



Contents lists available at [ScienceDirect](http://www.sciencedirect.com)

Energy Research & Social Science

journal homepage: www.elsevier.com/locate/erss



Perspectives

Crossing transdisciplinary boundaries within energy research: An ‘on the ground’ perspective from early career researchers

B. Mallaband^{a,*}, S. Staddon^b, G. Wood^{c,1}

^a Aston University, Aston Triangle, Birmingham, B4 7ET, United Kingdom

^b University of Edinburgh, Drummond Street, Edinburgh, EH8 9XP, United Kingdom

^c University of Birmingham, Edgbaston, Birmingham, B15 2TT, United Kingdom

ARTICLE INFO

Article history:

Received 3 January 2017

Received in revised form 30 January 2017

Accepted 30 January 2017

Available online xxx

Keywords:

Transdisciplinary

Social science

Energy research

Early career researchers

ABSTRACT

This paper considers some of the potential consequences of social scientists adopting physical energy terms in their publications in order to appeal to and hopefully influence policy-makers. There are a number of elements to this debate, from the more practical consideration of how energy is discussed by different parties, to more political considerations around the standing, inclusion and power of the social sciences. We also focus on the key issue of communication, the essential ingredient for translating complex information into everyday use, as well as understanding the people at the centre of energy reduction and who, in our opinion, hold the key to change. This paper highlights the importance of journals such as ERSS in providing a ‘safe space’ for social scientists to publish research specific to their discipline and to promote wider discussion in a suitable language.

© 2017 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

1. Introduction

We would firstly like to thank Adam Cooper for opening up this debate from his unique position of experience of both government department and academia. His experience is hugely insightful in understanding how the social sciences, and other disciplines, may better influence policy. As early career academics from two different fields within the ‘wider social sciences’ (User Centred Design and Human Geography), we welcome the opportunity not only to engage in the debate of how the social sciences can better influence energy policy, but also to partake in and guide the practicalities of how this might happen. We each have experience of working within cross-disciplinary socio-technical energy projects and have previously published on the mismatch and inequality of the role that the social sciences and individual early career social scientists play in these projects within the energy domain [1]; we thus feel able to offer an opinion in constructive debate, from the perspective of those working ‘on the ground’.

In our previous work we report that the social sciences were often included in cross-disciplinary projects for their methodological contributions and to help legitimise energy technologies, rather

than for their full epistemological or conceptual offerings. We suggest that such integration of the social sciences in cross-disciplinary projects is partial; falling short of an equitable relationship. This equitable relationship is what Barry et al. [2] refer to as interdisciplinarity based on an ‘ontological logic’ i.e. in which there is an equal and productive relationship between all disciplines. Working across disciplines has been much debated (e.g. [3,4]), however we suggested that communication was key to promoting successful cross-disciplinarity and we believe that this is equally true for transdisciplinary working, when engaging with policy-makers. We therefore agree with the spirit of Cooper’s call, of the need for better communication between academics (including social scientists) and policy makers. Without this, there is little hope that our combined research efforts will amount to much impact in the daily realities of those whom we, as social scientists, seek to champion e.g. the fuel poor. We are also broadly supportive of Cooper’s socio-technical approach to energy research and suggest this could be taken as an example of interdisciplinarity based on an ‘ontological logic’, as promoted in our own work [1] and also reflected by Castree and Waitt [5].

Whilst we appreciate Cooper’s nuanced discussion of a socio-technical approach in relation to the current imbalance of disciplines within energy research, we are troubled by his assertion that counting the number of times a physical energy unit is discussed in a social science paper either; constitutes a useful proxy for its meaningful engagement in the physical ‘stuff’ of energy, or

* Corresponding author.

E-mail address: b.mallaband@aston.ac.uk (B. Mallaband).

¹ Present address: University of Edinburgh, Drummond Street, Edinburgh, EH8 9XP.

<http://dx.doi.org/10.1016/j.erss.2017.01.021>

2214-6296/© 2017 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

indicates how useful that paper and its findings may be to a policy-maker. We would suggest that in order to understand the latter, an in-depth qualitative study would be required to ascertain how policy-makers access, value and utilise different forms of evidence; and how this changes over time, reflecting wider shifts in thinking. This would indeed be a very fruitful exercise and one from which many within academia (and no doubt policy-makers too) could learn a great deal. We agree with other papers in this volume [5,6] who expand in detail on the importance of understanding the policy-making process, rather than assuming any piece of research will influence policy merely by being published.

2. Publishing issues: sample sizes and publishing sanctuaries

There have been several recent calls for cross-disciplinary socio-technical energy related research projects under the Horizon 2020 and COST initiatives, the USGCRP in the United States and the recent EPSRC (Build)TEDDI fund.¹ Such projects provide great opportunities for ECRs to experience working in cross-disciplinary collaborations as postdoctoral researchers, however, the nature of publishing the results of interdisciplinary projects can be difficult [7,8,1] and tends to see separation of the physical and social sciences due to external constraints (e.g. the REF, monodisciplinary career progression, journal prestige). We feel that ECRs could be disadvantaged from papers written using the socio-technical approach Cooper suggests, as they may struggle to find suitable high-impact journals in which to publish. This suggests that some responsibility lies with publishing houses and individual editors to increase acceptance of socio-technical papers.

Whilst Cooper criticizes several research papers for their failure to include physical units of energy, we suggest that this might be a deliberate choice. Publishing in a chosen journal involves contributing to its particular ongoing debates, and doing so in the common language in which that conversation is conducted. We feel it is unlikely that authors of sociotechnical papers which include significant physical or technical details would choose *ERSS* as a location for such information, perhaps selecting a journal such as *Energy and Buildings* in order to contribute to ongoing technical conversations. We believe that Social scientists are likely to see *ERSS* as a 'safe place' to publish research specific to their discipline and therefore agree with others writing in this volume (e.g. [9]) that comparing the papers published here to those in *Energy Policy* is unfair, the latter being a journal which focuses specifically on policy implications.

This 'safe place' that *ERSS* provides is also key for publishing the type of research produced by social scientists, where some are conducted on a small exploratory scale due to its time and resource intensive nature; whilst other more technical journals which might demand large, more quantitative data sets that provide statistically relevant results. As the social sciences have in some ways been the underdog to the physical and technical sciences, this type of publishing sanctuary is essential, at least until academia in the UK (and beyond) is better able to support and promote all elements of cross-disciplinary research.

We do however suggest that neither the research carried out, nor the manner in which it is reported in journal articles is the main issue, rather the way in which this information is translated into a usable format for technologists and policy makers, a challenge which Castree and Waitt [5] also draw our attention to. Surely *how* energy is discussed is not the issue, rather the importance that it is discussed and that these discussions lead to an overall reduction in energy usage.

In this perspective, we consider some of the potential consequences of social scientists adopting physical energy terms in their publications in order to appeal to and hopefully influence policy-makers i.e. the central argument of Cooper's paper. There are a number of strands to this debate, from the more practical consideration of how energy is discussed by different parties, to more political considerations around the standing, inclusion and power of the social sciences. We also wish to focus on what we consider to be the underlying issue surrounding this topic and that which we will discuss further below: *communication*. This is the essential ingredient for not only translating complex systems into home use, but also in understanding the people who are at the centre of the complex issue of energy reduction and who, in our opinion, hold the key to change.

3. How do people make sense of energy?

Our main proposition here is that people in their homes and workplaces do not generally think about or discuss energy in terms of Kilowatt Hours (kWh) and other such technical terms, thus social scientists should be free to impress upon policy-makers the significance of the ways in which people *do* make sense of energy, rather than being forced to adopt one particular set of (technical) terms. Before the recent introduction and rise in popularity of digital displays in the home, householders could only use meter readings, bill information or sensory feedback to understand the way they use their energy for heating the home. The smart meter rollout and the increase of in-home displays have enabled easy access to real-time information in kWh as well as pounds and pence, but still social science research finds that people have difficulty in understanding kWh or relating this to their every action (e.g. [10]). We know that people do not 'use' energy; rather it is consumed in order to carry out everyday activities and routines, often subconsciously. Unfortunately, these new in-home technologies have often tended to highlight the energy consumption of appliances, rather than educating householders in the energy consumed from their home as a system, or seeking to uncover their understanding of this.

Researching energy use by asking the general public questions related to kWh has limited results, for this is not how they (or for that matter, we,) think of energy. Strengers [11] highlights the language used by a participant when discussing energy e.g. "kilowatt-*tevers*", intimating the participant's nonchalance surrounding this terminology and their lack of desire to understand it. Whilst, Royston [12] describes how people discuss and measure their temperature and comfort in terms of whether their toothpaste was solid (due to low temperatures) or snow-melt as a sign of roofs being poorly insulated. Clearly, these people are discussing very 'physical' measures of energy, not using the technical terms preferred by engineers or physicists, but rather in terms which make sense to them and encapsulate the impact energy has on their lives. In this we concur with Galvin [9] who argues against an 'elitism' implied by those promoting purely technical measures of energy. Clearly, users do not need an understanding of their energy use in kWh in order to reduce their usage.

Social scientists seek to capture people's understandings of energy use in their own words and through their own experiences, in the context of their wider lifestyles. In some research studies, the issue of cost is removed when discussing with users, as they can be distracted or confused by their level of understanding in relation to units of measurement [13]. Instead social science is keen to further understand the underlying behaviours, habits and thoughts which seek to explain their actions, which has led to studies utilising a wide range of methods such as home tours, participant observation, diary studies, probes, scrap-booking and in-depth interviews

¹ <https://teddinet.org/>.

[14–16]. However, such methods do not typically generate material which is measured in physical science terms.

Without understanding the context of use, it is extremely difficult, if not impossible to fully design a product or service which truly meets the needs of users (a core principle of User Centred Design, [17]). We have certainly seen a number of energy saving products, services and systems fail to reach mass market and therefore fail to have the impact needed for change. We suggest that this failure is due to the lack of understanding of the context in which they are to be placed, i.e. the lives, homes and lifestyles of their users. This extends to Government policies such as the Green Deal, is it possible that these government policies have failed because they don't discuss energy in terms that householders use and understand?

Cooper's assertion that social scientists should adopt such technical terms in the reporting of their research is thus, we suggest, misplaced. In our opinion it should instead, at least in part, be policy-makers who need to become more open to and appreciative of alternative (i.e. non-technical) measures of energy and the ways in which people make sense of it in their everyday lives, thus widening what is perceived as 'realistic' research (as termed by Castree and Waitt [5]). This would serve to bring policy-makers closer to the beneficiaries of their policies, and hopefully lead to the creation of more user-centred policy.

4. Thinking more creatively about energy policy through equitable transdisciplinarity

Cooper demands that '*To answer [policy] questions framed in these [physical] terms, answers with these terms are needed, or they have no traction*'. Many social scientists however seek not to provide neat answers to questions from policy-makers, but rather to *shift* or *widen* the terms and questions themselves. They seek to influence energy policy by applying external pressure, rather than creating internal traction. The value of research adopting a 'social practice theory' approach for example, is in widening the focus of energy studies to encompass the actions and competencies, the things and materials, and the meanings associated with energy. Hargreaves et al's [31] influential paper which adopts such an approach is, as Cooper states, "invaluable"; it does not however *claim* to have direct policy relevance. Rather its relevance comes about through a more *indirect* route; one which demands that policy-makers step outside of their normal frames of reference (such as kWh) and be open to alternative ways of thinking about energy demand and how that can be transformed. Discussing the value of interdisciplinary research in relation to climate change adaptation, Nightingale [18] asserts that the goal '*is not to form better predictions of change, but rather to think more creatively and widely about how to imagine response options*' (p.46). We suggest that this principle should also be applied to energy research, bringing together multiple disciplines (including the social sciences) and multiple professions (i.e. academics and policy-makers); thus allowing new 'response options' (i.e. policies) to be imagined. It should not simply be about one discipline conforming to the language of other more dominant disciplines, particularly if there is a chance of misrepresentation or misunderstanding of these terms, as discussed by Stephenson [19].

Redressing the historical side-lining of the social sciences in energy research is a central tenant of this journal. This is not however restricted to energy, we see for example a similar trend in research which explores the inclusion of local communities in the conservation of nature [20,21]. In this case, the ecological knowledge of local communities has historically been seen as inferior to that of Western scientific knowledge, although is increasingly being championed by social scientists, keen to call for a more political response to redress imbalances of knowledge, and therefore power, in how the natural resources are managed [22–24].

In our own work on interdisciplinary energy research [1], we frame the inclusion of the social sciences as *partial*, reflecting merely a 'logic of accountability' and 'logic of innovation' respectively [2]. We suggest that social scientists who are championing the language and conceptualisations of energy by people in everyday life, are similarly disadvantaged as the local communities mentioned above, particularly in light of calls by Cooper to turn their backs on those everyday understandings in order to adopt the technical language of energy professionals. We are concerned that the request for social sciences to compromise on their methods, approaches and communication could mean the discipline loses ground which several academics and journals such as *ERSS* have worked so hard to gain. There is a political imperative here that dominant narratives in energy demand reduction, for example, those which focus on and advantage technologically-minded 'Resource Man' [11], do not shut down alternative conceptualisations, knowledges and forms of participation in our combined efforts to reduce energy demand [32], and such sentiments are repeated by others in this volume (e.g. [5,9]). As scientists and researchers, we have a moral and ethical obligation to strive for more balanced forms of interdisciplinarity and transdisciplinarity, based on values of equality, rather than dominance. This type of interdisciplinarity will enhance and grow all those involved, as described by Stephenson [19] when recounting her own learning.

Cooper's call for social scientists to adopt technical energy terminology clearly connects to wider debates about the power and influence of particular disciplinary and epistemological communities. Terms in any branch of research are used intentionally, to convey a particular measurement, idea or issue of importance to the researcher. Specific terms emanate from particular sets of knowledges and beliefs about reality, and as such are merely the tip of the iceberg in what sets different disciplines apart. All forms of cross-collaboration are however inherently group-based activities, and as such require communication between those individuals involved. Therefore, we once more turn to the more practical side of the debate, this time to consider how different forms communication can lead to more creative and innovative energy policy.

5. Communicating for creative and innovative energy policy

In order to create effective policy; and in order to undertake policy-relevant academic research, there clearly needs to be effective communication between the academic community and policy-makers. Many authors have written about the difficulty of communication when working across disciplines (e.g. [19,25,8,33,34,26]) and in order to achieve the kind of integration discussed by Cooper, this is likely to require a common language and agreed definitions, used from the initial stages of the research. Communication entails a two-way dialogue (as illustrated in Stephenson's [19] 'conversation'), thus terms of reference need not necessarily come from one discipline alone, but rather could be borrowed from any discipline involved, or indeed a new terminology could be developed; an example being Cooper's sociotechnical approach. Disciplinary-specific terms, and the ideas and beliefs which underpin them, will need to be explained and translated throughout a collaboration or as part of research dissemination, but this process of sharing is vital for opening up possibilities for creative and innovative energy research *and* policy.

We can see examples of this in the role of the User Centred Designer, which is often a bridging role where data (often qualitative) from users' needs to be translated into a form which can be used by the technologists, as well as the translation of technical questions into research methods to elicit information from users [27]. These questions are often framed without using physi-

cal terms, in order to gain appropriate information from users, and therefore, answers do not come in this format either. Consequently, this information may then need to be translated into a different format. For social science papers, this translation may be minimal, as the raw verbatim descriptions are incredibly rich and insightful. Whilst it is not expected that those from more physical or technical sciences will begin to translate information from a raw qualitative format, likewise it should not be expected that those within the social sciences should always be constrained to portray their information in a physical format.

Whilst language and terminology are hugely important in communication, so too is the context in which it takes place, and whether that effectively enables an *exchange* of knowledge and ideas. Simcock et al. [35] argue for a more nuanced understanding of the ways in which information about (potential) energy savings is passed on to householders. Finding that the most useful information is that which is contextualised and easy to understand, particularly if relayed by a trusted source or someone with expertise or competency in the area. An interactive process of communication which cultivates an exchange of knowledge is also key [35]. We believe that these same conditions and circumstances are necessary for building effective communication and learning between academics and policy-makers, where improved communication goes beyond telling social scientists to adopt physical energy terms.

Academic papers, whilst the backbone of research practice and currency of academic careers, are widely known to be of minimal use and influence outside of academia. Better ways in which to communicate with policy-makers and to cultivate co-learning may arise from academics spending time with those creating policy, either through secondments or dedicated workshops or events. Such activities enable relationships to be built between individuals, which will hopefully generate a sense of trust and appreciation for the expertise of all those involved. In spending time with others, we learn more about the daily pressures and realities of their work, and thus can contextualise information. In such situations, ‘information’ may not only take the form of journal articles, but also specific insights offered up in response to particular questions or challenges. Many relevant insights may never even make it into journal articles, thus conversations between both governmental and non-governmental [28] individuals, whether they be face-to-face or virtual, are key, and clearly, this information and knowledge exchange needs to be interactive. In this age of ‘impact’, academics stand to benefit from this communication and co-learning just as much as policy-makers do. Whilst such physical interactions take time and money, more opportunities are opening up.²

6. Alternative propositions to Cooper’s hypothesis

Cooper’s assertion that social scientists should adopt physical energy terms presupposes that all social science research wishes to be policy relevant. Whilst the research may not all be conducted with the intention to directly influence policy, there may still be the desire to challenge or disagree with the current policy or political arguments. Stern [28] points out the potential influence social science research can have by speaking to *non-governmental actors*. Therefore we need to ask, how often and to what extent does energy social science research need to inform policy or fit into political agendas? Can social science be an equally respected discipline without always seeking to influence policy? Or how can we change policy in order for social science to have the required influence? Should policy be discussing terms which the general population

understands, rather than trying to reverse engineer their descriptions?

In terms of social scientists adopting physical energy terms, we might want to ask them directly, why it is that they currently do *not* use those terms? And what would it mean for their research if they did? We may also wish to ask questions of policy-makers, including how they go about accessing and engaging with academic papers? And why it is that they do not currently make full use of social science outputs? We may also wish to suggest to social scientists (that are interested) that they spend more time with policy-makers, to understand where they are coming from and how they may be of use to them. We would also suggest that BEIS (and policy-makers in other fields and countries) may wish to consider employing more social scientists, given the seeming dominance of economists, engineers and physical scientists, as referred to by Cooper. This would serve to increase internal capacity within the social sciences and to promote internal communication and co-learning between disciplines; in so doing, facilitating external collaborations with academics.

7. Conclusion and implications

Whilst Cooper suggests that there are two camps of energy researchers: mainly technical and mainly social, we would argue that there is a new breed of researchers who are daring to stand with a foot on the precipice of the other discipline. However, there is not yet a structure within UK academia or policy which provides a support system for these researchers, which may therefore result in them returning to the safety of their discipline in order to publish and progress in their own careers. We believe that these pioneering researchers hold the key to true inter- and transdisciplinary research, and are in the early stages of uncovering and developing working and communication practices to help its success. However, they can’t do it alone, and without a flexible support system which allows them to work in new ways and perhaps translate information in new and different forms, it is unlikely that we will solve the enormous energy related issues that we are facing; and therefore on that front, we agree with Cooper. We therefore call on funding bodies, senior academics and policy makers to engage in new ways of working which allow these cross-disciplinary researchers to operate, and to look for opportunities to support them where possible (for ideas of how to do this in practice see [1]).

It is difficult to argue what level of integration would be classed as ‘sufficient’ to translate a ‘social and technical’ study into a *socio-technical* one, but we would certainly argue that a socio-technical study cannot be defined by its results alone. For those of us who have ‘worked on the ground’ in these studies, regardless of the disciplinary dominance of the outputs, the work being conducted in the day to day running of the projects is no doubt socio-technical, as researchers from the social and technical disciplines work together towards a common goal, often overcoming many challenges in doing so (see [1] for more detail). We believe that, slowly over time, this helps everyone involved to widen their horizons and skillset and to think more creatively. Increased interaction and communication between academics and policy-makers, which goes *beyond terms alone*, will also, we believe, lead to more creative and innovative energy policy *and* research. This does not merely mean *more* research is conducted, rather that collaborative research takes on a new form [5].

For ECRs engaged in this field, we would encourage them to pursue new methods and ways of working which better allow them to work across disciplines. Whilst we do not feel they should necessarily start discussing their research in technical terms, there is some responsibility on all who work in this field to be mindful of the opportunities for translation of information and to assist the

² One recent example is the joint BEIS-TEDDINET smart metering-based innovation and building performance workshop [30].

understanding of others where possible. We also encourage social science ECRs to 'stand firm' in the working practices they know and love and not to be pressurised into change which compromises the validity and importance of their results to their own discipline.

We would ask for the editors of this and similar journals to heed their position as a 'publishing sanctuary' for social science researchers and not to force this research and its communication to change in a particular direction, rather to continue to celebrate the richness of the research conducted and the valuable insights into the everyday lives and practices of both society and individuals within it.

Whilst we appreciate that the task of the policy-maker is no easy one, we agree with Shipworth et al.'s [29] suggestion that policy-makers may need 'bifocals' when it comes to approaching the various insights and contributions of different disciplines. No singular research approach or discipline will succeed in influencing policy which brings about the changes needed. This is the academia of the past, and we know that the current grand challenges require a far more conjoined approach.

References

- [1] B. Mallaband, G. Wood, K. Buchanan, S. Staddon, N.M. Mogles, E. Gabe-Thomas, The reality of cross-disciplinary energy research in the United Kingdom: a social science perspective, *Energy Res. Social Sci.* 25 (2017) 9–18.
- [2] A. Barry, G. Born, G. Weszkalnys, Logics of interdisciplinarity, *Econ. Soc.* 37 (1) (2008) 20–49.
- [3] D. Spreng, Transdisciplinary energy research – reflecting the context, *Energy Res. Social Sci.* 1 (2014) 65–73.
- [4] B.K. Sovacool, S.E. Ryan, P.C. Stern, K. Janda, G. Rochlin, D. Spreng, M.J. Pasqualetti, H. Willite, L. Lutzenhiser, Integrating social science in energy research, *Energy Res. Social Sci.* 6 (2015) 95–99.
- [5] N. Castree, G. Waitt, What kind of socio-technical research for what sort of influence on energy policy? *Energy Res. Social Sci.* (2017) (this volume).
- [6] A. Mazur, A Sociologist in Energyland: the importance of humans in energy studies research, *Energy Res. Social Sci.* (2017) (this volume).
- [7] Committee on Facilitating Interdisciplinary Research, Facilitating interdisciplinary research, in: National Academies, National Academy Press, Washington, 2004.
- [8] M. Winskel, I. Ketsopoulou, T. Churchouse, UKERC Interdisciplinary Review: Research Report, UKERC, 2015 (Available at: www.ukerc.ac.uk/publications/ukerc-interdisciplinary-review-research-report.html).
- [9] R. Galvin, Humans and stuff: interweaving social and physical science in energy policy research, *Energy Res. Social Sci.* (2017) (this volume).
- [10] D. Lockton, F. Bowden, C. Greene, C. Brass, R. Gheerawo, People and energy: a design-led approach to understanding everyday energy use behaviour, in: Proceedings of EPIC 2013: Ethnographic Praxis in Industry Conference, 15–18, September 2013, Royal Institution, London, Washington DC: American Anthropological Association, 2013.
- [11] Y. Strengers, Negotiating everyday life: the role of energy and water consumption feedback, *J. Consum. Cult.* 11 (3) (2011) 319–338.
- [12] S. Royston, Dragon-breath and snow-melt: know-how: experience and heat flows in the home, *Energy Res. Social Sci.* 2 (2014) 148–158.
- [13] A. Spence, C. Leygue, B. Bedwell, C. O'Malley, Engaging with energy reduction: does a climate change frame have the potential for achieving broader sustainable behaviour? *J. Environ. Psychol.* 38 (2014) 17–28.
- [14] K. Leder-Mackley, S. Pink, From emplaced knowing to interdisciplinary knowledge: sensory ethnography in energy research, *Senses Soc.* 8 (3) (2013) 335–353.
- [15] S. Pink, K. Leder-Mackley, Video and a sense of the invisible: approaching domestic energy consumption through the sensory home, *Sociol. Res. Online* 7 (1) (2012) 3.
- [16] Practice Theory Methodologies, no date. Available online at: <https://practicetheorymethodologies.wordpress.com/>.
- [17] ISO 9241-210, Ergonomics of human-system – Part 210: Human-centred design for interactive systems, International Organisation for Standardisation (ISO), Geneva, Switzerland, 2010.
- [18] A. Nightingale, Adaptive scholarship and situated knowledges? Hybrid methodologies and plural epistemologies in climate change adaptation research, *Area* 48 (1) (2016) 41–47.
- [19] J. Stephenson, What does energy mean? An interdisciplinary conversation, *Energy Res. Social Sci.* (2017) (this volume).
- [20] M. Mascia, J.P. Brosius, T.A. Dobson, B.C. Forbes, L. Horowitz, M.A. McKean, N.J. Turner, Conservation and social sciences, *Conserv. Biol.* 17 (2003) 649–650.
- [21] L. Campbell, Overcoming obstacles to interdisciplinary research, *Conserv. Biol.* 19 (2) (2005) 574–577.
- [22] A. Agrawal, Indigenous knowledge and the politics of classification, *Int. Social Sci. J.* 54 (2002) 287–297.
- [23] P. Blaikie, Is small really beautiful? Community-based natural resource management in Malawi and Botswana, *World Dev.* 34 (2006) 1942–1957.
- [24] S. Staddon, A. Nightingale, S. Shrestha, Exploring participation in ecological monitoring in Nepal's community forests, *Environ. Conserv.* 42 (2015) 268–277.
- [25] S. Schmidt, H. Weigt, Interdisciplinary energy research and energy consumption: what, why and how? *Energy Res. Social Sci.* 10 (2015) 206–219.
- [26] C.P. Snow, R. Smoluchowski, The two cultures and the scientific revolution, *Phys. Today* 14 (1961) p.62.
- [27] B. Mallaband, V.J. Haines, Blurred lines: how does cross-disciplinary research work in practice, Proceedings of the 2014 ACM International Joint Conference on Pervasive and Ubiquitous Computing (2014) 963–970 (Adjunct publication).
- [28] P. Stern, How can social science become more influential in energy transitions? *Energy Res. Social Sci.* (2017) (this volume).
- [29] M. Shipworth, A. Cooper, C. Jenkinson, Energy policy needs bifocals, in: BEHAVE 2016: 4th European Conference on Behaviour and Energy Efficiency, Coimbra, 8–9 September 2016, 2016.
- [30] TEDDINET, Smart Metering-based Innovation and Building Performance; a BEIS/TEDDINET Exploratory Workshop, 2016 <http://teddinet.org/collaborating-with-stakeholders-activity.php?s=smart-metering-based-innovation-and-building-performance-a-beis-teddinet-exploratory-workshop>.
- [31] T. Hargreaves, M. Nye, J. Burgess, Making energy visible: A qualitative field study of how householders interact with feedback from smart energy monitors, *Energy Policy* 38 (10) (2010) 6111–6119, <http://dx.doi.org/10.1016/j.enpol.2010.05.068>.
- [32] Jason Chilvers, M. Kearnes, Participation in the making: Rethinking public engagement in co-productionist terms, in: Remaking Participation, Routledge, 2016, pp. 31–63.
- [33] J. Barry, K.N. Farrell, Building a career in an Epistemological No Mans Land. Beyond Reductionism: A Passion for Interdisciplinarity, Routledge, London and New York, 2013, pp. 121–153.
- [34] J. Klein, Crossing boundaries: Knowledge, disciplinarity and interdisciplinarity, University of Virginia Press, Charlottesville, VA, 1996.
- [35] N. Simcock, S. MacGregor, P. Catney, A. Dobson, M. Ormerod, Z. Robinson, S. Ross, S. Royston, S.M. Hall, Factors influencing perceptions of domestic energy information: Content, source and process, *Energy Policy* 65 (2014) 455–464.