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Technological Demonstration at the Core of the Energy Transition

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List of abbreviations

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

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

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

1 Introduction

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

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

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

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

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

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

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

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

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

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

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

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

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

(continued)

Table 1 (continued)

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

2 Demonstrating Low Carbon Technologies in the EU

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

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

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

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

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

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

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

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

3 Demonstration *Agencements* as Technologies of Democracy

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

7 Hectic Politics, Hectic Learning

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

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

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

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

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

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

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

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

(continued)

Table 2 (continued)

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

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

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

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

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

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

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

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

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

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

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

8 Conclusion

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

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

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

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

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

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Notes

1. 'One of the key roles of the Commission is to use its programmes to encourage the sharing of experience amongst organisations in the EU Member States, and to ensure that lessons are learned as quickly and efficiently as possible' (Gillett et al. 2001, p. 2), quoted by Hendry et al. (2010, p. 4518). Gillett, W., Gambi, R., Obled, C., Ossenbrink, H., Perujo, A., Scholz, H., 2001, Results from PV Demonstration Projects in Europe. In: Proceedings of the 17th, European PV Solar Energy Conference, Munich.
2. They were used, for instance, during the oil shocks in the US in order to foster the development of nuclear energy (Lefevre 1984).
3. EU, 2006a, "An Innovation-Friendly, Modern Europe," Communication from the Commission to the European Council, COM (2006) 589 final, 12 October 2006, Brussels.
4. EU, 2002, More Research for Europe Towards 3% of GDP—Communication from the Commission, COM (2002) 499 final, 11 September 2002, Brussels.
5. EU, 2006b, "Creating an Innovative Europe," Report of the Independent Expert Group on R&D and Innovation appointed following the Hampton Court Summit and chaired by Mr. Esko Aho, Brussels. http://ec.europa.eu/invest-in-research/pdf/download_en/aho_report.pdf.
6. ETPs are industry-led arenas which were established by the Commission in order to bring expertise to the Commission, and to devise technological visions and strategic agendas in different technological domains. JTIs are large industry-led technological projects.
   EU, 2005a, Commission Staff working document—Report on European Technology Platforms and Joint Technology Initiatives: Fostering Public–Private R&D Partnerships to Boost Europe's Industrial Competitiveness, SEC (2005) 800, June, Brussels.
7. EU, 2013a, Public–Private Partnerships in Horizon 2020—A Powerful tool to Deliver on Innovation and Growth in Europe, Communication from the Commission, COM (2013) 494, 10 July 2013, Brussels.
8. EU, 2008, Evaluation of the European Technology Platforms—Idea Consult, 31 September 2008, Brussels.
9. EU, 2005b, "Monitoring 2004—Implementation of Activities under the EC and Euratom Framework Programmes and Corresponding

Specific Programmes—Report of the 2005 External Panel," August 2005, Brussels.

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

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

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

20. Eiken, Ola, Philip Ringrose, Christian Hermanrud, Bamshad Nazarian, Tore A. Torp, and Lars Høier. "Lessons learned from 14 years of CCS operations: Sleipner, in Salah and Snøhvit." *Energy Procedia* 4 (2011): 5541–5548.
21. Monastersky R. "Seabed Scars Raise Questions Over Carbon-Storage Plan." *Nature* 504 (2013): 339–340, 19 December.
22. By Monsterky, idem.
23. This part and all the material and analysis about smart grids is based on Granclément and Nadai (2015).
24. https://www.earpa.eu/earpa/39/etp_smartgrids.html.
25. JRC, 2011, Giordano, Vincenzo, Flavia Gangale, Gianluca Fulli, Manuel Sánchez Jiménez, Ijeoma Onyeji, Alexandru Colta, Ioulia Papaioannou, Anna Mengolini, Corina Alecu, and Tauno Ojala. 2011. "Smart Grid Projects in Europe: Lessons Learned and Current Developments." Joint Research Centre Reference Reports, sy 8. http://www.fvu-center.dk/sites/default/files/smart_grid_projects_in_europe.pdf.
    JRC, 2013, Mengolini, Anna, and Julija Vasiljevska. 2013. "The Social Dimension of Smart Grids: Consumer, Community, Society." Joint Research Centre. https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/social-dimension-smart-grids-consumer-community-society.
26. Electricité de France (EDF) is the current main electricity provider. It was the former electricity monopoly, and is currently the main shareholder of the distribution grid manager ERDF (recently renamed 'Enedis').
27. Recently restated in the last Energy Efficiency Directive, precisely to prevent this type of monopolisation (Directive 2012/27/EU on Energy Efficiency—Article 18).
28. For more details about these actors, see Chapter 3, §4.3.
29. This case study is based on Labussière, 2014.
30. EU, 2005, European Commission Community Research, SP1-Priority 6-1, 6.1 Sustainable energy systems, Work Programme, Revision 4 for the TREN-4 Call, June 2005, p. 3. http://cordis.europa.eu/pub/fp6/docs/wp/sp1/f1_wp_200216_en.pdf.
31. CONCERTO, 2008, CONCERTO newsletter, issue 5, July 2008, p. 8.
32. CONCERTO, 2008, Position Paper on the Recasting of the Directive 2002/91/EC of 16 December 2002 on the Energy Performance of Buildings, 7 p.

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