The Power of Friends and Neighbours:

A review of community energy research

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Abstract

The threat of climate change and the Paris agreement to limit global temperature rise to well below 2⁰ Celsius and to pursue efforts to limit it to 1.5⁰ Celsius has stimulated research on and broad commitment to community energy. We investigate this research. We assess how nine different approaches study community energy over time, which methods they use, which countries and regions they focus on, and where they discuss and publish. We analyse the keywords used to identify the research and investigate how these differ along the approaches. We show that community energy research took off only very recently and that especially 'developed' countries, in particular, the United Kingdom, United States, Germany and the Netherlands, are studied. Different networks contribute to the understanding of community energy, however the maturity and reach of these networks varies and there is limited exchange between research networks.

Keywords: community energy; academic networks; renewable energy; local energy; energy transition; literature review

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Highlights:

- We investigate research on community energy
- Community energy is studied with highly different approaches
- There is little interaction between the approaches
- Research concentrates on a small number of 'developed' countries

1. Introduction

Community energy is of global importance given the ongoing concern about climate change and the global commitment to Sustainable Development Goals (SDGs) among others. The International Energy Agency (IEA) in its most recent World Energy Outlook[1] expects renewable energy to become the largest source of electricity generation in the EU by 2030, to be followed by other regions at a later stage. Further, the IEA in particular stresses the potential of locally sourced energy and community-based models of energy provision (IEA, p.4). Delina and Sovacool [1] argue that the complementarity of sustainable energy transitions and energy access provision are one of the key characteristics of both the SDGs and the Paris Agreement on Climate Change (see also [2–4].)

We define community energy as local production of renewable energy, governed by citizens, with a view to contribute to the transition to a sustainable energy system. We want to find out which factors drive community energy and which issues are at stake in different geographic regions. As such, our aim is to identify the key issues and concepts covered in the community energy research so far and to reflect on how it is studied. Community energy connects environmental, economic and social aspects of development. Moreover, community energy is a social movement, which involves civil society, (local) governments and the business sector to create local sustainable energy systems.

There already are several studies, which investigate a particular aspect of this emergent literature, notably [5–15]. However, an encompassing overview of community energy literature is still lacking. Therefore, we aim to augment these studies by investigating the developments, focus and highlights of community energy research through a systematic study of the literature. Since academic literature has a preparatory stage where research results are presented at academic conferences, we also trace the development of community energy as a topic in research networks by identifying relevant international academic conferences, associations and research networks.

2. Methodology

For our literature search, we proceeded as follows. We performed a literature search in Scopus for the period 1997 to 2018 (for this end year, we have data for January-February only). We started in 1997, which saw the Kyoto Protocol, an international agreement about greenhouse gas emissions that gave rise to new energy policies in most of the member-countries [16]. At the same time, the liberalisation of the energy sector created opportunities for citizens in their choice of their energy provider [17].

We initially used the search terms '*community energy*' and '*renewable'*. However, it showed that the terminology used to describe community energy activities appeared to be very varied. Therefore, we extended our search with the search terms *decentralized energy, community engagement and local energy*. Furthermore, we used keywords found in these articles that directly relate to our subject as a further search term: *low carbon communities, local energy governance, community action, decentralised energy, grassroots innovations, renewable energy, sustainable energy, and energy autonomy*. In addition, we fine-tuned the corpus to studies concerning citizens, local and regional projects. We included articles focusing on local governments, if citizens were involved in a meaningful way. We excluded papers that did

[1] International Energy Agency (IEA). 2016. World Energy Outlook. Paris: IEA.

not account for an active role of citizens. Furthermore, we limited our material to peer-reviewed articles and excluded working papers, proceedings and book chapters. As a result, we ended up with 263 studies, which is the corpus of studies on which we performed the review (available upon request).

We analysed the resulting list of research articles with Atlas.ti, which allowed us to identify keywords and search for theoretical frameworks and geographical names in the articles as a whole. Our findings provide an overview of the literature about community energy initiatives, both initiated by citizens and municipalities.

3. Theoretical approaches of community energy

Based on our qualitative analysis of the articles, we first identified nine broad categories of approaches, which are prevalent in community energy research. Wherever applicable, we also tracked the emergence of community energy as a topic in academic conferences related to these research approaches.

The first category is transition research, which used systemic approaches to study the energy transition. For example, Multi-Level Perspective identified local initiatives as niches or protected spaces that could eventually transform the energy system [18–21]. In the Research Agenda (2017) of the International Sustainability Transitions (IST) Conferences, community energy was identified as one of the 'green' innovations and practices that are investigated, as example of an impulse for radical change.

Secondly, we found that science and technology studies (STS) focused in particular on the interaction between technology and human actors and take socio-technical configurations as their starting point, see for example [17,22,23]. International STS-associations organize bi-annual conferences that attracted community energy scholars.

We ascertain that economic studies specifically focused on the economic and financial viability of community energy projects [15,24–32]. Most attention to local and community energy was in the subfields of energy economics and ecological economics. This group also included economic studies and business analysis and studies based on alternative economic views e.g. localism.

Fourth, we found that the acceptance perspective was mainly focused on the question if community engagement increases acceptance of renewable energy projects. We combined studies into acceptance as well as resistance/ not-in-my-backyard studies, which fitted our criteria listed above [7,8,33]. We discovered that the issue of community energy was not covered at academic conventions in this domain, although policy acceptance and attitudes of households in relation to renewable energy was debated.

Further, we uncovered that sociological approaches examined capacities of local actors, development of community initiatives, organisation aspects and social networks, for example. Still others drew on future studies, social movement theory or social practice theory [34–41]. The Energy & Society research network to date organized three larger international conferences.

Sixth, we observed that policy and governance studies investigated the new relations and opportunities on the municipal or regional level that come with the transition to a renewable energy system, for example [42–49]. Major themes were the new roles of local government, relations with private actors and the existing energy sector, relations

between different levels of governance, and the participation of citizens in municipal governance. The Netherlands Institute of Government (NIG) organized a yearly panel on governance of decentralised initiatives in energy transition since 2013.

Seventh, we found that energy planning studies investigated municipal or citizen-led energy plans in cities, regions or smaller communities [13,50–54]. This planning is a complex and time-consuming process, which was supported by methodologies that helped develop energy system variants.

Eight, we determined that spatial planning and design had landscape design and spatial impacts of renewable energy as its primary focus [11,55–57]. What are the challenges and opportunities that the energy transition poses to landscape architects, and how can landscape architecture contribute to the energy transition? The Energy Landscape conference in 2015 showcased two keynotes on local and community energy.

Ninth and last, we observed that norms and values related to meanings, discourses and values in the community energy discourse. The safeguarding of justice and equity were another primary concern in this approach [58–64].

In a second step, inspired by Turnheim & Geels [65], we clustered the nine approaches into four societal domains:

- sociotechnical studies, which include transition studies and science and technology studies
- social-economic studies, which include economic and sociological studies
- socio-psychological studies, which include studies based on the acceptance perspective as well as studies of norms and values
- governance and planning studies, which include governance and policy studies, energy planning and spatial planning

These domains account for the academic studies, but we felt that the perspectives of stakeholders also had to be integrated to arrive at a holistic framework for community energy studies. So in a third step, we turned to transdisciplinary research, which is increasingly seen as crucial in the implementation of sustainable development [66]. We found that transdisciplinary approaches open up new ways for 'sustainability learning' [67] in relation to energy transition. Building on Hadorn [68], we positioned community energy between academic disciplines on one side, and the perspectives of non-academic stakeholders on the other. The resulting framework (i.e. Figure 1) shows our perspective about the interconnectedness of community energy activities with global and local networks of human actors and technologies.

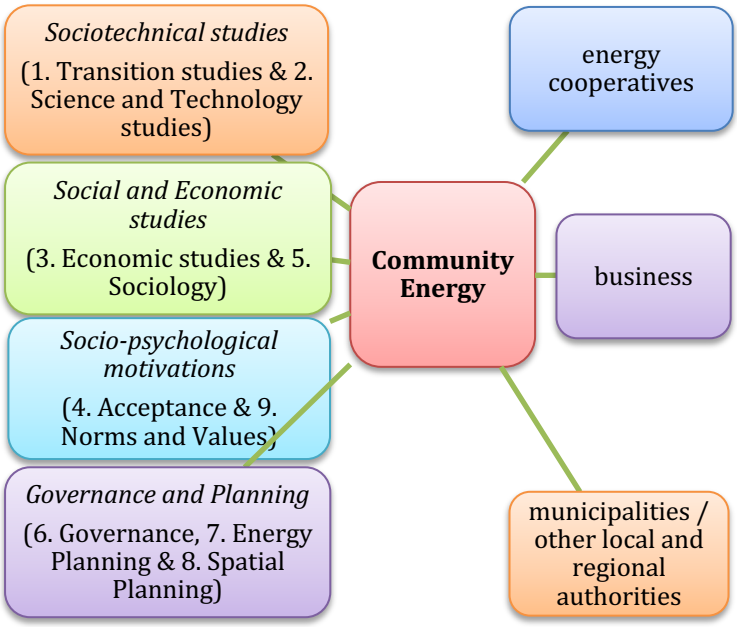

Figure 1. Academic domains and stakeholders of community energy research

4. Focus and scope of community energy research

Here, we report and discuss the analysis regarding focus and scientific scope of the community energy studies. To this extent, we provide an overview of the descriptive characteristics regarding geographical distribution, years of publication and journal outlets of the 263 studies sampled. Next, we provide an inventory of the keywords and relate these to the nine approaches. Last is that we investigate which approaches are predominantly used to study community energy.

4.1 Characteristics of community energy articles

We constructed Figure 2 to show the distribution of the community energy literature over the countries and years studied. We found that until about 2009, only few countries are investigated; an exception is 2007, which shows remarkable diversity. We observed a strong increase in geographic coverage with the course of time and relative dominance of the UK as a research object. Furthermore, we can detect the rise of community energy in Germany, against the background of the Energiewende. We also witnessed that the Netherlands shows a growth of publications following new policies regarding community energy.

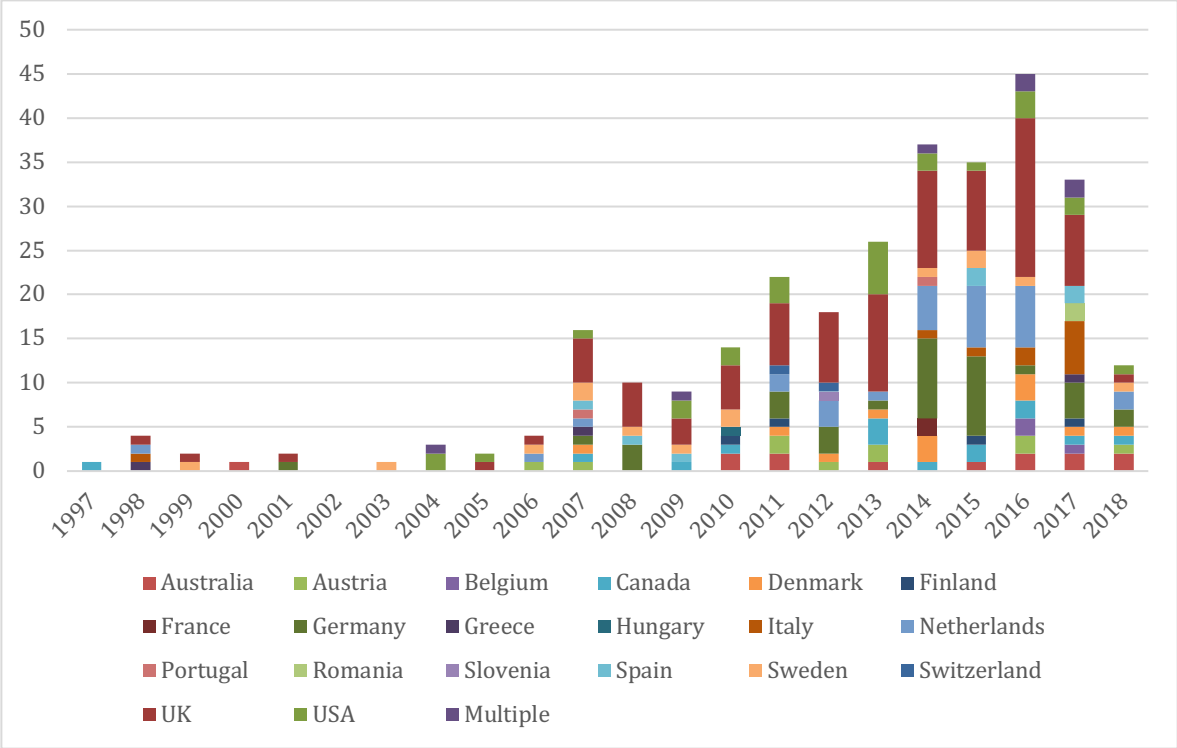

Figure 2. Geographical distribution of the studies in the sample period (number of studies)

We ascertained that the community energy articles in our sample were published in 82 journals, which implies that the average journal had 3.2 articles. However, their appearance was highly skewed: 51 journals published just one study on community energy, and 14 journals published two studies. Together, these 65 journals published 30% of all studies on community energy in our sample. We found that most studies appeared in Energy Policy with 1 in 6 of all papers appearing in this journal. We calculated that the top three journals published 25% of all articles on community energy. Thus, although several journals published on the topic, the community energy debate took place in only a small number of journals. In our view, this is a typical feature of emergent fields of study.

4.2 Keywords in community energy research

We investigated the keywords provided with the studies. Not all articles had keywords, as this can be journal specific. Hence, only studies with keywords were included in this part of the analysis. Most studies provided two or three keywords, but there could be up to six. We found that the journals offered no strict guidelines about what is an appropriate keyword. This implies that different authors might have different ideas in mind when they provided their keywords. Further, journal practices regarding keywords differed too. Some limited their number and some provided a list from which authors had to choose. Nevertheless, we felt that investigating keywords helped us specify what the literature did and where it was interested in.

We identified the usage of 1090 keywords in total (available upon request). In this sample, we encountered 670 different keywords: so, on average, a keyword was used in 1.6 cases. Five keywords (renewable energy, community energy, community, energy

transition, climate change) together accounted for 12% of the occurrences. 530 keywords appear only once (49% of all occurrences). We determined that the keyword used most ('renewable energy') appeared in 52 articles. The keyword ranking second was 'community energy' and the third was 'energy transition'. Hence, together, these three dominant keywords qualified the main topic of this research domain. If the permutations with these keywords, as in 'community renewable energy' or 'sustainable energy', are grouped in clusters of similar keywords, this trend is even stronger. We also want to draw attention to the keywords denoting theoretical outlooks, such as grassroots innovations, multi-level perspective, or niche management (each used in 9 articles). We think the large number of keywords is very interesting as it shows that community energy studies related to widely different issues. In addition, we think the lack of a clearly identifiable list of keywords in most studies again suggests that community energy studies is a field in progress and by far a coherent sub-discipline yet. As an illustration, in Figure 3, we provide a word cloud of all words used in the provided keywords, where the size of the words signals their relative frequency.

Figure 3. Word cloud of the community energy literature 1997-2018

4.3 Keyword identifiers of the theoretical approaches

To analyse the keywords denoting theoretical outlooks, we connected the identified approaches to the keywords employed in our sample. For each of the nine approaches, we investigated what typical keywords are used. Of course, the more general keywords and identifiers appeared in all approaches, but here we wanted to investigate what makes a particular approach special. This helped us to identify the focus of the respective approach. In Table 1, we listed typical keywords that refer to specific theoretical concepts related to the identified approaches.

We found that the keywords of Transition studies showed a strong connection to its related theoretical frameworks and accompanying concepts, such as multilevel perspective, niches and regimes. We found that the Science and Technology group

favoured socio-technical configurations, technology assessment and user-led innovations, reflecting less deterministic and bottom-up concepts. We determined that the Economics group related to keywords related to topics such as ownership, companies, utilities, but also criticism regarding neoliberalist perspectives. We detected the Acceptance approach had acceptance, resistance, but also public awareness, public opinion as keywords. We found that sociological approaches showed keywords related to organisation and process, while participation and agency also referring to the bottom-up actions of citizens. We ascertained governance keywords showed the institutional and governmental aspects, for example in citizenship, authorities and governance. In contrast, we found that energy planning had a strong systematic perspective and included concrete technology choices and calculations. We further determined that spatial design had typical keywords relating to landscape, urbanism and spatial and urban planning. We found Norms and values related to public values, public sphere, and trust. In addition, we detected that justice related keywords such as justice, equity are typical for this group. As such, we show that the approaches are quite distinct indeed, as the keywords reflected specific research interests and perspectives in the study of community energy. We argue the variety of perspectives contributed to the richness of the literature.

Table 1. Typical keywords used in theoretical approaches

Approach	Typical keywords
1. Transition studies	Energy transition, grassroots innovation, niches, regime, path dependence, energy innovation systems, socio-technical transitions, multilevel perspective, strategic niche management, innovation
2. Science and Technology	Socio-technical configurations, socio-technical change, constructive technology assessment, user-led innovations
3. Economic	Economics, markets, neoliberalism, economic development, impact, utilities, companies, ownership
4. Acceptance	Social acceptance, engagement, environmental awareness, public opinion, resistance, justice
5. Sociology	Social capital, participation, processual analysis, social resilience, behaviour change, environmental awareness, agency and capacity, organisation
6. Governance	Governance, institutional arrangements, environmental citizenship, local authorities, local government, collaborative planning, interactive governance
7. Planning	Energy planning, energy strategy, public participation, energy management, energy policy, community energy planning, municipal energy plans
8. Spatial	Spatial planning, landscape architecture, urban planning, eco-urbanism, resilience, regional development, sustainable urban development, geography
9. Norms	Justice, equity, public values, public sphere, procedural and distributive justice, trust, risk, social impacts

4.4 Country perspectives and theoretical approaches

We also wanted to find out whether studies after community energy in different countries investigated different topics or used different approaches. Figure 4 shows that most studies were about community energy in the United Kingdom. Combined, more than two thirds of all case studies investigated community energy in four countries: United Kingdom, Germany, Netherlands and United States. This reveals there is a substantial geographic bias. This bias is surprising as – of these four – only Germany produced a substantial part of its energy consumption with renewables (see footnote i). It also was the only country of the four where community initiatives generated a considerable part of the renewable energy. We observed that different approaches were used to investigate the sample countries. For some countries (Finland, Greece, Hungary, Portugal, Romania, Slovenia, Switzerland) we had just a few studies so here the graph is not very informative. For the others, it clearly shows that there was huge variation.

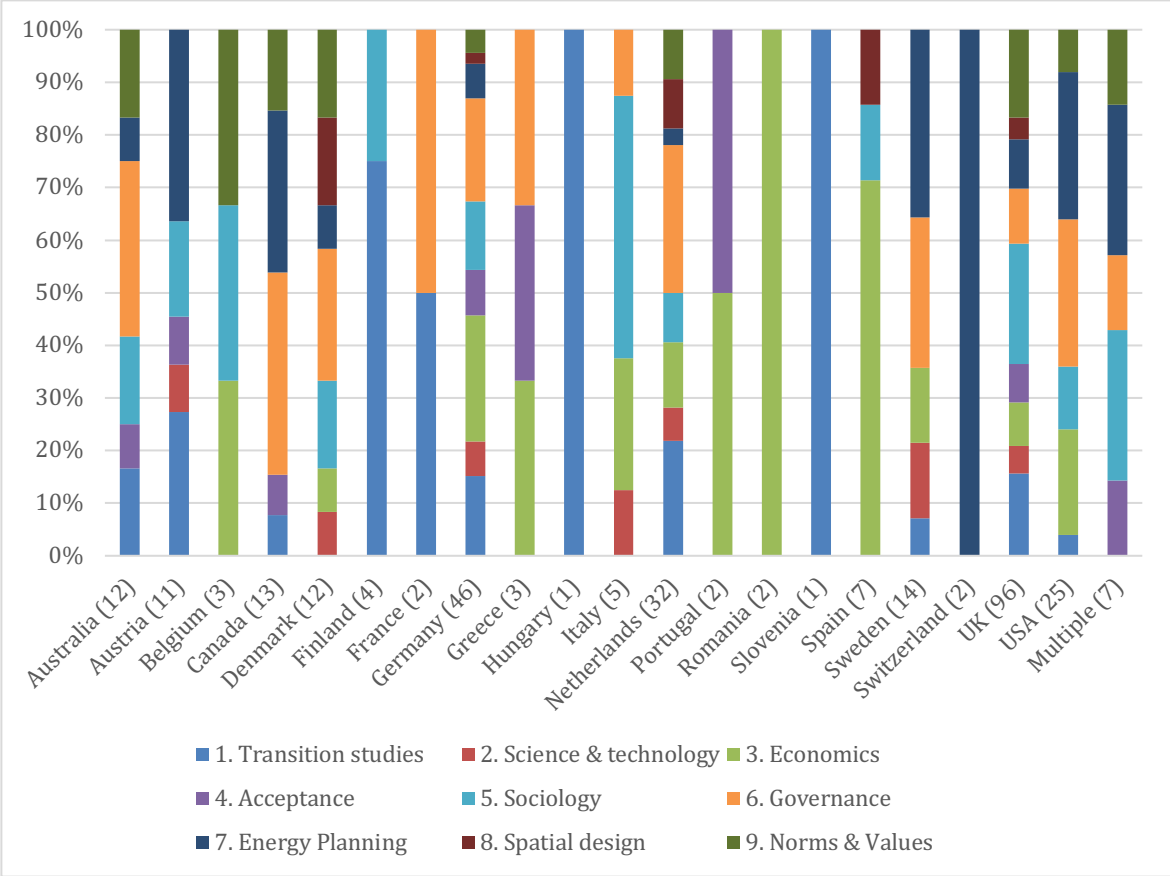

Figure 4. Approaches used to study community energy in the sample countries (the number between brackets refers to the total number of studies after each country)

5. Discussion

Community energy is the local production of renewable energy, governed by citizens, with a view to contribute to the transition to a sustainable energy system. It is of global importance given the ongoing concern about climate change and the global commitment to Sustainable Development Goals among others. There is a lot of potential of locally sourced energy and community-based models of renewable energy provision. Community energy research studies the production and distribution of renewable and sustainable energy at the level of neighbourhoods, small communities and municipalities. Community energy relates to academic disciplines and approaches on one side and to societal practices and stakeholders on the other. This sets this topical field apart from the technological studies of the transformation of the energy system [16] or sustainability transitions in its broadest sense [6]. Our study was not the first to reflect on the community energy literature [5,7,9,11,12,15,33]. However, we came up with an encompassing account of research on this topic, instead of taking specific conceptual approaches or specific countries or technologies as the starting point. We provided an overview of community energy networks and studies and accounted for nine different theoretical approaches.

With the mining of academic conferences and research networks, we followed the emergence of community energy as a research topic. The interest in community energy

has grown very fast as of recently, which was not only witnessed by the increasing number of articles and contributions to conference sessions, but also demonstrated by the rise in keynotes delivered on this topic. The most recent conventions showed not only what community energy could accomplish regarding the energy transition, but also highlighted possible socio-economic impacts on the existing energy sector. Especially, the rapid growth of 'Energy and Society' Conferences demonstrated the role academic networks can play in the expansion and development of a research topic. Similarly, the special issues initiated by a working group of the Netherlands Institute of Government showed how a relatively small network could effectively discuss and prepare contributions to the literature.

We found that community energy research was highly skewed in many dimensions, such as the countries studied, the keywords used, and the journals publishing community energy. There appears to be a bias towards traditionally industrialized countries. However, some of these in fact are not at the forefront of renewable energy at all (such as the US and the Netherlands) or have actually very limited commitment to community energy (like the US and the UK). At the same time, we determined community energy was studied using different approaches that hardly seem to connect to each other. The involvement of local stakeholders is apparent in many studies, but the approaches to study this phenomenon did not seem to allow for their inclusion. We concluded that the community energy field lacks consensus about appropriate theories and common methodologies.

Because the development and impacts of community energy undertakings are highly dependent on local cultural and political conditions and policies, it seems to us that it is important to replicate studies outside the United Kingdom, the United States, Germany and the Netherlands and to account for different perspectives to arrive at thorough understanding. In particular, we call for the inclusion of developing countries where community energy has a potential to improve access to energy services leading to better quality of life [1].

We strongly recommend the support of nascent research networks that aim at an integrated and inclusive approach of community energy, as in our view this is the only way in which the sustainability of the transformation of energy systems can be realized and studied at the same time. Such transformation is too complex to leave this to monodisciplinary fields. Together with the need to involve the perspectives of local stakeholders, we argue therefore that a transdisciplinary approach is the most promising way for further study of community energy.

Updated reference list

* papers of particular interest

** papers of outstanding interest

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They offer an epistemic and governance agenda to advance the imperative of speed in meeting ambitions of the SDGs and the Paris Agreement and to acknowledge the plurality of disciplines, actors, and institutions involved. Recognizing that the processes required to achieve these global goals entail navigating tensions, they suggest that shifts in ways knowledge is produced and transitions are governed could be based on a justice framework.

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This paper reviews interdisciplinary overviews of energy end-use and services in the relation to sustainable development, while paying special attention to the wider notion of inclusion, human wellbeing, social and gender implications, and related policy and institutional agendas.

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This article introduces the new journal Environmental Innovation and Societal Transitions (EIST). It analyzes the keywords in this field and provides and overview of the theoretical and empirical insights, policy issues and research challenges. It identifies four theoretical approaches to studying sustainability transitions.

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This study reviews energy trends and the associated technological, socio-economic, environmental and institutional issues shaping the development of integrated community energy systems. There are several business models for these systems. They can be accepted by different actors such as local governments, communities, energy suppliers and system operations as a means to achieve sustainability and may have a significant impact on the organization of the future energy system.

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Community renewable energy and energy efficiency initiatives offer a complementary model for renewable energy deployment and have several advantages over the prevailing "top down" strategy employed in the US. The paper is a review of the theoretical basis for community energy as a catalyst for energy behavior change; examine contrasting viewpoints of the definition of community energy; and review community energy literature. It compares energy behavior lessons from context independent individualistic and context dependent collective action theories. It lists the energy option and geographical focus of community energy studies. It provides data sources for a new US Community Energy Database and presents recommendations for future research in this rapidly growing field.

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The paper investigates the influence of renewable energy companies on the decision-making process in the German energy transition. It is based on interviews with 20 stakeholders and identifies clusters of different lobbying activities and styles. It finds that renewable energy companies have become important players. Second, lobbies by the renewable energy sector aim at the legislative framework. Third, there are numerous lobby activities, with highly different effectiveness and the strategies differ along companies. Companies have a strong influence on political-decision making and – together with governmental actors – form a 'policy network' that strongly shapes the German energy transition.

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This case study is about local low-carbon energy initiatives in the Netherlands (LLCEIs) and relates to innovations regarding low-carbon energy and energy efficiency. It argues that subnational governments can have a prominent role by engaging in institutional adaptation and policy innovation. It shows that a balancing process of authoritative and

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This paper relates sustainable development and transdisciplinarity. This is because research for sustainable development often is issue oriented and reflects the diversity, complexity and dynamics of the processes and is case specific. Accounting for the knowledge, needs, skills and interests of those involved is crucial for achieving insights and results. The papers describes the emergence of transdisciplinary.