Cosmopolitan, dynamic, and contested energy futures: Navigating the pluralities and polarities in the energy systems of tomorrow

Laurence Delina*, Anthony Janetos

Frederick S. Pardee Center for the Study of the Longer-Range Future at Boston University, 67 Bay State Road, Boston, MA, 02215, USA

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ABSTRACT

The futures of energy are cosmopolitan, dynamic, and full of contradictions. There are multiple actors and institutions with multiple aims and interests advancing the futures of energy; at the same time, these futures are envisioned differently and will, therefore, be produced and negotiated heterogeneously. This context highlights that energy futures are not free of cultural, political, and economic influence, and hence can be best-approached with cosmopolitan and plural lenses. This collection evidences plurality in terms of the disparate geographic locations, disciplinary foundations, conceptual frameworks, and methodological choices of our authors and their papers. This breadth points to the many roads of imagining the sociotechnicality of energy futures and of making these expectations real and durable. We suggest embracing plurality and reflexivity, and understanding the politics of energy futures, at the same time that we also issue a caveat on the complexity of these processes. Claiming no comprehensiveness or closure, our collective contributions should be taken as works-in-progress in the unending quest to understand, analyze, and critique the plurality of the futures of energy and the ways we imagine, navigate, and contest them.

1. Introduction

Energy—from its production to distribution to its use—has become a vital centerpiece in which contemporary societies order themselves and their institutions across local, national, and international scales [1]. These orderings, however, are in constant flux in the ongoing processes of change—processes that are either fluid or chaotic, depending on where one observes them and at what moment/s in time. The place and timing of energy transitions—the term that describes these processes, universally—are two of the most prominent themes in this journal.

Yet, the processes by which the futures of energy are imagined and produced, by whom, under what goals and circumstances, instrumentalities and mechanisms, and the moments at which they are contradicted and negotiated, and erased from or embedded within public discourse—all of these components are often under-studied and under-appreciated in the academic, business, and policy worlds. Accounts, stories, and narratives of these tensions and contradictions are important sites for engaging in the imagination and the production of both the futures of energy and the future of energy studies. These are also meaningful points of departure for academic, business, and policy analysis alike since they allow us to think about marginalized, yet important, issues such as whose futures are at stake and whose futures need to be given premium in future scholarship and practices; in other words, the processes of energy transitions touch upon areas of justice, equity, democracy, sustainability, and fairness—ethos that are universally upheld as important in modern life (cf. [2–6]). While one may say that the entire journal itself is dedicated to these ends, there are but a few papers that rigorously take into account, analyze, and situate the social studies of energy with that of the futurity of energy. This collection is an attempt not necessarily to address this gap but to expand and enrich the landscape by which we envisage and process these futures.

The study of the futures of energy from a social science perspective comes at a time when science is under constant attack [11–14], of a ‘post-truth’ world (see for examples a series curated and edited by Schiølin [15], and a special volume in this journal on post-truth politics and energy transitions), and of democracy under threat (see a series curated and edited by Simmet [16]). The dynamics in the politics, technologies, economics, and governance of energy are indeed moving fast.

Politically, many governments continue to advocate for continued reliance on fossil fuel systems using arguments that the transition
towards environmentally benign fuels would result in severe negative impacts on jobs and the economy (most notably by Trump’s ‘clean, beautiful coal’ narrative). This is despite overwhelming, if not universal, support for energy transitions in the context of decarbonization for climate mitigation and for sustainable development ends [18,19]. Nevertheless, present conditions seem to favor the transition towards sustainable energy futures. Technologically, for instance, we can observe advances in the junctions of mobility and energy, such as the push for electric cars [20–22]; although of course electric cars are not necessarily sustainable or environment-friendly, especially if they are powered by fossil-based energy systems. Policy-wise, we are seeing how, for example, the German Energiewende, the Chinese policy towards sustainable energy, and the Indian ambitious solar power targets are catching the imaginations not only of scholars but also of those working in policy and governments (e.g. [23]). Some examples are demonstrated in the goal of 100% renewable electricity generation in several Pacific economies, including the Cook Islands, Niue, Papua New Guinea, Samoa, Tokelau, Tuvalu, and Vanuatu.3 The market, too, is moving towards a favorable direction that brings energy transitions on track—e.g. the rapidly decreasing cost of renewable energy technologies [24], particularly of wind energy technology [25]. Institutions, both state and non-state, are also recognizing the transition as an imperative, and some have started updating and redesigning their structures and processes to accommodate this change (e.g. the Government of Thailand’s Energy 4.0 where sustainable energy dominates future energy mix). Despite these realities, other institutional views of energy futures run counter with sustainable energy scenarios. The United States Department of Energy through its Energy Information Administration [26], for instance, projects that fossil fuels would still account for 77% of global energy use in 2040. Nonetheless, it can be argued that our imaginings of how aspects of energy systems’ change interact with each other, and our understanding of how our current social orderings remain partial and uncertain at best and that their co-evolution with this change, are not at the same depth.

Each of us has their own visions, imaginations, dreams, predictions, anticipations, fabulations, and fantasies, even nightmares, with what the futures of energy may, can, and ought to look like (see for example Volume 31 in this journal on narratives including those by Moess et al. [27] and Raven [91] as well as in other outlets (in Futures, for example, about 1466 energy-related articles have explicitly mentioned the sense of futurity in their titles). Individually or collectively, it seems our fascination with the future is not easily satiated. We envisage what could be ‘the’ feasible, ‘the’ probable, ‘the’ plausible, and ‘the’ preferable futures for ourselves, our households, our communities, and our nations. We base these visions on our experiences, expertise, and biases, using different lenses—both fictional and logical. In short, these futures of energy are cultural, political, and economic—not just technologically—and are exceedingly and inarguably value-laden. While there’s nothing new in this claim (see [28]; cf. [29]), this acknowledgment and understanding opens up new challenges both in ways ‘energy’ is conceptually, theoretically, and empirically examined and studied, and practically in terms of designing and implementing new policy, market, and governance infrastructures, and interventions to meet the needs and ends of these highly-contested futures (cf. [10,6]).

Situated within these highly dynamic, yet integrated, interrelated, and interlinked, landscapes of energy technology-in-society, this volume presents the ways and approaches for envisaging and governing the futures of energy as their meanings and constitutions are continually changed, contested, and shaped—or in what, among others, Jasanoff [30] terms as the ‘idiom of co-production,’ Borup et al. [29] ascribe to as ‘sociology of expectations,’ and Stirling [31] calls ‘culturating’ of transformative change. We can also call these processes ‘negotiating and navigating of futures.’ The papers in this collection map and explore the myriad inquiries arising from these multiple dynamics. By electing to adopt a focus on ‘energy and the future’ (how energy systems would constitute life in the future) or the ‘futures of energy’ (where energy systems are at some time in the future) or, simply, ‘energy futures,’ this collection does not, in any way, stake a claim to be the first or the last issue on the topic either in this journal or elsewhere. The papers simply, yet collectively, show that a plural vision of the future of energy can be woven, and that our perceived current energy realities are not the only ones that we can fathom.

2. Negotiating and navigating multiple energy futures

The use of ‘futures’—in the plural form—in this volume is intentional to cover the breadth of disciplines, approaches, concepts, theories, and methods we collectively offer to help us understand and analyze the varied and multiple dimensions of the practice and scholarship of navigating energy futures. Adopting this pluralistic stance also allows us to capture the diverse narratives, stories, and discourses of futurity, which, by the same token, are also made and remade, produced and reproduced in multiple ways by multiple actors across multiple levels and spaces of inquiry and practices. The pluralities of these energy hetero-futures are, we concede, not easy to compact and compress under an overarching whole—which has never been our purpose anyway. Yet, it appears that while these futures are and can be imagined in multiple ways, few, if any, are capable of reaching a durable state [32]. As they are negotiated, minority futures are erased. In other words, only select futures are privileged to embed and dominate the community or the nation-state. This framing reverberates well with what Jasanoff and Kim [33] calls sociotechnical imaginaries, a concept that Jasanoff [34], in an edited volume [35], elucidates further. Sociotechnical imaginaries are ‘collectively held, institutionally stabilized, and publicly performed visions of desirable futures, animated by shared understandings of forms of social life and social order attainable through, and supportive of, advances in science and technology’ (p. 6). Along similar plane, energy systems can also be considered ‘works-in-progress’ rather than static, immovable systems. Such dynamism—sociotechnical energy systems being in constant development (and re-development)—reverberates with some theorizations in international studies particularly with regards to the origins and subsequent trajectories of international norms, where ‘norms’ are conceived as ‘processes’ instead of as ‘things’ or as ‘finished products’ ([36]; cf. [37,38]) on the processes of norm diffusion.

Apropos to Jasanoff’s [34] framing and the ways that navigating energy futures are entangled in the webs of complexities and power relations, energy technologies and systems are also enmeshed in social connections and spatial identities [39,40] and in the dynamics of traditions, norms, interactions and practices [29]. Considering that energy systems are interdependent webs of socio-material or sociotechnical connections at play, imagining, navigating, or culturing their futures is never apolitical. The future will either reaffirm existing regimes or require resistance to explicate a required change. This social construction of energy systems means that human choices and user preferences will mark their designs, the appreciation of risks and benefits, and the individual and social behaviours they encourage, exclude or seek to regulate [41]. This understanding also reverberates within the sociology of expectations, where, applied in energy systems, the ‘ideal’ expectations of future energy users and the attributes of future energy systems are ‘literally and materially scripted into’ these energy sociotechnical systems, ‘though these will inevitably be reinterpreted and even subverted in usage’ (129): 287–288). Social scientists, thus, has a role in advancing, rather than simply documenting, diverse energy futures.

As contested processes, navigating and negotiating energy futures imply understanding tensions between stability and change, between push and pull, that open up frictions and develop into struggles of

2 A claim that has been debunked, see Farley et al. [17].
3 See these policies in http://asianpacificenergy.org.
power [31,42]. This collection reveals many of these tensions as these processes, approaches, and frameworks are continually negotiated, and as energy technologies and societies are consequently reordered. But as these papers show, the materialities and performativities of the futures of energy are largely institutional or social phenomena, instead of purely technical ([43]; cf. [29]). Negotiations unpack the ways in which actors and institutions shape local, political, economic, cultural, ecological, and technological changes either during moments of resistance or calm. Peeking at these futures—particularly the ways they originate, embed, resist, and extend [44]—allows us to understand and value the trade-offs that inevitably accompany these negotiations. This, in turn, provides us clear and coherent lenses to make decisions and choices.

The business of imagining and negotiating energy futures is increasingly becoming ubiquitous, if not clichéd [9]. The reasons for this seeming banality are many but the imperative of decarbonisation to meet normative climate goals is regarded as the dominant driver [45,2]. Seemingly banal are many but the imperative of decarbonisation to our humble contribution to the ongoing conversations and debates surrounding this topic. Despite this and other limitations, which we clearly recognize, the collection celebrates the mixtures, hybridities, and complexities that these papers collectively offer. We are especially grateful that this collection provides a platform especially for discourses that, for a long time, have been silenced, sidelined, or marginalised. In so doing, we are attempting to address here some of the research challenges that Sovacool [10] outlined in this journal’s inaugural issue. We now focus our attention on some of the gaps he identified and how the papers in this collection contribute to filling them.

The plurality and heterogeneity of this collection is seen in terms of disciplinary traditions, the authors’ backgrounds, methodological and conceptual rigor, and the levels of analysis. We hope that with this variety we have contributed to enriching the intellectual and practical contours of our subject field, that of imaginaries and practices of the futures of energy. In addition, and in accordance with the objectives of the journal, we can say that we have contributed to the ongoing disruptions of the ‘flatness’ in energy studies. We see this flattening mostly in terms of the geographic and disciplinary locations of our authors, as well as in terms of gender representation. We are particularly grateful to the responses we received from scholars from the global South and from women authors; and while a number did not make it to the final collection, we are still proud to have included here some of their voices.

3.1. Embracing multiplicity of disciplines

This journal’s flagship paper has reported that most authors have focused on a single discipline (), and encourages us to examine issues about energy using lenses from various social sciences ([10]:12-13). We fully agree on the imperative of analysing the forms, types, and processes of energy production and distribution, and its use simultaneously with political, economic, and cultural work in these areas. And in response, the papers in this collection emanate from various disciplines, including political science (e.g. [46–48]), political economy (e.g. [49,50,47]), policy (e.g. [51–54]), science and technology studies (e.g. [47,55,50,56]), transition studies (e.g. [57–60]), innovation studies [58], development studies (e.g. [46,49,51,55,57,52,61]), geography (e.g. [62,50,56]), anthropology [63], modeling (e.g. [60]), psychology (e.g. [48,53]), philosophy (e.g. [64]), and urban studies (e.g. [56]). This is not to mention the variety of disciplinary backgrounds of the authors.

A closer reading of these papers, however, shows that the authors do not necessarily confine their work to a single discipline. Indeed, many of these papers transcend disciplinary silos within the academic inquiry about, on, and towards energy. A number of our authors have worked on energy futures and social science research questions using multidisciplinary lenses. For example: Sareen [46] uses comparative politics, policy, and development studies; Delina [55] mixes science and technology studies (STS), political economy, and development studies; Bornemann et al. [48] combine and relate insights from the multidisciplinary field of energy behaviourual studies with governance and policy design; Gui and MacGill [58] combine transition and innovation studies; Phadke [50] employs STS, geography and anthropology; Mori [49], Schaeube et al. [57], and To et al. [52] use transition and policy studies; Tozer and Klenk [56] mix urban studies, geography and STS; Schelhas et al. [63] integrate anthropology and STS; Moallemi and Malekopur [60] draw on sustainability transitions, exploratory modelling, and policy analysis to make an attempt at bridging the three fields through their proposed participatory modelling approach. An
innovative futuristic piece also arises from Wiseman’s [65] peer-reviewed perspective piece—an oration delivered by a Pacifica woman in the year 2050—which uses a combination of fiction-style writing and visioning.

3.2. Elevating voices from the margins

Sovacool’s [10] paper also reported statistics that worryingly show the tilt towards papers produced in the global north mostly by scholars from the developed world (), hence encouraging new contributions from scholars based in the global South. We responded to this call and enthusiastically report that seven papers are from or about these geographic spaces. While we could not claim to have attained universality in terms of geographic distribution (which we never intended to anyway), this collection offers papers covering ten developing countries on the continents of Asia, Africa, and South America. These include India [46], China [49,66], the Philippines [51], Thailand [55], Argentina [57], Mauritius [52], and Panama, Nicaragua and Costa Rica [61]. However, it is notable that only the Philippine study is produced exclusively from an institution based in the global South. We underscore these contributions by bringing them in the forefront of the thematic arrangements of this collection (with the exception of Madriz-Vargas et al.’s [61] which we placed in the ‘communities’ theme). This way, we highlight the opportunity for this journal’s readership to learn first, front and centre, the many challenges and opportunities in and from these understudied locations. We hope this emphasis enriches our understanding of how actors and institutions in these geographic spaces behave in terms of their energy choices, risk framing, and policy design in the context of the futures of energy.

Sovacool ([10]; 7, 25) also calls for publications produced by women scholars and authors, and we responded to that too. Our collection provides a platform for these voices from the margins in the academic and policy worlds. Twenty one women authors (Guanzon, Tan, Caleda, Recalde, To, Stephens, Gui, Mey, Bruce, Watt, Mitchell, Sohre, Di Giulio, Ruesch Schweizer, Phadke, Tozer, Klenk, Hitchner, Dignum, Malekpour, and Jasanoﬀ) contributed, with nine of them as principal authors (To, Gui, Mey, Di Giulio, Ruesch Schweizer, Phadke, Tozer, Dignum, and Jasanoﬀ). Interestingly, these contributions from the margins have also met the challenge of filling in key knowledge gaps in energy studies. These women authors expansively cover mostly unconventional topics, which raise awareness and attention, yet need deeper study to gain further traction. The futures of energy as they relate to issues of equity and justice, for example, are central in the paper by Phadke [50] on rare earth metals mining, as well as in the perspective pieces by Jasanoﬀ [5] and Cash [6]. Also, a paper by To et al. [52] provides their account of the unique policies supporting sugarcane bagasse cogeneration in Mauritius.

Authors aﬃliated with industry or government are another group of marginal voices that we highlight in the collection. We have contributions from John Schelhas, who works for the US Forest Service [63]; Teresa Ira Maris Padilla Guanzon, who is the Deputy Director of the Committee on Energy at the Philippine Senate [51]; and Lawrence Ang, who works at an impact investment advisory ﬁrm in Asia [51]. We are also honoured to have veteran climate negotiator Antonio Gabriel La Viña (in [51]) and Catherine Mitchell, a lead author for the Inter-governmental Panel on Climate Change Fifth Assessment Report (in [62]) contributing to this collection. With this variety, we hope to enrich the discourse on energy futures.

3.3. Employing rigorous methods

The volume also casts light on the importance of varied methodologies. Sovacool ([10]: 11, 25), reporting on the dearth of human-centred methods, saw the potential for expanding the use of multiple, mixed methods in future inquiries about energy. We agree that energy futures can be best be theorized and analysed using multiple, heterogeneous, and plural approaches to academic investigation; hence, we offer here papers that draw from multiple, often mixed, methods. Examples abound. Sareen [46], for instance, used field research and research interviews in his study sites in Rajasthan and Gujrat in western India. Delina [55] conducted walk-throughs, research interviews, and focus groups in Thailand. To et al. [52] did field work and research interviews in Mauritius. Madriz-Vargas et al. [61] used mix research methods including technical analysis of energy systems, semi-structured interviews, and participant observations in three Central American countries. Mey and Diesendorf’s [59] paper relies extensively on interviews with key renewable energy actors in Denmark. Defila et al. [53] introduced the ‘Futures Wheel’ method in their face-to-face interactions with their informants in Switzerland. Schelhas et al. [63] conducted multi-site ethnographies in the southern United States. Phadke [50] relied on news accounts, interviews, and field observation to ascertain the dynamics of mining rare earth elements in Minnesota, also in the United States.

Analyses of various practices also provided methodological rigour in examining the futures of energy in a number of papers in this collection. Some of the practices examined include policy discourses surrounding the processes of framing issues of risk and beneﬁts, and setting agendas, including attitudes towards markets and regulations. As these authors investigate these practices, language analysis proved to be a central tool. Policy documents, for example, have been extensively mined by some of our contributors for insights into how energy futures are framed and navigated in practice. Some examples of this can be found in the policy-oriented papers by Sareen [46] on western India, Mori [49] and Gallagher [66] on China, La Viña et al. [51] on the Philippines, Delina [55] on Thailand, Moallemi and Malekpour [60] on India, Schaube et al. [57] on Argentina, Mey and Diesendorf [59] on Denmark, Phadke [50] on Minnesota, and Dignum et al. [54] on the European Union. These papers, in a number of ways, show the close links between instrumental policy action and politics (cf. [44]), as well as of intense power relations that animate them [31].

Nonetheless, energy practices are not a sole province of state actors. Other papers in this collection focus their analyses on non-state practices, including that by Delina [55], which in addition to policy analysis is also dealing with the marginal and progressive voices in the making and re-making of energy futures in Thailand; Madriz-Vargas et al. [61] on rural communities in Panama, Nicaragua, and Costa Rica; Phadke [50], which, in addition to policy analysis, is in fact centrally ground on the experiences of project proponents, activists, and residents in Minnesota’s Iron Range; and Defila et al. [53] on Switzerland, which looks at the perception of an individual both as a consumer and as a citizen towards future energy policies. Of interest is the increasing focus on the role of local governments in setting up narratives of the futures of energy, usually in the context of climate action—an area of study that is gaining traction in this journal.4 On that regard, Tozer and Klenk [56] offer some of the practices by urban governments by looking at how carbon neutrality discourses are used as verbal tropes for envisaging energy futures in these geographic spaces. Bormann et al. [48] lay out the complexities of governing individual behaviour change by referring to potential governance approaches.

The practices of the marginals, outcasts, and outsiders of society are also present in some papers in this collection. Examples include papers by Burke and Stephens [47], which draws from the efforts of activists in advancing early concepts of energy democracy and in strengthening them; by Delina [55], which delves into the role of activist communities and rural communities in the production of Thailand’s energy future; by Mey and Diesendorf [59], which focuses on Danish communities and how they led the country’s energy transition; by Madriz-Vargas et al. [61], which describes how three Central American rural communities

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4 A quick search of the journal for titles bearing the word ‘city’ on 16 September 2017 yields 260 results.
are getting access to electricity in isolated, off-grid conditions via locally-governed renewable energy systems; by Soutar and Mitchell [62], which, among others, calls for increased citizen engagement in the production of narratives of energy futures; by Phadke [50] on incorporating voices of activists and residents in their analysis of rare earth metals mining; and by Schelhas et al. [63] on how citizens in communities in the South of the USA articulate, respond to, and alter national bioenergy imaginaries.

The analytic power of comparison is also evident across several papers in this collection. By examining various social, economic, and political structures and arrangements, our authors found comparison helpful in identifying the contents and contours of energy hetero-futures. Comparisons proved especially useful in revealing the normative commitments of multiple political communities that our authors have studied. We offer the kinds of comparison occurring and operating across almost all kinds of organizational variables including: geographic in relation to space—such as in states (e.g. Sareen's [46] work on Rajasthan and Gujarat, and Madriz-Vargas et al.’s [61] work across three Central American countries) and in cities (e.g. [56]), political across actors and institutions in multilevel governance (e.g. [55,57,52,61]), and also over time [49,54,51,59]. With comparisons, the pluralities of regularity, continuity and coherence, and, also, contestations and tensions, reflecting the complexities of energy futures, are brought to the surface.

3.4. Encompassing spatialities and transcending temporalities

Related to the last point above, some papers in our collection have drawn their analyses of energy futures on, across, and from multiple levels and spaces. This is in response to Sovacool’s (5) observation that, up to 2014, ‘issues relating to scale and geographic space were the least favoured topic’ among energy articles. Our collection includes papers that study the very bottom of the scale, i.e. the individual. We have at least four papers that look at this level of analysis. These are the papers by Soutar and Mitchell [62] on citizen engagement in the production of energy narratives; Bornemann et al. [48] on individual consumption behaviour change and their governance; Defila et al. [53] on how the dual role of an individual as a citizen and as a consumer oscillate in terms of how they perceive future energy policy; and Schelhas et al. [63] on how an ordinary citizen can influence a national energy policy.

The second level is that of neighbourhoods and/or communities. We especially welcome the rise (and even dominance) of community-oriented studies in this collection. Already mentioned but worth repeating here is that such focus on communities is something we have somehow anticipated given, for example, the primacy of community renewable energy in the German Energiewende [67], an oft-cited example of large-scale energy transitions and one that many in the community of scholars regard as a best practice.5 Additionally, the focus on community-based and locally-situated energy studies is, in many ways, the vogue.6 We see continued focus towards this area but with new avenues of analyses.

This collection offers at least two of these new focus areas. The first is about enriching case studies of both successful and failed attempts at community energy transitions. Mey and Diesendorf [59], who use the concept of strategic action fields, advance our understanding of the Danish energy transition. Madriz-Vargas et al. [61] delve into three case studies of community energy transitions in rural Central America. The second area of interest is about theorising the processes of change as they emanate and occur from below. Here, we have Burke and Stephens’ [47] synthesis of political power as it relates to renewable energy systems, a critical review advancing our understanding of the possibilities and limits of these technologies and raising important questions regarding their potential to support changes from below. Gui and MacGill’s [58] exploratory structures for analysing what they called ‘clean energy communities’ visualises possible organisations for these communities, their characteristics, and influences, in the context of the changing landscape of energy markets.

Next is the level where local governments thrive, fast becoming an important site for work on energy futures (e.g. see volume on urban transitions in Current Opinion in Environmental Sustainability, volume 22; [68,69]). Tozer and Klenk’s [56] paper recognises how cities are becoming critical nodes in the production of policy for the futures of energy as they relate with carbon neutrality. While this is of course a welcome contribution, we would also expect more studies on how the futures of urban energy unfold in the global South (e.g. [70]). One level up is the state and the nation-state where several of our authors have focused [46,49–52,57,55,59,63,60]. Further up the scale are the regional and the global, where Dignum et al.’s [54] paper on the European Union can be categorised.

As ideas and practices spread across spaces and social order, the timeframe of these dynamics—as the old reinforces their dominance, or as the new challenges the old—is also a key topic explored in a number of papers. This temporal element is mentioned in Morí’s [49] paper on China and in La Viña et al.’s [51] paper on the Philippines, which both discuss the evolutions of their respective national energy policy. Delina’s [55] paper on Thailand also touches on temporality, albeit different from the China and the Philippines’ paper. His study of the evolution of Thai energy policy describes how, across and over time, the dominant imaginary of energy future in that country is produced while, at the same time, erasing contrarian visions. Burke and Stephens [47] address the pace of energy transition in the context of climate change, noting the tensions between the urgency to end fossil fuels and the opportunity and possibly the necessity for inclusive development of renewables. Phadke [50] also concludes her paper by underlining temporality issues in terms of raising the tensions between short-term focus on ‘responsible mining’ and long-term sustainable development, as well as between the need for metals now and the goal of clean energy futures. Lenferna’s [64] piece on the carbon budget and the end of the fossil fuel era is also rife with temporal issues, asking questions related to justice and equity. Bornemann et al. [48] also point to the temporal element of individual consumption behaviour change by anticipating, among other factors, the transformative aspect of new governance design. Moallemi and Malekpour’s [60] paper on the long-term planning of energy transitions emphasises the importance of considering inter-generational changes for understanding energy transitions and of designing adaptive strategies which can remain robust over long-term timelines. Cash’s [6] perspective piece is also rife with calls for a fast transition to a clean energy future.

While these papers are welcome additions, we would certainly have desired for more papers that dealt with pressing issues, including, for example, universal energy access and pace. Access to energy remains a significant development issue, and will continue to be central in envisaging energy futures [2,6], especially in Sub-Saharan Africa and South Asia where projections of increasing populations and changing consumption patterns are expected to exacerbate access issues [71]. While Madriz-Vargas et al.’s [61] paper is looking at access issues in South American setting, our collection has regrettably missed to include explicit contributions about access issues in Sub-Saharan Africa and South Asia. Pace is also central with energy futuring [6], yet we are still in dire need of additional papers devoted to it such as those akin to or extending Sovacool’s [72] paper, and others that appeared in the section on ‘debating energy transitions’ in Volume 17 of this journal. Addressing temporality, in particular the question of accelerating energy transitions in light of rapid climate mitigation, remains a frontier for future research work on the sociality of energy systems (e.g. [2,45,73]). We, thus, continue to hope for the emergence of papers that look at

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5 As of 29 November 2017, at least 49 papers in this journal tackle the German Energiewende.

6 As of 29 November 2017, a quick search in this journal alone, using the key word ‘community,’ returns 512 results.
radical energy futures in the context of the temporal issues surrounding climate change. The collection would also have been richer with the inclusion of papers that explicitly study, for example, the complex dialectic between the past (or the present) with that of the futures of energy (e.g. [74]). Excavating past memories and reinterpreting them in light of our contemporary understanding and the hopes of the future could have been an interesting contribution (cf. [75,45,73]). We hope that these new research directions are included in future studies.

Notwithstanding these unaddressed gaps, the diversity of levels of inquiry in this collection still tells us that the scholarship and practices of energy futures encompass spatialities and transcend temporalities. As ideas and practice of energy futures spread across times and territories, we also come to acknowledge, again, that the futures of energy are configured, made and remade, organized and reorganized, following struggles and negotiations of power [31] and that energy technologies and systems evolve following social, political, cultural, and technical constraints.

3.5. Acknowledging the provisionality of our contribution

In part, the preceding discussion mentions some of the areas of inquiry that we miss to acknowledge absences in this collection. While this volume fills in some of the important lacunae in energy research and social science, our collective contributions remain provisional at best. The visions of energy futures in each of these papers are also inherently and unavoidably products of our own and respective epistemologies and experiences. It is but proper to acknowledge therefore the embeddedness of our papers in our respective cultures, disciplinary traditions, and the circumstances and locations by which we conduct our scholarship and/or practice. Furthermore, the pluralities of our life circumstances reveal that the distribution of the many visions we narrate or critique in our respective papers are also uneven, if not erratic. On that note, we ask our readers, as they critically engage with these narratives, to appreciate these contributions with epistemic charity, respecting our inherent theoretical, conceptual, and methodological differences.

4. Ties that bind

While standing on their own, germane in the papers in this collection are qualities that bind them together. The hinges attaching these papers together can be recognized in the following crosscutting areas: cosmopolitan approaches and plurality of practices, reflexivity, and the sense of democracy and justice.

4.1. Pluralism

Crucial to this collection is the understanding that myriad social roles, institutions, and practices inform and affect energy futures [31]. As described in the previous section, these papers present a view of the future of energy from multiple vantage points, which, are, at best, contrasting, but are coexisting within societies [30,10]. These pluralities in disciplinary background of the authors and the variety of methods employed show that dissent (rather than consensus), uncertainty (rather than predictability), turbulence (rather than laminar flows), and controversies (rather than settlements) are the norm—and will continue to be (cf. [76]). Producing visions of energy futures and navigating them, therefore, requires more layered, variegated, and culturally sensitive—or cosmopolitan—approaches and processes. In this volume, we transcend cultural, social, political, technological and economic differences by attending to contexts, adapting plasticity of approaches, and respecting culturally diverse audiences. Cosmopolitanism allows for openness and participation, qualities that, to us guest editors, are very valuable for producing robust debate on energy futures. The thematic arrangements by which the papers are presented echo this adherence to cosmopolitanism. Our papers in Theme 1 gave voices to the marginalised, the sidelined, and the unheard energy future dynamics in the global South. Those in Theme 2 unravel the multiple pathways for civic and community engagement to thrive on the spirit of our differences. Papers in Theme 3 elucidate some of the ways by which these multiple futures of energy can be generated and governed.

4.2. Reflexivity

Many papers in this collection respond to the long-time concern about how institutions and practices can act productively to the dynamics of sociotechnical change in the energy field. Reflexivity offers one pathway to address this need for responsiveness, especially in a deeply uncertain context of fast-changing, profound, and pressing challenges that beset the energy field and human societies more broadly. The design of future energy institutions and policy, for example, needs a reflexive revisit and reconfiguration as sociotechnical changes occur and, in particular, as they are disrupted by the need to account for the impacts of anthropogenic climate change (cf. [77,78,2]). This dynamic of change points at the need for information—for learning—is the circumstance by which almost all papers in this collection are hinged. Papers by Burke and Stephens [47], Gui and MacGill [58], Mey and Diesendorf [59], Soutar and Mitchell [62], Delina [55], Moallemi and Malekpour [60], Bornemann et al. [48], and Schelhas et al. [63], for instance, underscore that opportunities for learning are opened when reflexivity is built into systems of participation and civic engagement for negotiating and producing energy futures (cf. [79]). Whether political actors are prepared to exploit these new opportunities and incorporate them into their decisions, however, remains a key challenge as these papers either show or warn.

These papers also raise consideration of the hazards that civic engagement in energy futures-making entails. For example, Defila et al.’s [53] paper contains caveats with regard to the differences between an individual’s role as a consumer and as a citizen in appreciating impacts, risks, and benefits of future energy policy. As their paper shows, while the individual as a consumer tends to focus more on immediate personal needs and experiences, the individual as a citizen is more attuned of the needs of the collective, including placing a premium on natural resources. Designing civic engagement has to be sensitive to the necessity of being clear whether the individual is addressed as a consumer or as a citizen. Our capacity to learn, interpret things, and make decision is heavily reliant, if not constrained, by our personal experiences, and cultural and political frames. The same can be said with our institutions who also think and act based on constraining frames. Gui and MacGill [58], for example, demonstrate how different energy communities have different interests and problem interpretations, leading them to consider different solutions. This plurality is one of the principal reasons for divergent and multiple futures of energy. In the context of navigating these futures, avenues through which societies can collectively, yet reflexively assess and consider the inherent strengths and the relative weaknesses of these options for the future of energy (including of things and aspects that we are ignorant of) become more necessary [31,34]. To that end, public deliberations on how energy futures ought to proceed are imperative. In this collection, Delina [55], Burke and Stephens [47], Soutar and Mitchell [62], Moallemi and Malekpour [60], Bornemann et al. [48], Defila et al. [53], and Schelhas et al. [63] have reached almost that same conclusion. Jasano [5], also in this collection, calls for humility.

4.3. Politics

Evident in the majority of the papers in this collection, the form of politics that is used to drive energy futures will greatly influence the possibility for more democratic futures [80]. Burke and Stephens [47] in their critical review of the democratic potential of renewables argue for energy futures based on democratic ethos, underscoring at least three turns in the relationships between the social and the technological
in the historical and contemporary understanding of energy issues. First is with regard to the redefinition of individual consumers as citizens (e.g. Defila et al.’s [53] view of clearly distinguishing and taking seriously the role of the individual both as a citizen and as a consumer reflects this). Second is the concept of energy commodities and provisions as public goods, which is also central in Gui and MacGill’s [58] paper and, in some ways, in Dignum et al.’s [54]. And third is considering energy infrastructure as public works as also echoed by Mey and Diesendorf [59] and partly by Sareen [46]. These three points underlie the case for greater decentralisation as something that is more strongly compatible with democracy.

As the seven papers in Theme 2 in this collection suggest, new relationships are continually being forged, hence disrupting the traditionally understood politics of centralised energy technologies. This democratizing tendency of decentralised energy futures, however, also begets questions that Burke and Stephens [47] and Delina [55], among others in this collection, and others before them (e.g. [31]), ask: what purposes would or should these emergent systems serve? For whose benefit? And, who decides? Lenferna’s [64] paper on equity resonates with this focus, too. Additionally, Phadke [50], in her critical engagement of the politics around rare earth metal elements, queries: how can we carefully balance local community concerns with climate mitigation priorities? Following that, a related question arises: should decentralised systems be scaled? Madriz-Vargas et al.’s [61] note on the upgrading of stand-alone power systems into mini-grids offers an opportunity for examining this question since this poses a contingent issue whether mini-grids can still be considered democratic systems, especially when they are connected to and aligned with distribution networks that constitute the modern grid. At the same time, scale matters for climate mitigation and sustainable development [2,77].

In addition, it is vital to note that there are also views seeing an extended life for energy behemoths whose contributions to modernity and the intimate details of our everyday life must also be acknowledged [81]. It is key to note here that contesters of sustainable energy transitions are not solely industry incumbents. Their allies include even the ‘self-proclaimed’ climate leaders who are not always as pro-actively engaging in transitions as it might seem. China’s climate policy for example has been rated ‘highly insufficient’ by the Climate Action Tracker [82]. As niche level entrants continually challenge this hegemony, what will be the role of these giants and their cohorts in governments in the futures of energy? Gui and MacGill [58] may have some partial answer. Their paper emphasizes that new business models can be forged with large utilities by reforming them in ways that they would be welcoming of decentralised energy systems—a proposition that inarguably extends the debate of what energy democracy ought to be (cf. [79]). As many papers in this collection show, democratic values encourage openness, participation, and accountability, which, to us, are qualities imperative for a wider political mobilisation of durable, fair and sustainable energy futures (cf. [75,83]).

5. Thematic organisation

As one can already realise, the volume can be organised in myriad ways. We can follow the structure that illuminates how this collection fills some of the gaps and challenges that Sovacool [10] raised in this journal’s inaugural issue, i.e. in terms of disciplines, voices, methods, and levels. Another way is to structure the collection based on aspects of commonalities that we discussed in the preceding section, i.e. cosmopolitanism, reflexivity, and democracy. Yet another approach is to relate energy present to energy futures in terms of: goals or intentions (as in Mey and Diesendorf, La Viña et al., Burke and Stephens, Lenferna, and Phadke): agents and actors (as in To et al., Gui and MacGill, Madriz-Vargas et al., and Defila et al.); visions, discourses and imaginaries (as in Delina, Tozer and Klenk, Schelhas et al., Soutar and Mitchell, and Dignum et al.); and processes of change and/or stability (as in Sareen, Mori, and Schaupe et al.). While these obviously offer helpful hands in organising this collection, we feel strongly that the papers can be usefully arranged under four cohesive themes that, at the same time, reflect the discussion above. These themes are: the global South and their energy futures; citizens and communities in the futures of energy; and visions, discourses and ways of thinking about the futures of energy.

- **Theme 1: The global South and their energy futures.** Papers under this theme cover issues of pathways or trajectories, including historical analysis of policy and vision development, that lead to plausible future directions of energy systems in developing countries. This theme is opened by a perspective piece by Gallagher [66], which charts China’s global energy finance—an emergent financial mechanism that is poised to lead. The papers in this theme also speak about levels such as the nation-state as in Sareen’s [46] comparison of policies in two Indian states, La Viña et al.’s [51] focus on the Philippines, Delina [55] on Thailand, Schaupe et al. [57] on Argentina, and [52] on Mauritius. Also included is Mori’s [49] analysis of the osmotic dynamics in energy policymaking in China—one that oscillates between state and national interests as the Chinese energy policy is negotiated over time. In some ways, such osmotic movements across scales are also present in Sareen’s [46], Delina’s [55], and Schaupe et al.’s [57] papers.

- **Theme 2: Citizens and communities in the futures of energy.** Four papers comprise this theme: two offer case studies (Mey and Diesendorf’s [59] Danish cases, and Madriz-Vargas et al.’s [61] Central American cases), while the other two suggest ways of understanding the role of communities in the futures of energy—the critical review of the democratic potential of renewable energy systems by Burke and Stephens [47], and a suggested typology of energy communities by Gui and MacGill [58]. This theme is also focused on the methodological approaches to motivate citizens, mobilising them to take part in the creation of durable and desirable energy futures. Soutar and Mitchell’s [62] paper describes how citizens can be engaged in producing pragmatic narratives of the futures of energy. Bornmann et al.’s [48] paper urges how reflexivity must be included when governing individual consumption behaviour. Defila et al.’s [53] piece offers an exercise called ‘Futures Wheel’ to ascertain the differences between an individual’s role as a citizen and as a consumer in future energy policy.

- **Theme 3: Visions, discourses, and ways of thinking about the futures of energy.** Papers under this theme include approaches of how knowledges about the futures of energy are produced, by whom, and how they permeate our everyday discourse. This theme comprises papers that describe and critically analyse these processes and their contradictions (such as Phadke’s [50] piece on responsible mining of rare earth metals in Minnesota), the related trade-offs, frictions, and tensions (as in Schelhas et al.’s [63] work on how the US national bioenergy imaginary permeated and was altered in ‘everyday talk’), as well as their negotiations (such as Dignum et al.’s [54] paper on the European Union’s natural gas policy) including in a participatory exploratory modeling approach in energy planning to complement scenario modelling (such as in Moalllemi and Malekpour’s [60] piece that marries the quantitative tradition with qualitative approaches), and, at times, settlements (such as in Tozer and Klenk’s [56] analysis of carbon neutrality imaginaries in cities).

Following this introduction paper is a perspectice piece by pre-eminent STS scholar Sheila Jasano, heralding the collection with a call for just transitions and hoping that the ideas we collectively offer our readers ‘will spill out of this journal’s pages into the wider world beyond.’ Bookending this collection is another perspective piece by David Cash about our choices on the road to the clean energy future where he juxtaposes a path that expands fossil-fuel use with ‘a road that increases energy access, reduces poverty, expands economic opportunities and reduces the worst impacts of climate change.’ We close this collection with an oration penned by John Wiseman, delivered by an imaginary
Our organisation of the papers, as well as the content of our collection, we concede, is an imperfect one. Each paper, as we demonstrated earlier, illustrates the many dynamics in ways, approaches, and strategies to envisage the futures of energy production and distribution, and its use, including the processes by which actors and institutions navigate, negotiate, and/or settle them. While these papers tell either distinct or combined and multiple stories of imagined futures of energy, each also relates to one or more of the other papers with respect to the areas of commonalities, and similar methods of inquiry and theoretical frameworks discussed in the previous sections. We try to make these points of correspondence and intersections explicit through cross-referencing. In the end, we hope that readers can ultimately see and appreciate this collection, as a coherent whole yet composed of pieces that are woven together through overlapping themes rather than as distinct parts of blocks, sections, or subdivisions.

6. Conclusion

The futures of energy remain a lively and urgent topic of debate—in the academic, business and the policy worlds. As old and new energy technologies constantly interact with our social arrangements—through processes of making and remaking, of stabilising and destabilising—elevating the centrality of the social studies of energy in co-producing, negotiating, navigating, and culturing energy futures becomes more of an imperative rather than just an afterthought. Using the descriptive, analytic, and explanatory power of the social sciences in producing plural analyses of the sociotechnical futures of energy, this collection paid attention to the normative, aspirational, and desired dimensions of these futures—futures that are durable, fair, just, and sustainable. This collection, nonetheless, also points to narratives of dystopia, of futures that we do not necessarily want, and imaginaries that we need to avoid. Both are central to Wiseman’s [65] imagined oration. The papers in this volume indeed are scattered across a spectrum with some narrating efforts to preserve continuity (locking in and executing change slowly with almost laminar fluidity) and its reverse (capsizing unyielding regimes and enabling transcendence). Largely, as pointed out, this plurality arises from the cosmopolitanism that characterise this collection.

This collection prizes the capacity to imagine, to view alternate universes, to see beyond the limits, and to make new things out of the mundane. We offer these papers to illustrate how the futures of energy are taking and will take shape in heterogeneous, plural, and diverse social and cultural contexts. The papers have elaborated and exemplified these many futures by marrying social science theories with empirical observations to offer rich variations. In doing so, the papers show how, in the future, some of these imagined worlds would be welcomed and excluded, absorbed and constrained, allowed or denied. In these processes by which the future ultimately is strengthened and made durable, competitions, tensions, and negotiations become par for the course. And as the new thumps the old, the futures of energy could be unending moments of resistance and struggle. Already, as some of the papers in this collection show, powerful interests struggle to re-establish themselves on the same sociotechnical terrain where they, for a long time, marked their hegemony. At the same time, there are papers in this collection that narrate how the alternatives attempt at overcoming spatial and political boundaries. These social complexities and thickness—the cyclical process of emergence, conflict, and extension—give the study of the futures of energy their utility, allure, and import.

In a way, producing this collection is, for us guest editors, a voyage. We realise that the futures of energy can be best envisioned using as many enlightening perspectives as available, both in terms of concepts and methods. The variety and diversity of the papers we offer shows that envisaging the futures of energy is a process that needs to continue to fracture disciplinary boundaries, to borrow theories, concepts and methods from across the different fields of human inquiry, and, most especially, to give voices to the previously unvoiced most especially in terms of geography and gender. This approach to embracing plurality helps us to avoid analytic blinders. Indeed, and we humbly claim it here: the papers in this collection attest that this hybridity actually opens up fertile grounds in which desirable futures of energy can be produced, challenged, nurtured, and protected, while allowing undesirable futures to wither and be obscured. At the same time, the papers also acknowledge the dynamic interplays amongst these varied and multiple futures, recognising that these futures are open-ended and are therefore provisional and subject to revision.

We also hope that our collective academic efforts to envisage multiple futures of energy are projected for their practical use in policymaking, business decisions, and civil society activities. The policy implications of the papers in this collection are far too many to enumerate here. Nonetheless, we would like to stress again the three resounding themes emanating from this cacophony: an embrace of plurality, high regard towards reflexivity, and understanding of the politics. While we nudge policymakers to pay attention towards these aspects of imagining and navigating the futures of energy, we also caution them ahead of the many complexities these processes bring.

Nonetheless, our collection could not claim comprehensiveness. This collection is neither exhaustive nor definitive. Rather, it remains our humble contribution to the ongoing, lengthy, and contested discussions and debates about energy futures studies and the imperative of plural approaches necessary to open up and encourage multiple voices to emerge in processes of decision-making. Additionally, we concede that there are still areas worth investigating and expanding. These include, for example, envisaging the sociotechnical futures of non-renewable technologies (including nuclear) and grids, of mobility, and jobs, and of the role of the sharing economy, alternative economies and socio-financial systems, in the context of the fourth industrial revolution, increased population, and climate change (e.g. [84]). Extended analyses on the nexus of energy futures with sustainable development (particularly issues involving energy access) and climate change (especially as its impacts exacerbate), including the valuation of their tradeoffs, including in developing countries also offer ripe sites for inquiry [77,2]. Another opportunity for exploration is reconciling issues of pace and scale, as they relate with the need to accelerate sustainable energy transitions in the context of rapid climate change, and/or other types of crises (e.g. [78]). Corollary to that is filling in the gaps about the relationships of future energy systems with those of water, food, and agriculture systems. The issue of pace directs us to a number of related research questions pertaining to, for example, which technologies should be given premium in deployment, how the dominance of corporate power of Big Oil and Big Coal can be effectively challenged, and how democracy and justice issues can be embedded in its processes (e.g. [5]). This list is undoubtedly partial, showing that the scope of work on the social studies of the futures of energy, in particular those examining power relations, remains huge. And while the collection has made it possible to include marginal voices, to us, these voices are still in the minority; hence, we continually ask for additional contributions from the global South (especially from those whose vulnerabilities are increasing in terms of natural, economic, and political perturbations), women authors, and those whose practices are located in policy and industry.

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submissions have passed the rigours of the peer review process, this number evinces an ongoing interest and commitment in our community towards the production of energy futures analyses. We sincerely thank our authors not only for their papers but also for their patience during the peer review process. We also thank David Cash, Kevin Gallagher, and Sheila Jasanoff for writing perspective pieces that bookended this collection. We especially note and appreciate the contributions of these eminent authors who kindly agreed to our request on short notice. This project would not have come to fruition if not for this journal’s editor-in-chief, Benjamin Sovacool, who, during his visit in June 2017 at the Frederick S. Pardee Center for the Study of the Longer-Range Future at Boston University where we are based, invited us to propose a volume on the topic—a challenging invitation, which we gladly accepted. We thank Benjamin and the peer reviewers of our proposal for their thoughtful comments that help sharpen our focus and direction.

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