1 INTRODUCTION

Why an entire volume on energy entrepreneurship research? Who stands to benefit from this collision? What theoretical insights can entrepreneurship scholars gain from conducting research in this particular context? How will the energy community benefit? These are the questions we asked ourselves before starting this project. Curiously, our 'answers' to these questions – and thus our 'rationale' for this volume – has evolved substantially over the course of its development.

Today, we believe – based in part on our discussions about whether to take on this project, and in part as a result of the experience of reviewing submissions, editing accepted chapters, and discussing the emerging domain at the authors’ retreat that we hosted – that we have better answers to these questions today than we had when we began. Our introduction, therefore, is an attempt not only to set the stage and to make a case for the inclusion of this volume into the entrepreneurship canon, but also to share with you how we got to where we are.

Apart from the obvious intellectual fascination of exploring a new domain of academic research, we believe that readers will also share the contributing authors’ excitement for energy entrepreneurship as a topical and extremely relevant research context. The rich menu of research questions that have been examined in this volume provides ample evidence that the world is in the midst of a major energy transition that some observers call the ‘next industrial revolution’. The energy opportunity space is expansive, and we invite readers of this book – both academics and practitioners – to join us on a fascinating journey highlighting entrepreneurial activities spanning from harnessing the sun to the power of the oceans; from clusters of innovation in industrialized countries to the new geography of global entrepreneurship in emerging markets; from the venture capital community of Silicon Valley to financiers of innovation in incumbent firms; and all of this being shaped by fundamental shifts in customer preferences and policy frameworks.

The rest of this introduction is a detailed exposition of what we state here in brief: that several strands of scholarly research stand to benefit from the collision of literatures, theoretical perspectives, methods, and research programs presented in this volume; and that understanding the drivers of entrepreneurial activity in the emerging new energy sector (along with exploring the specific challenges faced by energy entrepreneurs) has tremendous practical relevance.
2 POSITIONING THIS VOLUME IN THE ENTREPRENEURSHIP RESEARCH LANDSCAPE

Small Firms, Large Firms, and Entrepreneurship

Over the past half-century, our understanding of the role of entrepreneurship in society has changed dramatically. Fifty years ago a generation of scholars systematically documented and supported the conclusion of Schumpeter, who argued that ‘the large scale establishment . . . has come to be the most powerful engine of progress and in particular of the long-run expansion of output’ (1942: 106). Today, however, our understanding of the role of entrepreneurship in society has largely reversed (Audretsch et al., 2006). A previous generation’s belief in the ‘dynamism, organizational innovation, and boldness’ of the corporate form (Servan-Schreiber, 1968) has given way to a new perspective, that of the high-impact entrepreneur (Acs, 2008) as the primary engine of economic development (Acs and Armington, 2006; Schramm, 2006; Audretsch, 2007).

Our understanding of the role of the natural world and its ability to support or constrain economic development has also evolved. Concepts like climate change and peak oil have entered the public discourse, and while the particulars of what will occur economically and socially during the transition away from high-carbon fuel sources is subject to debate, it is clear that regions and nations are carefully considering these issues when building relationships with other nation-states, setting public policy, and how and when to project power. The end of cheap, abundant high-carbon energy is clearly a challenge. But it is also an opportunity.

Where opportunities arise, one finds entrepreneurs. It has become apparent that the magnitude of the energy-related challenges we face will require more than incremental changes to existing patterns of production and consumption. Entrepreneurs are likely to play a significant role in this discontinuous change, as they are – to quote Schumpeter, again – the ‘promoters of new combinations’, individuals who can see both new possibilities and assess market needs. While research on corporate sustainability management – with its interest in the connection between the natural environment and various organizational levels of analysis – has gained significant sophistication and legitimization, the role of entrepreneurs in this process remains relatively unexplored. Yet a growing body of work from science and technology studies, strategy, and entrepreneurship suggests that the innovation process may be at its most potent when harnessed to entrepreneurial activity – either by new ventures or by established firms – and supported by robust internal and external capital markets and well-conceived institutional and policy frameworks. It is therefore important to consider the role of entrepreneurial activity in the development and commercialization of breakthrough energy technologies in both start-up and established firms (Moore and Wüstenhagen, 2004; O’Rourke and Parker, 2006; Wüstenhagen and Teppo, 2006). This volume is the result of our joint interest in these topics, and our belief that entrepreneurial action will play a significant role in the transition to a low-carbon, sustainable world.

In the case of established firms, well-established theoretical perspectives have been extensively employed to examine innovation-driven transformation at the level of the industry. In fact, the starting point for most theories of innovation is the established firm, taken as a given (Baldwin and Scott, 1987; Dosi, 1988; Cohen and Levin, 1989),
and conventional wisdom has long held that large enterprises able to exploit at least some market power will serve as the engine of technological change. In this view, large enterprises are uniquely endowed to exploit innovative opportunities because market dominance allows these enterprises to undertake the risks and uncertainties associated with innovation. The possibility of acquiring quasi-rents is the catalyst for large-firm innovation, as development is costly and that cost can only be borne by a firm with the resources associated with considerable size (Galbraith, 1956).

In addition to the ‘who’ of innovation, the ‘how’ – for example, transformation processes – has also been an area of longstanding scholarly interest. Here, again, insights from the broader literature in strategic management have been employed (Nelson and Winter, 1982; Anderson and Tushman, 1990), with the traditional perspective arguing that the emergence of breakthrough technology leads to the destruction of existing competences (Schumpeter, 1939; Tripsas, 1997). These insights have not been lost on the current crop of sustainability scholars, who extensively employ these perspectives on research in corporate sustainability and the dissemination of clean technology innovation (Hart, 1995; Hart and Sharma, 2004; Moore and Wüstenhagen, 2004).

Relatively under-represented in this literature, however, is an understanding of the role of new firms in this process, despite an explicit attempt in the existing literature to understand how to apply Schumpeterian-style creative destruction to the simultaneous benefit of firms, society and the environment (for example, Hart and Milstein, 1999; Wüstenhagen et al., 2008). Further, the inherent advantage of established firms in the innovation process has been cast into doubt by the profusion of empirical work that documents the crucial role of small enterprises in innovative activities (Jovanovic and Lash, 1989; Hobijn and Jovanovic, 2001; Jovanovic, 2001; Aghion et al., 2006). An emerging body of work by scholars at the intersection of entrepreneurship, social and environmental studies provides a theoretical starting point, detailing how opportunities related to sustainability and energy might arise through market imperfections (Cohen and Winn, 2007), discussing the role of entrepreneurship in the resolution of emerging environmental problems (Dean and McMullen, 2007), and addressing the nature of opportunity recognition in contexts of industry transformation (Monllor and Attaran, 2008).

These emerging contributions – all of which hew closely to the research questions and perspectives familiar to entrepreneurship scholars – will certainly help to generate a richer and more nuanced perspective on the entrepreneurial process for energy and sustainability-related endeavors. Yet, it seems to us that other research contributions targeting more fundamental questions – how, why, and when do entrepreneurial firms come into being? – has the potential to contribute greatly to the energy and sustainability research program as it has been enacted in environmental management, strategy, and organization literatures.

**Knowledge, Entrepreneurship, and Creative Construction**

The ‘knowledge spillover theory of entrepreneurship’ (KSTE) (Acs et al., 2006) and the process of creative construction (Agarwal et al., 2007) provide a theoretical frame from which to conceptualize and incorporate the role of both emerging and established firms in the diffusion of industry-transforming innovation. Taken together, they provide a potentially fruitful perspective from which to examine questions of interest to energy and
sustainability scholars. Given the role of small firms in catalyzing industry transformation, and the capability of established firms to either support or hinder the shift to new technologies for their own gain, these theoretical insights have great practical application for the field (Hockerts and Wüstenhagen, 2010).

Building on insights from the knowledge-based view of the firm (Teece et al., 1997) which proposes that competitive differences between firms are the result of the creation of privately held and tacit knowledge, the KSTE explores more fully the implications of the incomplete transformation of scientific/industrial knowledge by an incumbent firm into ‘economic knowledge’ (Arrow, 1962). That is, a substantial portion of the knowledge created by an incumbent firm languishes, unexploited. However, this knowledge is distinct from other resources, given its characteristics as a public good. It is non-rival and non-excludable – thus creating opportunities for knowledge spillovers. The KSTE proposes that the firm is created endogenously through the agent’s effort to appropriate the value of his/her knowledge through innovative activity.

An important insight of the KSTE is that the opportunity for entrepreneurs to exploit new knowledge is related to (i) the ability of the incumbent firm to exploit that knowledge completely, and thus reap the rewards and (ii) the cost and benefit to a prospective entrepreneur in exploiting that knowledge. The greater this ‘knowledge filter’ (Carlsson et al., 2007), the greater the gap between new knowledge and economic knowledge. It is this knowledge filter that creates a space for the entrepreneur to bring new innovations to market. As Arrow (1962) notes, knowledge is valued differently by different actors. If the gap in the valuation of the expected return between the incumbent firm and the inventor is sufficiently large, and the barriers involved with starting a new business sufficiently low, the employee may decide to leave the incumbent organization and establish a new firm. Thus, knowledge spillovers from new technology give rise to new opportunities (Shane and Venkataraman, 2000; Casson, 2003), and institutional constraints result in a subset of these opportunities not being exploited by incumbent firms, leaving a role for the entrepreneur (Acemoglu et al., 2005).

The entrepreneurship literature has extensively documented the fact that small firms are often born when a researcher in a large firm sees the power and utility of an undervalued innovation. Both Jaffe (1989) and Acs et al. (1992) document spillovers from university laboratories that have contributed to the generation of commercial innovations by private enterprises. Thus, whatever debate that may exist concerning the innovative capacity of small firms, we conclude that entrepreneurial enterprises play an important role in the commercialization of that innovation – whether in an existing firm or born out of a university research center.

**Entrepreneurship, Institutions, and Public Policy**

From our point of view, the energy context provides entrepreneurship scholars interested in the relationship between entrepreneurship, innovation and economic growth a fruitful research setting to explore the impact of institutions and policies on the commercialization process. An extensive literature has detailed the influence of various policy regimes (for example, the presence and absence of subsidies and feed-in tariffs) on innovative activity (for example, the deployment of wind turbines) in countries around the world (Jacobsson and Lauber, 2006; Wüstenhagen and Bilharz, 2006; Breukers and Wolsink,
An introduction to energy entrepreneurship research

2007; Lipp, 2007; Toke et al., 2008). Much of this literature in the energy policy research community is agnostic as to whether the outcome of such policies is actually the consequence of the activities of de novo firms or the activity of incumbent firms as long as the desired outcome (change in the overall energy mix) is achieved. Some authors, however, suggest that the effectiveness of energy policies in bringing about these changes actually hinges on providing the right incentive to entrepreneurs in small and large firms, and raises questions concerning the underlying assumption that as long as the outcome is achieved, the approach taken was ‘successful’. This challenge is underlined by anecdotal evidence of failure of ‘large corporate’ approaches to energy innovation, such as the early attempts by a consortium of German industrial establishment to commercialize the GROWIAN large wind turbine (Pulczynski, 1991; Wüstenhagen and Bilharz, 2006).

Along similar lines, Garud and Karnøe (2003) show how the ‘breakthrough’ approach of US research policies on renewable energy technologies led to inferior long-term results compared to the ‘bricolage’ approach pursued by their Danish counterparts. These findings suggest that energy policy aimed at supporting the transition to a post-fossil-fuel era may be more effective if it comes with an entrepreneurial flavor, or – as Hockerts and Wüstenhagen (2010) put it – what may be needed is an ‘ambidextrous innovation policy for sustainability’. One important feature of such policies, which would equally support both ‘Davids’ and ‘Goliaths’ in their entrepreneurial efforts rather than focusing implicitly or explicitly on innovation in large firms, would be that they effectively reduce risk, so that small firms and their financiers can actually successfully enter the new market (Mitchell et al., 2006; Bürer and Wüstenhagen, 2009).

Some exciting emerging research has been conducted at the nexus of entrepreneurship and energy policy – including some of the chapters included in Parts II and VI of this volume – but it is fair to say that the relationship between policy regimes and the broader entrepreneurship and strategy literature remains relatively understudied. We plan to explore these issues in future research, and hope to draw a community of interested scholars into this interesting and valuable area for entrepreneurship research.

Financing Energy Entrepreneurship: The Role of Venture Capital

While the widespread adoption of renewable energy technology depends on a constellation of actors, and (as detailed previously) management and sustainability literatures have tended to focus on the role of established firms in this process, other literatures – most notably those concerned with energy policy and science and technology studies – have extensively examined the role of institutions and policy regimes. But that is not the end of the story. The adoption of renewable energy technology – especially breakthrough innovation brought to market by innovative, high-growth firms – also depends on a set of actors that have been understudied to date: namely, the capital market actors that finance this innovative activity. Surprisingly, the strategy and innovation literatures take the allocation of capital as a given, and the relationship between the capital markets and innovative activity is relatively understudied outside of the entrepreneurship literature.

In entrepreneurship scholarship, a growing body of work suggests that private equity investment (in particular professional and corporate venture capital) may play an important role in the commercialization of breakthrough sustainable energy technologies (Moore and Wüstenhagen, 2004; Wüstenhagen and Teppo, 2006; O’Rourke and Parker,
Understanding these actors and their role in energy entrepreneurship is, in our view, an opportunity to contribute to our understanding of an evolving innovation process. Further, the renewable energy context highlights emerging challenges in the practice of venture investment, which have not yet been completely understood or incorporated into the scholarly research program.

An important contribution of the entrepreneurship literature to scholarly conversations about renewable energy is the role of professional venture capital as a catalyst for renewable energy innovation and a structure supporting its successful diffusion. We also suggest that renewable energy provides a fertile context in which to examine open (and emerging) questions in venture capital scholarship. However, we still know relatively little about the role that contextual factors play in shaping perceptions of opportunity, risk, and reward (Petty and Gruber, 2011) and we know little about the impact of these factors on the financing and performance of start-ups or the venture capital firms that fund them. Yet studies using renewable energy investment as the research context suggest that contextual factors significantly influence investment decision making (Bürer and Wüstenhagen, 2009). Examining early-stage investments in areas in which venture capital investors are familiar and contrasting those investment decisions with ones made in emerging industries may provide a fruitful context in which to examine (or, re-examine) venture capital decision criteria and processes.

While interviews with venture capital investors have provided great insight into the criteria used for evaluating individual investments in industries familiar to venture investors (Sahlman, 1990) these criteria have not been found to map cleanly to decision making in emerging industries (Christensen et al., 2009). In an emerging industry, investment best practices have yet to be delineated, markets have yet to mature, and a dominant design has yet to emerge. Thus investing in a new industry sector requires overcoming the tremendous uncertainty inherent in the financing of early-stage firms, and is compounded by the need to resolve these additional challenges. Research has documented in great detail idiosyncratic due diligence and processes venture capitalists employ to resolve the former but scholars have had much less to say about the latter. More work is required.

Our understanding of the role that corporate venture capital plays in the diffusion of breakthrough innovation may also change as a result of the collision with the world of renewable energy. Corporate venture capital – the investment of corporate funds directly in external start-up companies (Chesbrough and Tucci, 2004; Dushnitsky and Lenox, 2005, 2006) – is conceptualized as a complement to other knowledge-generating activities such as internal research and the formation of external alliances, employed to enable incumbent firms to tap into know-how developed inside another organization (Dushnitsky and Shaver, 2009). Corporate venturing programs – in contrast to professional venture capital investment – are intended to capture both strategic and financial benefits (Chesbrough, 2002; Dushnitsky and Lenox, 2006; Ivanov and Masulis, 2007). To succeed at their dual mission of generating both strategic and financial returns, corporate venture capital investors must master a set of skills distinct from those employed in professional venture investment (Hellmann, 2002; Dushnitsky and Lenox, 2006). In the same way that professional venture capital firms have evolved specialized know-how and idiosyncratic structural and contractual mechanisms optimized for capturing financial gains accruing from early-stage investment (Sahlman, 1990; De Clercq et al.,
successful corporate venture capital programs have developed specialized know-how that supports external knowledge search, evaluation and integration. Thus, given careful planning, organizing and structuring, a corporate venturing program can become a useful resource that firms can use to conceive of and implement their strategic objectives, becoming an important firm-specific asset in its own right (Porter, 1981; Barney, 1991). Our conjecture is that corporate venture capital programs may in fact be a source of significant advantage for incumbent organizations, although we acknowledge that the jury is still out as to how many incumbent energy firms will actually master the inherent tensions of corporate venturing activities successfully. While evidence for failure is abundant (Teppo and Wüstenhagen, ch. 9, this volume), the upside for those who succeed may be a recipe for survival in the emerging low-carbon economy.

The New Geography of Innovation

In the good old days of entrepreneurship, geography mattered a great deal: entrepreneurial activity appeared to occur around geographically distinct clusters of innovation, and policy makers trying to enhance the competitiveness of their nation-state seemed to have a clearly addressable audience. In fact, innovation policies around the world were often modeled to mirror the legendary success stories of high-tech hotspots, such as Silicon Valley or Route 128 in the North-Eastern US, hoping to create equally vibrant areas of entrepreneurial activity. While the success and failure of such policies is also subject to debate, we can clearly state that the world has changed. The phenomenon that is at the center of this book, energy entrepreneurship, occurs in an age of globalization, and this fact may have important consequences for entrepreneurial firms, as well as their financiers and policy makers.

Research has traditionally conceptualized the relationship between a start-up firm and its investor as an inherently local business, and the geographic concentration of both venture capital organizations and start-ups tends to support this depiction. The observed preference for local investment is conceptualized as the result of the tremendous information problems associated with investment in early-stage entrepreneurial ventures (Gompers and Lerner, 2004). The reliance on local networks of trusted partners (Shane and Stuart, 2002; Hochberg et al., 2007) are a crucial part of how a venture capital firm resolves those information problems. However, the spread of entrepreneurship globally, the development of breakthrough innovation in new nations, the migration of talent to new regional clusters, and the attendant need to participate in emerging growth markets have encouraged venture capital firms to develop global strategies and make offshore investments. Today, venture capital investment occurs in a ‘post-American world’ (Zakaria, 2008), one in which innovation, entrepreneurial opportunity, and talent are distributed globally.

Companies are increasingly sourcing and using top-tier science and engineering talent in globally dispersed locations (Antras and Helpman, 2004; Manning et al., 2008; Lewin et al., 2009) that correspond to the development of new regional clusters located in or around emerging urban centers (Howells, 1999; Bresnahan et al., 2001; Florida, 2005; Carlsson, 2006). It has become more difficult for the United States to retain the world’s best and brightest (Lieberthal and Lieberthal, 2003; Chanda and Sreenivasan, 2005; Zweig, 2005; Saxenian, 2006). These individuals are the high-impact entrepreneurs of
the future, and venture capitalists depend on them to start innovative, high-growth firms (Saxenian, 2002; Lee et al., 2004; Acs and Armington, 2006; Shane, 2008).

The innovative activity that attracts venture investment has evolved as well (Cantwell, 1995; Engardio and Einhorn, 2005; Ernst, 2005). Less than five years ago, the conventional wisdom was that the information and biotechnology fields – the core business of venture capital investors – would continue to be dominated by US firms, and that no other field would displace those sectors in the near future in size and speed of capital gains generation. This perspective is now at odds with the facts on the ground, as global-class technology is being developed all over the world (Reddy, 1997; Zhou and Leydesdorff, 2006). In the case of certain technologies, to be on the cutting edge one relocates to Haifa, Berlin, or outside Beijing (Ernst, 2002). And, for a number of promising technologies, including renewable energy, the United States is no longer the clear technical or market leader. There are more than 1,500 renewable energy start-ups operating worldwide, the majority of which are located outside the United States (Friedman, 2008). The intersection between energy and venture investment may be a fertile context for scholars interested in capability development, organizational change, or the internationalization process of both entrepreneurial firms and the venture capitalists that back them.

3 ENERGY ENTREPRENEURSHIP: THE CONTRIBUTION OF CHAPTERS IN THIS VOLUME

The Handbook of Research on Energy Entrepreneurship provides a distinctive and multidisciplinary starting point for scholars interested in energy and sustainability as a primary domain, as well as entrepreneurship and strategy scholars seeking an opportunity to make an impact in a field of growing academic and social interest. Across the different sections, the book provides a variety of insights on theoretical, conceptual and methodological approaches that may be fruitfully applied to the emerging research field on energy entrepreneurship. Given the many different directions and approaches there is a need to provide a reference work in this field. Each chapter offers a carefully presented summary of its area and discusses future research needs for different topics.

Part I, ‘The Role of Start-Up Firms in Energy Entrepreneurship’, addresses a perspective that is very popular in entrepreneurship research, namely the role of new firms in bringing about energy innovation. Three chapters are adopting this start-up perspective, each from its own unique angle.

Chapter 2 by Garnsey, Dee and Ford combines a theoretical approach with case studies to investigate some of the underlying fundamental questions of the relationship between market failures, market dynamics, and entrepreneurial opportunities in environmental markets, including renewable energy technologies. They argue that while market failures can be seen as a starting point for sustainable entrepreneurial opportunity (for example, Dean and McMullen, 2007), they can also create significant barriers to entrepreneurial activity. The authors illustrate their theoretical considerations with empirical evidence from environmental ventures in the UK, and conclude that an evolutionary economics perspective might be more powerful in explaining entrepreneurial innovation by environmental ventures than the neoclassical concept of market failure.
Chapter 3 by Marcus, Anderson, Cohen and Sutcliffe provides yet another illustration for how reality may differ from traditional models of innovation and entrepreneurship as a linear process from opportunity recognition to successful commercialization. Their contribution looks at a phenomenon they call ‘prolonged gestation’, referring to entrepreneurial ventures for whom market success remains elusive long after being founded. They study this phenomenon in the context of energy entrepreneurial firms in Minnesota in the 1990s. Their longitudinal case study design allows them to answer some interesting questions about what determines entrepreneurs’ sustained commitment to building companies in a new market, despite significant challenges.

Chapter 4 by Dickel and Andree takes a learning perspective on entrepreneurship. They attempt to advance entrepreneurial learning theories by advocating a dynamic learning model, concluding that different forms of learning (personal and codified learning and knowledge integration) apply in different stages of development of start-up firms. Their chapter is one of four in this book deriving their findings from the vibrant German renewable energy market, and the only one that investigates the biogas sector.

The common thread of the three chapters in Part II, ‘International Energy Entrepreneurship’, is that they add a distinct geographical dimension to the debate and address some of the topical questions of how innovation and entrepreneurship occur in today’s globalized world. The first two – Chapter 5 by Brachert and Hornych and Chapter 6 by Meersohn and Hansen – provide complementary perspectives on the same market, namely the emerging industry for solar power generation (photovoltaics, PV). Brachert and Hornych look at the German PV industry as an interesting case study for cluster formation in an industrialized country, and find it a fruitful context to explore the concept of ‘windows of locational opportunity’ (WLO; Scott and Storper, 1987; Storper and Walker, 1989). Another highlight of their chapter is to investigate the role of social movements in laying the institutional foundations for entrepreneurial opportunities, a theme that is explored further in Part VI.

In the following chapter, Meersohn and Hansen take the reader’s attention from Germany further East – towards the rising sun, so to say – focusing on the phenomenal rise of Chinese challenger firms in the solar energy industry. They show how this case contrasts sharply with the well-established conventional theories of firm internationalization, and propose theories of latecomer firms (Tolentino, 1993; Mathews, 2006; Buckley et al., 2007) as a fruitful alternative framework. Given the relatively short history of the phenomenon that they are studying, the authors successfully overcome data availability challenges by combining industry-wide data with three in-depth case studies of leading Chinese producers of solar panels.

Chapter 7 by Løvdal and Aspelund, takes the discussion of the previous two chapters on firm internationalization yet a step further by focusing on international new ventures (INVs), or ‘born globals’, in energy entrepreneurship. Based on a unique dataset of born globals in the offshore renewable energy sector (wave, tidal and offshore wind energy), the authors investigate a number of propositions on the founder, firm and context levels. Taken together, these propositions provide a highly interesting context for advancing our understanding of energy entrepreneurship in a globalized world. Similar to the previous chapter, the way the authors triangulate data from a variety of sources may provide some methodological inspiration to energy entrepreneurship scholars struggling with data availability issues.
While many of the above chapters have focused on small firms, thereby arguably reflecting a popular emphasis in entrepreneurship research in general, Part III, ‘Energy Entrepreneurship and Large Incumbent Firms’, looks explicitly at the other end of the spectrum. Chapter 8, by Schoettl and Lehmann-Ortega, reprises one of the popular themes of this book, namely solar photovoltaic (PV) technology as a particularly disruptive example of energy innovation, and asks how energy incumbents can overcome some of their legendary challenges in addressing radical innovation. The solution they are offering is to take a closer look at possible business models for PV, of which some are more adequate for electric utilities to adopt than others. In particular, they find it useful to deconstruct the PV value chain so as to identify those areas of the newly emerging industry that are competence enhancing rather than competence destroying from the incumbent’s perspective. As a conclusion, the authors identify a number of specific business models that allow incumbents to move from a perception of PV as a threat to their existing business to one of it being an opportunity to create future revenue streams.

Somewhat in contrast to the basically optimistic tone of Schoettl and Lehmann-Ortega’s contribution, Chapter 9 by Teppo and Wüstenhagen provides a more sobering perspective of innovation in large incumbent energy firms. Using the emergence and subsequent decline (‘sudden death’) of corporate venture capital funds in the European energy industry as a research context, their qualitative empirical research gives rich evidence of the challenges that incumbent firms face in trying to create a fertile ground for entrepreneurial activity, especially in the midst of a major technological transition. The authors point to differences in organizational culture between parent firms and their corporate venturing units as a possible factor to explain failure. On the methodological side, while somewhat unusual when compared to the plethora of research that focuses on success stories and factors, we believe that this chapter’s focus on cases of failure can provide energy entrepreneurship researchers with some inspiration to strive for a more balanced account of the possible outcomes of entrepreneurial activity.

Following up on Chapter 9’s introduction into the world of (corporate) venture capital, Part IV, ‘Financing Energy Entrepreneurship’, delves deeper with three chapters that nicely cover the full spectrum of entrepreneurial finance. Chapter 10 by Grichnik and Koropp starts the series at the earliest stage of the financing cycle, namely the role of business angels in funding early-stage energy technology firms. By drawing on data from a panel study of German business angels, the authors portray energy as an area of great interest to business angels. They also show, however, that there continues to be a significant gap between investors’ stated preferences for going into this sector and their actual behavior. The descriptive analysis by Grichnik and Koropp might provide an interesting starting point for future research that explores the causal mechanisms of how early-stage investors adapt to new opportunities in emerging industries, and the barriers they face in doing so.

In a variation of the optimistic versus pessimistic pair of chapters in the previous part, Kenney elaborates further on those barriers in Chapter 11, taking a skeptical point of view on venture capital investment in the energy sector. By contrasting some of the characteristics of the venture capital model of financing innovation with the realities of the green technology sector, the author identifies a number of challenges that raise the question whether that model is actually suitable for the context at all. The author underlines his argument with data about investment flows in green technology, which he shows to
be highly correlated with the volatile oil price, and qualitative data from venture capitalist interviews.

Chapter 12 by Loock rounds off the discussion of financing energy entrepreneurship by moving to stock markets as a means of providing expansion capital to innovative clean energy firms. He, too, uses the business model concept as a conceptual framework, and conducts an empirical analysis of how different business models relate to the financial performance of growth firms in the wind and solar industries. While the author does not provide investors among our readership with a performance guarantee for implementing his findings, this is yet another example of a chapter that is of direct relevance for investment practitioners, although Loock acknowledges the crucial role of timing in interpreting his findings. His analysis provides a number of interesting contributions to the business model literature, especially by linking different business model configurations to firm performance. From an energy perspective, the chapter provides an interesting snapshot on where the two sectors (wind and solar) are located on their way to full maturity, with wind having a head start of a few years over solar.

Part V, ‘Commercializing Energy Innovation’, provides three different perspectives on topics not neatly fitting any of the other boxes, but highlighting fruitful avenues for exploring energy entrepreneurship. Chapter 13 by Pogutz, Russo and Migliavacca investigates the role of strategic alliances and networks in the commercialization of fuel cell technologies. They use social network analysis to visualize and explore the centrality of different organizations in the emerging fuel cell industry. A small number of North American firms are shown to be at the heart of the fuel cell innovation network, but – particularly telling about the specifics of the energy sector – their centrality is even topped by a government agency, namely the US Department of Energy. The authors outline several routes for further research, and it is obvious that the current energy transition offers a variety of emerging energy technology sectors in which such analysis may be fruitfully applied beyond the case of fuel cells.

A different perspective is introduced by Abold in Chapter 14, looking at market research challenges in the new energy market. His chapter reminds us that the customer actually matters in the energy industry, and provides some insights into the ways in which professional market research agencies help their customers make sense of the new energy realities. He highlights two areas in which the behavior of residential energy customers poses particular challenges to market research: understanding customer loyalty, and identifying promising target groups for energy innovation. He points out that energy has traditionally been a low-involvement product, so any attempts to market specific products have to be preceded by overcoming significant inertia on behalf of the customers. Lifestyle typologies can be a promising way to address the second challenge, and provide for marketing efficiency. Another insight from this chapter is that conceptualizing the energy market as a single monolithic entity is not accurate; instead, energy innovators in small and large firms are faced with a complex set of markets ranging from electric utility services through oil and gas to building technologies and beyond. Carefully delineating their target market and investing in a proper understanding of customer needs should therefore be a priority for energy entrepreneurs, and this chapter provides two specific starting points for doing so.

Lovio, Mickwitz and Heiskanen offer yet another perspective in Chapter 15, and the common denominator with the previous chapter may be the observation of inertia.
Lovio et al. do not look at this on the level of individual customers, but instead change the level of analysis and explore path dependence in energy systems. They start out with the observation that energy systems are slow to change due to path dependence, but then take Garud and Karnøe’s (2001) idea of path creation and Schumpeter’s seminal work on creative destruction to ask whether and under what conditions energy systems change in the face of fundamental innovation. The authors illustrate their conceptual considerations with empirical evidence from the Finnish energy system, and conclude by pointing to the importance of new institutions in path creation.

Institutions are also one of the central themes of Part VI, ‘Energy Entrepreneurship, Institutions and Public Policy’. Chapter 16 by Hart sets the stage with a look at how public policy shapes the market for new energy technologies. His research context is carefully chosen: among the portfolio of new energy technologies that have recently been the focus of entrepreneurial attention, the solar photovoltaic sector is probably one of the most affected by policy. Apart from Germany, Spain and Japan, the US is a particularly promising market for solar energy, and more than federal policy, it is state-level policy that has had most influence on renewable energy growth (or its absence) in the US. Hence the New Jersey market is a promising context to study the relationship between policy, entrepreneurship and the emergence of new markets. Like the Teppo and Wüstenhagen, and Kenney chapters, above, Hart’s contribution reminds us that energy entrepreneurship consists of more than just plain success stories, and that policy cannot only make, but also break markets. Fortunately, the New Jersey case shows that policy makers have learned their lessons from trial and error, and the market is about to be remade. The author also touches upon another popular theme of this book, which is the differential role of start-up firms and large incumbents in energy entrepreneurship, by discussing how partnerships between entrepreneurial new entrants and established utilities could help overcome some of the current market challenges.

From the clearly defined state-level policy setting of New Jersey, Chapter 17 by Aleluia and Leitão takes us back into the world of international entrepreneurship, but this time with a policy perspective. The authors investigate one of the instruments of global climate policy, the clean development mechanism (CDM), and how it is being applied in China. This chapter makes a number of contributions to entrepreneurship scholarship: not only does it provide a handy overview of the full menu of international climate policies, but it also links those to the literature on international entrepreneurship and technology transfer. Finally, the chapter reiterates the theme of ‘making and breaking markets’ outlined by Hart in the previous chapter, by pointing out that the reality of policy making around energy and climate issues is anything but straightforward, and that the messy nature of those policy frameworks creates both opportunities and challenges to energy entrepreneurs.

If traditional policy is messy, then other institutions might take their role, some may argue. The final chapter by Peretz and Acs (Chapter 18) can provide some insights into one such ‘other institution’. It focuses on the role of incentive prizes – which may be offered by government agencies, but also by private foundations, universities or businesses – on promoting energy innovation and entrepreneurship. The chapter reviews empirical evidence from a number of prizes in the US renewable energy and energy efficiency sector. Based on a careful review of the experience with such prizes, the chapter provides a compact summary of what works well and what does not work so well, hence
providing important implications for policy makers – or perhaps more precisely, institution makers. In addition to a healthy dose of hands-on advice for practitioners, the chapter also touches upon some of the more fundamental questions of entrepreneurship research, including the issue of entrepreneurial motivation, and points out that the prestige associated with winning an incentive prize may be worth more than money.

4  PROMISING AVENUES FOR FURTHER RESEARCH ON ENERGY ENTREPRENEURSHIP

While we have done our best to put together an insightful collection of early research contributions on energy entrepreneurship, we believe that this can only be a starting point and the field clearly deserves more scholarly attention in the future. Among the multitude of aspects touched upon in this book, we would like to specifically point out four main areas for further research.

First, we believe that the current transition from a fossil-fuel-based energy economy to a cleaner energy future creates a rare opportunity for entrepreneurship scholars to study the emergence of a new sector of entrepreneurial opportunity, perhaps similar to the rise of biotechnology entrepreneurship two or three decades ago. Because major industry transitions have tended to occur rather infrequently, today’s entrepreneurship scholars would be well served to seize this opportunity as it unfolds (as our predecessors seized the opportunity to examine in detail the transition from large- to small-firm innovation 20 years ago). Arguably, a large part of this research opportunity concerns aspects that could perhaps collectively be coined as ‘institutional’, in that the research questions tend to transcend the level of the firm. How do venture capitalists and other investors adapt to an emerging opportunity outside their ‘home turf’? How does entrepreneurial talent migrate from one industry to another? What role do behavioral factors and cognitive biases play in the strategic choices involved? How can evolutionary perspectives, such as concepts of path dependence and path creation, improve our understanding of these issues? How do entrepreneurs and policy makers collectively try to create appropriate institutional frameworks to support the transition? In our view these are all interesting research questions and perspectives, for which the current nascent state of the ‘new energy economy’ provides a valuable window of opportunity for research.

Second, we think that there is more scope for specific research on entrepreneurial marketing. The marketing–entrepreneurship interface tends to be a somewhat understudied area, and so is the marketing–energy interface. We admit that part of this assessment is a personal preference for a world in which customers matter over one where energy suppliers conceive of them as ‘ratepayers’, but ultimately for an entrepreneurial venture to survive, it needs to provide solutions that create value for its customers (and other stakeholders). And just as Bhidé (2006) argues that ‘venturesome consumption’ of its inhabitants can help the United States maintain a competitive advantage in times of globalization, our diagnosis is that unleashing the power of the consumer in the energy market can pave the way for renewable energy innovation, given widespread public preference for clean, low-cost energy sources. Creating great technologies is a crucial first step; but, it is only a first step. Therefore, further research on entrepreneurial marketing in the energy sector could focus on identifying unmet customer needs, and on marketing
strategies and business models to fulfill them. When it comes to marketing clean energy innovation, researchers will be faced with the twin challenge surrounding an analysis of customer preferences for (i) new and (ii) sustainability-related products. When it comes to new, innovative products, some of the established marketing research methods work less well because customers are inexperienced with the research object, and hence their preferences for certain product features, pricing schemes and so on may be undeveloped. When it comes to sustainability-related products, the issue of social desirability becomes a concern, for example when it comes to assessing willingness to pay for environmental features. Successfully addressing those challenges requires an adequate set of methods, such as focus groups (for example, Kaenzig and Wüstenhagen, 2008), conjoint experiments, or test markets.

Third, even if this were not intentional, we realize that almost all of the chapters in this book interpreted energy entrepreneurship as entrepreneurial activities related to renewable energy technologies (or ‘cleantech’). We share the view that this is an area of particularly substantial opportunity, but it might also be worth exploring entrepreneurial activities and the development of new capabilities (or the absence of their development) in the existing energy business. Also, while many observers see particular potential in an increase of energy efficiency in areas such as industry, buildings and transportation, energy efficiency-related entrepreneurship has received relatively scant attention by scholars. So investigating how entrepreneurial solutions can improve the market diffusion of energy-efficient technologies might be a rewarding research endeavor.

Fourth, we believe that a particular feature of energy entrepreneurship is the fact that it occurs in a heavily politicized industry. The chapters in this volume provide a starting point for investigating the policy–entrepreneurship interface, but more could be done. It is important to note that more than one area of policy making is of relevance here. First, energy entrepreneurs are entrepreneurs, and as such are likely to be influenced by general research, technology and innovation policies, as well as specific energy policies. Second, though, because energy is a cross-cutting issue, entrepreneurial activity in this area can also be supported or hindered by a whole set of other policy areas, including environmental, climate, agricultural, transportation and defense policy to name but a few. Energy entrepreneurs and their investors are well advised to specifically consider ways of managing these policy risks (Bürer and Wüstenhagen, 2008), or transforming them into opportunities. This is probably an area where interdisciplinary research between entrepreneurship scholars and experts in political science looks particularly promising.

Fifth, energy systems are capital intensive and bound to substantial infrastructures. This will have implications for energy entrepreneurship, perhaps in a larger role of large corporations in bringing about the energy transition. Only two chapters in this volume explicitly address corporate venturing, but this is certainly an area for further investigation. Why do incumbent firms differ in their approach to embracing the clean energy opportunity? What explains such differences both between subsectors of the energy industry and between countries? How should corporate venturing models be adapted to fit the specific circumstances of the energy industry with its long lead times, capital intensity and geopolitical considerations? And what can be learnt from studying the power relationships that have historically been associated with control over energy resources, and that might be threatened by energy entrepreneurs?
Sixth and finally, while we have some geographical diversity by studying energy entrepreneurship in North America, Europe and China in this book, there is scope for taking this theme to new geographical horizons. Energy entrepreneurs in developing countries, for example, may face specific opportunities (unmet demand for energy, no competition from existing grids) and challenges (financing, political risk). Therefore, studying energy entrepreneurship (and its financing, for example through microfinance) in developing country contexts could generate new insights that could be transferred back North.

5 CONCLUSION

We started out in this introduction by pointing out the double excitement that energy entrepreneurship provides both as an area for scholarly investigation, and as a real-world phenomenon that combines tremendous market opportunities with a wider societal impetus. In our empirical work with energy entrepreneurs and investors, we felt that the sheer scale of the current energy transition, as well as the fact that entrepreneurial solutions in this area provide entrepreneurs and investors with the opportunity of doing well while doing good, or being part of the solution to what some observers consider to be an existential threat to humankind, provides an exceptionally motivating environment. We came across people who had pursued outstanding professional careers in developing innovative new ringtones for mobile phones, marketing the latest hairspray to yet another consumer group, or were among the high potentials in their enterprise resource planning firm – and yet they felt at least equally satisfied, if not more, after giving their career a new spin and ending up participating in the energy transition. We hope that our readers share some of this positive energy, on either side of the real-world–academia nexus, or perhaps even both sides – an experience that the authors of this introduction have found to be particularly enriching.

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