHG mitigation. The recent Paris agreement has confirmed this entering into the time of action, which energy transitions are part of.

Energy transitions, a (critical) democratic deadlock

Our approach to these energy transitions has itself been transformed. The devising of energy futures through multiple and sometimes diverging scenarios comes to be superseded by discussions about the timing, tuning and financing of long-term investments in order to get new energy/mitigation technologies developed in time. As rising climate change casts its shadow of urgency over the negotiation process, it steers our attention to "scalable" (big) solutions. Large-scale technologies, driven by market actors, such as Carbon capture and storage, nuclear or even (on- and offshore) wind power are presented as the main - if not the unique - road to success. "Scalable" solutions, however, are contested. In being so, they witness of a contemporary democratic deadlock by which the urgency of the climate issue cuts short the collective negotiations on the societal goals of the energy transition (Stengers, 2009). In many regards, social scientists are expected to find ways of alleviating what has been coined "acceptance issues", implicitly supposing that the charge of resolution lies in the hand of the recalcitrant public rather than in the re-casting of the transition projects, or in a better understanding of the 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 unlocking barriers to their implementation (e.g. social psychology, cultural approaches …) (e.g. 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 & Wylie, 2014 on fracking). While a large array of critical perspectives has been developed (Gailing & Moss, 2016; Geels, 2010), they oftentimes resulted in a straightforward application of analytical framing to the object of energy transition, without necessarily entering the (mess) field of energy transition processes and displacing the type of critics that could be expected. Calls for more critical approaches to the democratic dimension of the energy transition still are relevant (Stirling, ERSS XX), and a question remains open about what the 'energy transition' as a field of inquiry might do to social sciences. Said differently, if we suppose that disciplinary framings do not allow us to fully address the democratic deadlock that we are currently facing, how then shall we devise our inquiry so as to explore and re-conceptualise the critical matter beneath energy transition processes? This first displacement - from the 'critic' 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 multi-level or MLP approaches to energy transition (Geels & Kemp, 2007; Geels & Schot, 2007) – and the debate it triggered is illustrative of the dominance of the critics. MLP has fell under strong criticism for its lack of spatialisation and politicisation (Coenen, Benneworth & Truffer, 2012), social and cultural dimensions (Sarrica et al. 2014: 3). The limits of this framework does not,

however, only result from lack of openness to the works of social sciences - Geels (2010) has argued for the potential of MLP to develop interfaces with a number of other approaches in social sciences. Rather, it seems to ensue from its self-framing as a rational effort to translate transition processes into a strategic (goals/means) management issue. The proposal to strategically manage technologies (means) in order to progressively fit the societal demand results in placing the democracy into the hands of policy makers, firms and engineers. The focus on newness (innovation as the predominant issue) and the representation of the existing world as a sociotechnical regime (inertia as a correlate issue) overshadow both the realm of experience in which the transition is to be embedded and the consequences of technological development on this experience. The 'critical' field of democratic issues lies – as unknown and untouched - in the midst of this goals / means reasoning.

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 social sciences

First, inquiry points at a related *material.* This book is an attempt at reopening our sociotechnical exploration of energy transition processes thanks to a large set of empirical case studies. This material stems out of a five-year research project[1]. Five years ago, in France, the notion of "energy transition" was rising as a buzzword in both policy and academic arenas. Such a situation enticed us to go back to empirical descriptions of processes of energy change, with the aim to critically address the performative dimension of the 'energy transition' moto. This meant seizing energy transition processes within an encompassing perspective that could allow us to capture the framing of the transition at work – say, what it did to the ways in which energy changes were undertaken and the social implications of this way of doing. Going back to the field was thus a way to broaden and reopen our questioning about energy transition processes. We decided to do so by approaching these processes from different angles – local, national or transnational – and through a large set of empirical objects - seven medium scale technologies were covered through about thirty different case studies.

Second, inquiry points at *an approach in social sciences*. Inquiry is a notion and a method for social sciences which comes from the pragmatist tradition (Dewey, 1938, 1939, 2010 [Zask trad.]). The inquiry starts with an attention to the consequences of (energy) activities on actors and entities that are affected by them but neither part of them nor at the origin of their undertaking. It dedicates a specific attention to the ways in which this oftentimes heterogeneous and unorganised set of affected actors (coined 'public') attempts – and in certain cases succeeds – in collectively articulating the interferences they experience and turn them into shared concerns to have them accounted for. As a method, the inquiry brings the emphasis on the exploration of multiple worlds and degrees of (non) implication in relation with 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 but is tenuous, hardly discussed and accounted for. Inquiry also is an alternative to the goal/means instrumental dialectic, as goals (shared concerns) are seen to emerge with and along processes of change, through reflexivity and experimentation, rather than pre-existing to these processes and steering them.

[1] (introduce here project collener)

Such a perspective supposes a scope for experimentation and a certain plasticity of entities. As a sociological approach, the inquiry is part of a pragmatist tradition, sometimes coined '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 operationalize our approach. They explore the politics of processes that bring technologies into existence as well as 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, 1996; Mol, 1999).

Third, inquiry point at *a place and role for social sciences*, which has been debated since the founders of a pragmatist approach to democracy in political philosophy (Dewey, 2010 [Zask trad.]) until their 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 & Barthe, 2001; Pestre, 2013). The problematicness of political participation has been defined as the difficulty for actors intimately affected by technological development, to participate in the decisions to be made about it. The ensuing issue for these actors is to make themselves capable of influencing the course of things, an issue that has been assimilated to an *ontological trouble* in the sense of this 'public' being concerned but not relevant when it came to access to and act in the spheres where decision is made and actions are taken (Marres, 2012). In this context, the sociological inquiry endorses a role in contributing to make interferences and their politics explicit to actors, hence sustaining the public in turning itself relevant for decision and action (Zask, 2008). *Ontological politics* points at this role of social science in describing and making explicit the politics of the processes, which endow different actors with different capacities for political participation (Mol, 1999; Law, 2004; Woolgar & Lezaun, 2013).

(Democratic?) Energy transitions in the making

This book aims at reaching beyond both the management approach to the energy transition and its critics. In seeking to contribute to an inquiry - as just defined in the above - it supposes that the democratic dimension of energy transitions does not pre-exist to 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 shared history or representatives, or a passive, emotional and easily manageable body…) nor the *people* (a pre-existing social group with stabilized identity, culture, institutions, and symbolic place that would resist change and innovation...) (Zask, 2008). It as a '*public*', defined as a heterogeneous collective in the making, called for by the interferences they experience, 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 to such an approach would be to fall into particularism and restrict the inquiry to micro processes. Most of the case studies behind this book focus on the deployment of medium size technologies which induce large changes, new scalar assemblages, widespread processes of spatial colonisation and collective judgement. Hence its originality is to push forward the contribution of relational thinking both in the academic arena (Stirling, 2014) and for the policy debate.

The first part of this chapter introduces the motivation behind the research project that underlies this book and our empirical approach to energy transition processes. The second part discusses the notion of energy transition and its approaches in social sciences. 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 introduces the reader to the way in which our empirical material and inquiry is organised throughout the book.

1. A heterogeneous realm

As stated in the above, seven years ago, when we initiated the research project behind this book, transition was emerging as a buzz word and unquestioned policy moto in France. Meso-level theories such as multi level analysis or transition management were gaining international recognition (Geels & Schot, 2007) as well as first criticisms (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 nearby academic fields but not only, 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 inter-related viewpoints. This translated into a research project – initiated in 2012 - aimed at following different technologies from different points of observation, considered as site/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 in different networks, the 'site' captures an emerging reality and allows for a broader understanding (a 'sight') of a specific situation. Thus, the ensuing 'sight' does not proceed from nowhere: it endows the analysis with a critical perspective on the energy transition that is embedded into empirical processes – a perspective that was lacking at the time of the setting up of our project.

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

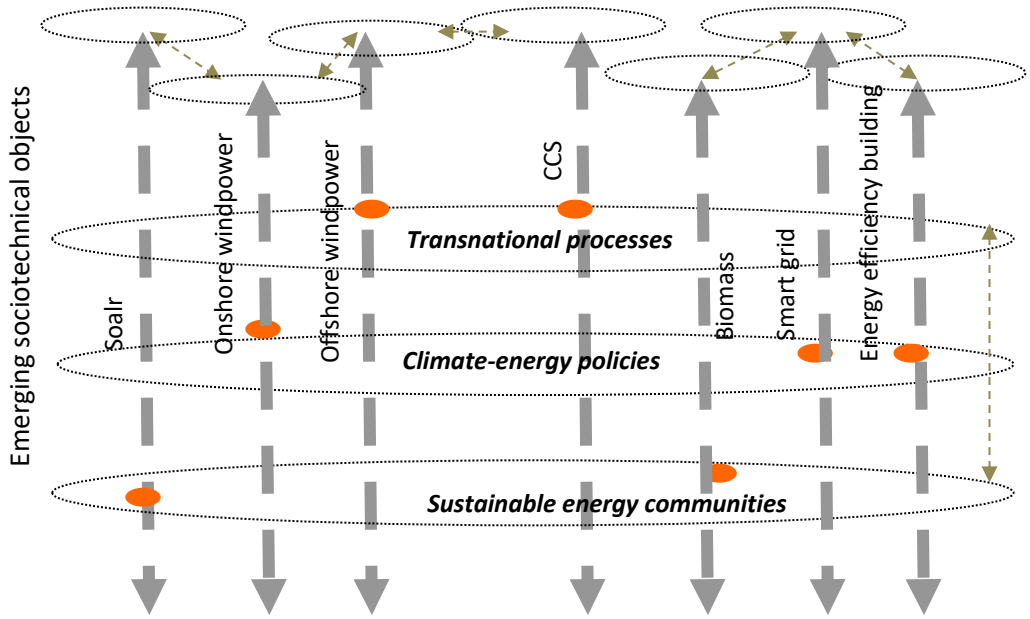
. the emergence of transnational processes and coalitions of actors which aim at framing the political and regulatory processes of the energy transition in order to scale up the development and deployment of new energy technologies (e.g. marine strategic planning, industrial wind power …),

. 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 which are more territorialized (e.g. the 2009 EU Directive on renewable energies, the declination of French climate energy policy through Local and Regional Climate Energy Plans …)

. the emergence of "renewable energy communities" corresponding to local, collective and networked processes and projects in the climate energy field ("transition town" movement,

"Positive Energy Territories" network in France, 100% Renewable Energy Regions in Germany, cooperative renewable energy projects …).

Figure 1 : Sites and sight in the collener project



The result was a set of about thirty case studies covering a broad range of empirical processes of energy transition processes so as to get a well-informed view: 31 case-studies covering 7 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 have purposely been conducted on multiple scales - local, national or transnational – in order to bring forth a trans-scalar perspective on transition processes.

No need to say that the result was a large set of very diverse processes, even for one and the same energy (e.g. Labussière & Nadai, 2014). Start or end points could not capture the issues or the social re-compositions at work in these processes, their innovative dimension or the course made in direction to energy change. Even the notion of energy transition itself, as pointing to a start-end points trajectory, sometimes seemed irrelevant in capturing the processes at work and their outcomes.

However, what stood out, were regularities in ways of framing the 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 on the level of the conduct of the energy transition, it became important to step aside the performative effect of the notion – say, to regard the focus on quantitative trajectories (start/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 better understand and critically assess the main approaches to the energy transition, their content and filiation.

2. Energy transitions and their approaches

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 counter productive. 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.

2.1. The 'Transition management' framework and its critics Approaches to energy transition in social sciences have attempted to address this complexity in various ways. In what follows, we shortly discuss a few important theoretical strands in order to posit our approach.

'Transition management' is one of them. This analytical framework has been developed over the past twenty years.

It originates from the Twente school's quasi-evolutionary theory (Rip, 1992; Schot, 1992; Rip and Kemp, 1998) aimed at developing a sociological understanding of the 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. Netherlands, UK, France). Both the historical evolution and the current assumptions which underlay this framework are important to consider. One important challenge behind the development of this theoretical strand was to understand and influence long-term changes in large socio-technical systems. The change behind socio technical transitions is conceived of as a process of shifting dynamic equilibria with reference to evolutionary and systemic thinking. Change proceeds by moving from one equilibrium to another (over periods of 25 to 50 years). It is envisioned through a multi-level 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: 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 emergent technical options: it produces and increases variety. The 'regime' defines 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. Different configurations of change are envisioned through the interweaving of this three dynamics: 'transformation', 'de-alignment / re-alignment', 'technological substitution', '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 from the distinction between the 'critics' and the 'critical'. It aims at building on the critics addressed to 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 can note: (i) the *functionalist argument*. MLP is a functionalist (Darwinist) approach that looks at innovation through standardized and pre-existing levels and functions but does not acknowledge the logics of action and their performativity (Meadowcroft, 2009). While 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'), he still left uncharted the reasons or underpinnings (either objects or settings) that makes 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 regime for instance); (ii) the *reductionist argument*. MLP has been pointed at as an ex post reconstruction of processes along predefined notional categories which simplifies the processes, reads them along notions of 'path dependency' and 'technological trajectories', and ends up privileging robust technical solutions (Bijker & Law, 1994; Shove & Walker, 2007); last but not least, iii) the *spatial argument* pointed at the lack of an effective conceptualization 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 the 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 them. Under the main influence of Gidden's work, actors are approached as engaged in a practical work of reproducing / adapting rules of social change, which in the long run participates in revising the collective structures of society (Geels & 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) are compatible with MLP in order to develop "crossover" foci on power relations, cognitive or ideological issues … The STS approach, flagged as 'relationalism', is clearly put 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.

2.2. Beyond transition as a 'management' issue

This recent generation of works reminds us that the 'transition management' approach has genuinely privileged a 'management' lens. This, however, was not necessarily inscribed in its genes (Shove & Walker, 2007; Geels, 2010), a point we would like to shortly discuss here in order to overcome a basic opposition between the not so well integrated multi-paradigm (the MLP opened to SocSci, as staged by Geels, 2010) and 'alternatives' that mostly result in the declination of existing frameworks to issues of energy (Gailing & Moss, 2016).

MLP scholars (e.g. Verbong & Loorbach, 2012) frequently refer to Nelson & Winter's (1982) evolutionist approach and seminal notion of 'technological regime', in 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…) and built as a 'sociotechnical landscape' (Rip & Kemp, 1998). In retrospective, a striking aspect of Rip & Kemp's seminal paper - entitled

'*Technological change'* - is that innovation was approached through a multi-level perspective in which levels were not yet standardized – this standardisation only came later on with Geels works on 'socio-technical regime' (Geels, 2002, 2004). Rip & Kemp's approach to levels was both hierarchical and relational. Levels were at the same time *perspectives on* the process of emergence of sociotechnical 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 with their embeddedness (from the micro to the macro) into 'seamless webs' – i.e. webs of very different elements (artifacts, entrepreneurs, networks, banks, regulations, users) that joined together in technological developments, in particular in large technical systems, and make the evolution of technology and the evolution of society inseparable and co-evolutive.

This analytical attempt, which weaved together evolutionary and sociotechnical approaches, was however discontinued by the authors on the grounds that sociotechnical approaches overestimated technological malleability. According to them, the strategy proposed by Collingridge in the 1980's [2] in order to control the development of technologies was disregarding the constraint put by the sociotechnical 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 realization of technology (1998:378). In arguing so, the authors opted for a certain (evolutionist) grain of analysis, interested in the 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 of it: one that was restricted to newness and niches (the only locus for flexibility when dealing with radical technological changes); one that targeted the weakening of the regime rather than the changes that could ensue from the (however experimental) large scale diffusion of mature technologies; and one that prioritized a strategic management over a relational approach. In foregrounding the idea that technological change should be managed strategically, in accordance with predefined societal ends, they paved the way for a progressive separation between the definition of (however multiple and hard to settle) 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 conveyed a normative and instrumental appreciation of democratic issues. Their definition ended up being disconnected from the experiential realm of technology diffusion and their fulfilling reduced to innovation pathways (niche selection, regime challenging and 'barriers' overcoming) rather than embedded into continuous, reflexive and contested socio-political processes.

[2] This occurred in relation with the so-called 'control dilemma' debate and disagreement 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 & Kemp, 1998:378) – could be overcome by nurturing technological flexibility – i.e. for instance by creating technology reservoirs. Rip & 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: 378)

As illustrated by the case studies in this book, new energy technologies get 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 breakthrough or changes in technological paradigm as captured by an evolutionist lens, they however contribute to addressing democratic issues and generate, for some of them, systemic effects. If we are serious about attending the democratic dimensions of the energy transition, such variations shall be regarded as significant changes in energy technologies and accounted for in our conception and vision of technological flexibility.

Such variations contribute in forming the potential - i.e. 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 admitted "potential /barrier" view (Shove, 1998): a view that conceives the 'technological potential' as a given 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 only does so on the surface. In supposing the potential as 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 or the environment any contribution to their definition as well as to the devising of solutions. It also suggests that the 'potential' of the energy transition only lies in selecting the right technological solutions to exploit energy resources. Resources, on their side, 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 organizations), witness of the limits of this approach in accounting for the actual processes through which various entities - such as: market forces, social organizations or the environment …. - constructively contribute to energy change.

3. Stepping aside, relations and interferences first

Attending the systemic effects of the contemporary energy transitions 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 seized along pre-defined functional dimensions such as: variation, inertia, 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 (2010): "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)." (: 505). Paradoxically, the criticisms to the MLP did not offer real alternatives to this perspective. In most cases[3], the energy transition has remained an

[3] See for instance Gailing Ludger & Moss Timothy synthesis of the analytical field (2016).

object framed and defined in conceptual terms that largely pre-existed its occurrence. A third way remains to be developed.

This book aims at contributing to a relational approach of contemporary energy transition processes – i.e. at following the making of transition issues and their coming out as political objects – their "issuefication" (Marres & Rogers, 2005). A few scholars have paved the way for such a relational approach to energy transition processes but they mostly did so with small scale (domestic) processes (Shove & Walker, 2007; Marres, 2012). Engaging with a broader relational study of large scale energy transition processes remains a challenge ahead of us. This book aims at addressing it by exploring processes of development of medium-size energy technologies (such as wind energy, solar energy, smart grid, etc.).

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

31. Following ambiguous energy transition *processes* (processes vs trajectories)

These questions call for a new type of inquiry, which only becomes possible if we take distance from notions of 'trajectory' as widely used in the making of long term scenarios. 'Trajectories' result from a combination of 'technological potentials', themselves defined in an essentialist way that puts aside a wide range of entities (environment, institutions, social forces…) and overshadows the role of these entities in the making of transition processes. Such a notion of 'trajectory' does not offer alternative to a reasoning in terms of ends and means. As we just pointed at in the above (cf. 2.2.), such a rationale leaves the hierarchy of ends unsolved and transfers the 'strategic management' of technological means into the hands of a small number of actors, resulting in a democratic deadlock.

The fieldwork observations gathered for this book point at how multifarious - if not ambiguous - the processes of deployment of new energy technologies 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 & Labussière, 2017). Sustainability has to be built on 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 sociotechnical assemblage that is brought together through project development. In certain cases, wind energy projects fall short in assembling the concerned parties in a manner that accounts for the ways in which they are affected by the projects. They then give rise to unstainable developments that deter local synergies and ruin 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. On key argument in this book, is that this 'ontological trouble' - to use a term coined by Noortje Marres (2012: 42 – inspired by Woolgar, 2005) - shall not be regarded an external effect of energy transition processes but that it is constitutive of it.

32. Interferences and the ontological trouble (concerned entities that are not relevant)

This book approaches the energy transition as a period of "ontological trouble". It starts with the assumption that the status of the entities embarked in 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 & Moss, 2016). It cannot be reduced to a "problem of demarcation", as if affecting/affected parties (individual/society, cause/consequence, etc.) and the extent to which they are affecting/-ed could easily be qualified, and as if the challenge ahead of us was just to bring them together in a joint settling process (Marres, 2012:14). The issue calls for an inquiry that follows the diverse entities and their becoming.

The inquiry that is proposed in this book is specific because of the attention it pays 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 are they concerned, impacted, implicated, or even redefined through these processes, sometimes without having a say on it, other times while being related or even actively engaged into it.

John Dewey's thought is an important source of inspiration for our inquiry (1927; 1938; 1939). John Dewey invites us to direct our attention to the different ways in which processes "interfere"[4] with numerous entities (landscape, animals, communities…). Interference here points at situations of misadjustment or unqualified relations between heterogeneous entities (e.g. to which extent might a wind farm located in a migratory corridor be compatible with bird migration?). Such situations trigger ontological issues (e.g. may birds migration become compatible with the presence of turbines? – and reciprocally) which give way to an ontological trouble (e.g. what then about birds, their cognitive skills to fly through/under/over/aside rotating turbines and their qualification as (un)protected species? And what about the way in which we, as birdwatchers, conceive of them?). They open up a new potential (e.g. Might wind be made shareable between birds and wind power developers if we traced the way they affect each 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 danger? Which settings might then allow such readjustments to come into existence?) (Nadaï & Labussière, 2010).

Interferences point at these (sometimes unintended) consequences of project development and the ways in which they disturb existing continuities in individual and collective experiences (e.g. the possibility for birds to freely use the wind in this migratory corridor in order to migrate, individually or collectively). Interferences also point at the interweaving

[4] In The public and its problems (1927) Dewey did 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) focus the attention on the 'public' more than the disruptive activities themselves. In the context of the energy transition, energy projects do not only indirectly affect entities because of their development. Some projects also do actively capture and reify situations, entities or collectives so as to entice them and make them part of their sociotechnical assemblage (the assemblage of the project). We use the verb 'interfere' to encompass the forces and strategies at work in the energy transition and the way they interact – both the (indirectly) affected forces which end up gathering and acting as a 'public', and the direct forces which aim at framing the ways in which entities are embarked (-ing) in the project. The notion of interference allows us to elaborate in a more symmetrical way on the strategies, effects and ontological recompositions at work for the different entities in presence.

between the different ways of involving or of getting others involved in energy transition processes: ways of making sense of under-articulated concerns with projects under developments, and ways of enticing others to articulate their concerns in specific ways (that serve, bend, or even contradict project development). 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 accounted for in the transition processes (i.e. were birdwatchers not following and qualifying wind power impact on bird and bird migration, wind power developers would probably not account for it). Many of them are instrumentally approached without any attention to their relational existence.

33. Interferences and the energy transition potential (entities that make themselves relevant)

As long as "interferences" remain external to the processes of energy transition – say, unaccounted for - it is impossible to bring to light both the impact of transition processes on the various entities they embark and the contribution of these entities to the structuring of these processes. There is thus an issue – endorsed by this book - in offering an alternative perspective on the energy transition, which allows us to identify and qualify empirically the 'interferences' generated by the current processes of energy transition and the associated, emerging 'transition potentials'.

In order to do so, we should not predefine the entities or the horizons of these processes, but attend the relationships between the entities involved (intentionally or not) in these processes so to characterize their (innovative or disruptive) contribution. The challenge is no longer to operationalize 'trajectories' and predefined 'technological potentials'. We do not suppose potentials and democratic ends to be settled. Our aim is to account for the 'interferences' generated by the current processes and to empirically specify the 'transition potentials' that are associated to them. Such a shift in analytical perspective - from *'technological potential'* to *'transition potential'* - allows us to account for a wider material in the analysis of energy transition processes and of their systemic effects.

We propose to specify the notion of 'interference' at the crossroads of different literatures. It can first be articulated with Gilbert Simondon (1989, 2005) seminal work about 'individuation'. As argued by Simondon, 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 do wind turbines and birds, in our example). Interestingly for our purpose, this pre-individual stage can be regarded as a domain of 'interferences'. Second, Noortje Marres work on the political construction of publics and issues is also inspiring to go ahead with the idea of 'interference'. Marres insists on the idea that issues do not emerge separately from publics, but that the "material dynamics of problematization are constitutive of the public's formation" (2012:44). The notion of 'public' draws from Dewey's work. It points at actors which are concerned by unintended consequences of technological developments and collectively engage in the articulation of the issues that are stake for them. Analysing this process of 'issueification' brings to light "the tenuousness of relations [what we here coin 'interferences'], and the challenge of finding the means to establish their relevance" (2012: 56). Said differently, the public is intrinsically problematic in that it faces the challenge of being concerned with certain relations but not relevant, because these relations are tenuous and under-articulated on a collective and political level, and because the public as a collective formation is also under

articulated and far from the arenas where relevant decisions can be made. Attending such misadjustments, following the ways through which they are progressively made sense of and overcome (or not) by the protagonists, 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.

34. Relations as potentials and the reach of relationalism

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

This approach radically differs from a 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 the ways in which entities that have been ill-embarked because of ill-framed transition problems, succeed (or not) 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, standardisation … Interferences, thus, are not approached as external effects from technological development to be internalised. They are tenuous interdependencies which specification contributes to exploring new ontologies and shared values that can sustain (or not) broader transition potential – say, potentials that encompass a broader array of singular experiences.

4. Our sociotechnical inquiry

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

41. Technology as an assemblage

A lot has been written about technology as a relational setting, especially in the STS / ANT tradition, but not exclusively. Technological innovation has been described as a complex process, technology as a complex system or network. Terminologies have proliferated.[5] Terms do not strictly mirror differences in appraisal – albeit decisive in certain cases – not the least

[5] As for instance : « innovation system» [Bergek et al. 2008, Lundvall 1992, Nelson, 1993 ; Nelson et Winter, 1982] ; « technological trajectories » [Dosi, 1982] ; « socio-technical systems » [Hughes, 1983] ; « sociotechnical constituencies » [Molina, 1994], social construction of technology [Bijker, 1995 ; Bijker & Law, 1994] ; sociotechnical systems" [Akrich, 1989]; "sociotechnical networks" [Law & Callon, 1992]).

because of translation issues[6]. For different reasons[7], we here choose the term 'assemblage' but attach to it a meaning that borrows to the description of agencement, that we will specify.

The differences that counts for us in this book are broadly speaking the ones that have been broached by the network approach to technology in STS, history or philosophy of technology. Related contributions include for instance Akrich ("sociotechnical 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 point at 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* a pre-given and stable physical entity. Rather, it is a sociotechnical assemblage, in the sense of a complex articulation of social and material components, both humans and non-humans (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 erased afterwards (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 its process of formation, the contribution of the object under consideration or of its context. This property has been coined *seamless web* (Hughes, 1986). Thus, by implicating (Akrich et al., 2002 a and b) - and partly aligning (Murray Li, 2007) - actors and entities, by changing their capacities and powers for action, the 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, S. 2004; Law, 2000; Winner, 1986).

From this understanding of technology, several consequences follow that are important for us in this book. 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. Second, *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). Third, since efficiency is a matter of alignment, it is always possible that *things would have followed another course* and endowed actors and entities with different powers and capacities for acting. Fourth, there is thus an *issue for social sciences in analysing the politics of technological change*, meaning by this 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 interest for analysing processes and things 'in-the-making' such as the formation of politics through materialities (Law & Mol, 2008) or of political issues around material objects (Marres & Rogers, 2005), the incorporation of politics into technological artefacts (e.g. Law, 2000; Akrich 1992) or their re-opening through controversies (e.g. Cupples, 2011).

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[6] As in the case of "agencement" and "assemblage"[6], two terms that have been distinguished one from the other by certain authors (e.g. Callon, 2008 ; Muniesa et al. 2007) or equated in translation exercises (De Landa, 2006).

[7] It seems to be more familiar in english langage 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 & Walker, 2013 use it for energy precarity),

While all these analytical strands seem important to 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 would like to discuss in more detail.

42. Ontologies, materiality and the distribution of the political work

Debates concerning the normative implications of technological developments have particularly been interested in the ways in which we could steer the development of technologies and make it more democratic. As stated in the above (See 2.2), in the eighties, David Collingridge (1980) had pointed at a dilemma consisting in us being ignorant about the potential impact of a technology when it is still malleable and open to re-orientation, and becoming knowledgeable about impacts only when the technology is developed but no longer open to re-orientation.

Such a dilemma somewhat crosses, albeit in a different register, an issue that had been debated by the american pragmatists, about the possibility for the public to steer technological and make it more democratic. As pointed at earlier in this introductive chapter, the pragmatist approach to technological development has pointed at the issue of public's relevance. Relevance has been defined as the (in)ability of a concerned public to articulate issues and have them accounted for in the arenas or processes through which the direction of technological change and its normative properties are decided. While Lipman (1927) 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 a delegation 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 (Dewey, 2010). 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 exclusively ensue from informed problem framing: they also result from progressive, cumulative and imperfect processes of experiencing technological developments. Different from Collingridge's generic dilemma framing, this suggests that the normative properties of technology could be revisited in time to allow for re-adjustment in the technological steering.

In social sciences, various options have been explored to overcome the Collingridge dilemma and allow for a more democratic technological development. In particular, STS scholars have suggested maintaining alternatives open by 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), valuing sociotechnical controversies as arenas for democratising technology (Callon, 1981, Rip, 1986) … Part 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, which underlay the ontological categorisation these objects. In particular, a "strong" co-production program has advocated, aimed at fully accounting for the joint production of social and natural orders at work in the emergence of new technologies (Jasanoff, 2005). This called for a broader view point on the processes of emergence of new

technologies, for instance by addressing multiple scales in the analysis, by accounting for multiple, nested realities with different levels of conflictuality, by accounting for and comparing underlying legal or institutional realms and their influence on the ways in which technological objects are framed (Joly, 2015).

In so doing, the critics also pointed at the need to overcome some limits of what has been coined by STS scholars the 'flat ontology'. The term has sometimes been understood by non STS scholars as a refusal to enter meso analyses and a posture privileging small scale, early innovation processes (Geels, 2010). In fact, the flat ontology is aimed at accounting for the fact that ontologies - and levels or scales of powers in particular - oftentimes are not given in advance (Callon & Latour, 1981; Latour, 2005) - they 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 and may displace the way in which we conceive what is economic or what is political (e.g. Callon, 2009), or even 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 through which we intend to account for the mutual relations between democratic participation and ontological orders.

One recent development in this direction comes from the analysis of the types of political participation that material devices (for environmental action, for instance) endorse and/or allow (Woolgar & Lezaun, 2013; Marres, 2015). Importantly, Noortje Marres (2015) has emphasized that, until recently, political participation has only been partly accounted for by STS scholars, because of the way in which they located and approached 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 thing to be endowed with definite agencies depended on the settings or dispositive through which they were developed (Gomart on methadone, 2002). Multiplicity, more precisely, meant that not only could various (contradictory) versions of the same object co-exist, 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 situation then hardly can be posited in terms of options or alternative but may point at attending the multiple arenas in which these ontologies and their politics are constructed and at play, so as to point at them and their interferences. This active engagement from sociologists - coined "ontological politics" (Mol, 1999) – relies on ontological premises that are different from the classical ontology (which 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 been coined '*empirical'* ontology (Marres, 2013 & 2015). It also presupposes that the politics of technologies or things unfolds through empirical processes, yet somewhat encapsulated in things, as under the radar of agents. Therefore, sociologists' role in explicating the politics of things.

Following material devices for environmental participation (e.g., an augmented tea-pot, ecohomes …) and the way in which they frame political participation, Marres shows that an approach attentive to the materiality of these devices allows locating and capturing differently political participation. Indeed, a *device centred* approach, accounting for the materiality of devices and the settings in which they are deployed, allows capturing the type of participation they foster and the various (more or less liberal) political tropes they convey. Such devices de-

compose and re-compose environmental action. They co-articulate daily actions (such as drinking tea, home energy refurbishing) with registers of environmental action (such as avoiding peak-load times, demonstrating climate-energy policy shortcomings), and they may even stage the political tropes underlying these co-articulations ("involvement made easy", "the more involved, the more engaged"). 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 by actors in a situation, potentially allowing them to undertake the political work of explic(it)ation.

Such a perspective – coined '*experimental'* ontology, because ontologies are not only engraved in the empirical but variably stem from experimentation - has four important consequences for our purpose. First, 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 pubic debate, public inquiry …): they are emergent, they can take various forms and are a matter for empirical explorations[8]. Second, 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. Third, the work of political participation is redistributed as actors and devices can themselves engage in experimentations that stage and render explicit the political dimension of technology and daily action. Sociologist can take part in this work but have no exclusivity in doing so. Last but not least, the type of inquiry that sociologists can undertake is broadened. While ontological politics calls for a politics of revealing the politics of co-articulation that is located behind/below (engraved/encapsulated in) the empirical, experimental ontology calls for attending the redistribution of the political work as staged by and through the materiality of things.

So what of our inquiry in this book? Does the type of inquiry to be undertaken depend on the objects /devices under consideration, on their scale? Or rather does it depend 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? Might any conclusion still be derived from confronting them along specific dimensions of the energy transition, such as participation and the possibility for actors to make themselves relevant?

This book mostly relies and explores cases of medium scale energy transition technologies development. It brings several of these processes in the light of a trans-scalar analysis by connecting processes which unfolds around singular material objects – such as solar farms, wind farms, smart meters, wood boilers, 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 sociotechnical objects: they explore the many entities and relations which are

[8] Incidentally, we should note here that this is a reason why approaches which proceeds from and through pre-defined levels of participation, such as MLP, seem to fall short in capturing issues of political participation.

part of their shaping, and describe their mutual re-compositions. In developing this relational approach, all case studies have to an extent or another been interested in the extent and modalities through which parties that were concerned – either because they were affected in their lives or 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 have pointed at different types of politics 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 oftentimes point at attempts at endowing these objects with new political dimensions – e.g. 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 – e.g. how a certain figure of the electricity consumer is inscribed in the materiality of a smart meter. The first type of case studies oftentimes foregrounds an experimental dimension, sometimes (but not always) successfully leading to the emergence of new dimensions in relation with 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 as the sociotechnical assemblage is deployed. The variety of case studies which underlies the book, allows us to point at 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. In so doing, as a set, they explore the extent to which various public succeed or not in making themselves relevant and contribute to the steering of these medium size technologies.

43. The language of the inquiry

In so doing, our inquiry follows sociotechnical assemblages as they are both specified and amplified. Specification stems from confrontations around *singular* materialities (or spatialities) and the requalifying of entities which endows them with new capacities for relevance, action and co-articulation. Amplification is the process through which a critical viewpoint is derived about the way in which energy transition processes trigger or address interferences. Both are complementary, as specification paves the way to redefinitions and co-articulations that allow for enlarged compatibilities between individual experiences and collective ventures. In order capture this interplay between specification and amplification, we propose a set of notions as a language for the inquiry: site/sight, dimension, scale.

Site/sight

The couple of notions is inspired from Andrew Barry critical analysis of EU techno-politics in which he proposes an articulation between situated/material and larger political action. Andrew Barry (1999) seizes an on-site opposition movement in England in the 1990s - the opposition to the Newburry highway project - in order to thematise EU's difficulty in structuring spaces for the political articulation of its techno-politics. In a close up analysis of the Newburry opposition, Andrew Barry shows how the demonstration renders manifest the damages caused by the project (by materially pointing to them on site), brings them into public existence (through artistic, press and media networks), and fosters a political perspective - a political '*sight*' - that makes Newburry into a political *site*.

As Michel Callon (2003) underlines it, 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 [from techno-science] may be publicly shown and discussed". Barry actually uses the Newburry case in order to distinguish between two types of politics. The '*politics'*, as generically defined as the set of institutions, organisations, procedural rules, governmental techniques and practices; and the '*political'* as 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 Newburry site lies in its potential for becoming a political *locus*, a place from which a political sight can find spatial and material expression from which to be amplified and overflow the ongoing politics.

The couple of notions 'site' / 'sight' thus captures the articulation between specificity and genericity as key dimensions of politicization. As far as our inquiry is concerned, distributing the case studies along different technologies and sites of action (local, national, transnational) is a way to bounce on Barry's notional pair - say, it is an attempt at exploring a multiplicity of sites in order to derive a critical sight on the energy transition (cf. §. 1, and figure 1.

Dimension

Transitioning is not a matter of solving general problems such as 'the transition' in general or 'the technological innovation' in general… Rather, it consists in transforming specific and problematic situations into assemblages and experiences that have a new coherence. Such processes call for being approached in terms of 'situation-setting', whereby ends and means are not considered as separate ('problem-setting' approach) but co-extensive and emergent – i.e. emerging from and with the process of changing situations (Frega, 2006).

Practically speaking, 'situation-setting' consists in appreciating the conditions and the issues associated with a specific situation – what John Dewey (1939) coins 'valuing' - and in deriving from these a way to go ahead (experimenting) that transforms the situation in a desirable way. Such a process calls for continuously revising and adjusting the best way to go (the 'end-in-view') with the result of experience. It is a process of solving situations.

Starting from a different viewpoint, Gilbert Simondon offers stimulating and complimentary insights on the emergence of technological assemblages as forms of resolution. In particular, his notion of *dimension* captures the very idea that the emergence of a technical object is driven by a process of 'resolution' that steers the assembling of technical and non-technical elements into a new operative system (Simondon, 1989, 2005). Said differently, the dimensions of a sociotechnical assemblage are the (solving) relational re-arrangements that emerge as part of it and allow for its stabilization. Consider, for instance, the development of an offshore wind farm, which commonly raises a set of issues, such as: where to site the farm, how to connect it to the grid, how to assess, limit and monitor its impact on marine environment and coastal fishing activities … Successfully developing the wind farm is not a matter of just bringing existing entities (turbine, grid, fish …) side-to-side in a new setting, because the entities themselves and their capacity to co-exist are challenged and redefined in the development of the project. The challenge is to (re)value these entities in the light of a rising offshore wind power project so as understand the extent to which they can become part of a new system and create a new reality (Nadaï & Labussière, 2014).

Gilbert Simondon insists on the relational nature of dimensionality. Entities do not pre-exist to relationships, neither the reverse: entities *are* relational and their capacity for action results from relations (Simondon, 2005, Montebello, 2010). In emerging, the technical object induces a new relational realm, with new dimensions and potentialities – for example, new shares of the marine space, new fishing practices, new methods for the protection of fish. The dimensions stem from practical processes of mutual appreciation and reciprocal adjustment of a myriad of entities. These processes are diverse as they weave together physical, technological and social realms. New entanglements and values (e.g. justice or equity as ways of sharing benefits, risks, powers…) are accounted for in these processes.

Gilbert Simondon also emphasizes the uncertain fate of dimensionality – as illustrated by the first 'never assembled' offshore wind power project in France stored in spare parts throughout Europe (Nadaï & Labussière, 2014). Thus, in a way, dimension is a proposition that may or may not find its way to amplification.

Scale

As emphasized in the above, energy transition policies are largely steered by long term scenarios combining 'technological potentials'. Assuming that technologies are endowed with potentials of their own allows planners to quantify energy futures and discuss investment strategies. Within this perspective, the more scalable the technologies (i.e. industrial, large scale), the faster our answer to the climate urgency. Nonetheless, such a framing of scalability postpones the political treatment of transition issues (e.g. lack of coherence, injustice, local oppositions …) to the real scale deployment and territorialization of energy projects.

This book proposes another way of understanding and addressing scalability issues. Instead of reasoning scalability as if it was encapsulated in the technology and ex-ante given, we propose to approach it as an emerging property. Scalability points at the issue of playing with emerging dimensions in a given sociotechnical assemblage in order to make it larger (e.g. processes of repowering community-based wind farms in Northern Friesland in Germany) or reproducible (e.g. processes of experimenting a model of community-based photovoltaic development in Rhône-Alpes in France). As suggested by these examples, the dynamics of energy projects, their networking, growth and management on a larger scale is underpinned by a political work aimed at continually re-adjusting the assemblage to its most widely shared value. Practically, this means constantly re-valuing what is most valued by ever larger and more heterogeneous collectives as well as the best way to carry on.

From this point of view, inspired by Deweys approach to the 'public', scalability points at a democratic challenge. The energy transition is no longer steered by ultimate values, derived from inherited institutions and powers. The growth and proliferation of energy projects give rise to new concerns and new 'publics', they connect multiples situations, unequal developments and conditions, call for contradictory processes in order to revise the 'end-in-views' and devise new, desirable horizons.

Here again, we take advantage of the complementarity between Dewey and Simondon approach in order to connect the political meaning of the 'inquiry' to a critical approach of the ontology of technology. As Simondon demonstrates it, individuation is not a one shot process: while concretizing a potential, it does not put an end to the evolution of a technical object and supports new processes of individuation. The process of 'amplification', as described by Simondon (2005a: 544), is not linear. It points at the capacity of a socio-technical system to propagate a degree of technical perfection by rearticulating itself with other sociotechnical

sub-systems of different ages (inherited/emerging), sizes and types of management in other places.

Reframed under this critical perspective, scalability becomes an empirical and relational issue. The notion allows us to explore the socio-technical conditions under which energy projects may cross over different levels of social organisation (micro-, meso-, macro-) without pre-defining these levels and their issues or reducing technological up-scaling to a linear process.

5. Organizing our material

As mentioned in the above (§.1) our book relies a significant number of case studies. In wanting to make sense of our somewhat large empirical material, we faced the challenge of how to organise it. Early on, comparing the advancement of our case studies, we came up with the intuition that the ways in which transition processes were framed – notably through market, demonstration or policy instruments – was important for the capacities of the parties engaged in them (or concerned with them) to influence the course of these processes. It also seemed important as to how resources, space and time were mobilised – and sometimes shaped by and naturalised - in these processes.

When it came to articulate this large material into an inquiry that conveyed this relational intuition in a more explicit manner – say, as just developed in the above, an inquiry that demonstrated the ways in which interferences triggered an ontological trouble that underlay the emergence and distribution of political capacities and transition potentials – two roads seemed possible. The first solution was to pick a few, most telling case studies. While a few 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 on board had the advantage of engaging relationalism on a broader scale of analysis, one with which it had been challenged by its criticisms as not wanting to cope with.

51. Chapters and case studies (targeting the deployment of medium-size technologies)

The structure of the book echoes our first intuition about the importance of the conduct of transition processes and the mobilisation of resource space and time. The six chapters successively explore: the ways in which resources are engaged in energy transition processes (chap. 2), the importance and consequences of passing through markets (chap. 3), policy instruments (chap. 4) and markets (chap. 5) for undertaking energy transition processes, the ways in which space (chap. 6) and time (chap. 7) are mobilised in these processes. Case studies have been mobilised by the authors of the chapters according to their respective relevance, resulting in a distribution that is presented in table 1. Certain case studies contribute to several chapters.

Table 1 : Chapters and case studies

	2 Flow/stock energy	3 Economicization	4 Policy instruments	5 Demonstration	6 Spatialities	7 Temporalities
Unconventional gas						
Unconventional futures for Lorraine's 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 Bone (Grenoble, FR)/ and the Concerto Program (UE)				•		
Smart grid						
Smart grid / responsive consumer [Linky case study] (FR)		•				[•]
Disitributed load-shedding for the electricity grid (Voltalys) [FR]	•	•				
Solar PV						
French PV solar policy (FR)			•			
PV solar mutalised development in Figeac (FR)	•	•	•			
PV solar cooperative 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 windpower in Northern Friesland (D)			•			
Weissach-im-Tal (éolien et solaire Allemagne) (D)			•			
Renaturing sites, empowering wind power potentials in Schipkau (Brandebourg) (D)					•	

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

52. Resources as relations

The first fact that stood out in the course of the research was that, whatever the primary resource under scope, the definition and the status of the **resource** almost never had been a subject of policy debate. Both at the national and European level, the devising of new energy policies initiated in the mid 1990's 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. tradable quota vs tariff debate) have mobilized the debate, but the type of resources engaged, their status, qualification, ownership and becoming have not been subjected to due debate. Oftentimes, 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 doing so, 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. With them, it is the so-called 'externalities' and the sustainability – i.e. the social and environmental consequences - involved in changing our ways of dealing with energy(ies) that are not fully addressed.

Ready-made dichotomies such as 'renewable'/ 'non-renewable', 'non-fossil'/ 'fossil' energy, serve this state of affairs in suggesting that such a qualification mirrors a natural qualification. The first category of energies (i.e. the 'renewable' and 'non-fossil' energies) is supposed to be sustainable, while the second is not ('non-renewable' and 'fossil' energies).

Nowadays that so-called 'renewable' energy technologies and finance have been industrialised and globalised, the question of whether and under which conditions they are - or are not - sustainable has become a current and actual issue. One can reasonably assume that the new economy of energy is framing the resource as an abstract flow (renewable *per se*) for renewability not to be conditioned upon the complexities of the development of the resource. In turn, laying bare the web of relations and entities as well as the transformations that are engaged in the process of commodification of these new energies, is a way to deconstruct renewability. This chapters considers a few case studies concerned with different energies. It explores the ways in which we extract, concentrate, circulate and consume these energies, and the related consequences as to which entities are concerned by these developments and which ones are empowered to make themselves relevant in the steering of these processes.

53. Mediations as relations (market, demonstration, instruments)

The second fact that stem out from our case studies was the recurrence of certain mediations in the conduct of the energy transition: **'market', policy instruments, and technological demonstration and demonstrators** are recurrently invoked and 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) – which aims at bringing R&D results on an industrial scale in an effort to develop market out of research and generate growth and employment from innovations. Important drivers in this new approach are competitiveness and market-geared policy as well as demonstration and public-private partnerships as key mode of policy devising, financing and implementation. This evolution went along with a redefinition of 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 RTD policies: technological roadmaps, strategic technological agenda, public-private partnerships organized around technology **demonstrators** have become key elements of this new policy approach.

On a more general basis, EU authorities and national governments have come to conceive the conduct of the energy transition in relation to **markets**. In official policy circles, conducting the energy transition through markets is supposed to mobilise all actors, to ease innovation and contribute in « fixing » our energy problems. Even more, in "passing through" markets, the energy transition may fuel new economic growth.

The recourse to **policy instruments** in implementing political decisions is also part of the repositioning of 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 articulation they set between renewable energy development and market deployment: renewable energy policy instruments are designed to support renewable energies *through their markets*.

Passing through these mediations is not neutral as to which actors are set into power for making themselves relevant in steering energy transition processes and the outcome that can be expected from these processes. Chapters 3 to 5 successively explore and discuss these issues for 'market', policy instruments, and demonstration.

54. Time and space as relations

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 (upscale investments, change energy mix, reduce carbon emissions …).

As useful as it can be in coordinating action, such an understanding of time is also limited as it does not account for the many temporalities that interfere and weave together in the construction of technological pathways. These clearly appear in fine grained empirical and longitudinal descriptions of energy transition processes. Time rarely is exterior to the actors involved. Filling in certain time horizons with dedicated technological representations - or even preempting the possibilities of doing so – is a way to use time as a resource for steering the transition. Seizing the past as a resource for steering the future – be it only by leaning on inherited spatial or material configurations in order to develop new options - is another way to use time as a resource. It is a time that has been "empiricised" in spatial and material configurations, as Milton Santos would put it (Santos, 1997). It is a time which offers grasps for action.

Once such multiplicity of time is recognized, its linear construction – albeit efficient – can be regarded as a no more than a dominant option, calling for analyzing the forces that enter its construction (relational dimension). Eventually, going down this path, a key argument became that space – understood as materiality, relationality, scales, and heterogeneity - offered an alternative entry into the analysis of the temporalities of energy transition processes.

Space itself and the way in which it enters energy transition processes and their analysis had to be reflected upon. Little attention has been devoted to the spatiality of energy transition

processes (Bridge et al., 2013). Oftentimes, the spatial dimension is analysed by following the networks of actors and their location, without properly accounting for the materiality and the heterogeneity that underlie their coming into existence (Coenen, Benneworth and Truffer, 2012). A starting point to take spatiality on board can be to account for the spatial distribution of new energy resources - wind, solar, shale gas or coal bed methane… are *diffuse* energy resources. Harnessing such resources imposes on us a renewed relation to space. Different from oil, coal or natural gas, these new energy resources need to be concentrated in order to find economic and market values, which gives rise to a competition for space and the colonisation of wide new areas, previously left aside world wide competition. The academic literature has tackled some issues of energy spatiality under the heading of emerging 'sustainable communities' (Seyfang & Smith, 2007; Walker & Devine-Wright, 2008; Walker et al. 2010), place attachment (Devine-Wright, 2013) or inherited socio-spatial configurations (Emelianoff & Wernert, 2015; Nadaï et al., 2015). However, spatial transformations in this context do not proceed through exclusive and monolithic occupation by large scale energy infrastructures, neither can they be reduced to issues of community involvement. Processes of co-occupation or juxtaposition between new and old socio-technical systems - of different ages - become key. They call for an analytical framework allowing us to follow the processes through which space is re/dis/qualified.

Chapters 6 to 7 successively explore and discuss these issues, respectively for temporality and spatiality.

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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