Imagining Sustainable Energy Communities: Design Narratives of Future Digital Technologies, Sites, and Participation

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ABSTRACT

Increasingly, research projects narrate visions of energy communities that portray hopes of more sustainable, democratic energy futures. However, it remains unarticulated how such research narratives are embedded in the design of digital technology for communal energy futures that are situated in everyday life. While sustainable HCI has identified relevant design narratives, little attention has been paid to those of communal energy projects. In this paper, we scope energy community literature at ACM to identify design narratives that tell stories about how energy communities are imagined and why they are relevant. Through a critical discourse analysis, we describe how design narratives currently shape energy community research on sites, participation, and digital technologies. We use these stories to discuss and suggest three trajectories of how future HCI researchers and practitioners may explore alternative and sustainable visions of energy community futures.

CCS CONCEPTS

• **Human-centered computing → HCI theory, concepts and models**; *Collaborative and social computing*.

KEYWORDS

energy communities, energy community, design narratives, discourse, participation, sustainability, future, energy technologies

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1 INTRODUCTION

The expanding focus on sustainable energy on a global scale [37, 129] has led to the imaginings of alternative forms of organizing everyday life towards sustainable energy futures. One emerging vision is that of ***energy communities*** where communities are envisioned to become better connected to local renewable energy initiatives [131]. The European Union (EU), in particular, is politically and financially invested in forming mainstream visions of energy communities as transformative steps towards organising *"collective and citizen-driven energy actions that help pave the way for a clean energy transition while moving citizens to the fore"* [38]. Embedded in this vision is a narrative that the individual householder will engage in a localized energy system and be empowered through a high level of digitalization, automation tools, and algorithmic real-time market signals [36, 71]. To animate this envisioned tool and community-oriented householder, we see digital energy technology being researched [87], designed [66], and demonstrated in real-life conditions [89, 135] promising a sense of collective renewable energy ownership and active participation among community members [44, 93, 103]. Nonetheless, as realizations of energy communities are still taking shape, a myriad of understandings and interpretations emerge revolving around how these future energy communities are to be enacted and how social everyday life is to be shaped by such future energy technology [12, 37, 38, 60, 132].

The research fields of Human-Computer Interaction (HCI) and computer science have recently engaged in designing and evaluating digital communal energy technologies. In this line of work, studies illustrate the potential of how digital energy technologies may engender community members' cooperation [45, 48], create energy awareness and communal learning [79, 86, 104], and remove barriers to communal energy interactions [19, 89]. Despite showcasing transformative potentials, the design visions of future (energy) technologies carry assumptions of sustainably energy futures that primarily are narrated by designers, developers, and other stakeholders from the energy sector [1, 124, 125, 136]. In reaction to this, we see a growing body of humanities scholars critiquing technology-oriented visions, imaginaries, and stories of sustainable futures, arguing that these visions often fall short of assumed improved sustainability [60, 90, 91, 123], and overlooking the diverse cultural and social practices in local communities [16, 63, 100].

In this paper, we frame those design visions, imaginaries, and stories as ***design narratives*** that shape *"who receives attention and credit for design work, how we frame design problems and challenges, how we scope design solutions, and what stories we tell about how design processes operate"* [25, p. 109]. Inadvertently, the storytelling aspect of design narratives comes to shape what sorts of issues are legitimate to engage with, as well as how we may engage with them, calling for more critical engagement of the narratives and assumptions embedded in designing [25]. At the same time, critics argue that sustainable HCI (SHCI) has limited itself to narrow visions of sustainability [18, 24, 70, 119], which may fail to consider the radical nature of sustainable transitions [15]. Despite this, research critically examining design narratives of energy community research is limited. Thus, we believe it is timely to identify visions in the emerging area of energy community research to understand their transformative potentials and pitfalls.

In this paper, we address this research gap by outlining design narratives in energy community research at ACM to discuss the implications of design narrative discourses for energy community research. To do so, we draw on Costanza-Chock [25]'s conceptualization of design justice to frame stories of values of digital technologies, practices of participation, and the situated sites of communities. Based on a scoping review methodology, we identify relevant papers, abductively grouping design narratives of *sites*, *participation*, and *digital technologies*. We characterize each design narrative using critical discourse analysis [57], surfacing assumptions for, and expectations towards, energy communities as a means towards more sustainable, democratic energy futures. By offering a coherent arrangement of current discursive design narratives of energy community research in ACM, our paper answers recent calls for the HCI research community to bring about critical perspectives on sustainability by questioning *"the place of technology and technology-oriented practices in creating a fairer, more sustainable, and flourishing society"* [24, p. 101]. We argue that the identified design narratives are limited in their ability to entertain radical energy community futures. Thus, ACM energy community research may fail to achieve the transformative potentials of energy communities towards sustainable energy systems. Considering the radical expansion of emerging energy communities on a global scale [65, 89, 118, 135], we believe that our design narratives bring new understandings of such research before such narratives' crystallization. Finally, we discuss how the HCI research community may engage with these design narratives by suggesting three trajectories to help envision alternative and sustainable energy community futures.

2 RELATED WORK

This section focuses on prior HCI research, engaging with understandings and narratives of design visions for sustainable energy futures. We base this on Costanza-Chock [25]'s conceptualization of 1) design *values* embedded in designed artifacts, 2) *practices* of inclusion in design, and 3) *situated* places where design is unfolding. Relating this to energy communities, we are interested in the values of *digital technologies*, practices of energy community members' *participation*, and the situated *sites* of energy communities.

2.1 Designing Digital Energy Technologies

The design, evaluation, and critique of digital technologies as a means to support societal transitions towards a more sustainable future have been a research agenda in sustainable HCI (SHCI) for over a decade [10, 18, 124]. This includes work on future energy systems designed with emergent digital technologies in mind, e.g., smart grids [2], local energy markets [82], blockchain [58, 137], smart home technology [106], automation [62], and eco-feedback [23, 67, 110]. In this body of work, digital technologies are considered mediating tools that enable householders to act more sustainably, both in a domestic space [40, 42, 99] and among householders [8, 45, 116]. Recently, we have seen a small number of studies that explore the role of emergent digital technology in the conceptualization of communal energy [22, 50, 55, 63, 116]. Some studies explore digital technologies as a means to facilitate cooperation among people by creating awareness through design that showcases the impact of collective energy interactions [28, 47, 97]. While some scholars argue that such communal energy feedback illustrates the potential to support energy learning in these communities [47, 97], other discuss the importance of situating collective contexts [28] and local practices [116] when designing for social engagement around energy consumption.

We also see SHCI research endeavors exploring the benefits and constraints of automating energy actions in the home [2, 13, 62, 106, 112]. Despite the home being a prominent site for such research endeavors, we see studies exploring the automation of energy services designed to support communities. For instance, Capaccioli et al. [19] discuss a possible future where production and consumption of renewable energies are supported in a decentralized energy system that may serve community members' habits. Similarly, Panagiotidou et al. [94, p. 18] argue that such automation may support easier coordination of energy in neighborhoods, which may *"require less micromanaging"*, while Jabbar and Bjørn [58] illustrate that emergent technology (blockchain) shapes how designers and engineers imagine future (energy) collectives. Yet, as these designers and engineers ascribe assumptions to the design of future energy technologies [63, 74, 121], studies show that visions of a sustainable technology-oriented future may not align with how everyday practices are performed sustainably [1, 122, 123].

While emergent energy technologies are often described as essential in sustainable communal transitions [55, 63, 133, 137], humanities and social science scholars have critiqued how technology-oriented visions neglect to acknowledge socio-technical imaginations of future energy systems [59]. Such perspectives highlight that collective social and cultural life shapes how these energy systems are to become embedded in diverse communities, which may bring about unintended consequences [60, 125]. For instance, Nucho [90] argues that post-grid energy imaginaries might promise to transform the existing energy system, and yet the decentralization of energy systems may lead to *"geographical disconnection, uneven access, and infrastructural abandonment"* [90]. This critique calls for advancing social scientific and humanistic methods when exploring and developing new design opportunities as part of sustainable energy futures [105, 121]. Hence, we see research arguing for moving away from techno-solutionist visions of communal energy [64] towards design efforts that take place in everyday life [73] where these communities are situated [19].

2.2 Participation in Sustainable Design

Participation of citizens and communities in sustainable transitions has been considered paramount in design [19, 52, 77]. For energy communities, this concerns "who is involved" [120, p. 437], and how, but also the structures and organisations through which people can become involved to affect decision-making [115]. In HCI, the notion of participation has been a concern throughout decades [11]. In sustainable design endeavors, Heitlinger et al. [52] bring a participatory design approach into the study of smart food infrastructures to engage culturally diverse participants, enabling a more democratic engagement with sustainable design transitions. Food, like energy, may be considered a scarce resource *"because the practices of food management involve neither new forms of production nor distribution"* [33, p. 11], and hence require community participation to re-negotiate these resource-intensive practices. Others illustrate that participation in community projects may include a wide variety of human actors and their institutions [53, 65], as well as non-human actors [53, 76, 113].

Despite this, participation in sustainable energy transitions is often envisioned as contingent of the interest of empowered individuals, in energy, and their willingness to alter behavior through digital technologies [121]. Yet, research illustrates that energy community participation contains significant tensions. The transformation of cooperative energy use into competitive energy use has been demonstrated in a number of papers [8, 45, 97]. Furthermore, Cila et al. [22]'s investigation of blockchain in energy communities shows that participation may be subject to tensions, for instance, in terms of incentive mechanisms having a manipulative effect. Similarly, communal energy projects may serve to bring in outside collaborators, which can challenge local participation [49, 65, 133]. To facilitate more democratic, local participation in community design projects, we see research that argues that situating design in the messiness of everyday practices [17, 73] and across neighborhoods [80] enables community members to create and sustain caring strategies for a better life in places they are living [111].

2.3 Places of Sustainable Transitions

The places in which sustainable transitions and participation are unfolded have shown to be paramount to consider. For energy communities, *"spatial proximity to energy generating infrastructure"* [39, p. 653] and location-based access to energy [115] are considered important elements. The spatial aspects of sustainability have also been given attention in SHCI. The inter-connectedness of people in a specific geographical region may support householders' abilities to retain access to electricity, as described by Hasselqvist et al. [50]. Moreover, local communities may share a common history [65], where they may already share a number of resources, including energy [118]. However, rural communities may experience difficulties in gaining access to energy infrastructure [116]. This can be further exacerbated due to the fact that rural organizations *"often lack the capacity for technical projects"* [142, p. 4], which can lead to slower dissemination of technologies and participation herein.

Despite a focus on the spatial context of sustainability, SHCI has been criticized as primarily focused on European and Northern American contexts [119]. For instance, Knowles et al. [70] argue that a shift in focus is necessary for computing research to engage with sustainability on a society-wide scale. However, such scale in SHCI may require considering how sustainability efforts may move environmental harms to other countries [9], as well as considering the situated environment around a community project as spatial infrastructures in and of itself [53]. Knowles et al. [69] and Dourish [31] have called for SHCI to take on a political nature. This politicization entails considering how situated places affect communal energy configurations, e.g., Swedish citizens' obligations to join housing cooperatives [47, 48], or how local districts shape possibilities and constraints of energy design interventions in villages in India [117].

Overall, these research strands show that critical energy community aspects of digital technologies, participation, and sites, are often shown in HCI and computer science research as being solutionist and removed from the local context. As energy community projects are still developing (e.g., [135] or [65]), research has yet to apply the above critical perspectives to energy community research. Bringing critical, alternative perspectives [24] is relevant to ensure that energy communities are developed to sustainable ends.

3 METHODS

In this paper, we seek to understand how ACM research has engaged with visions of energy communities and how this scope may be broadened. To collect this research, we use a scoping review methodology. A scoping review aims to understand key areas of concern within a subset of research through a systematic methodology, though refraining from assessing the quality of evidence and methods [3]. Our scoping review is inspired by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) [128] that provides a structured reference to identify relevant literature in a given research arena.

To identify and critically examine design narratives in research, we apply an analytical lens of critical discourse analysis (CDA) [5]. This humanities-based lens sees text as a reflexive conversation in the ways we engage with the world, as well as shaping, in continuous negotiation with other text, what are legitimate and appropriate engagements [43]. CDA has been used to highlight the discursive construction of robots as educational authorities [95], privacy conceptions of social networks [81], and the political entanglements of makers in sustainable HCI [107]. As such, CDA as a lens can challenge common assumptions of the world, as legitimized in research, to *"imagine and make arguments about how it might be organized differently"* [134, p. 1468] and produce alternative visions for how such futures may emerge [68].

3.1 Literature Identification and Selection

3.1.1 Database. To identify literature, we utilized the Association for Computing Machinery Digital Library (ACM DL)[1]. ACM conferences and journals have been recognized as premier venues for research on digital technologies, sustainability, and participation [11, 30, 46, 96]. In this paper, we are interested in understanding

[1] https://dl.acm.org/

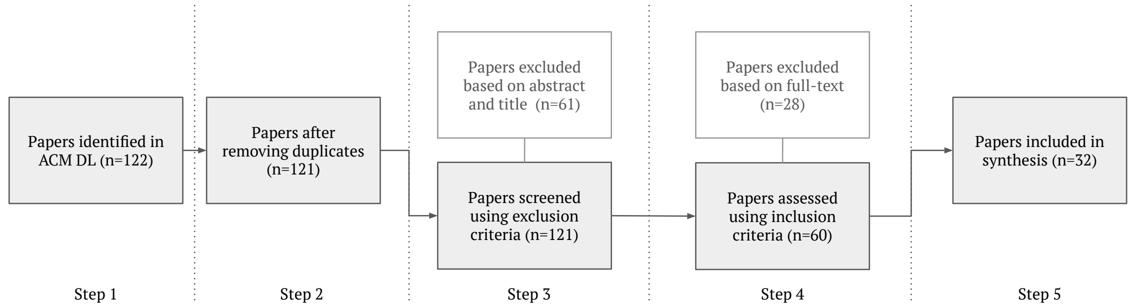

Figure 1: Overview of our process of literature selection as a PRISMA flowchart.

narratives in research on digital technologies for energy communities, making ACM DL an appropriate choice of database due to the oft-cited socio-technical perspectives found here. Our scoping review is based on the following research questions (RQs):

> **RQ1:** How do studies tell the story of where energy communities are sited?
> **RQ2:** How do studies tell the story of participation in energy communities?
> **RQ3:** How do studies tell the story of future digital technologies' role in energy communities?

We chose these three research questions as inspired by Costanza-Chock [25]'s framing of design narratives as a way forward to reorient perspectives on SHCI and energy community literature (see section 2).

3.1.2 Search Query. The topics of energy consumption and production are popular research trajectories at ACM. Thus, we opted to use a search query that specifically required papers to understand energy as a communal 'matter', despite other possible synonyms for this (see [71]) that are not explicitly community-focused. We used the following search query for our scoping review:

```
"query": AllField:([All: "energy community"] OR
[All: "energy communities"] OR [All: "community
energy"] OR [All: "communal energy"] OR [All:
"energy cooperatives"] [All: "energy cooperative"])
"filter": E-Publication Date: (01/01/2013 TO
12/31/2023), ACM Content: DL
```

We allowed all search phrases to be present anywhere in the paper, as energy communities are still a nascent research area at ACM. This means not all papers readily use these phrases within their main text. Furthermore, we filtered papers to only gather literature published from the 1st of January, 2013 to the 31st of December, 2023 (to allow for pre-published papers made available at ACM DL). We deemed this appropriate due to our interest in identifying design narratives in research that illuminate where future energy community research might be headed. We ran our search query in ACM DL to identify our final dataset on the 23rd of June, 2023. This yielded 122 publications (step 1 in figure 1), which were then investigated to assess inclusion.

Table 1: The exclusion and inclusion criteria for our scoping review.

Identifier	Exclusion criteria
EC1	The study is not peer-reviewed research.
EC2	The study is a meta-study of other papers (review, meta-analysis, etc.).
EC3	The study is not concerned with energy systems (e.g. energy as a psychological term)
EC4	The study is concerned with communal energy only in terms of technological performance (e.g. assessing the effectiveness of wind turbines).
Identifier	**Inclusion criteria**
IC1	The study is concerned with the *digitalization* of energy systems as a communal matter.
IC2	The study is concerned with human-centered *design* (as method and/or implication of the paper).
IC3	The study is concerned with communal energy as *socio-technical configurations.*

3.1.3 Literature Selection Process. To identify the final dataset of papers for our analysis of design narratives, we engaged in a selection process, shown in figure 1. Initially, we exported the results of our search query, using ACM DL's feature, into the reference manager Zotero. Then, we exported the Zotero collection as a CSV file, from which data were inserted into Microsoft Excel. We first identified duplicates (step 2 in figure 1) in our dataset for removal (n=1). In our screening of papers, Authors 1 and 3 collaboratively read titles and abstracts of papers (n=121). We determined if papers were to be excluded based on exclusion criteria (EC) shown in table 1. We used these to identify papers unrelated to the aim of the scoping review (step 3 in figure 1). We excluded papers if they were; not peer-reviewed research (n=6); meta-studies of other papers (n=5); not concerned with energy systems (n=33) or; only concerned with technological performance of communal energy (n=17).

The following assessment (step 4 in figure 1) was led by Author 1 in two rounds, where the remaining 60 papers were assessed for inclusion, and included papers were coded and synthesized (see section 3.2). In the first round, Author 1 assessed 20 papers for inclusion, excluding 8 papers – this assessment was discussed among

Table 2: The 32 papers included from our scoping review process.

Papers		
Capaccioli et al. [19]	Singh et al. [118]	B et al. [4]
Mahesh et al. [78]	Weinhardt et al. [135]	Mengelkamp et al. [84]
Kudo and Granier [72]	Orfanoudakis and Chalkiadakis [92]	Zhu et al. [141]
Simm et al. [116]	Wilkins et al. [137]	Mengelkamp and Weinhardt [85]
Jensen et al. [64]	Peña and Jensen [98]	Jensen and Jensen [65]
Cech [21]	Hansen et al. [45]	Schlund et al. [109]
Panagiotidou et al. [94]	Hasselqvist et al. [48]	Cila et al. [22]
Šikšnys et al. [143]	Duvignau et al. [32]	Valkanova et al. [130]
Jensen et al. [63]	Hasselqvist et al. [47]	Promann [101]
Scuri and Nunes [114]	Morais et al. [86]	Hasselqvist and Eriksson [49]
Huang et al. [56]	Neupane et al. [89]	

Authors 1, 2, and 3, where both the assessment method and preliminary data extraction were validated. After this initial validation, Author 1 assessed the remaining 40 papers for inclusion, continuing with data extraction and synthesis of these into design narratives. Thus, a total of 60 papers were assessed for inclusion. Papers were deemed appropriate for inclusion if they satisfied all inclusion criteria (IC) in table 1. IC1 is relevant for our focus on digitalization in RQ3; IC2 for covering aspects of human participation in RQ1 and RQ2; IC3 was used to ensure papers concerned both technical and human rationales and outcomes of digital technologies in energy communities (related to RQ3). We applied these inclusion criteria sequentially from IC1 to IC3 for every possible paper. Out of 60 assessed papers, those that were not concerned with *digitalization* of energy systems as a communal matter (n=18), *human-centered* design (n=10), or *socio-technical configurations* of energy (n=0) were excluded. We note that in assessing the fulfillment of IC1, we did not discriminate between the exact nature of communal energy (e.g., formal energy communities [65] versus public visualization [130]), as we were interested in a broad view. As Author 3 co-authored five of the 60 papers assessed for inclusion [45, 63, 65, 89, 98], Author 2 independently assessed this research and discussed it with Author 1. After this process, we ended up with 32 papers included for data extraction and synthesis (see table 2 and step 5 in figure 1).

3.2 Data Extraction and Synthesis

For the 32 included papers in our CDA, we extracted the following data items related to every RQ:

- RQ1:
  - Country location of the energy community.
  - Geographical distribution of the energy community.
- RQ2:
  - Envisioned participant groups.
  - People included in energy community futuring.
  - How people are included in energy community futuring.
- RQ3:
  - The expected outcomes of using digital technologies in energy communities.
  - The role of designers of digital technologies in energy communities.

These data items were decided upon collaboratively through a number of early discussions among Authors 1, 2, and 3 and in relation to how previous work critiques visions around future energy technology [1, 18, 31, 124]. For every data item, we extracted text snippets to keep the context of the item [14] (see table 3 for an example). Using the lens of CDA, we were not interested in simply summarizing these data items. Rather, we see these data items (and their contexts) as highlighting assumptions in the reviewed research [5]. We aimed to extract data related to energy community projects themselves, but not meta-related data (e.g., quantitative data analysis software was extracted if used inside an energy community, but not if used simply to analyze data from an empirical study). We also focused on data items related to the study described in the paper (e.g., descriptions of the study's contributions and methods). Author 1 then used emergent coding [75] to code data items for every RQ. These codes were inductively grouped into design narratives [25], thus enabling an abductive synthesis [127]. We grouped papers based on the extracted data items across the dataset for every RQ, meaning that one paper could be present in multiple groups for the same RQ. Afterward, Authors 2 and 3 partook in reviewing this first round of data extraction and synthesis, validating the process and the emergent codebook.

Table 3: Example of our data extraction table.

Data item	Text snippet
Title	Participatory Infrastructuring of Community Energy
RQ1 data extracts	"The Project has two pilot site areas, this paper focuses on the Italian area" [19, p. 2]
RQ2 data extracts	"293 people from 93 households" [19, p. 2]
RQ3 data extracts	"an empowering tool for the communities, helping them to reflect and to change their energy practices for the sake of the improvement of the community and to achieve collective selfdefined goals" [19, p. 2]

We used skeptical reading from CDA [43] to characterize the discourse of design narratives (i.e., *how* they talk about topics), which we also used to name identified design narratives. For example, section 4.3.3 was originally named "Creating Benefits Beyond the Individual, and the word "Incremental" was added as part of the CDA to characterize the nature of the discussion of benefits brought on by digital technologies in energy communities.

Throughout the writing process, we refined design narratives, clarifying analytical points in an iterative, collaborative fashion.

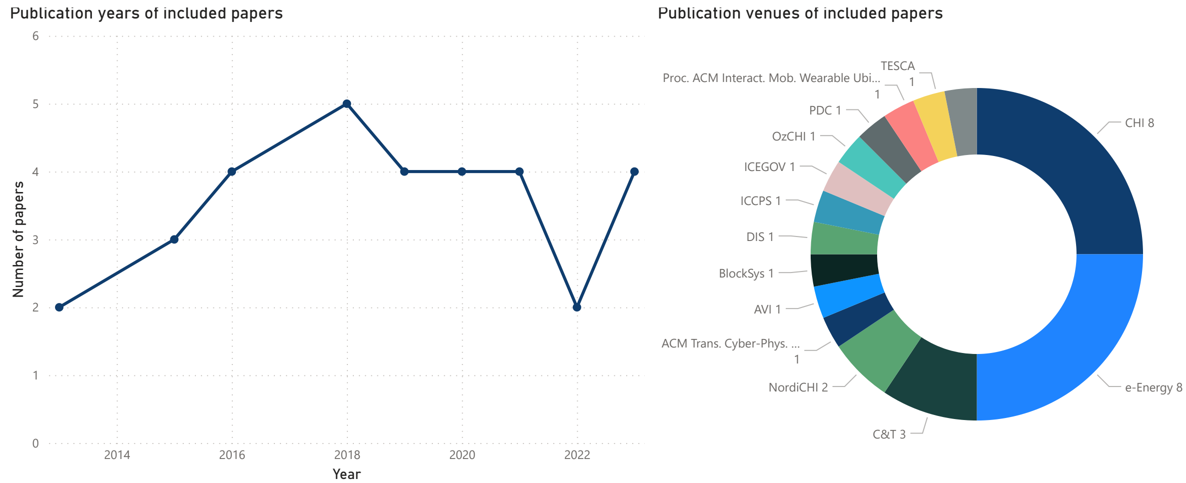

Figure 2: Publication years (left) and publication venues (right) of papers included using our scoping review methodology.

Table 4: Quantitative characteristics of our data extraction step for the final design narratives.

	RQ1	RQ2	RQ3
Number of text snippets in total	107	301	440
Number of unique papers	32	32	32
Average number of text snippets per paper	3.3	9.4	13.8

The final results of this synthesis concern three sets of three design narratives, which are presented in section 4. The three sets of three design narratives answer RQ1 (sites), RQ2 (participation), and RQ3 (future digital technologies), respectively. Table 4 shows the quantitative characteristics of our data extraction.

3.3 Paper Characteristics

A list of all papers included using our scoping review methodology is shown in table 2. Figure 2 shows publication years and venues of the papers included for critical discourse analysis. We note there is no clear trend in publication years. While some years have seen fewer papers published, this does not suggest a clear ongoing popularization of energy community research. On the other hand, the conferences CHI (the largest and broadest HCI conference) and e-Energy (a conference on future energy systems) are by far the most present publication venues in our set of included papers. Furthermore, we note only a few papers (n=2) are published in journals.

3.4 Author Positionality

We acknowledge that the knowledge produced in research is situated and not independent of researcher positionality [20] – thus, transparency in research also requires making clear researchers' positionalities. Authors 1, 2, and 3 have worked together at a European university on a research project as part of an industry-academia collaboration to explore a European energy community. In this collaboration, we encountered a number of assumptions from both energy community project workers and software development partners regarding what role digital technologies should play herein. This led us to consider to what extent these assumptions were normalized in energy community research and how we might challenge possible preconceptions about energy communities using reflection (inspired by humanistic HCI [5]). Author 4 has extensive experience with future-oriented research on sustainability and design anthropology approaches. This experience contributed to bridging the gap between energy community research and alternative design approaches, which helped to refine the study's findings and implications.

Further, we wish to acknowledge our position towards sustainability in this paper. Authors 1, 2, and 3 have backgrounds in human-centered design and the construction of digital technologies, while Author 4 has a background in the humanities, design anthropology, and participatory design. As such, our view on sustainability is primarily oriented towards understanding the entanglements of social practices and digital technologies, and ways in which sustainable futures might be supported by the design of digital technologies. Similarly, our research interests are primarily towards viewing sustainable futures as socio-technical transformations, where many challenges of sustainability and continued sustainable action intersect with — and are embedded in — current social, economic, and political structures [54]. Importantly, all authors' previous research has aimed to critically engage with visions of digitally supported sustainable development, and our aim with this paper is similar.

4 FINDINGS

In this section, we present the findings from our CDA of energy community research at ACM. We summarize the findings in table 5. Each overarching theme correlates to our three RQs and Costanza-Chock [25]'s conceptualization of design justice to help frame design narratives of sites, participation, and future digital technologies.

Table 5: Design narratives (and associated papers) identified through our critical discourse analysis of ACM research on energy communities.

Research questions	RQ1 – **Sites** of Energy Communities as…	RQ2 – **Participation** in Energy Communities as…	RQ3 – **Future Digital Technologies** in Energy Communities as…
Design narratives and papers	…Based on Proximity [19, 32, 45, 47, 48, 56, 63–65, 84, 86, 89, 92, 94, 109, 114, 116, 118, 130, 135, 137, 141] …Virtual Communities [4, 22, 32, 56, 78, 84–86, 92, 109, 135, 141, 143] …Shaped By Nations [19, 21, 32, 45, 47–49, 56, 63–65, 72, 84–86, 89, 94, 98, 101, 118, 130, 135, 137, 143]	…Nearby Involvement [4, 19, 22, 32, 45, 47–49, 56, 63, 64, 72, 78, 84, 85, 89, 92, 94, 98, 109, 114, 116, 118, 130, 135, 137, 141, 143] …Institutions and Technologies [4, 19, 21, 47–49, 63–65, 72, 78, 84–86, 89, 92, 98, 135, 143] …Being Represented by Others [19, 21, 45, 47–49, 64, 65, 72, 85, 86, 89, 92, 94, 98, 101, 116, 118, 130, 135, 137, 143]	…Mediating Sociality [4, 22, 32, 45, 47–49, 56, 63, 64, 72, 78, 89, 92, 94, 98, 101, 114, 130, 135, 137, 141, 143] …Providing Information and Empowerment [4, 21, 22, 32, 45, 47–49, 56, 63–65, 72, 78, 84–86, 89, 92, 94, 98, 101, 109, 114, 116, 118, 130, 135, 137, 141, 143] …Creating Incremental Benefits Beyond the Individual [4, 19, 21, 22, 32, 45, 47, 56, 63–65, 72, 78, 84, 86, 89, 92, 94, 98, 109, 116, 135, 137, 141, 143]

4.1 Sites of Energy Communities as…

4.1.1 …Based on Proximity. The first design narrative we present is that of energy community sites described as *based on proximity*. More often than not, research focuses on energy communities that are closely connected in a geographical and a social sense. Within this narrative, sites are often described as situated neighborhoods, for example, as the setting of energy community games [118], or designerly study sites [94, 130]. Broadening the geographical scale, we also see cities [114] and city districts [47, 130] described as energy community sites. Nonetheless, studies refer to sites as "local", which showcases who is expected to benefit from energy communities. For instance, the conceptualization of local electricity markets [84] suggests that the sites of the energy communities can *"keep financial profits locally and thus strengthen the local economy"* [135, p. 545]. Further, the local proximity of these energy communities is often envisioned through the lens of community-directed energy infrastructure, as they *"typically produce electricity for their own consumption"* [137, p. 1], but also by viewing energy community sites as a way of avoiding resource loss, as smaller energy distribution distances may mean smaller energy loss in the distribution. This discourse of local energy communities may imply a social and neighborly relationship between community members.

Studies of communal energy are also situated, e.g., university campuses [86], community centers [130], and high schools [65]. These locations' presence in research further illustrates that energy community sites are based in places where community members already gather, and do so under both geographic and social institutional boundaries. Moreover, energy communities can be seen as "rural", shaped around their disconnectedness from the surrounding communities. This is most clear in the work of Simm et al. [116], who argue that the Scottish island Tiree is nearly disconnected from the energy infrastructure of the United Kingdom, and thus engages with the energy produced by the communal wind turbine in a much more deliberate manner. An island is the site of Singh et al. [118]'s game "Electric City", where players must consider survival on an island as they generate their own energy resources. This shows how rural communities are enveloped in a discourse of communal self-sufficiency, also described by Jensen et al. [63].

However, some studies explicitly move away from the geographical clustering of members in energy communities [45, 64]. This is described in a discourse of looking *"beyond geographical limitations"* [45, p. 725], thus moving *beyond* the local focus in previous research. Although some of this research [45] imagines how digital technology can bring together geographically diverse people into energy communities for a greater "good", we also see digital technologies envisioned in these sites as punishing *"distant prosumers, because it [distance, ed.] increases grid losses"* [89, p. 366].

4.1.2 …Virtual Communities. A number of papers included in our critical discourse analysis describe a design narrative of energy community sites as *virtual communities*. These papers consider energy communities as entities we can understand, design, and criticize without these communities necessarily existing outside the context of individual papers. Simulations of energy communities exemplify this, which play a prominent role in the energy community literature at ACM. These simulations envision how digital technology is instrumental in the way community energy is consumed [86] and shaped by different infrastructural configurations [141], or artificial learning strategies for operating local electricity markets [84].

Predominantly, the discourse surrounding these virtual energy communities uses words like *"proof-of-concept"* [109, p. 320], which can be *"successfully tested as virtual demonstrator"* [135, p. 548]. Within this vision, the role of virtual energy communities, though not physically present, is typically described as a "help" to evaluate how energy communities may contribute to a sustainable transition. Many papers within this design narrative justify the performance of these virtual communities through *"real-life"* data [56, 86, 141] describing the many different configurations their simulations are run under [92, 143]. While surely an important quality measure of energy community research, we note the discursive legitimization of virtual energy communities as research subjects in this design narrative. This approach seems limited to quantifiable, performance-focused aspects and may thus neglect the many social- and human-centered aspects of energy communities. It is worth noting the work of Cila et al. [22] in this regard. While describing a non-existent energy community, they provide human-centered design insights for introducing blockchain herein. This shows how the use of virtual energy communities, which are not physically present "out there", has been adopted for critical perspectives outlined in our analysis.

4.1.3 …Shaped By Nations. We found that sites of energy communities are often seen as *shaped by nations*. Firstly, it is perhaps striking how many papers are situated in specific national contexts - and also *which* national contexts. The continent associated with most papers is by far Europe [19, 21, 45, 47–49, 63–65, 89, 94, 98, 118, 135, 137, 143], with Asia [72], South America [130], and North America [101] receiving scant attention.

Many energy community sites are typically described as *"experimental"* [135, p. 548], *"plot sites"* [143, p. 176], or *"burgeoning"* [65,

p. 1]. This description indicates that the conceptualizations and formations of energy communities are still being shaped. Despite this, studies often acknowledge that they are subject to the institutional and social structures that exist in the sites' national context. For example, studies describe national structures impacting the realization of energy communities. A study in Sweden highlights, for instance, that anyone *" who buys an apartment in Sweden must join the local housing cooperative"* [47, p. 476], while a Danish energy community is limited by Danish laws on cooperatives in the ways it must distribute costs and benefits [65]. This shows a discourse of how energy communities are subject to national, systemic, and political structures, which are thus unavoidable for the study and design of energy communities.

Not all energy communities shaped by nations necessarily take place within nations – rather, papers may base their studies on data obtained from national contexts. Studies might use energy technology data from specific countries [56, 84, 86], as well as national energy tariffs [85]. Such data may form a *"basis"* [85, p. 539], be *"real"* [55, p. 12], or *"derived"* [143, p. 177] from other data, implying that those are appropriate and legitimate, and that they have a foundation on preexisting, legitimate data. However, even simulated energy communities with no national context are still shaped by nations, when simulations are created using data from specific national contexts, also embedding built-in cultural assumptions from the data..

4.2 Participation in Energy Communities as…

4.2.1 …Nearby Involvement. The design narrative of energy community participation as *nearby involvement* was identified early in our CDA. Here, papers conceive of those participating in energy communities as individuals engaging in these communities and supporting technology [19, 45, 85, 94, 98, 116, 135, 137], as well as the situated places where participation is imagined unfolded close to energy technologies [19, 32, 45, 47–49, 56, 63, 64, 72, 84, 85, 89, 92, 94, 98, 109, 114, 116, 118, 130, 135, 137, 141, 143].

The nature of homes in this design narrative is expressed in a discourse focused on the productive capabilities of residencies and their inhabitants, which can have different energy technologies installed nearby. Words like *"consumer"*, *"producer"*, or *"prosumer"* are typically used to describe how different residents may be either producers of some sort of renewable energy, consumers, or both (prosumer). For example, papers often describe energy communities homes where a *"home with energy surplus is called an energy supplier while a home with energy shortage is called an energy demander"* [141, p. 221]. Further, such homes are usually associated with both photovoltaic energy technologies (e.g., solar panels on the rooftops) and energy storage technology (e.g., batteries) [109]. Participation is thus conceptualized through how residents engage with energy production. Such participation is often envisioned as financially motivated, using descriptions such as; *"flexibility potentials in their electricity use to increase self-consumption and benefit from lower tariffs"* [135, p. 548] or gaining *"financial savings"* [32, p. 36] as ways to organize residents into small energy groups. This discourse suggests an underlying capitalist logic to the design narrative, i.e., participation in energy communities requires engaging with markets and trading for economic benefits. Further, when we conceptualize participation through a discourse of production and consumption, there is the possibility of reinforcing barriers of engagement for those who might not engage in energy production.

However, nearby involvement is not just concerned with participation from those physically close to energy technologies, but also often discussed as participants already interested in sustainability concerns [19, 85, 94, 98, 116, 137]. Participation may be based on interest in the given energy community project [19, 116] or sustainability [85, 137]. Further, an energy community project *"which relies on participants stating their preferences every 15 minutes"* [135, p. 549] necessitates that participants have a preference strong enough to engage. Phrases like *"keen on issues of solar and sustainable energy"* [94, p. 9] suggest that participation in energy communities requires, or at least strongly benefits from, strong and positive opinions towards sustainability. In some projects, participants are found among existing customers of project partners [63]. While the focus on participants who feel close to energy community goals is admirable, it does leave out those perhaps less likely to engage, which raises questions like; what about those who are not *"already familiar and comfortable with each other"* [45, p. 726]? This showcases an assumption in research that energy communities be made attractive for those with interests similar to energy community projects. However, this inadvertently excludes possible participants who might possess other, though still legitimate, interests.

4.2.2 …Institutions and Technologies. We see a broad spectrum of papers conceptualizing participation in energy communities through envisioning changes to energy *institutions and technologies*. These papers typically consider participation as a concern for public institutions (e.g., a municipality in Japan [72]), new consumer and digital services provided by private (energy) companies (e.g., [89]), or through development of new "smart" energy infrastructures for specific use cases (e.g., EV driving [4]). In this design narrative, human participation is tacitly assumed, where future members willingly embrace these new digital technologies and services.

Interestingly, others envision physical infrastructure as participation. An energy community might contain *"different energy users such as houses, hospitals, and industries"* [78, p. 2], which are expected to intertwine with each other. Further, a "smart city" might expect *"large-scale introduction of next-generation vehicles and their linkage with public transport"* [72, p. 244], showcasing the introduction of technologies in a similar fashion. In this design narrative, institutions and technologies are seen as becoming entangled with other community members. An example is the vision of the GOFLEX platform, described as facilitating trading for prosumers, which includes *"households, tertiary buildings, industries, EV charging stations"* [89, p. 363]. Thus, institutions and technologies are provided agency through research discourse, thereby moving away from the human-centered focus of participation in energy communities.

4.2.3 …Being Represented by Others. In analyzing conceptions of participation in energy communities, we identified a design narrative of participation as *being represented by others*. This is, for example, the case of aggregators that trade flexibility on behalf of the owners of energy resources [89, 92, 143], or representatives of housing cooperatives [47–49].

Discursively, several papers consider design an activity of participation that can represent energy community interests. For example, the designers of Lumiphys [86] represented smart campus visitors by using designer-led assessments of design criteria. We also observe studies speculating about the future with (human) participants. For instance, Peña and Jensen [98, p. 205] use design as a means *"to probe potential energy community members"* about possible futures taking place in their context. Participation in formative energy communities is further illustrated with studies describing participation with words like "future" and "prospective" community members – they might not be *actual* community members (yet), but they are seen as important representatives for things, values, and contexts important to future community members. This discourse is sensible in that energy communities may be considered emerging socio-technical infrastructures. Results from a study might *"be cross-checked by ethnographic field-studies"* [118, p. 1524], suggesting that the speculative energy community depicted in a game might not adequately represent energy communities. Similarly, a study might be *"currently live"* [101, p. 5], suggesting that we can understand communal energy interactions through time-limited interactions that represent interests that also apply outside of the study's duration. This may be achieved through methods well-known from design, e.g., focus groups as described by [98]. Conversely, phrases like "observing" and "watching" imply a certain distance to the energy community, which assumes the energy community is an actual "thing" that can be observed over time.

Another interesting discursive construction is how the representation of community members is seen as a professional matter. This discourse uses words like "trade" or "manage" to signify representation as taking over responsibility in regard to professional competencies. For example, volunteer energy managers may be *"in charge of buildings with an average of about 40 apartments each"* [48, p. 1484]. Even though this group is mostly comprised of amateurs, they still fulfill a profession-adjacent role, for example, participating in meetings with multiple other energy professionals [47]. "Aggregators" might *"trade the flexibility"* [92, p. 2514] of smaller energy resource owners, as they are *"capable of actively performing local energy optimization while taking actual energy prices into account"* [143, p. 176]. Universities may become aggregators [89], taking on a professional nature similar to the volunteer energy managers described above. Thus, the act of participation as representation seems to require participants to not only take on new tasks, but to essentially become a new class of energy professionals.

4.3 Digital Technologies in Energy Communities as…

4.3.1 …Mediating Sociality. In analyzing our included papers, we, perhaps unsurprisingly, found that many papers describe a design narrative where digital technologies play an essential role of *mediating sociality.* In this design narrative, papers are often concerned with communal energy data i) as a way to foster collective understanding and caring [45, 47, 49, 64, 94, 101, 130], and ii) trading of energy [4, 32, 56, 63, 78, 89, 92, 94, 135, 141, 143].

In our analysis, we see papers that emphasize how community members, through technology, may change their conception of energy from an individual household concern to a community-based one. Papers here focus on how to *"stress the value of cooperation"* [114, p. 2], using words like "promote" and "allow" to describe how previous individual-based energy conceptions require different engagements from community members. However, scholars also point out that this design narrative brings about different challenges. For example, papers describe fears of communal engagement that may *"strain neighborly relations"* [94, p. 13], while highlighting the importance of countering participants' negative biases of others [101]. This discourse is further illustrated in the use of design strategies to mitigate possible conflicts. In a study of an imaginary energy community, Cila et al. [22] argue that algorithms should provide negotiation mechanics to manage conflicts between community members, with others arguing that it is when *"the peers come to a mutual agreement, the negotiation is considered [sic.] success and power transaction is initiated"* [78, p. 4]. This shows how community members are, maybe unwillingly, brought together and are expected to come to terms with communal energy. We see this as an assumption that digital technologies are implemented in energy communities to facilitate displeasing communal interactions.

When community members are envisioned to come together, they are seen to engage in a number of energy-related actions. Common for these actions is their market-based logic, a discourse constructed in a number of papers. For example, GOFLEX technology is described as *"a market-driven ICT platform"* [89, p. 363], similar to many other platforms described in the research. Often, studies consider *"trading"* between community members (e.g., [4, 94], where energy is bought and sold as part of social life). This is also shown in the use of phrases like "in return", where there is an expectation of socially oriented actions being rewarded proportionally. Thus, digital technologies are expected to mediate social relations between energy community members using a capitalist logic.

4.3.2 …Providing Information and Empowerment. A major design narrative we identified was the view of digital technologies in energy communities as *providing information and empowerment.*In this design narrative, information may be about energy, technology, and other community members. Papers often engage with how information is something that needs to be transformed and represented in different ways. Often, descriptions of binary opposites [140] of "visible" and "invisible" come into play here. For example, many consider that *"sources of energy are invisible to consumers"* [116, p. 1973], and that it may be relevant *"to make differences between one's own and other cooperatives visible for housing cooperative members outside of the board"* [47, p. 480].

While information may be available, that does not mean that community members are able to act upon it. This requires "visualizations" and "overviews", and we might interact with this information on different levels of granularity [94] and detail [89]. When Panagiotidou et al. [94] physicalize energy data from their workshop participants, they do this *"so that participants could collectively interact with them"* [94, p. 2], implying that before the physicalization, collective interaction was impossible, or maybe improbable. Further, as *"it can still not be expected that households spend an extended period of time daily (or even hourly)"* [85, p. 538] on communal energy, many papers focus on avoiding *"impacting the users' workload"* [141, p. 227]. Problems with current systems are also described in this discourse, e.g., the inconvenient Microsoft Excel-based approach for communal energy accounting described by Cech [21]. This showcases how it is assumed that digital technologies in energy communities need to be convenient to use, both in regard to functionality and information.

Furthermore, digital technologies are often depicted in a discourse of enabling users to gain awareness and act on this. Information may let community members *"explore, reflect and debate on socially-relevant issues"* [130, p. 3462], while it can help *"cooperatives to learn from each other's energy work"* [49, p. 7]. For instance, the ambient display Lumen aimed to encourage data exploration [45], while a laundry scheduling game was used to foster community reflection on how community members *"can adapt everyday energy activities"* [98, p. 206]. Describing digital technologies as something that "lets", "would", and "can" seems to signify a sort of agency in these technologies. This focus on agency is also discursively depicted through the democratic nature of energy communities, perhaps most clearly shown in Lumiphys' focus on *"democratization"* [86, p. 362]. Words like "participation" and "control" imply that digital technologies in energy communities should put power back into the hands of people. This is often done by giving "users" the ability to choose settings and scenarios, e.g., *"willingness to postpone operating the washing machine"* [64, p. 248] or facilitating *"energy managers to better decide what is an addressable challenge"* [47, p. 480]. There is a seeming tendency to understand digital technologies in energy communities, and the information they present, as something that provides new and empowering opportunities among community members.But how are community members transformed in their interaction with digital technologies in energy communities, and what sorts of communities are shaped by supportive and empowering technologies? Such questions typically remain unarticulated.

4.3.3 . . . Creating Incremental Benefits Beyond the Individual. In our critical discourse analysis, we find that papers often see digital technologies as *creating incremental benefits beyond the individual*. Papers signal a Triple Bottom Line approach [113], focused on *economic* (e.g., [4, 19]), *environmental* (e.g., [47, 86]), and *infrastructural* (e.g., [89, 141]) benefits of using digital technologies. This reflects the Triple Bottom Line's focus on sustainability as accounted for both in an organization's economic performance, and its commitment to investing in environmental and social initiatives [113].

In this design narrative, we see a discourse of reduction and slow transformations. Phrases of "minimizing consumption", "cost savings" or "coordination" imply that certain actions are allowed, perhaps encouraged, but only in specific amounts or ways. For example, digital technologies in energy communities may be successful if *"households can practically achieve an almost optimal financial cost saving"* [32, p. 44], or if technologies are *"compatible with a traditional AC power grid"* [56, p. 2] requiring fewer changes. This is similarly described by Wilkins et al. [137], arguing that communities trading energy locally might buy insurance to ensure energy access from the larger grid, while Jensen and Jensen [65] discuss how algorithmic systems might supply energy in compliance with current Danish law. Furthermore, many cases of "optimization" are also described in this discourse. A Japanese smart city might aim to "optimize distribution" of energy [72], while a European digital platform might "optimize consumption" of electricity [89]. This shows a discourse that is centered around energy communities as slowly increasing sustainability, e.g., the positive phrasing for how workshop participants *"showed a remarkable restraint in requesting unrealistic or sweeping changes"* [21, p. 266] to an energy accounting tool. This specific choice of words illustrates a narrative of designing digital technologies for communal energy projects, which are not too radical, but instead strive for smaller, incremental changes.

5 DISCUSSION

Through our study of design narratives, we have demonstrated how the discourse of ACM's energy community research shapes cerntain research trajectories. There are limitations to the study however. Firstly, there are limitations of using ACM DL as our only literature database. Energy communities are also studied in areas of energy policy, social science, and management, which are not part of the analysis presented in this paper. Despite this, ACM represents an opportunity to study how visions of future technology are articulated where this technology is researched, designed, and evaluated. Secondly, the search query was constructed to retrieve papers that explicitly acknowledge the "communal" nature of energy communities. Other terms could have been used to identify papers concerning energy communities, such as, "microgrids", "P2P smart grids" or "eco-villages". Nevertheless, our analysis reveals central assumptions embedded in current energy community research at ACM. Critically, we have shown that this research may fail to consider the transformative, sustainable transitions often associated with energy communities, and instead focuses on energy communities as initiatives that may reform current practices and systems [54]. While an assessment of the author backgrounds of the 32 analyzed papers was not conducted, this may be an interesting further analysis to perform. Royston and Foulds [108] show that humanities and social science research, such as the critical discourse analysis employed in this paper, is often excluded from energy policies at the EU level, which limits possible problem framings and future visions. It is relevant to understand not just voices embedded in energy community research at ACM, but also the backgrounds of those voices, to understand which disciplines are routinely (under)represented.

Our critical discourse analysis describes design narratives across aspects of energy community sites, participation, and digital technologies. In the following sections, we discuss our findings and future trajectories for researchers and designers alike to engage critically with energy community design by i) reshaping visions of future energy community technologies, ii) scaffolding infrastructuring for participation, and iii) building alternative narratives.

5.1 Reshaping Techno-solutionist Visions

The findings in this paper highlight the fact that a substantial portion of the ACM literature portrays a dominant techno-solutionist narrative, often presented from the point of view of an "engineer solutionist" character (e.g., [84, 101, 141, 143]). Here, designing is typically about exploring emergent technology with the promise of mitigating and improving energy technology "problems" in controlled academic settings. This may be through showing how market algorithms can perform more efficiently [89], proving how effective automated distribution of energy can be performed within local infrastructures [92], or improving interactive energy community tools from human-centered perspectives [45]. Here, we see "engineers" typically imagining future energy community technologies based on computational modeling and quantifiable measurements [74] – distancing research problems, development, and visions of sustainable transformations from the political, social, and local situations in which the "solutions" may become embedded.

Despite attempts to convey objective storytelling in these narratives, our findings also reveal that techno-solutionist imaginings play a pivotal role in shaping (social) conventions, intentions, and assumptions related to energy community research and development. This includes conventions such as "aggregators", "energy flexibility" and "prosumers", designerly intentions of, e.g., "fostering neighborly and communal relationships", and forming assumptions about householders, which are motivated by "financial savings" and "algorithmic and interactive convenience". Furthermore, as ACM energy community research is often articulated in technologically oriented venues, primarily CHI and e-Energy (section 3.3), we see certain stakeholders' perspectives become foregrounded [63, 91, 123] (e.g., the energy industry, software and hardware companies, and energy traders [89]). However, those stakeholders' perspectives often reflect hidden power structures already existing in the energy sector [41]. The findings however, illustrate that embedded in the techno-solutionist narrative, is an implicit expectation that a **just, sustainable communal** future will naturally follow with the design of these technologies without critically embracing the social, political, and (in)just design aspects [25] of, for instance, decentralizing our energy infrastructures [90], or communities becoming reliant on solar power production [125].

Nonetheless, the design narratives presented in this paper collectively illustrate that ACM energy community research carries significant social and political values. Within the techno-solutionist narrative, community energy is typically viewed as something for *"exploitation, accumulation, commodification, and extraction"* [111, p. 3]. This is reflected in our findings by a capitalist logic embedded in i) the sociality mediated by the digital technologies (e.g., stories of trading, financial savings, energy, and flexibility tariffs), and, ii) the envisioned participation through the engaged and involved prosumer empowered with energy technologies, akin to Strengers [121]'s Resource Man. Further, our findings reflect critiques found in SHCI arguing that sustainability research is often situated *"within the economic and political machinery"* [9, p. 228]. Our study complements this research, highlighting a socio-economic approach to energy communities that does not focus on total equality on a transformative level [54]. Specifically, the focus on trading identified in our study corroborates Scuri et al. [113]'s findings of sustainability in SHCI as part of market economies, which may come to reinforce imaginings of energy community participation through financial incentives [22].

To complement and further advance such perspectives, Jasanoff and Kim [60] suggest a need to place increased emphasis on the social dimensions of our socio-technical imaginings of energy transitions. For instance, the findings in this paper show how energy community research at ACM rarely grapples with the messiness of everyday life nor questions the status quo of energy community research. This provides HCI researchers with the opportunity to engage with the techno-solutionist to explore alternative ways of designing digital technologies for energy communities that deviate from the status quo. We believe this trajectory of research is ripe for engaging in collaborative design projects, including stakeholders from different research disciplines, as well as outside of research [26], e.g., energy community planners. HCI researchers may complement with provoking and speculative approaches to energy community design [34, 61, 73, 88, 102], thus encouraging the techno-solutionist researcher to reconsider the values we ascribe to energy community systems. However, HCI researchers may also consider engaging with researchers from social sciences and policy research. In this, we see the possibility of aiding the recent expansion in justice-related HCI literature (e.g., [6, 25, 65]) by implementing and reflecting on how digital technologies both can distribute goods in a democratic manner, foster open energy community decision-making [51], and uncover unjust imaginaries of energy infrastructures [90].

5.2 Scaffolding Participation in Energy Communities

In critically analyzing design narrative discourses, we see expectations arguing for the significance attributed to energy community participation as enablers for people to collectively engage in renewable energy issues [38]. Overall, the findings indicate that energy community research at ACM presupposes and predefines the sorts of empowerment and democratic engagement that energy community members are to experience. For narratives of energy community sites, the local proximity of community members is assumed to also entail a social connection that shapes participation (e.g., [137]). In narratives of community participation, the actual engagement in the collective is often contingent on community members already being involved or interested in sustainable initiatives and innovation projects (e.g., [45]). Finally, narratives of digital technologies assume participation and empowerment are realized through the development of emergent and transformative technologies (e.g., [130]).

Despite significant expectations of participation, our findings also suggest that ACM energy community research struggles with defining, shaping, and forming transformative participation at local sites. The struggle with approaching human participation in sustainability issues also reflects SHCI research that aims to transform community practices and participation, yet does not achieve *radical* transformation [24, 111]. For instance, researchers have argued that visions of community engagement, like fostering competition, may actually unintendedly transform practices in unsustainable ways [45, 64]. Also, Strengers and Nicholls [122] show how industry visions of smart home technologies shape participation in everyday practices, which may escalate energy consumption by requiring an increase of smart devices using energy in the home. This echoes other studies looking towards different kinds of resource consumption, like food, and how such consumption may be managed in ways that uphold scarcity, despite the abundance of such resources [33, 53]. Our findings complement ideas that non-transformative participation might have unintended consequences, e.g., community engagement becoming transformed into capitalist community relations, which does not grapple with necessary, radical transformations of the energy system [54].

Based on this, a future trajectory for energy community research can be formed by drawing on ongoing research in the field of participatory design and design anthropology. In this line of work, DiSalvo [29] illustrates how industrial agricultural drones can be used for non-industrial foraging practices to engage in a *"collective effort of exploring a desired future"* [29, p. 150], This experiment on limiting precision in agriculture in non-precise foraging practices, evokes new perspectives on the use of technologies. Similar, Teli et al. [126] describe how designers in community-based projects can promote i) transformations of local institutions, ii) the formation of publics based on common interests between designers and communities, and iii) be made redundant in the face of grassroots actions. Lastly, infrastructuring has been considered an opportunity in participatory design, which can facilitate empowering publics to choose and engage with issues over time, rather than simply using technologies during a project's duration [27].

Hence, there are fruitful opportunities for researchers to move away from demonstrating energy community technologies by deploying these at local sites in a domestic context without engaging actively with participants [89]. Instead, it seems imperative that we reconsider participation in energy communities, focusing on the ways in which community members themselves can foster and continuously engage with democratic and just energy engagements. Here, HCI research has a central role to play, by developing technologies that help energy community members create alternative narratives formed by the cultural and social practices unfolding in local communities. Focusing on more than 'designing for' — but also 'infrastructuring in' — energy communities, we can start to study how energy community practices and decision-making evolve over time and enable new ways of this. Such insights would help us contend with community-driven, rather than technology-driven, participation.

5.3 Building Alternative Narratives

In order to move energy community research forward, we propose to start actively building alternative design narratives. To do this, researchers may consider the notion of *pluriversal* design [35] perspectives of sustainable energy communities' sites. A pluriversal vision of the world considers how the global model of capitalism drives crises of sustainability, and how we may move towards supporting the existence of multiple different modes of knowing and living as part of sustainable world-making [35]. Pluriversal design recognizes the diverse meanings of the people, other "beings", their communities, and situated cultural and social practices, which we study and design for [35]. The pluriversal project has engaged with *"spatial, temporal, and experiential edges at which it repeatedly finds evidence of a pluriverse of indigenous communities resisting Eurocentric universalism"* [138, p. 7], where diverse communities coexist and flourish. Thus, we believe a view of energy communities as pluriversal can fruitfully challenge existing design narratives. Such perspectives may bring alternative imaginings of energy communities and enable a broader and more diverse vision of sustainable energy futures.

Conceptualizing energy communities through a pluriversal lens thus entails understanding how sustainable energy practices are situated in everyday, often messy, contexts. To understand such messiness, we believe it interesting for energy community research to draw out and learn from examples of low-scale community energy consumption in non-Western contexts. For example, Melnyk and Singh [83] use a design anthropological approach to show how local *"practices of improvisation, redistribution of energy and adaptation"* [83, p. 45] of local mini-grids help bolster decentralized energy grids in rural India while also facilitating social cohesion. For example, local citizens may bypass automated timers of mini-grids to connect music devices for religious festivals, in return taking ownership of the mini-grid and caring for its components [83]. Similarly, a study of a domestic solar energy system in rural Kenya uses defamiliarization to illustrate that assumptions of sustainable HCI, like excessive domestic energy consumption, are not universally applicable – here, participants' newly acquired light sources helped to care for hens and chicks [139]. Finally, Bidwell et al. [7]'s ethnographic action research of cellphone charging stations in a South African community describes how walking is integral to coordinating the use of electricity to charge phones and facilitating local social life.

Studies such as these illustrate how existing energy community sites may provide new opportunities for understanding how to engage people in sustainable and communal caring of energy. We suggest that HCI researchers study existing communities and locally situated practices by immersing themselves in these communities over longer periods of time. Methods such as participatory design [11] and design anthropology [29] can support the development of diverse and pluriversal understandings of situated energy communities and the many ways in which they may (co-)exist, thus broadening more democratic narratives to sustainability.

6 CONCLUSION

In this paper, we investigated the assumptions embedded in design narratives of energy community research at ACM. Our collection of data was carried out via a scoping review methodology to collect ACM papers related to energy communities, extracting text snippets related to energy communities' sites (RQ1), participation (RQ2), and digital technologies (RQ3). Through qualitative emergent coding, we inductively grouped text snippets into design narratives, and used a critical discourse analysis to understand taken-for-granted stances in energy community research at ACM. For every research question, we identified three design narratives, which were critically analyzed for their discourse.

Our findings underpin the diverse nature of energy community research at ACM. However, a number of common assumptions are articulated in the reviewed literature. We see a tendency for design narratives in the reviewed research to assume that energy community sites either require close geographical ties, or that local context is not definitive for energy communities. For participation in energy communities, we identified discourses related to implicit participation from community members, whose interests may be represented by, and through taking on roles of, energy stakeholders. Finally, digital technologies are described as facilitating easily accessed, capitalist benefits to energy community members and society. Together, these design narratives show where energy communities sites are situated, how participation is imagined, and which values embedded in technologies are voiced and foregrounded.

Based on these findings, we show that current research on energy communities can break with popular envisionments of energy communities by expanding into, and together with, other areas of research. We discuss how HCI researchers may foster reflection on energy community research in three trajectories. These trajectories concern collaborative energy community design across disciplines, infrastructuring of energy community participation, and pluriversal design in energy communities. We encourage researchers working with energy communities to consider radically different approaches that bring forth alternatives to commonly assumed meanings and understandings about energy communities to move towards more sustainable, democratic energy futures.

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REFERENCES

[1] Simone Abram, Karen Waltorp, Nathalie Ortar, and Sarah Pink. 2022. *Energy Futures: Anthropocene Challenges, Emerging Technologies and Everyday Life.* Walter de Gruyter GmbH & Co KG, Berlin, Boston.

[2] Alper T. Alan, Enrico Costanza, Sarvapali D. Ramchurn, Joel Fischer, Tom Rodden, and Nicholas R. Jennings. 2016. Tariff Agent: Interacting with a Future Smart Energy System at Home. *ACM Trans. Comput.-Hum. Interact.* 23, 4, Article 25 (aug 2016), 28 pages. https://doi.org/10.1145/2943770

[3] Hilary Arksey and Lisa O'Malley. 2005. Scoping studies: towards a methodological framework. *International Journal of Social Research Methodology* 8, 1 (Feb. 2005), 19–32. https://doi.org/10.1080/1364557032000119616

[4] Sai Shibu N B, Balamurugan S, Arjun D, and Nidhin Mahesh A. 2019. Decentralized Power System and Future Mobility: The Use Cases of Community Driven Electric Vehicle Charging Infrastructure. In *Proceedings of the 1st ACM International Workshop on Technology Enablers and Innovative Applications for Smart Cities and Communities.* ACM, New York NY USA, 50–53. https://doi.org/10.1145/3364544.3364829

[5] Jeffrey Bardzell and Shaowen Bardzell. 2016. Humanistic HCI. *Interactions* 23, 2 (Feb. 2016), 20–29. https://doi.org/10.1145/2888576

[6] Rosanna Bellini, Debora De Castro Leal, Hazel Anneke Dixon, Sarah E Fox, and Angelika Strohmayer. 2022. "There is no justice, just us": Making mosaics of justice in social justice Human-Computer Interaction. In *CHI Conference on Human Factors in Computing Systems Extended Abstracts.* ACM, New Orleans LA USA, 1–6. https://doi.org/10.1145/3491101.3503698

[7] Nicola J. Bidwell, Masbulele Siya, Gary Marsden, William D. Tucker, M. Tshemese, N. Gaven, S. Ntlangano, Simon Robinson, and Kristen Ali Eglinton. 2013. Walking and the social life of solar charging in rural africa. *ACM Transactions on Computer-Human Interaction* 20, 4 (Sept. 2013), 1–33. https://doi.org/10.1145/2493524

[8] Jon Bird and Yvonne Rogers. 2010. The pulse of tidy street: Measuring and publicly displaying domestic electricity consumption. In *workshop on energy awareness and conservation through pervasive applications (Pervasive 2010).* Springer Berlin Heidelberg, Berlin, Heidelberg, 0–6.

[9] Eli Blevis. 2006. Advancing Sustainable Interaction Design: Two Perspectives on Material Effects. *Design Philosophy Papers* 4, 4 (Dec. 2006), 209–230. https://doi.org/10.2752/144871306X13966268131875

[10] Eli Blevis. 2007. Sustainable Interaction Design: Invention & Disposal, Renewal & Reuse. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (San Jose, California, USA) *(CHI '07).* Association for Computing Machinery, New York, NY, USA, 503–512. https://doi.org/10.1145/1240624.1240705

[11] Susanne Bødker, Christian Dindler, Ole S. Iversen, and Rachel C. Smith. 2022. *Participatory Design: Synthesis Lectures on Human-Centered Informatics.* Morgan & Claypool Publishers, Switzerland. i–143 pages. https://doi.org/10.1007/978-3-031-02235-7_2

[12] Natascha van Bommel and Johanna I. Höffken. 2021. Energy justice within, between and beyond European community energy initiatives: A review. *Energy Research & Social Science* 79 (2021), 102157. https://doi.org/10.1016/j.erss.2021.102157

[13] Jacky Bourgeois, Janet van der Linden, Gerd Kortuem, Blaine A. Price, and Christopher Rimmer. 2014. Conversations with My Washing Machine: An in-the-Wild Study of Demand Shifting with Self-Generated Energy. In *Proceedings of the 2014 ACM International Joint Conference on Pervasive and Ubiquitous Computing* (Seattle, Washington) *(UbiComp '14).* Association for Computing Machinery, New York, NY, USA, 459–470. https://doi.org/10.1145/2632048.2632106

[14] Virginia Braun and Victoria clarke. 2006. Using thematic analysis in psychology. *Qualitative Research in Psychology* 3, 2 (Jan. 2006), 77–101. https://doi.org/10.1191/1478088706qp063oa

[15] Christina Bremer, Bran Knowles, and Adrian Friday. 2022. Have We Taken On Too Much?: A Critical Review of the Sustainable HCI Landscape. In *CHI Conference on Human Factors in Computing Systems.* ACM, New Orleans LA USA, 1–11. https://doi.org/10.1145/3491102.3517609

[16] Svenja Breuer, Maximilian Braun, Daniel Tigard, Alena Buyx, and Ruth Müller. 2023. How Engineers' Imaginaries of Healthcare Shape Design and User Engagement: A Case Study of a Robotics Initiative for Geriatric Healthcare AI Applications. *ACM Transactions on Computer-Human Interaction* 30, 2 (April 2023), 1–33. https://doi.org/10.1145/3577010

[17] Loove Broms, Josefin Wangel, and Camilla Andersson. 2017. Sensing energy: Forming stories through speculative design artefacts. *Energy Research & Social Science* 31 (Sept. 2017), 194–204. https://doi.org/10.1016/j.erss.2017.06.025

[18] Hronn Brynjarsdottir, Maria Håkansson, James Pierce, Eric Baumer, Carl DiSalvo, and Phoebe Sengers. 2012. Sustainably unpersuaded: how persuasion narrows our vision of sustainability. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems.* ACM, Austin Texas USA, 947–956. https://doi.org/10.1145/2207676.2208539

[19] Andrea Capaccioli, Giacomo Poderi, Mela Bettega, and Vincenzo D'Andrea. 2016. Participatory infrastructuring of community energy. In *Proceedings of the 14th Participatory Design Conference: Short Papers, Interactive Exhibitions, Workshops - Volume 2.* ACM, Aarhus Denmark, 9–12. https://doi.org/10.1145/2948076.2948089

[20] Martina Angela Caretta. 2015. Situated knowledge in cross-cultural, cross-language research: a collaborative reflexive analysis of researcher, assistant and participant subjectivities. *Qualitative Research* 15, 4 (Aug. 2015), 489–505. https://doi.org/10.1177/1468794114543404

[21] Florian Cech. 2021. Tackling Algorithmic Transparency in Communal Energy Accounting through Participatory Design. In *C&T '21: Proceedings of the 10th International Conference on Communities & Technologies - Wicked Problems in the Age of Tech.* ACM, Seattle WA USA, 258–268. https://doi.org/10.1145/3461564.3461577

[22] Nazli Cila, Gabriele Ferri, Martijn de Waal, Inte Gloerich, and Tara Karpinski. 2020. The Blockchain and the Commons: Dilemmas in the Design of Local Platforms. In *CHI '20: Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems.* ACM, Honolulu, HI, 1–14. https://doi.org/10.1145/3313831.3376660

[23] Adrian K. Clear, Samantha Mitchell Finnigan, Patrick Olivier, and Rob Comber. 2018. ThermoKiosk: Investigating Roles for Digital Surveys of Thermal Experience in Workplace Comfort Management. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems* (Montreal QC, Canada) *(CHI '18).* Association for Computing Machinery, New York, NY, USA, Article 382, 12 pages. https://doi.org/10.1145/3173574.3173956

[24] Rob Comber, Shaowen Bardzell, Jeffrey Bardzell, Mike Hazas, and Michael Muller. 2020. Announcing a New CHI Subcommittee: Critical and Sustainable Computing. *Interactions* 27, 4 (jul 2020), 101–103. https://doi.org/10.1145/3407228

[25] Sasha Costanza-Chock. 2020. *Design Justice: Community-Led Practices to Build the Worlds We Need.* The MIT Press, Cambridge, Massachusetts. https://doi.org/10.7551/mitpress/12255.001.0001

[26] Peter Dalsgaard, Kim Halskov, and Ditte Amund Basballe. 2014. Emergent boundary objects and boundary zones in collaborative design research projects. In *Proceedings of the 2014 conference on Designing interactive systems.* ACM, Vancouver BC Canada, 745–754. https://doi.org/10.1145/2598510.2600878

[27] Christopher A Le Dantec and Carl DiSalvo. 2013. Infrastructuring and the formation of publics in participatory design. *Social Studies of Science* 43, 2 (April 2013), 241–264. https://doi.org/10.1177/0306312712471581

[28] Tawanna R. Dillahunt and Jennifer Mankoff. 2014. Understanding Factors of Successful Engagement around Energy Consumption between and among Households. In *Proceedings of the 17th ACM Conference on Computer Supported Cooperative Work & Social Computing* (Baltimore, Maryland, USA) *(CSCW '14).* Association for Computing Machinery, New York, NY, USA, 1246–1257. https://doi.org/10.1145/2531602.2531626

[29] Carl DiSalvo. 2020. The Irony of Drones for Foraging: Exploring the Work of Speculative Interventions. In *Design Anthropological Futures* (1 ed.), Rachel Charlotte Smith, Kasper Tang Vangkilde, Mette Gislev Kjærsgaard, Ton Otto, Joachim Halse, and Thomas Binder (Eds.). Routledge, London ; New York : Bloomsbury Academic, an imprint of Bloomsbury Publishing, Plc, [2016], 139–152. https://doi.org/10.4324/9781003085188-11

[30] Carl DiSalvo, Phoebe Sengers, and Hrönn Brynjarsdóttir. 2010. Mapping the landscape of sustainable HCI. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems.* ACM, Atlanta Georgia USA, 1975–1984. https://doi.org/10.1145/1753326.1753625

[31] Paul Dourish. 2010. HCI and Environmental Sustainability: The Politics of Design and the Design of Politics. In *Proceedings of the 8th ACM Conference on Designing Interactive Systems* (Aarhus, Denmark) *(DIS '10).* Association for

Computing Machinery, New York, NY, USA, 1–10. https://doi.org/10.1145/1858171.1858173
[32] Romaric Duvignau, Verena Heinisch, Lisa Göransson, Vincenzo Gulisano, and Marina Papatriantafilou. 2020. Small-Scale Communities Are Sufficient for Cost- and Data-Efficient Peer-to-Peer Energy Sharing. In *Proceedings of the Eleventh ACM International Conference on Future Energy Systems*. ACM, Virtual Event Australia, 35–46. https://doi.org/10.1145/3396851.3397741
[33] Philip Engelbutzeder, Yannick Bollmann, Katie Berns, Marvin Landwehr, Franka Schäfer, Dave Randall, and Volker Wulf. 2023. (Re-)Distributional Food Justice: Negotiating conflicting views of fairness within a local grassroots community. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems*. ACM, Hamburg Germany, 1–16. https://doi.org/10.1145/3544548.3581527
[34] Anders Ernevi, Samuel Palm, and Johan Redström. 2007. Erratic Appliances and Energy Awareness. *Knowledge, Technology & Policy* 20, 1 (Aug. 2007), 71–78. https://doi.org/10.1007/s12130-007-9007-7
[35] Arturo Escobar. 2015. *Transiciones* : a space for research and design for transitions to the pluriverse. *Design Philosophy Papers* 13, 1 (Jan. 2015), 13–23. https://doi.org/10.1080/14487136.2015.1085690
[36] European Commission. 2022. Digitalisation of the energy system | Energy. https://energy.ec.europa.eu/topics/energy-systems-integration/digitalisation-energy-system_en
[37] European Commission. 2023. Clean energy for all Europeans | Energy. https://energy.ec.europa.eu/topics/energy-strategy/clean-energy-all-europeans-package_en
[38] European Commission. 2023. Energy communities | Energy. https://energy.ec.europa.eu/topics/markets-and-consumers/energy-communities_en
[39] Alister Forman. 2017. Energy justice at the end of the wire: Enacting community energy and equity in Wales. *Energy Policy* 107 (Aug. 2017), 649–657. https://doi.org/10.1016/j.enpol.2017.05.006
[40] Jon Froehlich, Leah Findlater, and James Landay. 2010. The design of eco-feedback technology. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. ACM, Atlanta Georgia USA, 1999–2008. https://doi.org/10.1145/1753326.1753629
[41] Flavia Gangale, Anna Mengolini, and Ijeoma Onyeji. 2013. Consumer engagement: An insight from smart grid projects in Europe. *Energy Policy* 60 (2013), 621 – 628. https://doi.org/10.1016/j.enpol.2013.05.031
[42] William Gaver, Mike Michael, Tobie Kerridge, Alex Wilkie, Andy Boucjer, Liliana Ovalle, and Matthew Plummer-Fernandez. 2015. Energy Babble: Mixing Environmentally-Oriented Internet Content to Engage Community Groups. In *CHI '15: Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*. ACM, Seoul, 1115–1124. https://doi.org/10.1145/2702123.2702546
[43] Rosalind Gill. 2000. Discourse Analysis. In *Qualitative Researching with Text, Image and Sound*, Martin Bauer and George Gaskell (Eds.). SAGE Publications Ltd, 6 Bonhill Street, London England EC2A 4PU United Kingdom, 172–190. https://doi.org/10.4135/9781849209731
[44] Vladimir Z. Gjorgievski, Snezana Cundeva, and George E. Georghiou. 2021. Social arrangements, technical designs and impacts of energy communities: A review. *Renewable Energy* 169 (May 2021), 1138–1156. https://doi.org/10.1016/j.renene.2021.01.078
[45] Anders Høgh Hansen, Rikke Hagensby Jensen, Lasse Stausgaard Jensen, Emil Kongsgaard Guldager, Andreas Winkel Sigsgaard, Frederik Monder, Dimitris Raptis, Laurynas Šikšnys, Torben Bach Pedersen, and Mikael B. Skov. 2020. Lumen: A Case Study of Designing for Sustainable Energy Communities through Ambient Feedback. In *OzCHI '20: 32nd Australian Conference on Human-Computer Interaction*. ACM, New York NY, 724–729. https://doi.org/10.1145/3441000.3441001
[46] Lon Åke Erni Johannes Hansson, Teresa Cerratto Pargman, and Daniel Sapiens Pargman. 2021. A Decade of Sustainable HCI: Connecting SHCI to the Sustainable Development Goals. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*. ACM, Yokohama Japan, 1–19. https://doi.org/10.1145/3411764.3445069
[47] Hanna Hasselqvist, Christian Bogdan, and Filip Kis. 2016. Linking Data to Action: Designing for Amateur Energy Management. In *DIS 2016, June 4–8, 2016, Brisbane, Australia*. ACM, Brisbane, 473–483. https://doi.org/10.1145/2901790.2901837
[48] Hanna Hasselqvist, Christian Bogdan, Mario Romero, and Omar Shafqat. 2015. Supporting Energy Management as a Cooperative Amateur Activity. In *CHI EA '15: Proceedings of the 33rd Annual ACM Conference Extended Abstracts on Human Factors in Computing Systems*. ACM, Seoul, 1483–1488. https://doi.org/10.1145/2702613.2732724
[49] Hanna Hasselqvist and Elina Eriksson. 2018. Designing for diverse stakeholder engagement in resource-intensive practices. In *Proceedings of the 10th Nordic Conference on Human-Computer Interaction*. ACM, Oslo Norway, 426–438. https://doi.org/10.1145/3240167.3240193
[50] Hanna Hasselqvist, Sara Renström, Maria Håkansson, and Helena Strömberg. 2022. Exploring Renewable Energy Futures through Household Energy Resilience. In *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems (CHI '22)*. Association for Computing Machinery, New York, NY, USA, 18 pages. https://doi.org/10.1145/3491102.3517597 event-place: New Orleans, LA, USA.
[51] Raphael J. Heffron and Darren McCauley. 2014. Achieving sustainable supply chains through energy justice. *Applied Energy* 123 (June 2014), 435–437. https://doi.org/10.1016/j.apenergy.2013.12.034
[52] Sara Heitlinger, Nick Bryan-Kinns, and Rob Comber. 2019. The Right to the Sustainable Smart City. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (CHI '19)*. Association for Computing Machinery, New York, NY, USA, 1–13. https://doi.org/10.1145/3290605.3300517 event-place: Glasgow, Scotland Uk.
[53] Sara Heitlinger, Lara Houston, Alex Taylor, and Ruth Catlow. 2021. Algorithmic Food Justice: Co-Designing More-than-Human Blockchain Futures for the Food Commons. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems (CHI '21)*. Association for Computing Machinery, New York, NY, USA, 17 pages. https://doi.org/10.1145/3411764.3445655 event-place: Yokohama, Japan.
[54] Bill Hopwood, Mary Mellor, and Geoff O'Brien. 2005. Sustainable development: mapping different approaches. *Sustainable Development* 13, 1 (Feb. 2005), 38–52. https://doi.org/10.1002/sd.244
[55] Yilin Huang, Giacomo Poderi, Sanja Šćepanović, Hanna Hasselqvist, Martijn Warnier, and Frances M. T. Brazier. 2019. Embedding Internet-of-Things in Large-Scale Socio-technical Systems: A Community-Oriented Design in Future Smart Grids: Technology, Communications and Computing. In *The Internet of Things for Smart Urban Ecosystems* (1 ed.), Franco Cicirelli, Antonio Guerrieri, Carlo Mastroianni, Giandomenico Spezzano, and Andrea Vinci (Eds.). Springer Cham, Cham, 125–150. https://doi.org/10.1007/978-3-319-96550-5_6
[56] Zhichuan Huang, Ting Zhu, David Irwin, Aditya Mishra, Daniel Menasche, and Prashant Shenoy. 2016. Minimizing Transmission Loss in Smart Microgrids by Sharing Renewable Energy. *ACM Transactions on Cyber-Physical Systems* 1, 2 (2016), 1–22. https://doi.org/10.1145/2823355
[57] Maria Håkansson, Sara Renström, Jenny Lööf, László Sall Vesselényi, and Julia Jonasson Tolv. 2022. "Do they pass the woman test?": Navigating and negotiating the gendering of residential solar panels. In *Nordic Human-Computer Interaction Conference*. ACM, Aarhus Denmark, 1–12. https://doi.org/10.1145/3546155.3546643
[58] Karim Jabbar and Pernille Bjørn. 2019. Blockchain Assemblages: Whiteboxing Technology and Transforming Infrastructural Imaginaries. In *CHI '19: Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. ACM, Glasgow, 1–13. https://doi.org/10.1145/3290605.3300496
[59] Sheila Jasanoff. 2015. *Future imperfect: Science, technology, and the imaginations of modernity*. University of Chicago Press, Chicago. 1–33 pages.
[60] Sheila Jasanoff and Sang-Hyun Kim. 2013. Sociotechnical Imaginaries and National Energy Policies. *Science as Culture* 22, 2 (2013), 189–196. https://doi.org/10.1080/09505431.2013.786990 arXiv:https://doi.org/10.1080/09505431.2013.786990
[61] Rikke Hagensby Jensen, Enrique Encinas, and Dimitrios Raptis. 2022. Spicing It Up: From Ubiquitous Devices to Tangible Things Through Provocation. In *Sixteenth International Conference on Tangible, Embedded, and Embodied Interaction (TEI '22)*. Association for Computing Machinery, New York, NY, USA, 1–15. https://doi.org/10.1145/3490149.3502257 event-place: Daejeon, Republic of Korea.
[62] Rikke Hagensby Jensen, Jesper Kjeldskov, and Mikael B. Skov. 2018. Assisted Shifting of Electricity Use: A Long-Term Study of Managing Residential Heating. *ACM Trans. Comput.-Hum. Interact.* 25, 5, Article 25 (Oct. 2018), 33 pages. https://doi.org/10.1145/3210310
[63] Rikke Hagensby Jensen, Dimitrios Raptis, Laurynas Siksnys, Torben Pedersen, and Mikael B. Skov. 2022. Design Visions for Future Energy Systems: Towards Aligning Developers' Assumptions and Householders' Expectations. In *Nordic Human-Computer Interaction Conference (NordiCHI '22)*. Association for Computing Machinery, New York, NY, USA, 13 pages. https://doi.org/10.1145/3546155.3546655 event-place: Aarhus, Denmark.
[64] Rikke Hagensby Jensen, Maurizio Teli, Simon Bjerre Jensen, Mikkel Gram, and Mikkel Harboe Sørensen. 2021. Designing Eco-Feedback Systems for Communities: Interrogating a Techno-solutionist Vision for Sustainable Communal Energy. In *C&T '21: Proceedings of the 10th International Conference on Communities & Technologies*. ACM, Seattle, WA, 245–257.
[65] Victor Vadmand Jensen and Rikke Hagensby Jensen. 2023. Exploring Values of Energy Justice: A Case Study of a Burgeoning Energy Community. In *Extended Abstracts of the 2023 CHI Conference on Human Factors in Computing Systems (CHI EA '23), April 23–28, 2023, Hamburg, Germany*. Association for Computing Machinery, New York, NY, USA, 9 pages. https://doi.org/10.1145/3544549.3573864
[66] Olamide Jogunola, Yakubu Tsado, Bamidele Adebisi, and Mohammad Hammoudeh. 2022. VirtElect: A Peer-to-Peer Trading Platform for Local Energy

Transactions. *IEEE Internet of Things Journal* 9, 8 (April 2022), 6121–6133. https://doi.org/10.1109/JIOT.2021.3109613
[67] Li Jönsson, Loove Broms, and Cecilia Katzeff. 2010. Watt-Lite: Energy Statistics Made Tangible. In *Proceedings of the 8th ACM Conference on Designing Interactive Systems* (Aarhus, Denmark) *(DIS '10)*. Association for Computing Machinery, New York, NY, USA, 240–243. https://doi.org/10.1145/1858171.1858214
[68] Os Keyes, Burren Peil, Rua M. Williams, and Katta Spiel. 2020. Reimagining (Women's) Health: HCI, Gender and Essentialised Embodiment. *ACM Transactions on Computer-Human Interaction* 27, 4 (Aug. 2020), 1–42. https://doi.org/10.1145/3404218
[69] Bran Knowles, Lynne Blair, Paul Coulton, and Mark Lochrie. 2014. Rethinking Plan A for Sustainable HCI. In *CHI '14: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. ACM, New York, NY, USA, 3593–3596. https://doi.org/10.1145/2556288.2557311
[70] Bran Knowles, Lynne Blair, Mike Hazas, and Stuart Walker. 2013. Exploring sustainability research in computing: where we are and where we go next. In *Proceedings of the 2013 ACM international joint conference on Pervasive and ubiquitous computing*. ACM, Zurich Switzerland, 305–314. https://doi.org/10.1145/2493432.2493474
[71] Binod Prasad Koirala, Elta Koliou, Jonas Friege, Rudi A. Hakvoort, and Paulien M. Herder. 2016. Energetic communities for community energy: A review of key issues and trends shaping integrated community energy systems. *Renewable and Sustainable Energy Reviews* 56 (April 2016), 722–744. https://doi.org/10.1016/j.rser.2015.11.080
[72] Hiroko Kudo and Benoit Granier. 2016. Citizen Co-designed and Co-produced Smart City: Japanese Smart City Projects. In *Proceedings of the 9th International Conference on Theory and Practice of Electronic Governance*. ACM, Montevideo Uruguay, 240–249. https://doi.org/10.1145/2910019.2910103
[73] Lenneke Kuijer, Annelise de Jong, and Daan van Eijk. 2013. Practices as a Unit of Design: An Exploration of Theoretical Guidelines in a Study on Bathing. *ACM Trans. Comput.-Hum. Interact.* 20, 4, Article 21 (sep 2013), 22 pages. https://doi.org/10.1145/2493382
[74] Débora Lanzeni, Karen Waltorp, Sarah Pink, and Rachel C Smith. 2022. *An anthropology of Futures and Technologies.* Taylor & Francis, Oxon OX UK.
[75] Jonathan Lazar, Jinjuan Heidi Feng, and Harry Hochheiser. 2017. *Research methods in human computer interaction* (2nd edition ed.). Elsevier, Cambridge, MA.
[76] Szu-Yu (Cyn) Liu, Shaowen Bardzell, and Jeffrey Bardzell. 2018. Out of control: reframing sustainable HCI using permaculture. In *Proceedings of the 2018 Workshop on Computing within Limits*. ACM, Toronto Ontario Canada, 1–8. https://doi.org/10.1145/3232617.3232625
[77] Alex Jiahong Lu, Shruti Sannon, Savana Brewer, Kisha N Jackson, Jaye Green, Daivon Reeder, Camaria Wafer, and Tawanna R Dillahunt. 2023. Organizing Community-based Events in Participatory Action Research: Lessons Learned from a Photovoice Exhibition. In *Extended Abstracts of the 2023 CHI Conference on Human Factors in Computing Systems*. ACM, Hamburg Germany, 1–8. https://doi.org/10.1145/3544549.3573846
[78] A. Nidhin Mahesh, N. B. Sai Shibu, and S. Balamurugan. 2019. Conceptualizing Blockchain based Energy Market for Self Sustainable Community. In *Proceedings of the 2nd Workshop on Blockchain-enabled Networked Sensor*. ACM, New York NY USA, 1–7. https://doi.org/10.1145/3362744.3363345
[79] Prodromos Makris, Nikolaos Efthymiopoulos, Dimitrios J. Vergados, Emmanouel Varvarigos, Vassilis Nikolopoulos, John Papagiannis, Andrew Pomazanskyi, Boris Irmscher, Krassen Stefanov, Katina Pancheva, and Atanas Georgiev. 2018. SOCIALENERGY: A gaming and social network platform for evolving energy markets' operation and educating virtual energy communities. In *2018 IEEE International Energy Conference (ENERGYCON)*. IEEE, Limassol, 1–6. https://doi.org/10.1109/ENERGYCON.2018.8398797
[80] Lone Malmborg, Ann Light, Geraldine Fitzpatrick, Victoria Bellotti, and Margot Brereton. 2015. Designing for Sharing in Local Communities. In *Proceedings of the 33rd Annual ACM Conference Extended Abstracts on Human Factors in Computing Systems* (Seoul, Republic of Korea) *(CHI EA '15)*. Association for Computing Machinery, New York, NY, USA, 2357–2360. https://doi.org/10.1145/2702613.2702645
[81] Nora McDonald and Andrea Forte. 2021. Powerful Privacy Norms in Social Network Discourse. *Proceedings of the ACM on Human-Computer Interaction* 5, CSCW2 (Oct. 2021), 1–27. https://doi.org/10.1145/3479565
[82] Arne Meeuw, Sandro Schopfer, Benjamin Ryder, and Felix Wortmann. 2018. *LokalPower: Enabling Local Energy Markets with User-Driven Engagement.* Association for Computing Machinery, New York, NY, USA, 1–6. https://doi.org/10.1145/3170427.3188610
[83] Anna Melnyk and Abhigyan Singh. 2021. Constructing an inclusive vision of sustainable transition to decentralised energy. In *Dilemmas of Energy Transitions in the Global South* (1 ed.). Routledge, London, 39–54. https://doi.org/10.4324/9780367486457-3
[84] Esther Mengelkamp, Johannes Gärttner, and Christof Weinhardt. 2018. Intelligent Agent Strategies for Residential Customers in Local Electricity Markets. In *Proceedings of the Ninth International Conference on Future Energy Systems*. ACM, Karlsruhe Germany, 97–107. https://doi.org/10.1145/3208903.3208907
[85] Esther Mengelkamp and Christof Weinhardt. 2018. Clustering Household Preferences in Local Electricity Markets. In *Proceedings of the Ninth International Conference on Future Energy Systems*. ACM, Karlsruhe Germany, 538–543. https://doi.org/10.1145/3208903.3214348
[86] Luiz Morais, Lívia Sampaio, Gibran Yásser, and Andrey Brito. 2021. Lumiphys: Designing a Long-Term Energy Physicalization to Democratize Smart Campus Data. In *Proceedings of the Twelfth ACM International Conference on Future Energy Systems*. ACM, Virtual Event Italy, 362–366. https://doi.org/10.1145/3447555.3466596
[87] Thomas Morstyn, Niall Farrell, Sarah J. Darby, and Malcolm D. McCulloch. 2018. Using peer-to-peer energy-trading platforms to incentivize prosumers to form federated power plants. *Nature Energy* 3, 2 (Feb. 2018), 94–101. https://doi.org/10.1038/s41560-017-0075-y
[88] Chris Muashekele, Heike Winschiers-Theophilus, Kasper Rodil, and Alphons Koruhama. 2023. Ancestral and Cultural Futuring: Speculative Design in an Indigenous ovaHimba context. In *Proceedings of the 11th International Conference on Communities and Technologies* (Lahti, Finland) *(C&T '23)*. Association for Computing Machinery, New York, NY, USA, 85–95. https://doi.org/10.1145/3593743.3593761
[89] Bijay Neupane, Laurynas Siksnys, Torben Bach Pedersen, Rikke Hagensby, Muhammad Aftab, Bradley Eck, Francesco Fusco, Robert Gormally, Mark Purcell, Seshu Tirupathi, Gregor Cerne, Saso Brus, Ioannis Papageorgiou, Gerhard Meindl, and Pierre Roduit. 2022. GOFLEX: Extracting, Aggregating and Trading Flexibility Based on FlexOffers for 500+ Prosumers in 3 European Cities [Operational Systems Paper]. In *Proceedings of the Thirteenth ACM International Conference on Future Energy Systems (e-Energy '22)*. Association for Computing Machinery, New York, NY, USA, 361–373. https://doi.org/10.1145/3538637.3538865 event-place: Virtual Event.
[90] Joanne Randa Nucho. 2022. Post-grid Imaginaries: Electricity, Generators, and the Future of Energy. *Public Culture* 34, 2 (97) (05 2022), 265–290. https://doi.org/10.1215/08992363-9584764 arXiv:https://read.dukeupress.edu/public-culture/article-pdf/34/2 (97)/265/1620892/265nucho.pdf
[91] Sophie Nyborg and Inge Røpke. 2011. Energy impacts of the smart home: Conflicting visions. In *Energy Efficiency First: The foundation of a low-carbon society*. European Council for an Energy Efficient Economy, Stockholm, 1849–1860.
[92] Stavros Orfanoudakis and Georgios Chalkiadakis. 2023. A Novel Aggregation Framework for the Efficient Integration of Distributed Energy Resources in the Smart Grid. In *AAMAS '23: Proceedings of the 2023 International Conference on Autonomous Agents and Multiagent Systems*. International Foundation for Autonomous Agents and Multiagent Systems, Richland, SC, 3 pages. https://doi.org/10.5555/3545946.3598986
[93] Irati Otamendi-Irizar, Olatz Grijalba, Alba Arias, Claudia Pennese, and Rufino Hernández. 2022. How can local energy communities promote sustainable development in European cities? *Energy Research & Social Science* 84 (Feb. 2022), 102363. https://doi.org/10.1016/j.erss.2021.102363
[94] Georgia Panagiotidou, Enrico Costanza, Michael J. Fell, Farhan Samanani, and Hannah Knox. 2023. Supporting Solar Energy Coordination among Communities. *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies* 7, 2 (June 2023), 1–23. https://doi.org/10.1145/3596243
[95] Isabel Pedersen and Ann Hill Duin. 2022. AI Agents, Humans and Untangling the Marketing of Artificial Intelligence in Learning Environments. In *Proceedings of the 55th Hawaii International Conference on System Sciences (HICSS): January 4-7, 2022, Hyatt Regency Maui, Hawaii, USA*. University of Hawai'i at Manoa, Hamilton Library, Honolulu, HI, 4-13 pages. https://scholarspace.manoa.hawaii.edu/server/api/core/bitstreams/522ac070-0c6a-4807-93c4-ba7d2d7f3d8a/content Meeting Name: Hawaii International Conference on System Sciences.
[96] Laura J Perovich, Catherine Titcomb, Tad Hirsch, Brian Helmuth, and Casper Harteveld. 2023. Sustainable HCI Under Water: Opportunities for Research with Oceans, Coastal Communities, and Marine Systems. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems*. ACM, Hamburg Germany, 1–16. https://doi.org/10.1145/3544548.3581291
[97] Petromil Petkov, Felix Köbler, Marcus Foth, and Helmut Krcmar. 2011. Motivating domestic energy conservation through comparative, community-based feedback in mobile and social media. In *C&T '11: Proceedings of the 5th International Conference on Communities and Technologies*. ACM, Brisbane, 21–30. https://doi.org/10.1145/2103354.2103358
[98] Èlia Gil Peña and Rikke Hagensby Jensen. 2023. The Character of Eco-feedback Systems for Energy Communities. In *The 11th International Conference on Communities and Technologies (C&T)*. ACM, Lahti Finland, 203–214. https://doi.org/10.1145/3593743.3593783
[99] James Pierce and Eric Paulos. 2012. The Local Energy Indicator: Designing for Wind and Solar Energy Systems in the Home. In *Proceedings of the Designing Interactive Systems Conference (DIS '12)*. ACM Press, New York, New York, USA, 631–634. https://doi.org/10.1145/2317956.2318050

[100] Sarah Pink, Kari Dahlgren, Yolande Strengers, and Larissa Nicholls. 2022. Anticipatory Infrastructures, Emerging Technologies and Visions of Energy Futures. In *Infrastructural Being*, Jarno Valkonen, Veera Kinnunen, Heikki Huilaja, and Teemu Loikkanen (Eds.). Springer International Publishing, Cham, 33–60. https://doi.org/10.1007/978-3-031-15827-8_3

[101] Marlen Promann. 2018. Examining the Role Visual Graph Structures Play in Collective Awareness and Cooperative Decisions. In *Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems*. ACM, Montreal QC Canada, 1–6. https://doi.org/10.1145/3170427.3180303

[102] Larissa Pschetz, Kruakae Pothong, and Chris Speed. 2019. Autonomous Distributed Energy Systems: Problematising the Invisible through Design, Drama and Deliberation. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. ACM, Glasgow Scotland Uk, 1–14. https://doi.org/10.1145/3290605.3300617

[103] Victor M.J.J. Reijnders, Marten D. van der Laan, and Roelof Dijkstra. 2020. Energy communities: a Dutch case study. In *Behind and Beyond the Meter*. Elsevier, Cambridge, Massachusetts, 137–155. https://doi.org/10.1016/B978-0-12-819951-0.00006-2

[104] Bent Richter, Philipp Staudt, and Christof Weinhardt. 2022. Designing Local Energy Market Applications. *Scandinavian Journal of Information Systems* 34, 2 (2022), 39–88. https://aisel.aisnet.org/cgi/viewcontent.cgi?article=1799&context=sjis

[105] Rosie Robison, Tomas Moe Skjølsvold, Tom Hargreaves, Sara Renström, Maarten Wolsink, Emily Judson, Viera Pechancová, Melike Demirbağ-Kaplan, Hug March, Johanna Lehne, Chris Foulds, Zareen Bharucha, Liliia Bilous, Christian Büscher, Giuseppe Carrus, Sarah Darby, Sylvie Douzou, Mojca Drevenšek, Bohumil Frantál, Ângela Guimarães Pereira, Andrew Karvonen, Cecilia Katzeff, Maria Kola-Bezka, Senja Laakso, Gudrun Lettmayer, Yael Parag, Fanni Sáfián, Mariusz Swora, Lise Tjørring, Ellen Van Der Werff, Bas Van Vliet, Grégoire Wallenborn, and Annemie Wyckmans. 2023. Shifts in the smart research agenda? 100 priority questions to accelerate sustainable energy futures. *Journal of Cleaner Production* 419 (July 2023), 137946. https://doi.org/10.1016/j.jclepro.2023.137946

[106] Tom A. Rodden, Joel E. Fischer, Nadia Pantidi, Khaled Bachour, and Stuart Moran. 2013. At Home with Agents: Exploring Attitudes towards Future Smart Energy Infrastructures. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (Paris, France) *(CHI '13)*. Association for Computing Machinery, New York, NY, USA, 1173–1182. https://doi.org/10.1145/2470654.2466152

[107] David Roedl, Shaowen Bardzell, and Jeffrey Bardzell. 2015. Sustainable Making? Balancing Optimism and Criticism in HCI Discourse. *ACM Transactions on Computer-Human Interaction* 22, 3 (June 2015), 1–27. https://doi.org/10.1145/2699742

[108] Sarah Royston and Chris Foulds. 2021. The making of energy evidence: How exclusions of Social Sciences and Humanities are reproduced (and what researchers can do about it). *Energy Research & Social Science* 77 (July 2021), 102084. https://doi.org/10.1016/j.erss.2021.102084

[109] Jonas Schlund, Lorenz Ammon, and Reinhard German. 2018. ETHome: Open-source blockchain based energy community controller. In *Proceedings of the Ninth International Conference on Future Energy Systems*. ACM, Karlsruhe Germany, 319–323. https://doi.org/10.1145/3208903.3208929

[110] Tobias Schwartz, Sebastian Denef, Gunnar Stevens, Leonardo Ramirez, and Volker Wulf. 2013. *Cultivating Energy Literacy: Results from a Longitudinal Living Lab Study of a Home Energy Management System*. Association for Computing Machinery, New York, NY, USA, 1193–1202. https://doi.org/10.1145/2470654.2466154

[111] Mariacristina Sciannamblo, Marisa Leavitt Cohn, Peter Lyle, and Maurizio Teli. 2021. Caring and Commoning as Cooperative Work: A Case Study in Europe. *Proceedings of the ACM on Human-Computer Interaction* 5, CSCW1 (April 2021), 1–26. https://doi.org/10.1145/3449200

[112] James Scott, A.J. Bernheim Brush, John Krumm, Brian Meyers, Michael Hazas, Stephen Hodges, and Nicolas Villar. 2011. PreHeat: Controlling Home Heating Using Occupancy Prediction. In *Proceedings of the 13th International Conference on Ubiquitous Computing* (Beijing, China) *(UbiComp '11)*. Association for Computing Machinery, New York, NY, USA, 281–290. https://doi.org/10.1145/2030112.2030151

[113] Sabrina Scuri, Marta Ferreira, Nuno Jardim Nunes, Valentina Nisi, and Cathy Mulligan. 2022. Hitting the Triple Bottom Line: Widening the HCI Approach to Sustainability. In *CHI Conference on Human Factors in Computing Systems*. ACM, New Orleans LA USA, 1–19. https://doi.org/10.1145/3491102.3517518

[114] Sabrina Scuri and Nuno Jardim Nunes. 2020. PowerShare 2.0: A Gamified P2P Energy Trading Platform. In *Proceedings of the International Conference on Advanced Visual Interfaces*. ACM, Salerno Italy, 1–3. https://doi.org/10.1145/3399715.3399948

[115] Neil Simcock. 2016. Procedural justice and the implementation of community wind energy projects: A case study from South Yorkshire, UK. *Land Use Policy* 59 (Dec. 2016), 467–477. https://doi.org/10.1016/j.landusepol.2016.08.034

[116] Will Simm, Maria Angela Ferrario, Adrian Friday, Peter Newman, Stephen Forshaw, Mike Hazas, and Alan Dix. 2015. Tiree Energy Pulse: Exploring Renewable Energy Forecasts on the Edge of the Grid. In *CHI '15: Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*. ACM, Seoul, 1965–1974. https://doi.org/10.1145/2702123.2702285

[117] Abhigyan Singh, Natalia Romero Herrera, Hylke W. van Dijk, David V. Keyson, and Alex T. Strating. 2021. Envisioning 'anthropology through design': A design interventionist approach to generate anthropological knowledge. *Design Studies* 76 (2021), 101014. https://doi.org/10.1016/j.destud.2021.101014

[118] Abhigyan Singh, Hylke W. Van Dijk, Bard O. Wartena, Natalia Romero Herrera, and David Keyson. 2015. 'Electric City': Uncovering Social Dimensions and Values of Sharing Renewable Energy through Gaming. In *Proceedings of the 33rd Annual ACM Conference Extended Abstracts on Human Factors in Computing Systems*. ACM, Seoul Republic of Korea, 1519–1524. https://doi.org/10.1145/2702613.2732929

[119] Robert Soden, Pradnaya Pathak, and Olivia Doggett. 2021. What We Speculate About When We Speculate About Sustainable HCI. In *ACM SIGCAS Conference on Computing and Sustainable Societies (COMPASS)*. ACM, Virtual Event Australia, 188–198. https://doi.org/10.1145/3460112.3471956

[120] Benjamin K. Sovacool and Michael H. Dworkin. 2015. Energy justice: Conceptual insights and practical applications. *Applied Energy* 142 (March 2015), 435–444. https://doi.org/10.1016/j.apenergy.2015.01.002

[121] Yolande Strengers. 2014. Smart energy in everyday life: are you designing for resource man? *Interactions* 21, 4 (July 2014), 24–31. https://doi.org/10.1145/2621931

[122] Yolande Strengers and Larissa Nicholls. 2017. Convenience and energy consumption in the smart home of the future: Industry visions from Australia and beyond. *Energy Research & Social Science* 32 (2017), 86 – 93. https://doi.org/10.1016/j.erss.2017.02.008

[123] Yolande Strengers and Larissa Nicholls. 2018. Aesthetic pleasures and gendered tech-work in the 21st-century smart home. *Media International Australia* 166, 1 (2018), 70–80. https://doi.org/10.1177/1329878X17737661 _eprint: https://doi.org/10.1177/1329878X17737661.

[124] Yolande A.A. Strengers. 2011. Designing eco-feedback systems for everyday life. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. ACM, Vancouver BC Canada, 2135–2144. https://doi.org/10.1145/1978942.1979252

[125] Imre Szeman. 2020. On Solarity: Six Principles for Energy and Society After Oil. *Stasis* 9, 1 (Jul. 2020), 128–143. https://doi.org/10.33280/2310-3817-2020-9-1-128-143

[126] Maurizio Teli, Marcus Foth, Mariacristina Sciannamblo, Irina Anastasiu, and Peter Lyle. 2020. Tales of Institutioning and Commoning: Participatory Design Processes with a Strategic and Tactical Perspective. In *Proceedings of the 16th Participatory Design Conference 2020 - Participation(s) Otherwise - Volume 1*. ACM, Manizales Colombia, 159–171. https://doi.org/10.1145/3385010.3385020

[127] Stefan Timmermans and Iddo Tavory. 2012. Theory construction in qualitative research: From grounded theory to abductive analysis. *Sociological theory* 30, 3 (2012), 167–186. Publisher: SAGE Publications Sage CA: Los Angeles, CA.

[128] Andrea C. Tricco, Erin Lillie, Wasifa Zarin, Kelly K. O'Brien, Heather Colquhoun, Danielle Levac, David Moher, Micah D.J. Peters, Tanya Horsley, Laura Weeks, Susanne Hempel, Elie A. Akl, Christine Chang, Jessie McGowan, Lesley Stewart, Lisa Hartling, Adrian Aldcroft, Michael G. Wilson, Chantelle Garritty, Simon Lewin, Christina M. Godfrey, Marilyn T. Macdonald, Etienne V. Langlois, Karla Soares-Weiser, Jo Moriarty, Tammy Clifford, Özge Tunçalp, and Sharon E. Straus. 2018. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Annals of Internal Medicine* 169, 7 (Oct. 2018), 467–473. https://doi.org/10.7326/M18-0850

[129] United Nations. 2023. THE 17 GOALS. https://sdgs.un.org/goals

[130] Nina Valkanova, Sergi Jorda, Martin Tomitsch, and Andrew Vande Moere. 2013. Reveal-it!: the impact of a social visualization projection on public awareness and discourse. In *CHI '13: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. ACM, New York, NY, USA, 3461–3470.

[131] Gordon Walker and Patrick Devine-Wright. 2008. Community renewable energy: What should it mean? *Energy Policy* 36, 2 (Feb. 2008), 497–500. https://doi.org/10.1016/j.enpol.2007.10.019

[132] Harald Taxt Walnum, Åshild Lappegård Hauge, Karen Byskov Lindberg, Mads Mysen, Brita Fladvad Nielsen, and Kari Sørnes. 2019. Developing a scenario calculator for smart energy communities in Norway: Identifying gaps between vision and practice. *Sustainable Cities and Society* 46 (April 2019), 101418. https://doi.org/10.1016/j.scs.2019.01.003

[133] Martin Warneryd, Maria Håkansson, and Kersti Karltorp. 2020. Unpacking the complexity of community microgrids: A review of institutions' roles for development of microgrids. *Renewable and Sustainable Energy Reviews* 121 (2020), 109690. https://doi.org/10.1016/j.rser.2019.109690

[134] Fiona Webster, Samantha Bremner, Eric Oosenbrug, Steve Durant, Colin J. McCartney, and Joel Katz. 2017. From Opiophobia to Overprescribing: A Critical Scoping Review of Medical Education Training for Chronic Pain. *Pain Medicine* 18, 8 (Aug. 2017), 1467–1475. https://doi.org/10.1093/pm/pnw352

[135] Christof Weinhardt, Esther Mengelkamp, Wilhelm Cramer, Sarah Hambridge, Alexander Hobert, Enrique Kremers, Wolfgang Otter, Pierre Pinson, Verena Tiefenbeck, and Michel Zade. 2019. How far along are Local Energy Markets in the DACH+ Region?: A Comparative Market Engineering Approach. In *Proceedings of the Tenth ACM International Conference on Future Energy Systems*. ACM, Phoenix AZ USA, 544–549. https://doi.org/10.1145/3307772.3335318

[136] Brian Whitworth. 2015. Future Imperfect: Science, Technology, and the Imaginations of Modernity. In *Dreamscapes of Modernity: Sociotechnical Imaginaries and the Fabrication of Power* (2 ed.), Sheila Jasanoff and Sang-Hyun Kim (Eds.). University of Chicago Press, Chicago, IL, 1–33. https://doi.org/10.7208/chicago/9780226276663.003.0001

[137] Denise J. Wilkins, Ruzanna Chitchyan, and Mark Levine. 2020. Peer-to-Peer Energy Markets: Understanding the Values of Collective and Community Trading. In *CHI '20: Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*. ACM, Honolulu, HI, 1–14. https://doi.org/10.1145/3313831.3376135

[138] Japhy Wilson. 2022. The Insurgent Universal: Between Eurocentric Universalism and the Pluriverse. *Nordia Geographical Publications* 51, 2 (April 2022), 1–10. https://doi.org/10.30671/nordia.116150

[139] Susan Wyche, George Hope Chidziwisano, Florence Uwimbabazi, and Nightingale Simiyu. 2018. Defamiliarizing the Domestic: Exploring "M-Kopa Solar" and Sustainable Practices in Rural Kenyan Households. In *Proceedings of the 1st ACM SIGCAS Conference on Computing and Sustainable Societies*. ACM, Menlo Park and San Jose CA USA, 1–11. https://doi.org/10.1145/3209811.3211888

[140] Wei Yu and Xinyu Jiang. 2016. The Third-Type Settlement: Research of Unified Urban and Rural Living Organisms and Its Interaction Design. In *Design, User Experience, and Usability: Novel User Experiences*, Aaron Marcus (Ed.). Vol. 9747. Springer International Publishing, Cham, 527–536. https://doi.org/10.1007/978-3-319-40355-7_50 Series Title: Lecture Notes in Computer Science.

[141] Ting Zhu, Zhichuan Huang, Ankur Sharma, Jikui Su, David Irwin, Aditya Mishra, Daniel Menasche, and Prashant Shenoy. 2013. Sharing renewable energy in smart microgrids. In *Proceedings of the ACM/IEEE 4th International Conference on Cyber-Physical Systems*. ACM, Philadelphia Pennsylvania, 219–228. https://doi.org/10.1145/2502524.2502554

[142] Matt Ziegler. 2019. Who Breathes the Smoke: Technologies for Community-Based Natural Resource Management. In *LIMITS '19: Proceedings of the Fifth Workshop on Computing within Limits*. ACM, New York, NY, USA, 1–10. https://doi.org/10.1145/3338103.3338107

[143] Laurynas Šikšnys, Torben Bach Pedersen, Muhammad Aftab, and Bijay Neupane. 2019. Flexibility Modeling, Management, and Trading in Bottom-up Cellular Energy Systems. In *Proceedings of the Tenth ACM International Conference on Future Energy Systems*. ACM, Phoenix AZ USA, 170–180. https://doi.org/10.1145/3307772.3328296