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Social Planning for Energy Transitions

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Abstract Energy transitions are thoroughly social affairs. Despite this fact, energy policy rarely incorporates the social dimensions of energy systems change in an intentional, explicit, and broad fashion. Reviewing extensive recent research, we introduce the concept of *social planning for energy transitions* as an innovative framing for energy policy that can accompany technical and economic analyses and decision-making, especially in the current context of flux and uncertainty in the energy sector. We define social planning as understanding and preparing for the societal outcomes of energy transitions, as well as developing strategies to incorporate these considerations into energy policy. We review five areas of capacity-building for social planning in energy transitions: mapping socio-energy relationships, envisioning socio-energy futures, designing just socio-energy systems, building socio-energy partnerships, and governing socio-energy transitions.

Keywords Sociotechnological systems · Socio-energy systems · Policy · Justice · Future · Community · Society · Scenario planning · Management · Governance · Redistribution · Organization · Imagination · Power · Public · Deliberation · Society

Introduction

Energy transitions are thoroughly social affairs. Energy historians have documented in detail the widespread societal ramifications that accompany—and social dynamics that drive—changes in energy technologies [1•, 2•, 3–5]. Despite this fact, energy policy rarely incorporates the social dimensions of energy systems change in an intentional, explicit, and broad fashion. Major national energy policy and planning documents, for example, have concentrated almost exclusively on energy technologies, including the US Department of Energy's recent quadrennial self-review [6] and *America's Energy Choices*, prepared by the US National Academy of Engineering [7]. Even where social considerations do enter in, they tend to be narrowly economic, focusing on energy prices, jobs created in energy industries, and, to some extent, energy access. While these are important aspects of social planning for energy transitions, they significantly underestimate the depth and breadth of social issues at stake in large-scale transformation of energy systems, thanks to the coupling of social organization to energy production and consumption [8]. Recent analyses have gone so far as to suggest that social and technological elements are so tightly intertwined as to demand analysis as integrated *socio-energy systems* [9].

The concept of *social planning for energy transitions* offers an innovative framing for energy policy and planning that can accompany technical and economic analyses and decision-making, especially in the current context of flux and uncertainty in the energy sector. In this article, we define social planning for energy transitions as the process of seeking to understand and prepare for the societal implications and outcomes of energy transitions and to develop strategies for incorporating these considerations into energy system design, as well as energy policy and planning. We review extensive recent research that helps to illuminate the concept, to provide specificity to its definition, and to offer different strategies for implementation for participants in energy decisions. Significant dimensions of social planning for energy transitions that we include in this review are:

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1. Documenting and analyzing not only the social and economic trends driving changes in energy demand but also the social meaning and impacts of changes to the organization and dynamics of socio-energy systems [10•].
2. Visioning, via scenario development or other tools that engage the social as well as the technological imagination [11, 12], in order to explore the kinds of sustainable futures that are desirable to communities and the relationships of energy to those desires [13].
3. Developing innovative, multi-criteria strategies that can incorporate a diverse range of dimensions of human thriving and justice into the design of future socio-energy systems [14].
4. Forging meaningful partnerships between diverse publics, energy analysts, and the energy sector that enable productive deliberation, dialogue, and decision-making in processes of energy systems change [15•, 16].
5. Governing and managing transitions processes in socio-energy systems [17–19].

Altogether, this research suggests that the social dimensions of energy transitions are already vast and will continue to grow in relation to the array of simultaneous transformations currently taking place in the energy sector, including the shift from conventional to unconventional oil and gas; the rise of renewable energy; the renaissance of nuclear energy; and the prospects for electrifying transportation.

The Social Dimensions of Energy Transitions

The idea of social planning for energy transitions is built on the growing recognition in the energy literature that energy systems are quintessentially sociotechnological systems. As Miller et al. describe, sociotechnological systems are systems that so fully intertwine social and technological elements that the two are difficult if not impossible to disentangle [10•]. In the case of energy, technologies of electricity, heating and cooling, and transportation are bound up with a highly diverse array of social and political phenomena, including regulatory frameworks (e.g., fuel economy standards [20]), geopolitics [21], urban planning (e.g., postwar automobile cities [22]), social movements [23], gender relations [24•], and national imaginaries [11]. The depth of integration is such that, over time, the dynamics and organization of socio-energy systems (i.e., sociotechnological systems whose primary technologies are energy technologies) emerge and take form in tightly interlinked patterns of technological and social configuration. The essays in *Nuclear Disaster at Fukushima*, for example, offer an illuminating account of this coupled production of energy and society (the literature in science and technology studies terms it *the co-production of technology and society* [25]) and its implications for understanding the nuclear disaster at Fukushima Daiichi [26•].

If energy systems are, in reality, socio-energy systems, then it should not be particularly surprising that changes in energy technologies are accompanied (arguably, inevitably) by changes in society. At its most incremental, this may mean that new energy hardware introduced into a plant—or a new programmable thermostat introduced into the home—requires new skills to successfully operate. At the other end of the spectrum, the rise of new energy resources (or the end of old ones) can give rise to massive reconfiguration of social, environmental, and technological landscapes, as has occurred over the past century along the Louisiana and Texas coastlines as a result of the offshore development of oil [27]. Because energy is so integral to the Gulf Coast, the Obama Administration's 2011 moratorium on drilling for oil in the Gulf of Mexico threatened to send shockwaves throughout the social and economic fabric of Gulf Coast communities, presaging the deeper social, technological, and environmental challenges that confront both the oil industry and the region's communities in the face of climate change, sea level rise, coastal degradation, and peak oil (for an assessment of the economic impacts of the moratorium, see Park et al. [28]). Looking forward, as the world contemplates major changes to energy technologies, social planning for energy transitions will necessarily confront the potential for this kind of large-scale transformation in socio-energy relationships.

Four crucial elements of social change may accompany energy system change and should be addressed in social planning for energy transitions: redistribution; reorganization; reauthorization; and reimagination.

Redistribution Energy systems are integral to the distribution and redistribution of wealth and risk in modern societies. New energy production is often portrayed as providing economic benefits through new jobs, declining energy prices, and ancillary economic development [29]. Yet, this perspective is often narrowly framed in terms of net benefits to specific regions, ignoring a range of additional considerations. For example, Jones argues on the basis of historical evidence that, within a region, the distribution of energy benefits varies as a function of the type of energy transmission technology that is adopted [30]. Building and operating canals for coal transport generated significant ancillary economic development along the transport route, which did not occur for either pipelines or transmission lines. The recent US State Department environmental impact statement for the Keystone XL pipeline likewise indicated that current rail transport of oil from Alberta to the Gulf Coast is generating significant economic benefits along the rail lines, which will disappear should a pipeline be built [31]. Other studies show that, within energy regions, not only are the benefits of energy development unevenly distributed across groups (see, for example, recent research

highlighting gender disparities in oil employment [32]) but also the benefits to some can be accompanied by strong costs and risks to others, as has occurred with the rapid rise of social risks in North Dakota, due to a boom in oil and gas development [33•]. The result of these redistributions can be an increase in social and environmental injustice [34•, 35, 36].

Reorganization Changing socio-energy systems can create structural shifts in social organization that run parallel to—or perhaps across—their redistributional consequences. These organizational shifts are most easily seen in long-term analyses of regional energy transitions, such as the history of fossil fuels development in the Northeastern USA and the rapid economic rise of cities along the Mid-Atlantic coast as centers of industrial production [1•], or the history of oil development along the Louisiana coastlines and its tremendous social and environmental transformation of the Gulf Coast region [27]. Social organization can also be observed at the micro-scale of individual behavior. Recent studies have shown, for example, that new forms of social organization can drive the adoption of new energy technologies in the home [37] and, at the same time, the adoption of new energy technologies in the home can give rise to new forms of social behavior and new social norms [38].

Reauthorization Power and authority in modern societies are also linked to energy, and the dynamics of change in political and energy systems are often interconnected [39]. Globally, power and energy have long been central to patterns of geopolitics and a source of conflict. Increasingly, similar patterns are observed in regional conflict. Perhaps the most contested example of this phenomenon over the past two decades has been the politics of energy in India, which has seen widespread social mobilization in opposition to a series of large-scale energy programs, as part of a larger critique of the development project in India, especially in terms of the social and environmental costs these projects would create for India's poorest communities [40]. In many respects, the fight over dispossession by the construction of large dams in the Narmada Valley epitomized this conflict [41]. Today, however, the fight has expanded across the full range of the energy sector, including ongoing political struggles over renewable energy and the politics of the Clean Development Mechanism [42], as well as the politics of nuclear energy development in the wake of the US–India nuclear deal and the nuclear meltdown at Fukushima Daiichi. The last has generated widespread social protest movements across much of the country [43, 44]. Nor, of course, is India alone in witnessing growing political conflict over energy resources. Biofuels, for example, have become a source of widespread social resistance and political violence in many countries [45–47].

Reimagination In the end, energy systems are not merely manifestations of material technologies; they are expressions of how communities imagine themselves and also the possibilities and limits of technological civilizations [11, 48]. Disputes about energy futures, therefore, are often far more than disputes over technology choices or distributions of benefits and costs. They are often also about disagreements over what kind of future societies are envisioned and desired by those who will have to inhabit them [13]. As with many of the social facets of energy discussed above, questions of imagination are most deeply felt in times of large-scale transitions, when the future of whole regions and even countries is deeply at stake. Yet, social identity is present even in the most mundane of energy settings, as Rolston observes in her study of gender dynamics in the mining industry in Wyoming, as men and women work out how to build futures for themselves, their families, and their communities in one of the most demanding industries on the planet [24•].

Strategies for Social Planning for Energy Transitions

The depth to which social dynamics and structures are integrated into energy systems suggests a need to build new capacities for social planning as an element in energy policy choices, especially in the context of significant energy transitions. We highlight below five areas of focus for capacity-building. The first three explore the development of strategies, methods, and approaches for deepening understanding of the ways in which people inhabit socio-energy systems, both now and in the future, as a tool to create more comprehensive planning. The final two examine possibilities for novel governance strategies attuned to the unique challenges of transitions in socio-energy systems.

Mapping Existing Socio-Energy Relationships Social planning for energy transitions demands additional knowledge that is not readily available through conventional energy analysis. Growing research in energy studies is laying the groundwork for new methods and approaches for more comprehensive assessment of extant systems. These include the wide diversity of ways in which people live, work, and play with, in, through, and around energy technologies. Methods are needed to assess the meaning and significance of energy transitions for energy labor and management, for the individuals and communities who inhabit energy landscapes (whether of production, transmission, or consumption), and for energy users and consumers. Such assessments must include not only questions of social, economic, and political impacts and risks but also broader questions of social relationships, organization, institutions, and identities—and they must extend beyond individual cities, utilities, or power plants to include

whole energy systems, energy lifecycles, and energy supply chains.

The implications of energy transitions for labor offer an illuminating example of the need for more comprehensive methods. Labor is a common focus of energy policy analyses, especially with regard to employment gains [49]. Yet, supplemental measures of the distribution of types and geographies of jobs created and lost, both in the energy industry and more broadly in the economy [50], potential impacts on the power and organization of labor and labor movements [51], and implications for the identities and daily activities of energy laborers [24•] would make a significant difference in the ability of communities to plan for energy transitions.

Similarly, research is now highlighting the significance of energy landscapes as an important site of social mobilization and conflict surrounding energy transitions, suggesting a strong need for new, more anthropologically inspired techniques for understanding the historical and social contexts of both existing and proposed energy systems [27, 34•, 35, 52]. In a study of struggles over wind energy production in Australia, for example, Hindmarsh observes that understanding of local resistance to large-scale wind projects requires deeper knowledge of local environmental politics and values, as well as the ways in which new energy systems threaten to disrupt the social webs that form local communities [53].

Beyond individual analytic methods for tackling parts of socio-energy systems, there is also a need for more systematic models and assessment techniques to inform decision-making on the part of the public, government, and industry. Such models might, for example, seek strategies for incorporating a variety of socioeconomic variables, on different social scales, into broad assessments of natural resource development [54]—or they might look for ways to build social variables into models for designing engineering requirements for complex, sustainable, sociotechnological systems [55]—or they might seek to model socio-energy systems directly, such as building agent-based models that can integrate with physical models of energy dynamics [9].

Envisioning Socio-Energy Futures New methods are also needed for understanding potential future socio-energy systems. Social planning for energy transitions requires strategies for envisioning futures that engage the social imagination—and the imagination of the social—as much as the technical imagination [18]. In developing quality criteria for visioning strategies for sustainability projects, for example, Wiek and Iwaniec emphasize the centrality of the social as an element in many of the most important criteria and recommend, especially, a systems approach to visioning that integrates social and technical elements and approaches [56]. In contrast, approaches that focus solely on the technical can arrive at absurd conclusions. For example, Byrd et al. model potential photovoltaic energy production in cities and conclude that suburbs can provide more than sufficient solar energy to power their transportation needs [57]. Yet, unfortunately, in a fact missed by the analysis, suburban commuter vehicles will not be in the suburbs most days when the sun is shining—instead, they will be located in urban parking lots.

Working closely with a Swiss community, Trutnevyte has built, tested, and evaluated a successful integrated sociotechnological approach to future energy systems visioning [58, 59].Her approach begins with community deliberations and social surveys that diagnose the variety of social values and preference orderings that exist within the community. Using a methodology called EXPANSE (EXploration of PAtterns in Near-optimal energy ScEnarios), she then examines diverse possible future energy mixes and their implications for achieving diverse community values. Her method then closes the loop to determine community responses to the modeled outcomes, often observing shifts in observed community values. Her analysis finds that effective visions address not only qualitative aspects of energy transitions but also quantitative aspects that go beyond assessing technological applications in purely economic contexts. She concludes that, if arrived at in an integrated sociotechnological fashion, visions can be valuable tools for strategic planning for energy transitions.

Designing for Just Socio-Energy Transitions The third focus for capacity-building for knowledge is novel criteria and methods for incorporating social elements and values into future energy designs [60]. Designing, creating, and implementing energy transitions that replicate past injustices —or create new ones—not only does not lead to sustainable and equitable energy futures but also wastes a significant opportunity to create improved human outcomes via sociotechnological systems transformation. Needed are new methods that (1) emphasize human thriving, social wellbeing, and social equity as outcomes for energy systems; (2) assess how the benefits, costs, and risks of socio-energy systems are distributed and evaluated within communities; and (3) evaluate the implications of socio-energy systems change for marginalized groups, so as to inform comprehensive and sustainable social planning that proactively addresses the social and environmental dislocations and ruptures that energy systems produce [61–63].

Of particular importance is the ability to link these kinds of analyses to the problem of socio-energy system design. Recent research highlights, for example, that the design of energy systems—understood to include the design of not only energy technologies but also the much more extensive supply chains

that feed into the manufacturing and operational lifecycle of energy systems—can have a variety of implications for justice. These include not only unjust outcomes, such as inequitable distributions of risks and benefits (see, for example, an examination of a variety of justice concerns associated with electric vehicle production and use [14]), but also potential implications for the ability of communities to make strong environmental justice claims [64]. Unfortunately, the absence of clear insights into the extensive and widely geographically distributed social footprint of new energy technologies creates a power asymmetry between those who create energy systems and those who inhabit them, limiting the ability of consumers and users to make decisions on the basis of these considerations [14] and placing significant burdens on engineers to be significantly more effective in integrating justice concerns into engineering design [34•].

Building Socio-Energy Partnerships Social planning for energy transitions requires not only new knowledge but also new approaches to governance that recognize and engage the social dimensions of energy systems. Of particular significance are new approaches to governance that significantly engage the publics and stakeholders in more meaningful ways, nurture public trust in energy decision-making, create a collaborative environment for energy deliberations, and build effective partnerships on wider scales between communities and energy industries [65, 66].

Considerable recent research has experimented with and assessed strategies for facilitating public processes to achieve systems change without major defections of key stakeholders. Processes that engage in careful deliberations and stress collaborative efforts between the stakeholders and the energy industry offer new ways of understanding how to effectively integrate social considerations into planning for energy transitions. Pisarski and Ashworth, for example, used a citizen's round table approach to reimagine and redesign the concept of the public meeting, transforming it from a one-way strategy for informing the public into a multi-directional deliberation that increases public comfort with expressing ideas and offering critical views of new technologies [67]. This approach allows for assessment, communication, and contribution of public ideas and input into the planning process, and also reframes the public not as a roadblock to energy transitions but as meaningful partners in creating energy futures. In a similar vein, Phadke advocates a "consult–consider–modify–proceed" model for citizen engagement in relation to wind energy application in the USA, rather than a dualistic approach where the public either accepts or rejects proposals for energy projects [52]. Other approaches to planning and governance that strengthen opportunities for engaging citizens could also be applied in the energy sector, such as participatory budgeting, sustainability indicators projects, and open-source decision-support tools.

Marginal communities are a particularly difficult group to successfully engage in governance partnerships, as a result of past injustices in the distribution of energy risks and benefits that often continue to adversely affect marginalized communities today. Brookshire and Kaza examine strategic energy planning among Native American tribes as just such a challenge [68]. They conclude that new partnerships between tribes and federal agencies offer the possibility for an alternative approach that strengthens access to energy, increases recognition of tribal sovereignty, and enhances tribal sustainability and resilience, but only under conditions that put tribes squarely in control of their own energy futures.

Governing Socio-Energy Transitions Our final area of focus for capacity-building for social planning for energy transitions is the governance of transitions in sociotechnological systems. Governance, in this context, refers to the practices, processes, and policies of energy regulatory institutions, as well as the larger political dynamics and structures within which they are embedded. Recent studies suggest that a wide range of challenges derive from the fact that existing governance institutions and approaches have largely neglected the social dimensions of energy transitions. These challenges include managing trade-offs among different groups and across diverse sectors of society and the economy [69]; maintaining public trust in an ongoing fashion during transition processes [52]; understanding and engaging the broader politics of energy [18, 43]; managing sociotechnical transitions in a fashion that effectively integrates the social and the technical [19]; identifying, diagnosing, and redressing the social dislocations that occur in energy transitions [70]; and orchestrating across multiple levels of governance and political jurisdictions [71].

For instance, Klinsky's analysis of the Western Climate Initiative's (WCI's) attempt to create a climate market in North America shows the difficulty of establishing goals across several levels of governance, from the individual to the international [71]. While cap-and-trade schemes require international cooperation, the WCI is driven by a decentralized, bottom-up approach to climate markets, which allows for non-state actors and collective action to give input into the design of the system. The WCI example also shows how dependent climate change actions are on public perceptions of climate change, on the distributional benefits and risks of system change, and on the types of policies that are proposed (taxes and subsidies being generally opposed in the USA). Similarly, efforts to create renewable grids in Northern Africa are complicated by the need for regional cooperation, which requires accommodating deep political and cultural differences, a more nuanced understanding of the ways in

which reliable energy systems and political stability are connected, and appropriate consideration of past historical relationships between imperial powers and their former colonies [18].

Conclusion

The field of energy and society research has exploded in recent years. While the significance of energy to society and the economy has been known for a long time, the seemingly incremental nature of change in regulated electricity monopolies and the global oil, gas, and coal industries meant that the social, economic, and political dimensions of energy could often be taken for granted as being relatively fixed and unchanging. Today, that assumption is widely recognized to be false. The already significant shifts happening in the energy sector (the rise of new technological approaches to—and new geographies of—oil and gas extraction, electrification of the transportation sector, development of a significant biofuels industry, rapid expansion of renewable electricity generation, electricity deregulation, and the potential for a new nuclear renaissance) have driven a new politics of energy that has brought the social dimensions of energy transitions to the forefront of energy policy debates. Particularly striking is the evenhandedness of social mobilization around energy. Every major form of energy production is currently subject to social protest and conflict somewhere around the globe.

In the face of these challenges, energy policy and planning need to rapidly develop new capacities for assessing and governing the social dimensions of energy transitions. Fortunately, research in the field of energy and society is now responding at an unprecedented scale. In conducting this review, we were amazed at the depth, breadth, and impact of new research being published using a wide range of social science methodologies. While extensive research continues to be needed across all of the social dimensions of energy transitions discussed here, as well as all of the diverse foci of capacity-building we have identified, the foundations have been well laid for that research both to continue to deepen in significance and to begin to offer valuable insights into energy policy and planning. We look forward to the continued maturation of this tremendously exciting field of research in the years to come.

Compliance with Ethics Guidelines

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