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Should we quit our jobs? Challenges, barriers and recommendations for interdisciplinary energy research

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ABSTRACT

Many plea for a better integration of social sciences in energy research, which would imply more comprehensive interdisciplinary energy research. We argue that in order to achieve this, institutional barriers and research challenges need to be recognised and addressed. We identify six challenges and barriers, and provide recommendations for working towards solutions. We conclude that to engage in interdisciplinary research implies extra costs and fewer rewards for all researchers, particularly early and mid-career academics. We propose a new conceptualisation of practices and incentive structures among academic institutions, funding agencies, and publication outlets, and urge all energy researchers to join this debate.

1. Introduction

Interdisciplinary research is needed to solve complex societal problems (Van Rijnsoever and Hessels, 2011). In this paper, we define interdisciplinary research as the synthesis of two or more disciplines, leading to the establishment of a new level of discourse and integration of knowledge. Conceptualized this way, interdisciplinary research differs from multidisciplinary and transdisciplinary research (Klein, 1990). Multidisciplinary research is defined as a process for providing a juxtaposition of disciplines that is additive, not integrative; the disciplinary perspectives are not changed, only contrasted (Klein, 1990). Transdisciplinary research can be defined as a holistic approach that subordinates disciplines, looking at the dynamics of whole systems (Klein, 1990). Although multidisciplinary and transdisciplinary research are undoubtedly useful and needed to solve complex societal problems as well (Klein, 2008; Spreng, 2014), we focus on interdisciplinary research, along with its unique challenges and barriers.

Energy research is an exemplary interdisciplinary domain that integrates across many different disciplines, including but not limited to engineering, environmental sciences, computer sciences, mathematics, geoscience, economics, anthropology, business, and psychology (for a complete overview, see Sovacool (2014b). Following our definition, the collaboration between two or more of these disciplines that establishes a new level of discourse, and integrates knowledge across the disciplines to address energy challenges, would constitute interdisciplinary energy research.

Energy research includes many technical challenges, and historically, many technical disciplines have worked on them. However, societal issues are also integral to energy research, and hence social sciences can contribute significantly (Rochlin, 2014; Ryan et al., 2014). This contribution relates to three main areas. Firstly, social sciences illuminate the factors that explain why consumers engage in energy behaviour and how energy behaviour may be changed, related to both when and how much energy is used. Secondly, they inform the development and evaluation of the effectiveness of interventions intended to change consumers' energy behaviour. And finally, they shed light on the factors that underlie public support for energy policies, technologies and infrastructure. These contributions go beyond "modelling" exercises, which are often used to capture energy problems (Jefferson, 2014). Social sciences can reveal important "errors" and "irregularities" in these models, and challenge underlying assumptions of other disciplines. The complex puzzle of building a sustainable and reliable energy system for the future cannot be solved without consideration of these crucial components.

Despite their central role in developing effective energy technologies, programs, and policies, social sciences are still hugely underutilised in energy research (Felt, 2014; Sovacool, 2014a, 2014b; Sovacool et al., 2015). Hence, a better integration of social sciences in energy research is needed, which is acknowledged by a variety of audiences including social scientists (Felt, 2014; Schmidt and Weigt,

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2015; Sintov and Schultz, 2015; Sovacool, 2014a, 2014b; Steg et al., 2015; Stern, 2014), engineers (iiESI, 2015), funding agencies (Winskel, 2014) and universities (National Academies, 2005). In line with prior work that explored similar topics (Rochlin, 2014; Ryan et al., 2014; Jefferson, 2014; Sovacool, 2014b), we organize our ideas around challenging three major systems, that is, universities, the publication process and, funding and policies. We aim to discuss how we may make changes in these systems in order to foster the inclusion of social sciences in interdisciplinary energy research, particularly for early career scholars.

We are both environmental psychologists by training, and at the time this article was written, we both had joint appointments in (1) engineering schools and (2) business and public policy schools, respectively, to do exactly that: integrate social sciences in energy research.[1] Whilst joint appointments like ours are part of an upward trend that goes beyond recognizing the importance of interdisciplinary energy research to stimulating it (National Academies, 2005), we have grappled with several institutional challenges and barriers that still hinder its success. We argue that before "true" interdisciplinary energy research can be realised, that is, the collaboration between different disciplines which leads to knowledge integration, such challenges and barriers need to be recognised and addressed. We identify six of the most important barriers and challenges, some of which are intertwined with more general issues in academia and/or apply to interdisciplinary research(ers) in general, but all of which are particularly relevant for interdisciplinary energy research(ers). We provide suggestions for working towards solutions.

2. Challenges, barriers and recommendations for interdisciplinary energy research

2.1. Insufficient knowledge and skills hinder successful interdisciplinary collaboration

If future energy researchers do not understand the full context of the subject area, they are not likely to grasp the problems, and thus the solutions to this challenging research space. Additionally, as the integration of knowledge is key in our definition of interdisciplinary (energy) research, to maximise success, researchers need to acquire the necessary skills to do so (Shapiro et al., 2007). Therefore, training in how to conduct interdisciplinary research is much needed, and should start early to properly equip academics. Training should be scientifically rigorous and focus on mutual understanding of methodologies, (assumptions underlying) research traditions, goals and outcomes (Rynes et al., 2001). To achieve this, formal training can be used to increase knowledge about different angles of relevant problems and include a solid overview of technical challenges, (financial) risk analyses, demand side management and the role of markets and consumers. In fact, training programs that are centered around tackling specific problems to guide learning and inquiry, rather than around core components of a given discipline, have been suggested previously to reach similar educational outcomes (Sovacool et al., 2015). In addition, training "on the job" can aid in the development of other skills (e.g., communication with other disciplines, industry partners and policy makers). Integrating graduate students and post-docs in all aspects of interdisciplinary collaborations can aid in the latter (Cummings, 2005; Van Rijnsoever and Hessels, 2011).

It is important to acknowledge that one cannot become "inter-disciplinary", as all who engage in interdisciplinary research need to have their own disciplinary expertise. After all, how can a researcher without expertise in a given subject matter ever succeed in the synthesis needed to establish a new level of discourse and integrate knowledge? Hence, it is important that all researchers are experts in their own unique areas, and interdisciplinary training should be seen as another layer woven into training to acquire additional skills.

Recommendation: Interdisciplinary training needs to start early and focus on cross-cutting knowledge and skills whilst also allowing individuals to develop their own expertise.

2.2. Limited funding is available for interdisciplinary research and not proportionally equally distributed over disciplines

Obtaining funding for interdisciplinary research can be a major challenge, as funding schemes often focus on disciplinary areas in silos, such as biological sciences, geosciences, or economic and social sciences, rather than on crossovers between them. If interdisciplinary energy research is funded, the traditional distinction between Science, Technology, Engineering and Mathematics (STEM) research and social sciences, which is often strictly kept by funding bodies, blocks the integration of social sciences in energy research (Felt, 2014; Sovacool, 2014a, 2014b). Moreover, Sovacool et al. (2015) argue that social sciences suffer from "disciplinary chauvinism", implying that they are treated as secondary and peripheral to STEM topics.

Although STEM research can justifiably require more funding than social sciences due to the nature of the work (e.g., equipment, field work, lab facilities), social scientists in interdisciplinary projects are often relatively under-funded compared to STEM researchers. This can limit the time, resources, and hence ideas that social scientists are able to contribute, thereby limiting knowledge integration. For instance, in the United States (U.S.), the National Science Foundation (NSF) is organised into "directorates" representing broad disciplinary categories; since 2000, the Social, Behavioural, and Economic sciences (SBE) directorate has had the smallest budget of all NSF science directorates (AAAS, 2015), ranging from 3.3% to 4.1% of the total budget, whereas other directorates such as engineering have received twice to three times that amount. However, half of projects in SBE's portfolio were co-funded by other NSF directorates from 2001 to 2011 (Nichols, 2014), suggesting a desire to collaborate between social scientists and researchers from other disciplines, and the necessity of co-funding to enable such work. Similarly, the U.S. Department of Energy allocated an estimated 35 times more of its budget to research on hardware and infrastructure than it did to consumer behaviour and energy efficiency research (Gaffigan, 2008). Such funding priorities do not allow for perspectives from the broad range of social sciences to be brought to bear on the impacts of energy policies and innovations, and must be re-envisioned so that social sciences can become better integrated in energy research. Funding schemes should foster strategies that improve integration of all relevant disciplines in order to give energy research a chance to reach its full potential. This should be done at all levels of funding – (inter)national, local, and university – to ensure that academics in all stages of their career can build on this.
Recommendation: Funding schemes should stimulate interdisciplinary energy research that integrates social sciences.

2.3. Funding evaluation criteria are not fit for measuring scientifically rigorous interdisciplinary research

Tackling the challenge of reviewing interdisciplinary energy research proposals is not an easy task for funding bodies (Nightingale and Scott, 2007; Winskel, 2014). In contrast to mono-disciplinary proposals, reviewers are usually not experts on all proposal aspects. Instead, the evaluation of interdisciplinary energy research proposals tends to include experts from the involved disciplines, but lack experts in their linkage and integration (i.e., synthesis of knowledge). Perhaps to aid in this challenge, "proxy" evaluation criteria are becoming increasingly common, which may result in de-prioritising scientific rigour (Nightingale and Scott, 2007). Among them is the extent to

[1] The second author has since accepted a new position in an interdisciplinary department at another institution, partly because of some reasons explained in this paper.