Original research article

Socio-energy systems design: A policy framework for energy transitions

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ABSTRACT

In the context of large-scale energy transitions, current approaches to energy policy have become too narrowly constrained around problems of electrons, fuel, and carbon, the technologies that provide them, and the cost of those technologies. Energy systems are deeply enmeshed in broad patterns of social, economic, and political life and organization, and significant changes to energy systems increasingly are accompanied by social, economic, and political shifts. Energy policy is therefore, in practice, a problem of socio-energy system design. In this article, we offer a definition of socio-energy systems, reconceptualize key questions in energy policy in terms of socio-energy systems change, analyze three case studies of energy policy development as problems of socio-energy systems design, and develop recommendations for rethinking energy policy and governance in the context of socio-energy systems transitions.

1. Introduction

Over the past quarter century, extensive research has documented that energy—typically represented as a technological and economic phenomenon—is also fundamentally social in its origins and organization, woven into societal, geographic, and geopolitical arrangements at scales from the individual to the planet (for recent reviews, see [1–3]). To date, however, work in the energy social sciences has had little impact on energy policy. There are a few notable exceptions. In parts of Europe, policy and planning increasingly recognizes the significance of the societal facets of energy for both building public support for energy policies [4] and in designing future energy systems by incorporating, e.g., innovative ownership models [5] and diverse public values [6]. Similarly, civil society organizations are increasingly pushing energy projects in developing countries to attend much more closely to the design challenge of linking the delivery of energy services to concrete strategies for alleviating poverty [7].

In most of the world, however, and certainly in the United States, whose perspectives largely dominate global energy markets and the energy projects of the major development banks, energy policy remains a largely techno-economic problem. What we might

term the human and social dimensions of energy barely rate a mention—let alone receive detailed, substantive treatment—in, for example, recent high profile US energy policy analyses, such as the National Academies' *America's Energy Future* (2008), the Department of Energy's Quadrennial Technology Review (2012), or the Department of State's review of the Keystone XL Pipeline (2014), [8, 55, 75]. Nor do insights from the energy social sciences factor significantly into more routine energy policy analyses and decisions, e.g., the permitting of drilling, the regulation of electricity markets, or the development of renewable energy mandates. Instead, energy policy routinely relies on caricatured, tacit or implicit, not-reflected-upon models of people and societies that rarely conform well to reality [9].

In this article, we propose that energy policy institutions adopt a more expansive conceptual framework that integrates social considerations more effectively into energy analysis and decision-making. We term this framework *socio-energy systems design*. In proposing this framework, we respond specifically to Sovacool's call in the inaugural issue of *Energy Research and Social Sciences* for new ways to communicate effectively about social science research in mainstream energy conversations [1]. Our objective is to shift the framing of energy policy from what we consider an overly narrow conventional approach—what technologies do we need to deliver energy, at what price, and with what carbon or other environmental costs—toward a perspective that recognizes that the conceptualization and design of energy systems is, fundamentally, an exercise in the simultaneous conceptualization and design of

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diverse social arrangements.[1] Through time, energy policy choices reconfigure societies, even as societies reconfigure energy systems, especially at moments when new energy systems are brought into being or during periods when existing systems are significantly rearranged through the persistent evolution, growth, and embedding of energy into human affairs [10,11]. Thus, we argue, the social dimensions of energy systems are particularly salient for energy policy choices in the context of large-scale energy transitions, such as those currently underway in global energy markets due to the rise of hydraulic fracturing technologies for oil and gas extraction, the deployment of renewable energy generation to address climate change, and the development of alternative fuel, hybrid, and electric vehicles.

Contemporary energy transitions are reshaping not only the technologies and economics of energy but also physical and social geographies, social meanings, and the political organization of energy production, distribution, and consumption. Not surprisingly, around the globe, these changes have catalyzed growing socio-political resistance to energy policy and energy system change, with virtually every major form of energy technology confronting social protest and political controversy [12]. Only by reconceiving energy policy in more social terms, we believe, can the world hope to lessen conflict over energy transformations in the coming quarter century [13]. The framework of socio-energy systems design aims to accomplish this task, reframing energy policy debates as debates not just about how to produce energy but about what energy production and consumption means for the diverse groups and communities who inhabit energy systems.

Most energy social scientists will not be surprised by the basic outlines of socio-energy systems design as an energy policy framework. The framework is heavily indebted to theories of *sociotechnical systems*: interconnected, integrated systems that link social, economic, and political dynamics to the design and operation of technological systems. Theories of sociotechnical systems have been used extensively and productively for some time to explain historical developments in the energy sector [14–20] and to analyze strategies for fostering sustainable energy transitions [21–23]. Building on theories of sociotechnical systems and the co-production of technology and society [24], our objective is to establish socio-energy systems as a forward-looking design concept that can alter the lenses through which policymakers view energy policy choices, expand the range of analyses conducted to support those decisions, and enable publics to more effectively imagine and evaluate what energy policy may mean for individuals, families, and communities.

In the article's first section, we define the concept of socio-energy systems and illustrate how it can be applied to reformulate the goals and objectives of energy policy, as well as how its use as a lens transforms key ideas in energy policy, such as energy transitions and energy justice. In the second section, we offer three short case studies of current energy policy choices, drawn from our own research, that highlight the value of reframing energy policy choices as problems of socio-energy system design. In the third section, we offer four strategies for incorporating the concept of socio-energy systems design into energy policy practices and institutions. Although our argument could in principle be applied anywhere, in this article, we draw primarily on examples and case studies from the United States. We have made this choice in part because the United States is where we conduct our research and are most knowledgeable of the details of energy policy. But it is also, as we have suggested above, because US conceptualizations of energy policy are highly influential in global energy markets and institutions and because the United States is a central player in global energy transitions. Reframing US energy policy debates therefore has the potential to pay dividends not only in the United States but also in many other parts of the world.

2. Rethinking energy policy as socio-energy systems design

2.1. Defining socio-energy systems

What do we envision when we suggest reframing the object of energy policy analysis and decision-making as an exercise in the design of socio-energy systems? First and foremost, we envision a way of recognizing that energy systems involve the work, behavior, and choices of many different kinds of people. Perhaps ironically, one of the best places to see energy and people in an integrated fashion is in children's books written a half century ago, not so long after the electrification of many homes and farms in the United States and the rise of the automobile as a common family purchase. Richard Scarry's books, in particular, *What Do People Do All Day?* and *Cars and Trucks and Things That Go*, offer a vibrant picture of individuals, families, and communities living with new forms of energy. In Scarry's images and narratives, energy technologies come to life not just as assemblages of machinery but also as integral elements in the daily experiences of diverse people: workers, homeowners, beach goers, students, a "lazy fellow," and many more. Individuals in the books mine coal, transform it into electricity, and use it to power televisions, vacuums, and backyard barbecues. They harness the movement of water to transport trees and convert them into lumber for houses and boats and paper, as well as to power lights and irrigate crops. They drive cars and trucks and fly airplanes. They wire electrical systems in houses, retrofitting some and constructing others with wires already inside the walls. People's everyday lives and livelihoods—the activities that give them purpose and identity and that enact and animate the community of Busy Town—are thoroughly wrapped up in systems for producing and consuming energy.[2]

Scarry's imaginative world offers a lens through which it becomes possible to see energy policy choices markedly differently from conventional energy analyses. In the world depicted in the National Academies recent report, *America's Energy Future*, for example, the only facets of the future that seem to matter are which technologies to choose, how much to pay for them, and how much that will reduce carbon emissions [25]. The world is stripped bare of its human dimensions, and people are all but entirely absent from this image of the country's future, neglecting that the people of America's future will not only shape their energy systems but also inhabit forms of life partly configured by them [73]. Energy policy choices shape not just technological trajectories but trajectories in how people envision and construct themselves and their relationships to one another and to the world [26–28]. Yes, in the world made visible in Scarry's imagery, energy policies shape the technologies and the costs of electricity flowing through the wires; yet, they also act on all other aspects of the images, too.

Scarry's images make visible a host of dimensions of energy policy that social scientists have gone on to study in detail. The electrification of the home was as much about women's roles as

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[1] Jasanoff and her colleagues term this *co-production*. See [24,34].

[2] Scarry's images can be seen online: power plant (http://3.bp.blogspot.com/-i7-ENiBDyOw/Tgn6HMOQwjI/AAAAAAAAAV8/u9wb1r7v0vg/s1600/Electricity+generation+production+richard+scarry+what+do+people+do.jpg); coal mine (http://scienceblogs.com/worldsfair/wp-content/blogs.dir/389/files/2012/04/i-1e3c3801c1d14d8203e4a04f37cd97d1-digging1small.jpg); river transport of logs (http://exampleschildrensbooks.files.wordpress.com/2012/06/scarry-trees.jpg).