



CO-PRODUCTION AND EMERGENCE OF DIVERSE  
PUBLIC ENGAGEMENTS IN ENERGY TRANSITIONS:  
TOWARDS RELATIONAL, SYMMETRICAL AND  
SYSTEMIC UNDERSTANDINGS OF PARTICIPATION

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Established in early 2011, and building on a tradition of leading environmental social science research at UEA, we are a group of faculty, researchers and postgraduate students taking forward critical social science approaches to researching the social and political dimensions of environment and sustainability issues.

The overall aim of the group is to conduct world-leading research that better understands, and can potentially transform, relations between science, policy and society in responding to the unprecedented sustainability challenges facing our world. In doing this our approach is:

INTERDISCIPLINARY, working at the interface between science and technology studies, human geography and political science, as well as linking with the natural sciences and humanities;  
ENGAGED, working collaboratively with publics, communities, civil society organisations, government and business; and REFLEXIVE, through being theoretically informed, self-aware and constructively critical. Our work is organised around five interrelated research strands:

KNOWLEDGES AND EXPERTISE  
PARTICIPATION AND ENGAGEMENT  
SCIENCE, POLICY AND GOVERNANCE  
TRANSITIONS TO SUSTAINABILITY  
SUSTAINABLE CONSUMPTION



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3S researchers working across these strands focus on a range of topics and substantive issues including: climate change, energy, emerging technologies (such as biotechnologies and geoengineering), natural hazards, responses to the economic and financial crisis, and grassroots actions and social movements on sustainability.

## **ABSTRACT**

The field of sustainability transitions research has a strong theoretical emphasis on the sites and modes of intervention in socio-technical systems, with the intention of informing the purposive ‘steering’ of the system. For critics, questions of power and politics are often obscured in what, it is argued, are optimistic and technocratic transition mechanisms. In addition, the dynamics of participation in and the democratic implications of transitions processes have been underexplored in the literature hitherto. In order to address this lacuna, this paper develops a more comprehensive and systemic perspective on what it means to participate in socio-technical transitions, with specific reference to sustainable energy transitions in the UK. For the first time, we bring the transitions literature into a systematic and sustained conversation with constructivist STS perspectives on participation to offer a conception of public and civil society engagement in sustainability transitions as emergent, co-produced and interconnected collectives of participation. Our comparative analysis of four diverse cases of civil society involvement in low carbon energy transitions – ranging from government-led deliberative consultations and behaviour change interventions to forms of activism and distributed innovation - highlights similarities and differences in how these participatory collectives are orchestrated, mediated and subject to exclusions as well as their effects in producing particular visions of the issue at stake and implicit models of participation and ‘the public’. In conclusion we reflect on the value of this approach for opening up the politics of civil society engagement in transitions, building systemic perspectives of interconnected ecologies of participation, and better accounting for the inherent uncertainties and indeterminacies of all forms of participation in transitions.

**Key words:** Sustainability transitions, Participation, Publics, Co-Production, Emergence, Energy.

**3S strands:** Transitions to Sustainability, Participation and Engagement, Knowledges and Expertise

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## 1. INTRODUCTION

Bringing about transitions to sustainability has emerged as one of the key organizing global challenges over the past four decades (Meadows et al. 1972; WCED, 1987; United Nations, 2012). This imperative has become particularly crucial in the energy domain faced with the so-called ‘trilemma’ of global climate change, energy security and socio-economic challenges and inequalities (Sautter et al. 2008; World Energy Council, 2012; Hammond and Pearson, 2013). Despite conflicting interpretations of the problem and visions of the future, substantial efforts are now underway - from global to national and local levels - to initiate more sustainable and low carbon energy transitions. This has been the case in the UK, the empirical focus of this paper, linked to political momentum for tackling climate change and the UK government’s legally binding target of an 80% cut in carbon emissions by 2050 (HM Government, 2009).

It is within this context of seeking to understand, anticipate and potentially ‘steer’ system change in energy and other sustainability domains that the interdisciplinary field of sustainability transitions has emerged over the last two decades. Drawing on theoretical insights from science and technology studies (STS), evolutionary economics and sociology, it has developed a number of different approaches for the conceptualisation of socio-technical system change (Grin, Rotmans, & Schot, 2010; Kemp, 2010; Smith, Voß, & Grin, 2010). Interventionist interests in governing and ‘steering’ system change have led to the development of two specific approaches for purposively intervening in socio-technical systems – Transition Management (Rotmans and Lorbach, 2010) and Strategic Niche Management (Hoogma et al., 2002; Raven et al., 2008). Furthermore, the development of the concept of transition pathways reflects a particular anticipatory approach to exploring future energy provision, (Geels and Schot 2007, 2010; Foxon 2012; Foxon et al., 2012; Verbong and Geels, 2012).

As the theoretical sophistication and empirical diversity of the field has grown, so too have a range of dissenting voices seeking to draw attention to potential theoretical shortcomings. Recent critiques of the transition literature have argued that the dominant approaches do not fully account for actor dynamics (Smith et al., 2010) or the role of power and politics inherent to transition processes (Smith and Stirling, 2007; Shove and Walker, 2007; Meadowcroft, 2007). A concern that links both the conceptualisation of actor dynamics and questions of democratic legitimacy is how ‘public’ or ‘civil society’ actors are involved in or excluded from transition processes. Yet, as Hendriks (2009: 341) has observed, “[r]ecent debates on how to ‘manage’ policy transitions to sustainability have been curiously silent on democratic matters, despite their potential implications for democracy.” Notwithstanding Hendriks’ own work on Transition Management, the processes, visions, and normativities of participation and public engagement in sustainability transitions have largely remained implicit and taken for granted in existing analyses.

To address this gap, a principal aim of this paper is to bring sustainability transitions theory into conversation with constructivist STS perspectives on participation as a way of deepening understandings of the politics and democratic implications of transition interventions and offering a new way of conceiving of and thinking about participation in transitions. In doing this we move

beyond popular notions of participation, that remain dominant in the sustainability transitions field, which adopt a procedural focus on devising public involvement methods (Renn et al., 1995) and normative principles that define *pre-given* models of what constitutes good deliberation and participation (Habermas, 1984; Dryzek, 1990; Bohman, 1996). Rather, we introduce a constructivist STS perspective which views participation as an *emergent* and *co-produced* phenomena in itself, and pays particular attention to the circumstances of its construction, performance, productive dimensions and effects (Irwin and Michael, 2003; Irwin, 2006; Lezaun, 2007; Chilvers, 2009; Laurent, 2011; Marres and Lezaun, 2011). Our analytical focus in this regard is on heterogeneous collectives of participation 'in the making' that become established at particular sites in often quite ephemeral time-spaces.

In doing this our analysis draws attention to the processes by which these collectives of public engagement are *orchestrated and mediated*, and the exclusions that occur in terms of social actors or competing visions of energy futures. We begin to appreciate the partiality of all forms of participation and the degree to which different possibilities for system change are either opened up or closed down by different collectives (Stirling, 2008). Furthermore, our approach draws attention to the way in which these collectives are *productive* in multiple ways: producing issues and visions as well as versions of the public and models of democracy. What is more, these participatory collectives have material dimensions and effects. They are not just discursive spaces; they are often attempts to intervene in system change.

The conceptual approach and empirical analysis developed within this paper builds on the outputs of an international workshop that was convened in order to explore questions of participation in sustainability transitions (see Chilvers and Longhurst, 2012). The results of this workshop have been augmented by drawing on relevant studies in the literature and undertaking further documentary analysis. Before presenting this analysis, and considering implications for research and practice in the final section of the paper, we begin in the next section by outlining how ideas of participation are conceived in existing strands of the transitions literature and how a constructivist STS perspective on participation can both open up and deepen these understandings.

## 2. PARTICIPATION IN TRANSITIONS

### 2.1 Transitions, actor dynamics and participation

A notable feature of the sustainability transitions literature is that it contains both analytical and interventionist aspects, the two sides existing in a recursive relationship. One of the cornerstones of the approach is the multi-level perspective, most obviously reflected in the work of Geels, which has become a significant conceptual lens within the field (Geels 2002, 2004). Central to the MLP is the concept of a technological regime which originally referred to

the rule-set or grammar embedded in a complex of engineering practices, production process technologies, product characteristics, skills and procedures, ways of handling relevant artifacts and persons, ways of defining problems; all of them embedded in institutions and infrastructures.

Rip and Kemp (1998: 340)

Whilst it has since evolved in meaning and become open to competing definitions, the regime remains integral as the meso level of multi-level analyses – reflecting the dominant way of delivering particular societal functions such as energy, transport and food (Smith et al., 2010). Within the MLP, the regime is distinguished analytically from the niche and the landscape levels. The landscape reflects the exogenous, macro context that is beyond the direct influence of actors (Schot and Geels, 2008). Changes in the landscape can put pressure on existing regimes, opening up ‘windows of opportunity’ for systemic change. Conversely, niches are spaces where it is possible to deviate from the rules of the regime (Geels, 2004: 912). Niches are therefore conceptualised as the loci of system innovation; spaces where radical (system changing) innovation emerge. Consequently the purposive enactment of ‘niches’ has become a key focus of the sustainability transitions literature. In keeping with the significant focus on niches as sites of possibility, two models of purposive intervention have predominated within the sustainability transitions literature: Transitions Management (TM) and Strategic Niche Management (SNM). These are both attempts to ‘modulate’ socio-technical systems (Hoogma et al., 2002; Kemp and Loorbach, 2006).

TM is a form of governance experiment that is intended to contribute to the solving of complex societal problems (Rotmans and Lorbach, 2010). Loorbach (2010) suggests that whilst TM follows in the tradition of innovation in Dutch policy making (e.g. collaborative policy making, long term planning etc.) it also reflects a substantive break with the dominant policy approaches by having the explicit objective of radical innovation through a selective approach which focuses on ‘frontrunners’. Adopting a multi-actor, multi-level approach that focuses on the creation of ‘Transition Arenas’ it is an explicit attempt to intervene in the dynamics of socio-technical systems. A number of different transition management experiments have been implemented over the last decade (see Loorbach and Rotmans, 2010; Rotmans and Lorbach, 2010). The related approach of SNM focuses on the analysis of technological niches, spaces that ‘protect’ emerging technologies from a ‘selection environment’ that would otherwise prove hostile to their development. The establishment of protective niches therefore reflects an attempt at purposive intervention in socio-technical systems. Academic research around SNM has therefore focused primarily on the processes that lead to the ‘successful’ scaling up of niche technologies leading to the identification of both a number of ideal niche

characteristics and different mechanism by which they interact with existing systems (Geels and Raven, 2006; Smith, 2006; Raven, 2007; Raven et al., 2008).

The focus on niches as the key drivers of system change has led transitions theory to be criticized for exhibiting a 'bottom up bias' (Scrase and Smith 2009; Geels, 2011), suggesting that the focus on purposively created niches potentially obscures the influence of a range of different other actors (Berkhout et al., 2004). Consequently, in both TM and SNM, the regime has remained somewhat 'blackboxed' (Genus and Coles, 2008; Smith et al., 2010). Related to this is the fact that the MLP is underpinned by a fundamentally market driven model of system change, whereby system shift occurs with the profitable scaling up of a new technology (Lawhon and Murphy, 2011). Furthermore, the argument has been made that there is a bias towards innovation as the principle mode of intervention within the sustainability transitions literature (Shove and Pantzar, 2005). In some ways this is an expected consequence of its intellectual heritage but obscures the potential influence of a range of other actors. Thus, as Grin et al. (2010: 331) note, the role of consumers and grassroots initiatives in transitions is underrated and under-conceptualised. In other words, recognising the distributed nature of power within modern societies opens the door for multiple routes of intervention, from various actors (Meadowcroft, 2007).

One of the few existing studies of participation and deliberation in sustainability transitions is Hendriks' (2008, 2009) analysis of democratic and inclusionary processes in Dutch TM experiments. The democratic criteria of inclusion (who is involved/participates?) and legitimacy and accountability (how should reforms be legitimised and accountable to the public?) are used to assess TM practice. Transition arenas are shown in this case to be distinctly 'technocratic'. The emphasis being on facilitating partnerships between frontrunners, entrepreneurs and representing their elite/specialist knowledges, to the exclusion of many potentially affected actors in civil society and the wider public. While calling for the design of more inclusive sustainability transitions and opening up important questions of democracy in transitions, Hendriks' analysis to some extent narrows down possible imaginations of participation and the public. For example, the analytical focus on involvement in policy decision-making brackets out forms of participation associated with 'distributed innovation' and more active forms of citizenship (Felt and Wynne, 2007). Furthermore, the implicit emphasis on how sustainability transitions should/could be made more 'democratic' forecloses wider appreciation of the diverse sites at which social actors are *already and continuously engaged* in sustainable energy transitions.

Whilst not explicitly analysing the dynamics of participation per se, some strands of the transitions literature have begun to explore the multiple roles that publics and civil society actors play in system innovation. There is a growing body of work exploring the role that civil society actors play in distributed innovation processes. These 'grassroots innovations' are often ideologically motivated, innovating to meet specific social or environmental goals (Seyfang and Smith, 2007) and building new forms of institution and organization rather than just articulating political claims or objections to the status quo (Collom, 2007). Other work emphasises the role of 'wider publics'. Walker and Cass (2007) argue that there are multiple ways in which publics engage with emergent renewable socio-technical configurations describing ten different categories of actors from 'passive consumer' to 'energy producer'. Furthermore, work on the sociology of consumption adopts practice theory to explore the role that practitioners play in constructing and reproducing energy systems. In

developing an analytical perspective in which practices are the central object of analysis, consumers are recast as practitioners who interact with the energy system through the daily performances of everyday life (Shove 2012).

These various literatures on practices, publics and grassroots innovations all open up different perspectives on the multiple roles that public actors can play in transitions processes, but each also remains somewhat partial, bracketing out the primary foci of the others. Indeed it is notable that specific descriptive terms such as 'civil society', 'publics', and 'practitioners' are predominately associated with particular forms and theories of public participation. In this paper we use the term *public engagement* to encompass all of these diverse forms of public and civil society participation in sustainability transitions. Drawing on insights from social movement theory, Smith (2012) does attempt to map the breadth and variety of public engagement in energy transition processes. Mapping the multiple instances of civil society intervention onto the different levels of the MLP, he suggests that there is a need for more detailed work on these different forms of participation, seeking to understand their interactions and effect on potential transition pathways. In what follows we answer this call by drawing on theoretical insights from STS to explore different configurations of participatory collectives. A significant advantage of this approach is that it allows a more symmetrical and comparative analysis of diverse forms of public engagement across socio-technical systems.

## **2.2 Emergent participation**

Constructivist STS perspectives on participation can be seen to pose an altogether different theory of participation compared to mainstream political/democratic theory (e.g. Habermas, 1984; Dryzek, 1990; Bohman, 1996) which has informed the transitions literature and indeed earlier procedurally-oriented work on public engagement in STS (e.g. Rowe and Frewer, 2000). Rather than adopt a procedural focus on methods and/or normative principles that define pre-given models of what constitutes good deliberation and participation in advance, a constructivist and co-productive STS approach views all forms of participation as *emergent* phenomena and social experiments in themselves, paying close attention to their construction, performance, productive dimensions and effects (Irwin, 2006). While specific approaches vary, key works developing this perspective (e.g. Barry, 2001; Irwin and Michael, 2003; Callon et al. 2009; Marres and Lezaun, 2011) are inspired by the relational ontologies of actor network theory (ANT) and assemblage theory in conceiving of forms of public engagement and participation as heterogeneous *collectives* of human and non-human actors, devices, settings, theories, public participants, procedural techniques, and other artefacts. Actors are included or excluded from a collective of participation through mechanisms of enrolment and its eventual constitution highlights the productive ways in which approaches to participation construct the object (or issue), subjects (or publics/participants), and the specific procedure (or political philosophy) of participation (Irwin and Michael, 2003; Marres, 2007). These represent key emergent qualities or effects of particular instances of public participation.

Understanding participation as emergent and *coproduced* in this way offers a number of analytical possibilities, of which we focus on two in this paper. The first centres on the work that goes into orchestrating a collective of participation through processes of *enrolling actors* and *mediation*. Enrolment refers to the way in which different actors are drawn into a particular form of



participatory collective and definition of the problem. Mediation refers to the way in which the collective is held together by different devices, processes, skills or technologies of participation. Mechanisms for enrolment can be a highly centralized and mediated by a small number of actors in the collective. This tends to be the dynamic in formalised 'technologies of participation' - such as citizens panels, focus groups or other established deliberative participatory techniques - which have standardized design blueprints for enrolling 'representative' samples of human subjects and configuring participatory collectives. Such instances are often mediated by professional facilitators who invest work in disciplining participants to conform to a particular political epistemology or normativity of participation (Lezaun, 2007), moves that can be subject to resistance and de-description by participating actors (Felt and Focher, 2010). The enrolment of actors into a collective of participation can otherwise be more distributed, rhizomic and fluid where multiple actors simultaneously enrol one and other, which has been observed in forms of counter-scientific, informal and citizen-led forms of engagement (Irwin and Michael, 2003). Powers of enrolment and mediation are not just human qualities and can be imbued in material objects, devices or technologies in shaping heterogeneous collectives and maintaining connections between actors and across sites (Barry, 2001; Marres, 2007, 2012). While these forms of orchestration can differ in emphasis between collectives, highlighting the power of different actants to bring participation into being, a constant is that all forms of participation are by definition exclusive, lead to exclusions, are always partial, framed in particular ways, and subject to 'overflows' (Callon et al., 2009). This marks a departure from the emphasis of inclusion and inclusivity in procedural theories of participation, including those evident in interventionist strands of the transitions literature.

The second main analytical focus in this paper to be drawn from constructivist STS understandings of participation centres on the productive dimensions and effects of emergent participatory collectives. In particular we focus on the ways in which diverse collectives of public and civil society engagement in low carbon energy transitions construct particular definitions of the *issue* at stake, *models of participation* and *the public*, and bring about *material commitments*. This involves continual work to stabilize collectives of participation around particular problematizations, which is simultaneously subject to continual trials, contestation, ambivalent attachments and external critiques (Laurent, 2011). In other words, participatory collectives can be fraught with tensions and multiple forms of resistance, both 'internal' and 'external.'

With respect to the *issue* in question around which publics are brought into being (Marres, 2007), collectives of participation can be subject to powerful framing effects, especially in institutionally orchestrated processes where the matters of concern are often pre-defined by incumbent interests (Irwin, 2001; Chilvers and Burgess, 2008; Stirling, 2008). Participatory procedures and forms of mediation have also been shown to 'fix' the issue in technical terms thus constructing and maintaining a boundary *via-a-vis* the social and ethical concerns of 'mobile' public participants (Lezaun and Soneryd, 2007; Laurent, 2009). Yet, the issue remains emergent and coproduced amongst actors enrolled into a collective, in defining both how the problem is framed and, as part of this, anticipatory visions of desired futures (what should to be done and why). Even when this is a discursive process it can indirectly link to material commitments in shaping future pathways. However, articulation of a collective of participation also produces immediate *material commitments* through producing or reconfiguring practices, objects and artifacts.

Emergent collectives of participation produce *publics* as well (Michael, 2009; Braun and Schultz, 2010; Pallett and Chilvers, 2013) through constructing particular identities of the actors involved, such as: ‘innocent citizens’ or ‘pure publics’ that are assumed to have limited prior knowledge of the issue in question or deemed to be ‘representative’ of a wider public; ‘interested’ or ‘affected’ publics who have a personal attachment to the object of participation, including through exposure to risk or illness; or more ‘active’ or ‘innovative citizens’ who are constructed as bringing about various forms of action. Problematizations of the public in any one collective are closely associated with the problem of participation, whereby the relations between actors in a collective conforms to or creates a particular normativity or political ontology of *participation*. So while particular models of participatory democracy – ranging from consensual to agonistic – have become dominant taken-for-granted meanings of participation in many policy fields, including Transitions Management, normativities of participation are empirically variable, which should thus be symmetrically explored across diverse sites, collective practices and spaces of participation (Lezaun, 2007; Marres and Lezaun, 2011).

### **3. EMERGENT PARTICIPATION IN UK LOW CARBON ENERGY TRANSITIONS**

In order to empirically explore this emergent perspective on participation we draw on four distinct case studies of public engagement in UK low carbon energy transitions. These cases are *illustrative* in that they have been specifically selected to reflect diverse forms of public engagement in energy transitions. Two significant axes of difference can be distinguished in this regard. The first axis relates to the institutional location of the key orchestrators of the collective, whether they are ‘inside’ or ‘outside’ the incumbent energy system. This is a similar distinction to one already made within the literature on public participation which distinguishes between ‘invited’ forms of participation organised in terms of formal governance institutions and ‘uninvited’ engagement organised by citizens themselves (Leach et al. 2005; Wynne, 2007). Similarly, the literature on innovation contains notions of ‘outsider’ innovation – innovation which rejects the dominant rules of the technological regime (van de Poel, 2000).

The second axis of difference relates to the object of participation. The argument here is that whilst participatory collectives are co-produced and mediated by human and non-human actors, there is often a specific aspect that forms a more central point around which they cohere. Within our four cases we make a distinction between those forms of participation where a specific *issue* of public debate and those where particular technological objects are more significant in bringing the participatory collective into being. Acknowledging this distinction allows us to develop insights into the way in which different collectives unfold. On this basis we have analysed the four diverse case studies summarised in Figure 1.

		<b>Relation to incumbent regime</b>	
		<b>(More) Insider</b>	<b>(More) Outsider</b>
<b>Object of Participation</b>	<b>(More) Issue centred</b>	<b>Energy 2050 Pathways – Public Dialogue</b> A public dialogue process to engage the public in the debate about transforming the energy system, based around DECC’s 2050 Pathways Calculator.	<b>Camp for Climate Action</b> A direct action protest movement that took place at a number of different sites in the UK between 2006 and 2011.
	<b>(More) Device centred</b>	<b>Visible Energy Trial</b> A pilot exploring how early adopters interact with smart meter technology.	<b>Dyfi Solar Club</b> A civil society initiated solar club which aimed to provide access to low cost solar panels.

**Figure 1.** Case study selection and key axes of difference.

These cases therefore reflect four different archetypes of public engagement: a deliberative consultation (DECC 2050); a technological trial (Visible Energy Trial); an environmental social movement (Camp for Climate Action) and an example of grassroots innovation (Dyfi Solar Club). Whilst each of these cases are, as individual collectives, fairly well defined and of a modest scale, they are all representative of a wider diversity of different forms of public participation. Furthermore, should the system trajectory move towards an even more distributed configuration, such forms of participation would become increasingly significant and widespread.

In exploring these diverse forms of participation we are interested in two specific analytical themes highlighted in section 2 above. The first relates to how the collective of participation emerges and is articulated. What forms of enrolment, mediation and exclusions are involved? Secondly, what are the productive dimensions and effects of the participatory collective – in terms of the definition of the issue at stake, the model of participation and the public, and material commitments? In what follows each of the four cases are analysed in turn in relation to these two main analytical themes. In doing this we draw on material from the international workshop where the four cases were considered as part of a broader analysis (Chilvers and Longhurst, 2012). This is supplemented by additional documentary analysis of grey and academic literature sources which have been coded against the two main analytical themes. We conclude this section with a comparative analysis that draws out key similarities and differences across the four cases.

### **3.1 Energy 2050 Pathways Public Dialogue**

The DECC 2050 Public Dialogue was a public participation process intended to stimulate public deliberation on how the UK should meet its legally binding greenhouse gas emissions reduction target of 80% by 2050. A central focus of the process was to improve the ‘energy literacy’ of the

public participants and engage them in ‘informed debate’ around the different possible energy pathways. Thus, the underlying objectives of the DECC 2050 Dialogue were for the public to understand the scale of the challenge and the trade-offs involved and to explore and test their own preferred solutions (Comber and Sheikh, 2011: 12). The dialogue consisted of local deliberative workshops, where participants interacted with the DECC 2050 calculator to explore different energy pathways, alongside an advisory youth panel and a web-based process where publics engaged with a ‘My2050’ online ‘serious game’. In this case study we focus in particular on the deliberative workshops, which aimed to: engage local community leaders in a dialogue about the 2050 emissions target; understand how they approach the challenge of reducing UK greenhouse gas emissions; and establish if their views on the subject changed during the process (Comber and Sheikh, 2011).

The deliberative dialogues were designed and facilitated by the market research company Ipsos-MORI. Three workshops were held in London, Cumbria, and Nottingham, attended by 40, 27 and 19 participants respectively. The process of enrolment was centralized and institutional, controlled by key actors within the energy regime who enrolled specific categories of participant: local politicians; elected members of boards and committees; local business forum representatives; local Non-Governmental Organisations (NGO) representatives. Initial participants were approached via ‘active search’ and use of a government database and then encouraged to suggest other possible recruits. There were some problems with recruiting participants, particularly elected representatives (Ipsos-MORI, 2011: 17). As the workshops were invited – micro forms of participation there were significant exclusions in terms of geography and of actors who were not deemed to be representative of the community.

The collective was mediated primarily through a specified technology of participation, a citizen panel-type deliberative workshop format that was organized along principles set out in the Sciencewise-ERC<sup>1</sup> guiding principles (see Sciencewise-ERC, undated). The DECC 2050 pathways calculator was an important technology within this collective, governing the way in which the participants were able to develop future pathways. Further subsidiary forms of orchestration were the tendering processes and legal contracts which enrolled and governed professional organisations such as Ipsos-MORI. Within this process it was therefore DECC and Sciencewise-ERC who set the parameters of the participatory space in terms of the issue definition and how the participatory process would be managed. The model of participation produced through this process was one which was invited, deliberative and professionally facilitated. The version of the public produced by the DECC 2050 Dialogue was predominantly one of ‘innocent citizens’ that have to become informed and educated in order to effectively deliberate and make judgements on complex issues.

The issue produced by the DECC2050 deliberative process was framed by the UK Government’s commitment to achieving an 80% reduction in carbon emissions by 2050, based on 1990 levels, a legally binding obligation as set out in the Climate Change Act (2008). The process explicitly framed the fact that achieving this target required specific technological choices to be made. The vision was therefore one of a technocratic and managerialist low carbon energy transition, one that ignored the potential political and social implications. For example, the levers on the 2050 Pathways tool predominately relate to the deployment of a pre-defined set of different technological mixes.

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<sup>1</sup> Sciencewise-ERC is funded by the Department for Business Innovation and Skills (BIS) and is intended facilitate public dialogue processes in order to inform policy decisions around science and technology.

Secondly, the deployment of technology is portrayed as unproblematic. The fact that certain technologies might be politically controversial (nuclear, wind), or unproven (carbon capture and storage) is not foregrounded. Thirdly, the centrality of 'choice' and the way in which this is embodied in the tools suggests a high degree of control over the energy system that the successful governance of the system is straightforward, and not in any way partial or contingent.

Perhaps not surprisingly then, the resistance within this collective related primarily to the way in which the DECC 2050 calculator framed the low carbon transition. Some participants challenged the framing of the issue, and refused to reach the 80% reduction targets (Ipsos-MORI, 2011: 17). The fact that people had strong views about certain technologies was also a problem for the calculator, which assumes 'rational discussion based on facts' and meant that that some people found it difficult to use (ibid). This form of resistance relates to certain assumptions that were built into the DECC2050 pathways. For example, participants challenged the range of choices available, the lack of cost data, and the lack of accounting for other factors such as fossil fuel depletion or future technological development (Comber and Sheikh, 2011: 40; Ipsos-MORI, 2011: 35). Furthermore it was felt that behaviour change was not fully accounted for and the assumptions on the demand side could have been more radical. External resistance to the DECC 2050 process occurred when, in the process of developing their own energy pathways, the Centre for Alternative Technology 'hacked into' the DECC2050 calculator to change some of the underlying assumptions in relation to nuclear energy, before sending the revised version back to DECC (Chilvers and Longhurst, 2012).

In terms of the production of material effects, the process produced social intelligence that had the potential to inform government decisions and policy-making commitments relating to particular low carbon pathways. However, at this stage it is not clear how the information produced by the process fed into policy-making and potentially shaped it.

### **3.2 Camp for Climate Action**

The Camp for Climate Action (CCA, otherwise known as 'Climate Camp') was a grassroots environmental movement which organised a series of direct action events between 2006 and 2011 across the UK. Taking the form of an annual protest camp, the first event was located at the DRAX power station in West Yorkshire, whilst in 2008 it targeted the Kingsnorth power station in Kent, in order to protest against plans for the first new coal fired power station in the UK for 30 years. The various locations of the climate camps were selected for their symbolic value, and were explicitly linked to the issue of 'carbon'. Direct action against perceived causes of climate change was one of the four stated purposes of the Climate Camp movement. The others included to educate; to build a movement against climate change; and to provide a demonstration of sustainable living (Saunders 2012). In relation to the latter objective, the Camp itself took the form of a low impact community whereby specific attention was paid to minimizing the ecological impact of the event, which offered an example of the possibilities of sustainable living. This particular form of participation was inspired by the 'Horizon eco-village' which was developed as part of the protest movement against the Gleneagles G8 summit in 2005 and which also provided the template for decision-making and logistics at the climate camps (Schlembach, 2011).

CCA therefore emerged from the multiple and overlapping networks of UK radical direct activism (Plows, 2008; Doherty et al., 2007). Woodsworth (2008) in particular draws attention to the overlap with the anti-globalisation movement and the anti-roads protests of the 1990s. Therefore the camp as a whole was orchestrated by a set of experienced environmental activists, who, to a greater extent, were self-defined anti-authoritarians and anarchists (Saunders, 2012). However, it is important to note that the process of orchestration for the camps was decentralized and inspired by an 'autonomous' political philosophy that was manifested in leaderless, horizontal organization principles (Woodsworth, 2008). The enrolment and organisation of the camps occurred through regional networks which subsequently formed physical 'neighbourhoods' at the actual camps, whereby participants were self-selecting and self-organising. Whilst 'activists' formed the core participants of the camps other categories of social actor were also drawn in, including 'novice' activists who had more recently been politicized. In some cases local protesters were enrolled in the collective (for example at Heathrow, 1997) and prominent green spokespeople were also involved (e.g. George Monbiot at Kingsnorth). Climate science was also enrolled in the CCAs, particularly at Heathrow where the activists marched under the banner 'We are armed only with peer-reviewed science' (Schlembach, et al., 2012). During the camps themselves the mediation of the collective was primarily via daily neighbourhood meetings using structured, consensus decision-making from which a spokesperson was sent to a central meeting. Such carefully managed processes were intended to guarantee the cohesion of the collective and ensure that its decisions were democratic.

CCA produced an uninvited model of participation that focused on the production of counter-discourses relating to climate change and which was organized according to decentralized and autonomous politics. The camps can be understood as an explicit attempt to create a form of political space, albeit that this space was often contested (Schlembach et al., 2012; Schlembach, 2011; Saunders and Price, 2009). A particular function of this space was to appraise the strategic repertoire for tackling climate change both generally (i.e. 'What kind of solutions are necessary?') and specifically (i.e. 'what actions should we take?'). Thus, in the latter case, the discussions sometimes closed down around a commitment to a specific form of direct action. Whilst the decision-making processes themselves were open, the underlying anti-technological ethos of many CCA activists meant that technologies such as nuclear and carbon capture were excluded as viable solutions to the climate issue. The form of public produced was a form of sustainability citizenship where citizens are active in shaping future possible pathways (Plows, 2008). However, in defining climate change as a systemic problem, the CCA challenged the discourses of 'individual lifestyle change' that were promoted by mainstream environmentalism and government bodies. The issue framing produced by the climate camps was that the causes of climate change are related to the incumbent (capitalist) political economy (Saunders, 2012). In doing so it framed the issue of climate change as a political and moral issue not just a technical one. Thus, for many camp participants transitioning to a low carbon electricity system requires fundamental systemic socio-political change. The prefigurative politics of CCA were also reflected in the materiality of the camps, which explicitly attempted to show case small-scale demonstrations of sustainable living. Thus the camps attempted to produce a material example of an alternative future, a 'heterotopia' (Saunders and Price, 2009). In doing so, Skrimshaw (2008) has argued that it represented the production of a new form of activism – combining this element of demonstration with direct action.

Despite the careful mediation of the collective, certain internal tensions did arise. For example, at the 2008 Kingsnorth camp a conflict emerged surrounding the perceived anti-coal stance of the camp. A former National Union of Mineworkers (NUM) official suggested that the antipathy towards coal reflected a form of class politics which excluded the interests of working class people.<sup>2</sup> Another debate that emerged at the Kingsnorth camp related to the extent to which radical activism should engage with the state. George Monbiot who, in a public speech, argued that state apparatus should be used to address climate change typified this 'reformist' position. One consequence of this was an open letter from a group of 'Anti-authoritarians' who felt the camp was losing touch with its anti-capitalist roots, which could be understood as a form of resistance to the consensual-discursive processes (Saunders and Price, 2009). In addition to these 'internal' tensions the CCAs were subject to other forms of external resistance, including aggressive policing and some objection to the camps from local people (Saunders and Price, 2009).

### **3.3 Visible Energy Trial**

The Visible Energy Trial (VET) was a technological trial which explored household interaction with In Home energy Displays (IHDs). IHDs are devices that produce visual displays of domestic energy consumption. Deployed in conjunction with the planned roll-out of smart meters they are intended to function as a key piece of infrastructure within the emergence of a Smart Grid which will underpin not only a decentralized system of energy production, but also new patterns of 'conscious' energy consumption where consumers are implicated as co-managers of the system (Darby and McKenna, 2012). The VET project was a collaborative venture between a small company who were developing visual display monitors (Green Energy Options [GEO]), British Gas, an academic consultancy specializing in data mining (SYS Consulting Ltd [SYSCo]) and researchers from the University of East Anglia (UEA). Throughout 2008-2009, 275 households from across eastern England were recruited to trial three different IHDs of varying complexity, plus a control group. As part of this wider project, social scientists from the UEA also undertook longitudinal qualitative research with a smaller cohort of participants – 15 'early adopter' households – exploring their day-to-day interactions with this novel technology (See Hargreaves et al., 2010, 2013). The enrolment of participating households varied according to the type of IHD. For one, participants were recruited through Housing Associations. For the other two IHDs enrolment was through general advertising (e.g. newspaper advertisements) and via the UEA CRED initiative that encouraged individuals and groups to pledge to reduce their carbon footprint. The public participants were therefore self-selecting, although it could be argued that that the device itself played an important role in processes of enrolment. Indeed IHDs played an on-going and significant role in stabilizing and mediating the collective by acting as a form of 'boundary object' which acted as a mediator between the different social worlds within the assemblage (Irwin and Michael, 2003; Barry, 2001). Survey methods and qualitative research methods were also important in mediating the collective. The overall process of enrolment within this case can be characterized as centralized and institutional. In this particular example it was the Department for Energy and Climate Change (DECC) who were responsible for the highest tier of orchestration by setting a strong policy agenda around the rollout of smart meter technology in the UK, with the stated ambition of rolling out smart meters by 2020 to all UK households (DECC, 2009).

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<sup>2</sup> However, such dialogue did lead to further engagement between trade unions and climate camp activists (Schlembach 2011: 203).

Responding to this GEO (the technology developer) recruited a UEA research team to assist with the trial.

The model of participation produced in this case is of information – visualization and of household behaviour change. IHDs can be conceptualised as a particular kind of participatory technology which turns everyday material activities into engagements with the environment (Marres, 2011). Marres (2011) argues that devices such as smart meters materialize new forms of public participation by codifying participation by material means, and that by doing so, participation is granted specific ‘logics’. In the case of smart meters one such dominant logic is that of ‘making things easy’, a logic that is prominent in both the development of domestic technology and in liberal political theory. This particular mode of participation therefore produces a public that requires specific assistance in order to participate, indeed the form that the assistance takes is in the provision of information, indicating how a second logic of smart meters is a tacit endorsement of information deficit models of behaviour change (Hargreaves et al., 2010). The public are therefore framed as a particular form of consumer citizen, whereby a greater degree of ‘consumer engagement’ will shift the consumer from passive user to empowered and active part of the system (DECC 2009, 19). Relatedly, the issue produced by this collective is the low carbon energy transition as essentially a technological problem in which individual responses are a necessary element of the response (DECC 2009). This issue framing is not opened up at all, the solution to the development of a low carbon energy system is presented as a technologically optimistic vision of the future, both in terms of technologies of community and new information technologies – with the visions of householders being notable exclusions (Chilvers and Longhurst, 2012).

Yet despite stating that consumers should be involved in shaping the emerging smart grid, the decision to undertake a UK rollout of smart meters was taken with little reference to potential public concerns and as such may become subject to forms of public resistance around data protection (AlAbdulkarim and Lukszo, 2011) or health concern (Hess and Coley, 2013). Hargreaves et al. (2010, 2013) also describe several other forms of resistance to the governmentality of the IHDs in the VET trial (see Hargreaves, in press). Indeed, whilst many participants did use the monitors to develop an understanding of their *normal* electricity consumption, and indeed some developed a ‘new’ normal, the monitors did not produce significant examples of behaviour change or reconfigurations of the materiality of household energy consumption. Indeed, one aspect of this resistance was that households felt the monitors put an unfair onus on households to take responsibility for carbon reduction when compared to other social actors, what Marres (2011) calls the ‘distribution’ of the problem. Whilst these forms of resistance did not challenge the stability of the VET collective they certainly challenged visions that the technology might function as a tool for behaviour change. This facet of resistance was also picked up by some elements of the media that reported the findings of the research (Poulter, 2011). Some of the technology also resisted by refusing to perform as required, which delayed aspects of the trial, causing participants to drop out and hindering the flow of data. This is significant because a key facet of experimental devices such as smart meters is that they produce *information* which can have multiple effects, including political (Barry, 2001). Certainly in this case various forms of information were produced both for households and for the wider trial. Some of this fed back into the design of the artefact itself but, as detailed above, the information on consumption had only a limited effect on the material commitments of the participants in terms of direct energy consumption. One other way in which this information did have an additional effect on



the material commitments of participants was in some cases where awareness of the energy consumption of particular appliances led to them being replaced.

### **3.4 Dyfi Solar Club**<sup>3</sup>

The Dyfi Solar Club (DSC) emerged in Machynlleth in the mid-Welsh County of Powys in 1999. The project was led by the Dyfi Eco Valley Partnership, a community based regeneration partnership which originated as a community energy focused project in 1998 with support from the European Regional Development Fund matched with other funding. It is indicative of the type of community energy initiative that grew in popularity through the late 1990s and into the 2000s in the UK (Walker et al., 2007). The Dyfi Solar Club was one of the five community based renewable projects that the partnership was obliged to deliver under the contractual terms of their grant. The purpose of the DSC was to provide access to low cost solar water heating systems through a combination of negotiated discounts, subsidies, and self-installation.

The project officer of the Dyfi Eco-Valley Partnership instigated the Dyfi Solar Club, and its orchestration was a centralized civil society led process that involved the bringing together of a number of different elements. The original inspiration came from successful examples of solar clubs in Switzerland and around the time that project started the *Centre for Sustainable Energy* (CSE) in Bristol began to train people to install commercial solar panels themselves. Having successfully developed a model in Bristol, CSE and partners launched the National Solar Clubs network. The DSC was an early member of this network and adopted the manual, contracts and publicity material for the DSC. The orchestration of the collective also involved the enrolment of other social actors. A trainer was recruited from the Centre for Alternative Technology (CAT), originally established in Machynlleth in 1973 as a pioneer of Alternative Technology and which has continued to develop and promote renewable technologies. Two local heating engineers were also recruited to undertake assessments and quality checks.

Enrolment of public participants was undertaken using established community development techniques such as structured public meetings. These were publicized using the local media and through reproductions of a leaflet from the National Solar Club. In order for the training to be cost effective it had to be undertaken in groups. The solar panels themselves also played an important mediating role. Their requirements, in terms of aspect, pitch and area of roofing determined whether some social actors were excluded or not from the collective. The individuals interested in the solar club tended to be middle class, some retired and often with background in engineering or being keen on DIY. Arguably those who lacked confidence or skills for self installation were potentially excluded from the collective, although the DSC did develop a number of different installation 'routes' which could include installation by a professional engineer. A second dimension of exclusion was economic. Despite being subsidized by European funding, an initial home assessment visit cost £35 followed by a minimum membership fee of £50. The costs of the equipment were between £1,250 and £2,000 depending on the specific technology. Although this was cheaper than a straightforward commercial system, and that grants were also available, those on low incomes may have been unable to participate in the club.

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<sup>3</sup> This case draws extensively on an 'innovation history' of the Dyfi Solar Club. See Hargreaves (2012).

The model of participation produced by the Dyfi Solar Club was one of social or grassroots innovation, whereby the public were imagined as active, resourceful, 'hands on' and technically competent. It also produced a notion of the public would embody an ethic of mutual aid, although it is not clear the extent to which this was actually manifest in the actual development of the systems. The public were also imagined as being susceptible to the influence of their peers and neighbours, a social psychological understanding of behaviour change (Nye et al., 2010). The assumption that publics would be predisposed towards solar technology was influenced by the fact that a 'green milieu' had built up in the area since the 1970s, rooted in the proximity of CAT. The issue being produced by the DSC related to the economic development potential of renewable energy, both in terms of building on and catalysing the expertise already existing within the Dyfi valley, and in terms of providing green and cheaper energy in a geographical area where many households were 'off grid'. Related to this was a vision to promote a distributed energy system. The project therefore sought to address the lack of visibility of solar thermal within the locality. DSC saw the development of a critical mass of demonstration households as a crucial step in normalizing the technology and consequently leading to the enrolment of further members.

External resistance towards the collective began to arise in 2003 when the Department of Trade and Industry and the International Solar Energy Association raised concerns about the product liability of the systems and who might be responsible for technical faults. Furthermore, there were issues surrounding health and safety concerns that many of the self-installs had not been done with the recommended safety equipment. The material effect of the solar club was that between 1999 and 2002 eighteen systems were installed. Following the end of the European funding the DSC was, with the support of Powys County Council expanded into the Powys Solar Club. However, this proved to be less successful, in part due to the larger geographical area covered which made public meetings, training events and home visits problematic. By 2003 policy changes and cheaper market entrants meant that the cost-savings offered by solar clubs had been considerably undermined. This led to the demise of this particular model of participation, with the closure of many local clubs, as well as the national network.

### **3.5 Comparative analysis**

A summary comparison of the four cases against the main analytical themes is presented in Table 1. All four cases attempted to be inclusive and open up engagement in the UK low carbon energy transitions to social actors. They achieved this to varying degrees. Importantly, however, our analysis highlights a continual *tension* between inclusion and exclusion in all four cases, which is endemic to any form of public engagement. Whilst claiming to be inclusive, the collectives formed in each case were *all* partially framed and subject to 'overflows' (Callon, 1998; Callon et al., 2009). They thus excluded certain actors, issue definitions, and vision of the future. For example, actor exclusions included: interest groups or protestors in DECC 2050, low income groups and houses without the appropriate aspect in Dyfi Solar Club, business or incumbent interests in Climate Camp, and household types that did not meet the entry criteria in the VET. In some cases these exclusions were deliberate and purposive, in others they were the unintended consequence of orchestration.

	<b>DECC 2050 Dialogue</b>	<b>Climate Camp</b>	<b>Visible Energy Trial</b>	<b>Dyfi Solar Club</b>
<b>Enrolment &amp; Mediation</b>	Centralized Institutional  Technologies of participation (citizens' panels, web interface)	Distributed/ Organic Citizen-led  Consensual decision-making procedure	Centralized Institutional  In home displays / Survey & qual. research methods	Centralized Civil society-led  Community development techniques / Solar thermal panels
<b>Model of Participation</b>	Invited-deliberative / Professionally facilitated	Uninvited-discursive / Autonomous-horizontal	Information-visualization / Household behaviour change	Social / grassroots innovation
<b>Public</b>	Innocent citizens	Active / activist citizens	Consumer-citizens	Resourceful citizens
<b>Issue / Vision</b>	UK Government 80% carbon reduction target  Technocratic managerialist vision	Incumbent political/ economic system as the key driver of climate change  Low carbon energy transitions require fundamental systemic socio-political change	Techno-rationalist  Technology creates a social solution to demand management	Low carbon as economic development strategy  Distributed low carbon technology demonstration / uptake
<b>Material commitments</b>	Social intelligence for governmental decision-making	Demonstrations of sustainable living  Potential influence on public debate	Changes in consumption patterns or changes in technology	Installation of solar panels
<b>Exclusions and Resistance(s)</b>	General public excluded from processes  Some resistance to the framing of the issue and to the calculator assumptions	Energy business interests excluded  Internal resistance to consensual process and tension over reformism  External resistance of police / locals	Techno-phobes / certain household types  Resistance to the distribution of the problem and to governmentality of the IHDs  Technological resistance	Households with the 'wrong' roofs / low income households  External resistance to the legality and safety of the model

**Table 1.** A summary of each case study in relation to the main analytical themes.

A further commonality across all four cases is the central role of 'technologies' to mediating each collective of participation, organizing it, and configuring connections between actors. As shown in Table 1, these 'technologies of engagement' range from technologies as procedural formats, either in the form of highly standardized deliberative designs (DECC 2050) or consensual decision-making procedures (Climate Camp), as well as material objects such as digital visualization technologies (in the VET) and low carbon technologies (in Dyfi Solar Club). In short, these engagements would not have happened without the work invested by human actors and material technologies in enrolling

other actors and mediating the collective in an attempt to stabilize its configuration and definition of the issues at stake. For example, in the DECC 2050 Dialogue professional facilitators attempted to discipline participants to a particular deliberative model of participation and a technocentric definition of the issue at stake through workshop techniques linked to a web interface. Perhaps most striking is the Climate Camp case which, despite enacting a leaderless ‘horizontal-autonomous’ political philosophy, relied on consensual decision-making procedures to reach agreement on strategic commitments to the exclusion of other knowledges, framings and perspectives within the collective.

Through these processes the stability of issue framings and visions of low carbon energy futures were achieved to varying degrees across the cases, but were also subject to challenges and forms of resistance. The two cases that were institutionally orchestrated by incumbent interests in government and industry (DECC 2050 and the VET) pre-imposed a technocentric issue framing or vision which was met with some internal resistance in each collective but not to the extent that it was opened up or transformed. The two cases where processes of enrolment were more citizen-led or ‘bottom-up’ (see Table 1) produced visions of low carbon energy transitions that emphasized wider socio-political, as well as technical, dimensions. In the case of the Dyfi Solar Club this framing was more stable throughout the life span of the collective, perhaps owing to the material attachments and mediating role of the solar technologies themselves. Out of all four cases the issue framing of Climate Camp was less stable and subject to transformations (closings and reopenings), due to the more distributed and organic processes of enrolment which enabled resistance by some actors within the collective to reorientate its strategic commitments. A crucial finding from the current analysis is that each of the four collectives represented in Table 1 were subject to external challenges and also interacted with other competing collectives of participation. A key example is the attempts by CAT to challenge the governmental technologies and framings of the DECC 2050 process.

In addition to issues, all four collectives shown in Table 1 produced models of participation, or democratic innovations, as well. In many respects the cases move beyond meanings of participation with the existing transitions literature, into private spaces of the household (in the VET) and the adversarial spaces of activist networks (in Climate Camp). Yet, all four bring into being particular models or normativities of participation which are highly varied, loosely reflecting Habermasian deliberative theory (DECC 2050), liberal political theory (VET), anarchist ideas (Climate Camp), and communitarian philosophies (Dyfi Solar Club). This is not insignificant as these philosophies, and the particular socio-technical configurations formed in each collective, offer differential potentials or constructions of ‘the public’ (see Table 1). Both institutionally orchestrated processes (DECC 2050 and VET) brought forward constrained and passive models of the public, which closed down other public potentialities. While more exclusive in terms of actors represented, the two citizen-led collectives produced more ‘active’ publics, and a more overt politics of promise and possibility (Arendt, 2005), rather than only forms of resistance. This is reflected in the potential material commitments emerging from each case, which poses a paradox. The two cases that are institutionally sanctioned and closer to the governmental regime only had indirect links to material commitments, whereas the two ‘outsider’ processes led to direct material commitments but their contribution in terms of overall system change was much less clear (Chilvers and Longhurst, 2012).

#### 4. DISCUSSION AND CONCLUSION

In this paper we have brought literatures on socio-technical transitions into closer conversation with those on democratic engagement - including, for the first time, STS perspectives on participation as constructed and emergent - as one way of addressing calls to better understand actor dynamics and the politics of transitions (Shove and Walker, 2007; Smith et al., 2010). Adopting this more relational approach has proved valuable in opening up meanings of participation in transitions beyond sites of Transitions Management and deliberative fora (e.g. Hendricks, 2009; Einsiedel et al. 2013) to multiple forms of public engagement across low carbon energy systems (Smith, 2012) including activism, community innovation, and interactions with more mundane technologies in everyday life. An important advance of our approach has been to allow the sort of symmetrical comparative analysis across diverse cases of engagement that has not been evident in the sustainability transitions or participation literatures hitherto. More specifically, a key feature of the analysis is that rather than take ideas and normativities of participation and civil society as pre-given categories that can be mapped on or assessed in relation to socio-technical systems (cf. Smith, 2012), these categories – as well as models of the public and definitions of the issues at stake – are viewed as being actively produced through the construction and mediation of collectives of participation. We argue that understanding participation ‘in the making’ in this way is important for exploring the politics of transitions.

As noted earlier, existing analyses of participation in transitions have found transitions management arrangements to be overly technocratic and exclusive (Hendricks, 2008; Lawhon and Murphy, 2011) whereas so called ‘bottom up’ or grassroots processes are more closely associated with the social shaping of innovation in line with the needs of the communities (Seyfang and Smith, 2007). While there are no doubt differences along these lines, our analysis is particularly revealing in highlighting commonalities and complexities across all cases, which upset and question a simplistic technocratic/democratic binary. All four of our cases were mediated and orchestrated through work invested by human actors and technologies of engagement, thus being subject to significant exclusions. These dynamics apply just as much to what might be considered ‘bottom up’ processes (Climate Camp, Dyfi Solar Club) as the two institutionally orchestrated ones (DECC 2050, VET). Furthermore, in all four cases we have seen how models of participation, of publics, and definitions of the issues or visions of low carbon energy futures are actively constructed at particular sites through these processes of mediation. These productive dimensions are not inevitable, however, and are the outcome of struggles and forms of resistance which were again evident in all cases but to varying degrees, highlighting the politics of participation in energy transitions. Rather than only judging collectives of participation in transitions against pre-given categories or normative principles our findings suggest that future analyses should focus on the relationship between the way in which heterogeneous collectives of participation are configured and the political openings/closings that occur (with respect to models, publics and objects of participation) (cf. Barry, 2001; Stirling, 2008).

Our analysis also has implications beyond the level of individual cases of participation and intervention in system change which has been the dominant scale of analysis in studies of participation in both STS and the transitions literature to date. Through a multi-case approach, which attends to diversity in forms of enrolment and the objects of participation, we have developed a perspective that emphasises the sheer *multiplicity* of collectives of participation - in the cases we

have analysed and many others that are similar or different to them - which coexist in any one socio-technical system or 'issue space'. In beginning to build this perspective in the context of UK low carbon energy systems, our analysis illustrates how *all* of the diverse collectives of engagement across socio-technical systems have effects in relation to these systems. This includes negotiated visions and potential material commitments which play a role in shaping future energy pathways, as well as producing varying modes of participation or 'democratic innovations' (Smith, 2009) in transitions. While some may consider our four case studies to be insignificant in relation the 'driving forces' of the UK energy system, this would be to dismiss the alternative voices, resistances, commitments and possibilities that they bring into being, and the cumulative effects of multiple forms of engagement that are seeming mundane but numerous and widespread. It would also be to privilege certain meanings or normativities of participation over others, as existing strands of the transitions literature, such as TM and SNM, arguably have (as discussed in section 2 above).

One further productive aspect of bringing constructivist STS concepts on participation into a deeper conversation with the transitions literature is that it brings the situated relational understandings of the former up against the systemic perspectives of the later. This raises the possibility of a more systemic perspective on participation than is currently evident in STS and other interdisciplinary fields of participatory research. In addition to building a picture of a complexity of coexisting collectives of participation our analysis also suggests that these collectives are to some extent mutually contingent and subject to complex interactions. We see this through the interactions between CAT's counter-appraisal and the DECC 2050 process, as well as interactions between Climate Camp and other grassroots transitions movements emerging at the time. In this sense, multiple collectives of participation in UK low carbon energy transitions can be viewed as diverse, co-evolving and interconnected 'ecologies of participation' (Chilvers, 2010b, 2012). This offers cues to building more systemic understandings of public participation in science, technology and the environment. It could be likened to the recent move in deliberative democratic theory from an emphasis on 'mini-publics' to that of 'deliberative systems' (Parkinson and Mansbridge, 2012), although our analysis places greater emphasis on the emergent, dynamic and co-evolutionary qualities of systems of participation.

Our constructivist STS approach to participation is more akin to 'flatter' relational ontologies emerging in the transitions literature (Shove and Walker, 2010; Garud and Gehman, 2012; Jørgensen, 2012) which pose fundamental questions and tensions *vis-à-vis* what some would see as the more 'structural' framework of the multi-level perspective. Rather than simply being mapped onto a multi-level framework, emergent collectives of participation in transitions - such as those in our four cases - make up socio-technical systems themselves, their topologies, and their stability and change. If we move to this perspective, though, what then constitutes the collective of the diverse collectives of participation across socio-technical systems? This is a question which has plagued relational ontologies inspired by the STS actor-network theory tradition, where even innovative attempts to bring politics and democracy back into STS analytical frameworks and procedural formats have deferred to linguistic/dialogic models of democracy to solve this question without sufficiently accounting for the materialities and construction of dialogue or democracy itself (Latour, 2004; Callon et al. 2009; cf. Marres and Lezaun, 2011). One possible way forward is to focus on institutions, and the diverse 'ecology of institutions' (Brown, 2009) for representing science and democracy, yet this would have the effect of foreclosing symmetrical analytical attentiveness to the

distributed and emergent forms of participation, innovation and agency highlighted by our case studies. These remain crucial questions for future research, which would benefit from attempts to pursue flatter ontological frameworks as well as attempts at integrating relational STS understandings of emergent participation with multi-level or institutional perspectives (for an example of the latter see Hargreaves et al. 2013). What we can conclusively say from our findings, however, is that forms of participation and democratic engagement are co-produced in mutual interaction with the coevolution of socio-technical systems, rather than existing as separate procedures or tools that are somehow 'bolted on' or integrated in (cf. Horst and Irwin, 2010; Jasanoff, 2011).

Finally, the analysis presented in this paper holds implications for more interventionist ambitions in the fields of sustainability transitions and participatory governance of science and technology. Where the interest lies in *designing* or catalysing new forms of participation and spaces of intervention in system change - whether that be transitions management platforms, pro-environmental behaviour change initiatives, grassroots innovations processes, or any other form of social actor engagement - our findings suggest the need for actors involved to be reflexively aware of partialities and exclusions of these collectives with respect to framing effects and 'overflows', constructions of publics, and the models of participation enacted. We would go further in suggesting that, given the inherent partiality and exclusivity of anyone form of participation in transitions, any interventionist ambition would need to also attend to the need for multiple entry points for social actor engagement and representation, in a system-wide and more thoroughly distributed sense.

Our findings also hold important implications for any attempt at *knowing* the system, which is a continual demand of 'reflexive governance' strategies in steering system change and future transitions pathways (Voß et al. 2006). The cases analysed illustrate the inherent uncertainty and indeterminacy of participation and the public, which is not currently acknowledged in participatory practice and science advisory processes. Attempts at speaking for or representing any one collective of participation should be accompanied by at least some effort to account for the partiality of framings involved and significant exclusions in terms of actors, visions and so on. Yet, these complexities multiply when considering system-wide ecologies of participation. Here our analysis suggests that attempts to understand participation and the public in low carbon energy (or other socio-technical) transitions through seemingly 'comprehensive' opinion surveys and deliberative techniques, can never be enough on their own, even if they account for aforementioned uncertainties. Our findings suggest the need for mapping complex patternings of diverse collectives of participation as they exist *in situ* across the system as part of any attempt to generate 'social intelligence' for reflexive governance of system change. This presents future methodological challenges for devising ways of mapping across diverse collectives of participation in governing system change (Marres, 2012; see also Chilvers 2010a). Perhaps more crucial, however, is the need to build the reflexive capacities of actors, institutions and distributed systems in sustainability transitions to attend to the uncertainties, indeterminacies and politics of participation and the public outlined in this paper (cf. Stirling, 2006; Smith and Stirling, 2007; Chilvers, 2013). Yet, it is both the analytical and interventionist implications we have considered in conclusion that are important for moving towards more deliberately reflexive governance for sustainability and attending to the politics of socio-technical transitions, at least when it comes to participation and 'the public'.

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