Contents

Introduction

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There is growing understanding that energy is a social issue with technical components, not the other way around (Sovacool 2014a). As novel forms of energy development proliferate across the United States and around the world, the need for credible and informed scientific research on the potential environmental and community impacts of energy development becomes more pronounced (National Research Council 2014). Reflecting these changing understandings and priorities, a growing cadre of researchers has gathered to produce important new research on social, economic, and behavioral impacts from large-scale energy development. This collection demonstrates the momentum and dynamism of the present moment in energy impacts research.

The volume developed through the efforts of a network funded by the National Science Foundation to coordinate research on the social impacts of energy development across the diverse academic landscape in which this research occurs. A centerpiece of that network was The Energy Impacts Symposium, a two-day research symposium held July 26–27, 2017, in Columbus, Ohio. In concert with the event, we issued a call for submissions

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to this volume, which read, in part: "Chapters for this book shall compare, synthesize, bridge, or otherwise work to traverse heretofore constraints on coordination of energy impacts research. We are particularly interested in multidisciplinary author teams and papers that bridge academic disciplines."

The language of the call reflects the circumstances for the research coordination network's activities circa 2015–2017. A proliferation of new energy development had inspired a boom in research on energy and society broadly defined, the products of which stood to be mutually informative and potentially transformational. However, common themes and comparability among diverse strands of the energy impacts literature proved elusive. As such, the *specific goals* of this network were to

1. *build a cross-disciplinary research community* around social, economic, socioeconomic, community, governance, and public health impacts from energy development to coordinate research activity across geographies, energy types, and social science disciplines, increasing effectiveness and reducing redundancy;
2. *develop and promote a set of data collection standards, framing concepts, and research design* to allow for comparison of data acquired across energy landscapes; and
3. *develop a shared library of research tools and educational resources* to engage both academics and nonacademic audiences via integrated tools, concepts, findings, and curricula to inform and engage energy research, policy, and impacts.

Chapters submitted to this volume underwent a blinded peer-review process, managed by the editors. Each chapter was reviewed by at least 2 but often 3 or 4 anonymous reviewers, and the chapters underwent a revise-and-resubmit process that concluded in late spring 2018. Unfortunately, not all chapters made it through the peer-review process.

The twelve chapters in this book and the diverse disciplinary orientations of the authors reflect this original call. We have organized the volume into three main sections—"Section One: Theoretical and Conceptual Approaches," "Section Two: Methodological Approaches," and "Section Three: Case Studies and Applications." At the end of each chapter, we have included one-page "Chapter Summaries," indented to provide a brief overview of the chapter content along with "highlights" or "key takeaways" that

showcase how the chapter can inform future policy, regulation, or research in energy-impacted communities.

Section One: Theoretical and Conceptual Approaches

Section one features four chapters that encourage scholars as well as stakeholders in energy systems to rethink conceptual approaches to energy impacts and their evaluation. Together, these chapters indicate the potential significance of interdisciplinary communication and challenging scholarly and cultural norms about energy transitions.

In chapter 1 ("From Climax Thinking toward a Non-equilibrium Approach to Public Good Landscape Change"), Kate Sherren introduces readers to the concept of climax thinking. After defining the concept of climax thinking, Sherren describes the pathology of climax thinking, elaborates on the need for a non-equilibrium model for managing public good landscape change, and proposes an action-oriented research agenda for landscape transitions.

In chapter 2, Seven Mattes and Cameron T. Whitley's engaging essay about the "entangled impacts" that link human and animal lives in energy landscapes and systems ("Entangled Impacts: Human-Animal Relationships and Energy Development") introduces readers to a little-considered dimension of energy impacts, that of the human-animal bond. The authors extend to energy landscapes the notion, established in animal studies scholarship, that society is diminished by the failure to acknowledge the extent and importance of human-animal connections. In addition to an interdisciplinary literature review, the authors consider two very different but exemplary case studies: impacts of fracking on human-animal relationships and the Fukushima Daiichi nuclear accident and its impacts.

In chapter 3 ("The Need for Social Scientists in Developing Social Life Cycle Assessment"), Emily Grubert explores the important and often underappreciated links between engineering and the social sciences, exploring the basis of this importance and introducing new tools for the siting of large industrial projects that incorporates the work of social scientists. Life Cycle Assessment (LCA) is a major decision support tool that is increasingly used in policy making, and one of the major applications of LCA is for evaluating energy systems, both standalone and as contributors to other product systems. As noted, utilizers of LCA aspire for it to be a comprehensive and systematic approach

to holistically evaluating a product, process, policy, service, or system; however, in practice, LCA has historically been primarily an environmental assessment tool with socially oriented impacts rarely considered. This chapter calls social scientists to action in contributing to the development of LCA and discusses major needs, such as definition and development of social indicators that could be used in such assessment, approaches to defining scope and descriptive approaches, and critical assessment of the full suite of life cycle methods with respect to justice, ethics, application, and others.

In chapter 4 ("Societal Impacts of Emerging Grassroots Energy Communities: A Capabilities-Based Assessment"), author Ali Adil urges a new deliberative framework for evaluating energy transition scenarios. His case study is the case of Grassroots Energy Communities. The framework Adil offers orients to three axes—equity, justice, and sustainability—and is transdisciplinary in its use of scholarship from policy studies, political theory, and environmental studies. Adil proposes that this framework avoids normative "forcing" of specific visions of progress, and he offers it as a tool for use by decision makers in a variety of contexts and scales.

Section Two: Methodological Approaches

The next section of the collection introduces a set of chapters that reflect on or deploy innovations in methodological approaches to evaluating energy impacts. This includes Fernando et al.'s synthetic evaluation of the variety of existing approaches to data collection and analysis and argument for the merits of mixing methods, with specific respect to the study of shale development's social impacts. It also includes examples of the application of Q method (Parkins and Sherren) and Laninga et al.'s discussion of a new capitals-based assessment tool for energy development projects.

In chapter 5 ("Analysis of Research Methods Examining Shale Oil and Gas Development"), Felix N. Fernando, Julia D. Ulrich-Schad, and Eric C. Larson provide an in-depth review of the research methods used by social scientists to gather data on the social impacts of shale energy development. The authors highlight the various benefits and constraints associated with using either a quantitative or qualitative methodological approach to data collection. They then argue for the increased use of mixed methods in social scientific shale energy research.

In chapter 6 ("Identifying Energy Discourses across Scales in Canada with Q Methodology and Survey Research"), John R. Parkins and Kate Sherren use a mixed methods approach to identify variation in discourses on energy development in Canada at the national and regional levels. Combining data from in-person Q-sorts of individuals who were generally informed about energy issues in three Canadian provinces—Alberta, Ontario, and New Brunswick—with a national survey of Canadian citizens, the authors uncovered a high degree of alignment between regional and national discourses about energy development.

In chapter 7 ("A Capitals Approach to Biorefinery Siting Using an Integrative Model"), an interdisciplinary team of scientists and engineers discusses how decision support tools can enhance industry and public understanding, thus aiding site selection decisions. The authors provide their own innovative decision support tool that incorporates the Community Capitals Framework, and they test this tool with case study locations across the Pacific Northwest.

Section Three: Case Studies and Applications

The final section of the book presents a close look at an array of energy landscapes and their experiences of energy infrastructure transitions. This includes a critical look at the overlay of bioenergy and agriculture in Pennsylvania by Eaton, Hinrichs, and Burnham and a qualitative reflection on experiences of local residents with shale development in the Marcellus region (Podeschi et al.). Ratledge and Zachary offer a comparative exploration of the quantitative and qualitative data describing how public schools fared in US localities that hosted intensive shale development. A complementary chapter led by Myra Moss and colleagues discusses the dimensions of effective community engagement in the context of shale development. Finally, a large, interdisciplinary team from Virginia Tech offers a synthetic model for improving the process of wind facility siting, drawing on extensive local experience.

Chapter 8 ("Cultural Counterpoints for Making Sense of Changing Agricultural and Energy Landscapes: A Pennsylvania Case Study") by Weston M. Eaton, C. Clare Hinrichs, and Morey Burnham examines how cultural resources and social representations for working landscapes influence landowner responses to an emerging bioenergy industry. The authors

draw from a case study of bioenergy development in western Pennsylvania's Crawford County, a place undergoing a slow and uneven transition away from traditional agricultural and energy extraction industries, toward new forms of land use that include bioenergy and bioindustry development. In this chapter, the authors show how two cultural counterpoints influence landowner decisions about land use including growing bioenergy crops on their land. Landowners experience, on the one hand, a sense of obligation toward their family's previous generations, and on the other, a yearning for autonomy in the form of flexibility and control over their own land use decisions. Considered are how these cultural counterpoints inform the social-psychological processes through which landowners make sense of changes in land use and community life. The chapter concludes by highlighting the important role cultural meanings for rural landscapes play in social responses to renewable energy technology development that is premised on land use change.

Chapter 9 ("The Wider Array: A Qualitative Examination of the Social and Individual Impacts of Hydraulic Fracturing in the Marcellus Shale") by Christopher W. Podeschi, Lisa Bailey-Davis, Heather Feldhaus, John Hintz, Ethan R. Minier, and Jacob Mowery provides a qualitative analysis of residents' experiences with shale energy development in three communities in the Marcellus Shale region of Pennsylvania. Podeschi et al. use these data to emphasize the voices of local residents and illustrate the wide array of individual and social impacts associated with shale energy development.

In chapter 10 ("Drilling Impacts: A Boom or Bust for Schools? A Mixed Methods Analysis of Public Education in Six Oil and Gas States"), Nathan Ratledge and Laura Zachary examine whether public school districts that experienced the shale energy boom in Pennsylvania, Ohio, West Virginia, North Dakota, Montana, and Colorado fared better or worse in terms of financial and educational outcomes than comparable school districts that did not experience the shale boom in those states. Through the use of secondary data and over seventy predominantly in-person interviews, the authors elaborate on both the short-term benefits and long-term consequences experienced by school districts in the shale boom regions.

In chapter 11 ("Effective Community Engagement in Shale-Impacted Communities in the United States"), an experienced team of University Extension educators provides an overview and case study of effective and

(often less-than-effective) attempts on industry's part to engage with host communities. This chapter provides a theoretical and applied contribution based the authors' over three decades of observation and experience with shale-impacted community engagement. As Extension professionals, the authors have been working closely with communities in the Marcellus and Utica shale regions of Pennsylvania and Ohio as well as with Extension peers in other shale regions of the United States and throughout the world. The authors share their reflections and identify best practices and needs for further research, contributing to the larger field of energy research by providing unique experience-based insights into lessons learned and best practices for engaged shale-impacted communities, adding depth and direction to future social science research.

In chapter 12, an interdisciplinary team from Virginia Tech argues that to achieve a sustainable energy supply, public support must reflect adequate consideration of both positive and negative environmental, social, and economic impacts of wind energy facilities (WEFs). Their chapter, "A Framework for Sustainable Siting of Wind Energy Facilities: Economic, Social, and Environmental Factors," draws on research and practice in geography, wildlife biology, economics, and other fields to propose a framework for facility siting that responds to the complex issues involved in siting of WEFs.

Taken together, these chapters reflect a decade or more of novel research into energy impacts. The collection lays the groundwork for continued collaboration across social science disciplines through examples of conceptual, practical, and analytical benefits of going beyond the constraints that have historically separated energy impacts scholarship.

Contributions of this Collected Volume

As the amount of new energy development expands across the United States and elsewhere, the growth of new social science research on energy development has been extraordinary. In the United States, for example, the pace, scale, and intensity of new energy development has included hundreds of thousands of oil and gas wells, over 55,000 wind turbines, over 200 large-scale ethanol plants, and over 130 large-scale biodiesel plants that have been built in or near host communities (and has prompted a major expansion in associated pipeline, rail, and transmission infrastructure) (AWEA 2014; RFA 2014; USEIA 2014).

In response, a mountain of new research has been published. In 2018, Darrick Evensen counted "well over 1,000" (2018:417) English-language publications regarding the impacts of shale development, a number that assuredly continues to grow. However, when the Energy Impacts research coordination network was first proposed to the National Science in 2014, there was not a central forum or clearinghouse for social science research on energy development. Since that same time, Benjamin Sovacool published a comment in the journal *Nature* on the need for social science in energy studies (Sovacool 2014b). Elsevier began publishing the journal *Energy Research and Social Science* on this very subject, producing over 500 articles since 2014, as well as hosting a series of international conferences. Other journals such as *The Extractive Industries and Society*, *Energy Policy*, and *Society and Natural Resources* likewise have produced numerous articles on this topic.

This plethora of scholarship brings various nodes of inquiry and debate to address specific social dynamics of these new energy development technologies, such as the social and economic costs and benefits to landowners, residents, and communities; the efficacy of existing regulatory and governance regimes; and the perception of public health risk (for example, see the August 5, 2014, special issue of *Environmental Science and Technology* entitled "Understanding the Risks of Unconventional Shale Gas Development"). However, research discoveries and insights are often compartmentalized into disciplinary territories in ways that limit their transformative and informative potential.

While there will never be singular theory or approach that can incorporate all the varied research on this broad and complex topic, the entire body of research in this topical area benefits from increased coordination and communication across the various geographies, industries, and disciplines. Sending an uncoordinated army of social scientists out to energy communities to study the impacts of development risks redundancy and inefficiency as well as missed opportunities for synthesis, comparison, and innovation.

The primary contribution of this collected volume is to initiate interdisciplinary dialogue, reflection, and comparison. The collection attempts to span disciplinary and geographical boundaries that have previously isolated energy impacts research. The thirty-seven authors who produced the twelve chapters in this collection offer theories, methods, and approaches

to understanding the impacts of energy development from an array of disciplines, ranging from economics, geography, sociology, engineering, community development practice, and beyond. Many of the chapters produce theoretical frameworks or methodological approaches that can be applied across numerous locations or energy types.

Limitations of this Collected Volume

In the face of the broad research constraints outlined in this induction, and despite the original lofty goals of this collected volume, we recognize that this volume is still limited in a number of important ways. This book comprises works submitted in response to the open call for submissions—we did not specifically solicit works to address particular issues. The benefits of this process include that we received a number of remarkable and imaginative chapters that we could not have anticipated or solicited, but a downside of this process is that some critical areas are not specifically addressed.

A Focus on North America

The chapters included here focus largely on North America, though the conclusions or applications of these works need not be limited to this continent. We recognize that other areas of the world grapple with impacts from energy development, with the developing world facing a unique and critically important set of circumstances, and we hope the works here can be applied in international contexts and further adapted for use around the globe.

Academic Disciplines

Despite a diverse range of academic disciplines represented within these works (sociology, engineering, anthropology, science and technology studies, geography, communication, political science, community planning, education, and landscape architecture, to name a few)—we recognize that not all disciplines are represented. Economics and history, in particular, are two areas underrepresented in this volume.

Representativeness in Research Subjects and Authors

We recognize that marginalized populations are particularly vulnerable to the impacts of energy development; indeed, our own prior research has focused on the issues of differentiated costs and benefits from energy development. However, the works in this volume largely do not specifically focus on marginalized populations. Although issues of fairness in the distribution of costs and benefits are embedded in several chapters, we recognize issues of environmental justice (indeed, "energy justice") relative to specific populations—the poor, Sovereign Native peoples, people of color—make up an important and underresearched area of energy social science.

These limitations are not unique to this particular volume but rather speak to the limitations and challenges for the discipline as a whole. The works in this collected volume do attempt to bridge a number of the constraints identified in this introductory chapter, and we hope that these concepts, frameworks, and approaches will serve as the basis for new branches of synthetic and interdisciplinary scholarship, helping to inspire a new generation of social scientists.

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