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Individual and household interactions with energy systems: Toward integrated understanding

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ABSTRACT

This paper argues for the value of developing an integrated, trans-disciplinary science of human–energy interactions and suggests that *Energy Research and Social Science* can provide a space for further development of this science. It sketches this intellectual domain and then focuses on that part of it that encompasses interactions of individuals and households with energy systems. It considers the roles of these actors as energy consumers, as citizens who may influence the development and regulation of energy systems, as energy producers, as participants in organizations and institutions, and as parties affected by energy systems. The paper shows, in each case, that single disciplines rarely provide the depth of knowledge that is desirable for understanding or influencing individual and household interactions with energy systems and that integration of knowledge and insights from multiple disciplines is required. It also suggests some promising research directions.

Energy Research and Social Science creates a new venue for publishing research and analysis and encouraging analytic discussions on a very broad range of energy phenomena. It can be different from most other journals in this domain, which focus on a single academic discipline (e.g., *Energy Economics*), on policy and only incidentally on social science (e.g., *Energy Policy*), or on broad environmental or social topics (e.g., *Global Environmental Change*), only occasionally publishing work on energy. This new journal can provide space for the further development of an integrative, trans-disciplinary science of human interactions with energy and energy systems. This science can be considered as a key part of what I have previously called "a second environmental science: human–environment interactions" [1]. The call for such a science responded to the focus of most of standard environmental science on physical, chemical, and biological processes in the non-human environment and set aside analytically the processes by which these are influenced by human action and in turn affect human well-being. These latter processes are the domain of the second environmental science. Energy science is in an analogous state: it has focused primarily on the development of energy technologies, and thus has been treated mainly as a branch of applied physical science (this is indicated by the contents of major energy journals, see [2]) When governments have experienced a need to change the trajectory of energy systems, they have gone outside the physical sciences for input, but even in this case, mainly to economics. I argue here for the value, both for fundamental understanding and for informing practical choices, of developing an integrated, trans-disciplinary science of human–energy interactions. In the available space, it is possible only to illustrate a bit of what such a science can produce. I begin by sketching a rough map of this territory in order to situate my comments within that larger field.

1. The dimensions of the energy-social science space

The metaphor of a map is more than a little inadequate because the territory of *Energy Research and Social Science* is highly multidimensional, both on the energy side and the social science side. One familiar dimension is the *energy life cycle*. "Energy", in the social sciences, usually refers not only to an output of various physical transformations but also, and more often, to fuels, to pure energy sources such as sun, wind, and heat from earth and water, and to the transformations that can put energy-carrying materials and pure energy sources to practical use doing work for people. Thus, the energy life cycle involves social processes of energy resource exploration, extraction of energy sources or resources, the conversion of energy sources into energy products and the associated development of conversion facilities, the distribution of energy products, the use of the products, and the disposal of fuel byproducts and of

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energy-using equipment. The most important social processes are different in different phases of the life cycle. The energy life cycle can be thought of as a cradle-to-grave temporal sequence, though there are also feedbacks from later phases to those listed here as earlier in the life cycle.

On a second dimension is arrayed various *energy sources and products*: coal, oil, gas, electricity, the many renewable energy sources, and energy efficiency and conservation. Each of these has a life cycle, and the social processes in the energy life cycle often differ depending on the energy source. The notion of "energy services" is also part of this dimension, in the sense that the energy sources are means to other ends, which can sometimes be accomplished with lower levels of use of energy sources and products. A prominent current example is reduced energy use by substituting teleconferences for travel to accomplish person-to-person communication.

A third dimension is the *actors* involved in energy systems, including individuals, organizations, and social institutions. Actors can operate at various scales or levels. Major classes of actors are individuals and households; formal organizations in the private and public sectors and in the international arena; formal or informal networks of individuals or organizations; and social institutions, such as scientific, regulatory, and market systems, which may operate at scales from local to international and provide knowledge or rules that set contexts for action by individuals, organizations, and networks.

The topics of energy social science research are also multidimensional. Social science may consider the *human causes* of energy phenomena. The "drivers" of energy-related phenomena include economic motives, demographic processes, the development and spread of technologies, human values and beliefs, ideologies, political coalitions, and many other factors in social systems. It may consider the *human effects* of energy sources and systems: the ways they change individuals or social entities at any point in the energy life cycle. In this way, energy social science is much like research on other kinds of human–environmental interactions (see [3]; Fig. 1).

Energy social science may also consider *human understandings* of energy systems and the effects of these understandings: the ways the causes and effects of energy phenomena are mediated by the ways people at all scales of action think about and perceive the energy system and its impacts and the ways their understandings affect their actions. And it may consider *decision making processes* that affect the operation of energy systems. These, like the energy systems themselves, have a life cycle. Human decision making in the energy–environment arena has sometimes been characterized in terms of an idealized set of phases: problem formulation, decision process design, selection of options and outcomes, information gathering, information synthesis, decision making, implementation, and evaluation, all of these involving processes of analysis and of deliberation, and with the possibility of cycling back to reconsider "earlier" phases of the process as needed (see [4]; Fig. 2). These various phases of decision making may apply to any phase of the energy life cycle, at any scale, with any energy course, and with regard to intervening in the causes of effects of energy systems' operation.

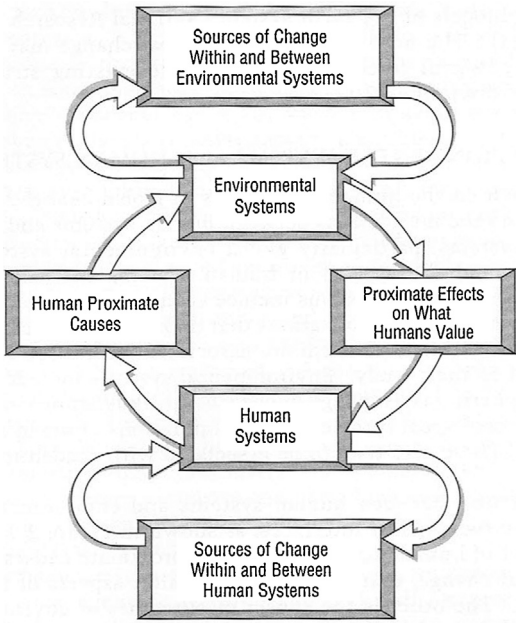

Fig. 1. Interactions between human and environmental systems. From [3], elaborating on Clark (1988).

The terrain of "energy research and social science" can also be subdivided by the academic disciplines likely to conduct the research, the intellectual questions that may stimulate research, the interest or value perspectives from which research questions arise (business perspectives, sustainability concerns, etc.), and the action needs that suggest research questions (e.g., meeting human needs for energy services, managing the financial costs of those services, managing risks associated with energy production and use, coping with damages from energy systems, and so forth). Thus, the "energy research and social science" terrain is highly multidimensional on both the energy and social science sides of the connection. To try to map the space, let alone to fill it with knowledge, is a worthy project for an interdisciplinary effort lasting decades. This effort can be part of the mission of *Energy Research and Social Science*.

Within this large and only partly mapped terrain, this paper focuses on individuals and households as they interact with energy forms, products, services, and systems. It briefly explores a few areas within this part of the territory, discusses them in terms of the roles of individuals and households in relation to energy

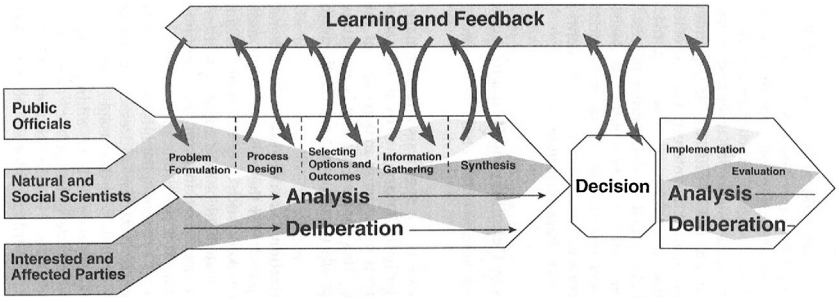

Fig. 2. A schematic representation of a risk decision process.

Source: [4].

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