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Purely ornamental? Public perceptions of distributed energy storage in the United Kingdom

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ABSTRACT

Distributed energy storage technologies (DES) are expected to help in decarbonising the power sector, decentralising power sources and meeting the mismatch between the produced and consumed energy. However, the likelihood of the use and acceptance of these technologies will partly hinge on public perceptions. Here, we present results of three focus groups and dialogue from the city of Leeds (UK) held with members the lay public with and without personal experience of technology (photovoltaic panels) about public perceptions of distributed energy storage technologies at household and community scale. We apply and adapt the Energy Cultures framework, which was initially developed for understanding energy behaviours as mediated by individual psychological factors, by practice-based, energy-related culture and infrastructural elements. Accordingly, we connect what people *think*, *do and have* in energy contexts, to better understand perceptions of DES technologies as part of a broader renewable energy landscape (culture) that is both materially and socially constructed. We show how a variety of elements such as forms of energy consumption; costs; expectations of family members; previous experiences; perceptions of government and the municipal authority; and expectations about the technologies, are likely to shape acceptance and adoption of battery storage at the household and community level.

1. Introduction

A move towards less centralised, more integrated and interactive energy systems is increasingly understood as crucial to meet future energy challenges, supporting the development of a low-carbon electricity systems and helping to integrate renewable energy into future energy supply [1,2]. Distributed energy storage (DES) is relevant to both residential and commercial consumers [3]. As a term, DES includes energy in the forms of electricity, heating and cooling and includes various technologies, such as flywheels, hydro pump or heat storage systems, although in this paper we focus our investigation on small-scale battery (electricity) storage.

DES infrastructure located close to energy demand loads has the potential to provide key system and user-level benefits that cannot be provided by storage located at other points in the system, such as household-level peak demand shaving and embedded generation [4]. Accordingly, decentralised energy in general has received more attention in government policy and strategy in recent years, and local governments have ambitions for energy projects and initiatives [5] to deliver a number of benefits [6].

Overall then, renewable DES has the potential to support change in current centralised energy models, to more decentralised, lower carbon and collaborative models that are able to better manage energy input from multiple, typically renewable sources. DES generation and storage sources should provide the end user with local resilience, as well as assist grid operation by managing demand in such a way as to reduce peak loads. What is missing in the public domain, though, are the views of the end users, as citizen-consumers. Here we are concerned with how lay publics perceive domestic-level DES technology, before this technology has been introduced, on an anticipatory and hypothetical basis. As described above, DES offers potential benefits for these users in a posited future of more variable electricity supply. Yet we know neither how the scenario of DES as providing these benefits is perceived now, nor how they will be perceived in future, by end users themselves. Such information, we suggest, would be useful for informing the policy design and communication strategies of both commercial and public sector actors.

To shed light on these issues, we use the Energy Cultures framework

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(ECF) [7–9], principally for its broad and integrative nature. Using the ECF as an interpretative lens enables us to identify a wide range issues in the 'receiving' energy culture that are relevant for acceptance of DES. While the ECF can be used for detailed analysis, here we use it to provide an overview of the issues that arise in exploratory, qualitative work in the United Kingdom (UK). We use a sample of both 'typical' members of the public, who are unfamiliar with DES, and, as an analogy of typical public exposed to storage technology, a group of local authority tenants with experience of household-scale battery storage as part of photo-voltaic (PV) systems *that they did not choose*. That is, who are not pro-environmental in attitude or motivation.

While the number of studies on public perceptions and the acceptance of renewables and new energy technologies has proliferated [10,11], there are as yet few studies of public perceptions of energy storage [12,13]. Of these, Romanach et al. [14] describe the results of a survey in which various issues relating to batteries at the household level are addressed, highlighting the paucity of our knowledge and areas for further research. In the Japanese context [15] there is also research on consumer perceptions of solar photovoltaic panels (PV) in relation to energy storage. This suggests that publics lack information about the potential benefits, and also that attitude-formation towards DES systems are in its infancy.

To our knowledge, though, there is as yet no publicly available research on the qualitative aspects, meanings and interpretations of DES technologies, partly because the deployment of energy storage technologies is still in the early stages and relatively unknown to the general public. In advance of the study, we anticipated that the main concerns about batteries would relate to cost, expectations of the technology and institutional design [16]. We also anticipated that individuals' previous experiences, together with their level of knowledge of the technologies, would likely structure their perception of DES technologies [17]. The results broadly supported our suppositions and provided more detail on the ways in which these issues can play out in practice.

The specific objectives of the paper are as follows. First, we aim to understand more about public perceptions and acceptance of batteries at household and community levels, bearing the above suppositions in mind. Second, using the Energy Cultures framework (ECF) [8,9], we aim to characterise issues relating to the uptake and acceptance of DES technologies, specifically in terms of the ECF and participants' meanings of technology in this context [18]. The core research questions are: (i) what are the characteristics of the prevailing energy culture(s) within which DES will need to operate; and (ii) what issues do these raise for public acceptance of DES? Thus we use the ECF both to explore the prevailing energy culture, and to identify how norms (expectations and aspirations), material culture and practices relating to energy may be influential in supporting (and hindering) the adoption of DES. We first begin with an overview of the nature and value of the ECF.

2. The Energy Cultures framework

Many theoretical lenses have been applied to the study of public responses to energy technology, with emphases ranging across causal factors and dimensions of the problem in relation to place [19–21]; practice [22,23] and habits [24–26]; institutional arrangements [27]; scientific knowledge [28]; socio-cognitive representations [29–33]; and risk perception [21,34]. In addition to this are micro-economic and behavioural economic perspectives [35,36].

Each of these and other approaches highlights and addresses particular aspects of the problem. However, the perspective that we use here, the Energy Cultures framework (ECF) is deliberately general, global and holistic. As a multidisciplinary perspective, the ECF is intended to allow the study of the individual as an autonomous agent, capable of making their own decisions and generating changes [8] within a wider perspective comprising values, beliefs and knowledge, the broader socio-cultural context, and the regulatory and market environment among others, all of which can affect or drive energy-related behaviours [8]. The ECF was initially developed to provide an understanding of why people would perform the same patterns of energy-related behaviours while it seemed 'logical' to change them, where that logic is based on some external criterion such as economic or financial cost. The perspective recognises individual agency to some extent but also attaches importance to external influences, e.g. place, time, culture or power relations, that could cause energy cultures to change or remain the same.

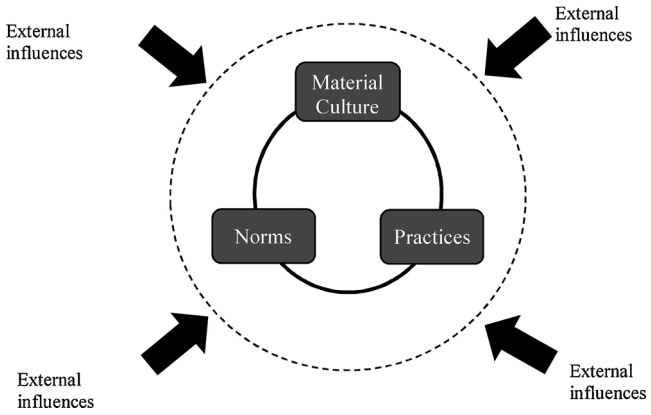

Fig. 1. The Energy Cultures framework (Stephenson et al. [7,9]).

The framework is composed of three elements: practices, material culture and norms (Fig. 1). These elements interact with each other to organise different views on energy use practices [8,37]. Here, practices are understood as everyday actions (both routinized and less frequent) that are common across social peers. The ECF also incorporates the acquisition of the material objects that enable people to enact and reproduce those practices [9]. The material culture are those available objects, technologies and individuals that can control, influence, and affect people's energy demand. The cognitive norms are expectations of a particular service or behaviour that are shaped by a specific meaning attributed to them. As such, within the ECF, cognitive norms include values, beliefs and attitudes. In addition, the ECF acknowledges the importance of external influences when shaping uses of energy and energy behaviours. A particular set of these three elements together with the external influences, give rise to a distinct energy culture, specific for one actor or group of actors.

The ECF can be applied at different levels (e.g. community, individual) and for different subjects of acceptance, as the previous definition suggests [38]. The ECF framework is particularly useful for understanding how energy behaviours are shaped by material objects, such as a PV system [39]. It has been applied in the field of mobility and transport [40], individual GHG reduction behviour [41] and the uptake of photovoltaic technologies [39].

Overall, the ECF draws on both psychological and sociological insights and has not (at least in its original design) been significantly concerned with arguments about potential ontological irreconcilability [42]. Rather, the aim has been to create a multi-factor framework that is comprehensible to natural scientists but defensible for social scientists [9]. That said, possibly the most contentious aspect of the approach is not so much its applied eclecticism, but rather the claim that an entity as abstract as energy should have an associated 'culture'. From a psychological perspective, attitudes have specific 'objects', and from the sociology of practice perspective, specific aspects of the material world (including technology) are an integral part of the account. Energy is a more general conceptual category than the types of specific technology and behaviour analysed within environmental behaviour or sociology of practice frames. One can readily conceive of a 'car culture' or a 'food culture', both of which have implications for energy use, but 'energy culture(s)' is substantially more abstract.

Yet we think the ECF valuable for several reasons. First, it likely