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A conceptual framework for understanding the social acceptance of energy infrastructure: Insights from energy storage

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ABSTRACT

Although social acceptance research has blossomed over the last decade, interdisciplinary studies combining market, socio-political and community aspects are scarce. We propose a novel integration of social science theory in which the belief systems or social representations held by key actors play a crucial role in fostering acceptance of novel technologies, and where a polycentric perspective places particular emphasis on ways that middle actors mediate processes of change between scales. We advance a methodological approach that combines qualitative and quantitative research methods and exemplify the framework by focusing on acceptance of renewable energy storage solutions to accommodate high levels of renewable energy deployment. A research agenda for the social acceptance of energy storage is proposed that sets out key research questions relating international, national and local levels. The outcome of such studies would not only lead to enhanced understanding of processes of social acceptance, but deliver important insights for policy and practice.

1. Introduction

Social acceptance has been a prominent topic of research by energy social scientists for at least the past decade (Devine-Wright, 2005, 2011; Wüstenhagen et al., 2007; Sovacool and Ratan, 2012; Aas et al., 2016). In this article we propose a novel, interdisciplinary conceptual approach to explain why changes to energy systems are accepted or resisted in different ways in different geographical contexts. We elaborate the methodological requirements needed to develop this approach empirically, and trace a pathway for research to address a novel and hitherto neglected topic: the social acceptance of renewable energy storage.

We adopt a critical approach to social acceptance, mindful of how energy social science research has been skewed towards understanding resistance to technology implementation by the 'NIMBY' concept (Not In My Back Yard) (Devine-Wright, 2011), with the result that research into support has been neglected by comparison, associated with a focus on public responses to the detriment of policies, institutions and other stakeholders (Batel et al., 2016).

For example, it has already been demonstrated how different epistemological and methodological frameworks lead to different policy conclusions (e.g. Batel et al., 2016; Shwom and Lorenzen, 2012). These indicate how positivist, quantitative, and individualist frameworks produce partial pictures of the social acceptance of energy technologies, failing to consider the roles of different actors, their expectations and interactions, and the diverse materialization of technologies at different scales.

In contrast, our approach aims to provide a first step in understanding the full gamut of societal beliefs about, and responses to technological change, including objections and resistance, support and adoption, apathy, disinterest and disengagement (Batel et al., 2013), and by different actors (e.g. companies including smaller enterprises and incumbents; policy makers and regulatory bodies; nongovernmental organisations and other members of civil society, the media and local residents).

A highly cited framework proposes three dimensions to social acceptance: markets, socio-political and community (Wüstenhagen et al., 2007), with a revised version separating the political from the societal/community aspects (Sovacool and Ratan, 2012). Whilst the framework is useful for distinguishing contrasting aspects of accep-

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tance, each involving different actors, it is weakened by a lack of emphasis upon how each dimension inter-relates across different geographical scales (from macro to micro; international, national and local). Moreover, we observe that few empirical studies have encompassed more than one of the three aspects in their respective analytical frames.

Our interdisciplinary approach to social acceptance integrates theoretical ideas from social psychology (social representations theory, Batel and Devine-Wright, 2015; Gaskell et al., 2015), governance (polycentric governance and the role of middle actors, (Parag and Yanda, 2014) and human geography (micro to macro scales, Herod, 2011). It is therefore similar to theories of social practice, but still different in that we go beyond materials, competences, and meanings (Galvin and Sunikka-Blank, 2016) and extend our analysis beyond the unit of a practice or circuit of practice.

Social representations theory (SRT, see Batel and Devine-Wright, 2015; Gaskell et al., 2015) explains how social knowledge changes over time. Specifically, it elaborates the socio-psychological processes through which actors make sense of change, or what happens when a new idea or technology (e.g. renewable energy storage) becomes more widely known, talked about and understood in society. The process of understanding is theorised as operating simultaneously at *both* individual and societal levels. Communication is central to the theory, as it is the basis of constructing knowledge and our understanding of the objects around us, and is shaped by power asymmetries between actors.

Communication is often studied by analysis of public talk during focus group discussions and by analysis of media reporting, as the media are considered within the theory as one of the most important actors in circulating and shaping public representations of social and potentially controversial issues. Social representation processes are also present and revealed by communications amongst actors within economic and political systems and by institutional arrangements that will influence how belief systems change and develop over time (e.g. Batel and Castro, 2009). This is why the theory of social representations is suitable for research on social acceptance that integrates policy, market and civil society actors. In turn, social representations theory can also be articulated with insights from other important theories regarding people's relations with technologies, such as theories of practice (see Batel et al., 2016 for an extended discussion) that are useful to examine social acceptance at the local level.

In theories of energy system change, actors are typically positioned at either national/regime or local/niche levels (e.g. Stern et al., 2016). The Wüstenhagen et al. (2007) framework exemplifies this by reference to (national) socio-political and (local) community dimensions. Although important, this neglects the role that 'middle-actors' play in driving (or obstructing) system change, and in diffusing innovative technologies and practices. Middle actors refer to those who work from the 'middle out' with the agency and capacity to influence transitions by making change upstream (to top actors), downstream (to bottom actors) and sideways (to other middle agents) (Parag and Yanda, 2014).

Accordingly, we take a polycentric perspective (Ostrom, 2010) on the process of social acceptance of energy system change. This involves investigating actors that are working independently of each other at macro, meso and micro levels within the same energy system, thus transcending both conventional 'top-down' *and* 'bottom-up' understandings to investigate the complex dynamics between technological solutions and actors over time. This requires analysis of multiple societal groups (Pierre and Porter, 2005), remaining cognizant of the potential implementation of novel technologies at different levels/scales, with a particular interest in the dynamics *between* several levels of decision-making and intertwined policy areas that encompasses both public and non-governmental strategies and actors (Bache and Flinders, 2004). At the same time, we recognise that incumbents may find current processes and accompanying changes as a challenge to conventional belief systems and ways of working. Path dependence may create a form of lock-in (Unruh, 2002) or inertia to change – even if change is politically approved and socially acknowledged. This has already been documented by studies of renewable energy policy implementation in Europe (Lafferty and Ruud, 2008).

At its core, our integrative framework focuses upon the role of belief systems held by diverse social actors (e.g. policy makers, journalists, community leaders), based on the assumption that these are crucial to social acceptance within each of the three dimensions proposed by Wüstenhagen et al. (2007), and cannot be understood without also taking existing political, economic, socio-cultural and geographical factors into account. Hence, the scope of our approach is holistic and interdisciplinary. Cross-cutting these levels, we use the geographical concept of scaling as an analytical lens, mindful that the scale at which energy systems generally, and energy storage in particular, are deployed is not preordained (Bridge et al., 2013).

2. From theory to application – assessing the social acceptance of renewable energy storage

High levels of renewable energy deployment (e.g. wind and solar) are a fundamental element of policies for the low carbon transition and for responding effectively to the threat of climate change (e.g. European Commission (2014)). However, there are significant challenges involved with balancing supply and demand in a system with high levels of variable or intermittent energy sources (Qvenild et al., 2015), challenges that have been a longstanding concern of system experts (e.g. Royal Academy of Engineering 2002). The curtailment of renewable energy generation is already a widespread global phenomenon (Weitemayer et al., 2015), leading to loss of revenues, threats to the satisfaction of basic needs and delay in progressing climate change mitigation.

Energy storage is one of a number of measures proposed to deliver system flexibility, and is an area of rapidly developing technological and economic activity (McKinsey, 2015). Storage solutions, like many energy technologies, can be deployed at a range of scales, involving many forms of 'hardware' and 'software' (cf. Walker and Cass 2007). Storage hardwares encompass systems at the micro level that might be installed in domestic settings (or taking advantage of the batteries already installed in electric vehicles), at the meso level, for example larger scale solutions that might be attached to a particular renewable energy project such as a ground-mounted solar farm or a community energy facility, and macro level, grid-scale solutions – each of which involve varying storage time, voltage levels, ramp rates, response times and costs. These aspects are necessarily intertwined with diverse softwares, for example procedures of governance, market and business models, and public roles and expectations.

Despite its emerging significance, social acceptance of renewable energy storage has been overlooked to date by energy social scientists. This is problematic as it provides a deficient evidence base to inform policy making and practice, and may lead to resistance towards technical solutions, implemented at micro, meso or macro scales, which are based upon flawed assumptions about user or public expectations. Research has already documented the prevalence of 'information deficit' (Owens and Driffil, 2008) and 'NIMBY' (Not In My Back Yard, Barnett et al., 2012) ways of imagining publics and critiqued their consequences in relation to strategies of public and community engagement (e.g. Burningham et al., 2015). Research is needed to investigate the ways that these representations shape technological trajectories and siting strategies for energy storage, for example leading to grid-scale solutions that are driven by, in part, assumptions of domestic apathy or resistance. In consequence, it is important to examine multiple technological proposals at different scales of deployment and to fully reveal the representations of publics, and social acceptance, that underlie these.

To address the lack of social science research on social acceptance of energy storage to date, we propose that research should adopt an