Innovative Approaches to Energy Governance: Preliminary Quantitative Insights from the Literature

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Abstract With a significantly changing global climate and related impacts on our societies becoming increasingly visible, the call for a significant change of the energy production and consumption system gets increasing attention. Defined as energy transition, such change involves at least two dimensions: one technological and one social. Especially the latter is gaining importance because it is argued that the impact of technological innovation could be limited, if not harmful, if the technological would not be matched with social innovation. This refers to the emergence of decentralized energy systems at the local scale, and the increased involvement of non-state actors in shaping the transition, like civil society, business, and local public authorities. It includes new forms of governance, ranging from energy communities to the design of urban living labs. This work aims to provide the first insights for the further development of a theoretical framework in relation to governance and social innovation in the context of energy transition. It builds on a bibliometric quantitative analysis to explore the extent to which changes in energy governance are reflected in the scientific literature. Results indicate that energy governance issues have quite settled in the scientific literature across the world, but that social innovation is only a recently emerging topic. A snapshot interpretive analysis is then performed to get a better understanding of what types of energy governance and social innovations are addressed. These mostly refer to energy communities and organization types related to the use of renewable energies (e.g., cooperatives and public–private partnerships), as well as obstacles and opportunities that drive their implementation. A keyword analysis is used to get the first indications on the direction of the discussion. Generally, this seems rather heterogeneous, though most often it is related to urban development and cities, as well as in relation to the planning practice. Future research should extend and carry out further in-depth analysis of the preliminary insights outlined in this work.

Keywords Energy transition · Energy governance · Social innovation · Bibliometric analysis

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1 Introduction

As recently reported by the United Nations, which is responsible for assessing science related to climate change, the climate is dramatically changing, and its impacts are already affecting our societies (Intergovernmental Panel on Climate Change 2018). Thus, a disruptive revision of the energy production and consumption system is urgently needed. The energy transition can be characterized as a complex change process concerning the way energy is produced and consumed (Cherp et al. 2018). In fact, the energy transition involves at least two dimensions: the technological one requiring the introduction of technological innovations and the societal one whose impact would be limited or even potentially harmful if such a change would not be matched by social innovation (Domanski et al. 2019; Hoppe and de Vries 2018). At the same time, it has been widely recognized that such a process involves a change also in the governance of the energy system: decentralized energy systems need a multi-level and polycentric governance approach that embraces strategies at different scales, including, even if not limited to, the local one. In addition, non-state actors are gaining a central role in energy decision-making, like civil society, business, and local public authorities (Sovacool 2011, 2014). In this context, new approaches to energy governance are emerging, which can be described as forms of social innovation, ranging from energy communities to the design of urban living labs (Hoppe and de Vries 2018). However, a theoretical framework linking together and exploring the connections among the concepts of governance and social innovation in the energy transition is still lacking. By providing the first insights into the quantitative interplay of the concepts of governance and social innovation in the context of energy transition in the scientific literature, as a result of an extensive bibliometric analysis, this work aims to shed some preliminary light on the knowledge gap on the topic and to further inform the author's development of such a framework, related to new approaches to energy governance in the energy transition. In this regard, it is expected to contribute to expanding the knowledge about new approaches to governance of the energy transition and aims to support the local energy planners in including the social innovation dimension in their local energy strategies.

This paper is structured as follows: Sect. 2 introduces the key research questions and describes the method selected and used to perform the extensive literature review, including the quantitative bibliometric analysis and the qualitative content analysis of the identified literature bodies. Section 3 provides the results of such analyses, which are further discussed in Sect. 4, where also conclusions are drawn.

2 Method

This study analyzes the linkages between the concepts of governance and social innovation in a context of energy transition in the scientific literature. Hence, the central research question addressed by this work is:

Fig. 1 Overview of the systematic literature search via Scopus and Web. *Source* Own elaboration

To what extent are innovations in energy governance referenced in the scientific literature?

It can be further broken down in two sub-questions:

1. *What types of energy governance are addressed?*
2. *Is the social innovation dimension considered in energy planning?*

The first main question is answered by an extensive bibliometric analysis, while the following two sub-questions are addressed by an initial, mainly quantitative content analysis: the first one by digging deeper in the scientific publications looking for case studies; the second one by performing a keyword frequency analysis.

2.1 Bibliometric Analysis

Bibliometric analysis applies quantitative and statistical methods to study scientific publications (Wu et al. 2020). The authors performed an extensive and systematic literature review of the concepts “energy transition,” “governance,” and “social innovation,” using the two most common scientific search engines, i.e., Scopus and the Web of Science (core collection) (Andrés 2009). More specifically, since the objective of the research and analysis is to investigate the concepts of “governance” and “social innovation” in the energy field, in each search the keyword “energy” appears. Figure 1 shows the eight datasets obtained and the parameters used for each search.¹ Since the aim of this work is to explore the first quantifiable linkages among different

¹Last update: 29/11/2019.

Table 1 Summary of the bibliometric analysis results and type of analysis performed

Dataset number	Search keywords	Dataset size	Search engine	Type of analysis
1	Energy/governance	150	SCOPUS and WEB OF SCIENCE	Temporal and geographical analysis; Citations count; Publication platforms; Salient keywords
2	Energy/social innovation	13	SCOPUS and WEB OF SCIENCE	Temporal and geographical analysis; Citations count; Publication platforms; Salient keywords
3	Energy/governance/social Innovation	23	SCOPUS and WEB OF SCIENCE	Temporal and geographical analysis; Citations count; Publication platforms; Salient keywords

Source Own elaboration

concepts, for each search we added the condition that either the word “definition” or “concept” should also appear. In addition, the search is limited to keywords in abstracts, title and keywords.

Table 1 shows the final datasets containing the literature bodies obtained once the preliminary ones were merged, harmonized, and cleaned, and synthesizes the types of analysis performed on each dataset. These analyses provide descriptive statistics such as:

- Number of publications per year for each dataset, to understand the evolution of publication trends. All publication platforms, such as journals, books, and conference proceedings have been considered;
- Geographical distribution of publications by country. The analysis takes into account the countries affiliated with all authors, i.e., not just the affiliation of each publication’s first author. The geographical analysis of publications contributes to understanding if the scientific discussion in the field is spread all around the world or rather occurs in selected regions;
- Likely impact of research on the scientific community, measured by citation frequency, both of publications and journals;
- Most salient keyword terms associated with each subset of datasets. When merging the preliminary datasets obtained from the two different search engines, if different, the list of keywords for each publication were integrated.²

²This refers to the list of keywords not given by the author, i.e. Index Keywords for Scopus and Keywords Plus® for Web of Science.

2.2 Content Analysis

Content analysis makes possible performing a more in-depth analysis of the selected publications, although the key focus of this study was a quantitative approach by looking into the frequency of some selected terms. The authors selected a range of publications based on their content, looking for the following keywords either in the title or among the article keywords listed: case study; approach; top-down; bottom-up; energy community; energy cooperative; and living lab. We obtained a list of 64 publications which were further screened in order to realize a final selection down to eight relevant articles and to carry out a snapshot interpretive analysis.

3 Results

In general, the energy/governance literature body is the largest with 150 publications, while the other two literature datasets are smaller. The temporal analysis of the publication trends however shows (see Fig. 2) that the literature bodies “energy/social innovation” and “energy/governance/social innovation” are more recent. While the concept of energy/governance appeared already in the literature in the early 1990s and has gained momentum since 2007, the concept of social innovation in energy research emerged just ten years ago and is still rather underrepresented in the scientific literature body.

The geographical distribution of the three literature bodies widely varies, as Table 2 shows. The concept of energy/governance is researched all over the world, particularly in Europe and North America, except in South America. However, also Chinese

Fig. 2 Temporal analysis of the publication trends: number of publications, for each dataset, per year (1993–2020). *Source* Own elaboration of data of the three datasets

Table 2 Geographical distribution of the three literature bodies. For dataset 1, only countries with up to six affiliations are shown

Dataset 1. Keywords: Energy/governance		Dataset 2. Keywords: Energy/Social Innovation		Dataset 3. Keywords: Energy/social innovation/governance	
Germany	41	Germany	9	Netherlands	8
Netherlands	30	United Kingdom	7	United States	7
United Kingdom	29	Japan	4	France	6
United States	29	Italy	3	Germany	5
Finland	16	Netherlands	2	Canada	2
Australia	15	France	1	Australia	1
China	14	Austria	1	Sweden	1
Sweden	13	Spain	1	Belgium	1
Malaysia	12	Poland	1	India	1
Canada	9	Brazil	1	Italy	1
Belgium	7			Austria	1
Mexico	7			Japan	1
Norway	7			Brazil	1
India	6			United Kingdom	1
Ireland	6				
Singapore	6				

Source Own elaboration of data about authors’ affiliations of the three datasets

and Australian academics significantly contribute to the scientific literature body about energy/governance. Such a worldwide diffusion reflects the long-lasting article production as illustrated before.

The scientific literature about social innovation in energy research originates mainly in Europe, where Germany is the country producing the largest number of articles, similar to the first dataset. However, energy/social innovation is also discussed in Asia (i.e., Japan) and South America (i.e., Brazil), as Table 2 illustrates.

Finally, even if the scientific discussion about social innovation and governance related to energy issues in literature takes place mainly in Europe and North America, contributions to it come from every continent, Africa excluded (see Table 2).

The citation analysis is assumed to identify the scientific literature that likely has had the most significant impact on knowledge. The ten most cited publications of the overall dataset obtained with the three strings are reported in Table 3. Overall, it includes eleven publications, due to the last two articles having an equal amount of citations. None of the papers belonging to the second sub-dataset are part of the list, reflecting also the limited size of the extent of the scientific literature’s discussion concerning social innovation. Interestingly, two authors appear more than once in the list of the most cited publications. Both publications do not address energy issues specifically. They focus on governance in relation to the urban environment and the

Table 3 Overview of the ten most cited publications

Authors	Title	Year	Cited by	Dataset
Haase, D., Frantzeskaki, N., Elmqvist, T	Ecosystem services in urban landscapes: practical applications and governance implications	2014	261	1
Florini, A., Sovacool, B.K	Who governs energy? The challenges facing global energy governance	2009	143	1
Bhattacharyya, S.C	Energy economics: Concepts, issues, markets and governance	2011	142	1
Turnheim, B., Berkhout, F., Geels, FW., Hof, A., McMeekin, A., Nykvist, B., van Vuuren, D.P	Evaluating sustainability transitions pathways: bridging analytical approaches to address governance challenges	2015	115	1
Orsini A., Morin, J.-F., Young, O	Regime complexes: a buzz, a boom or a boost for global governance?	2013	114	1
Benson, D., Gain, A.K., Rouillard, J.J	Water governance in a comparative perspective: from IWRM to a “nexus” approach?	2015	100	1
Späth, P., Rohrer, H	Local demonstrations for global Transitions-dynamics across governance levels fostering socio-technical regime change towards sustainability	2012	85	1
Walker, G	The role for “community” in carbon governance	2011	85	3
McPhearson, T., Andersson, E., Elmqvist, T., Frantzeskaki, N	Resilience of and through urban ecosystem services	2015	82	3
Zelli, F., van Asselt, H	The institutional fragmentation of global environmental governance: causes, consequences and responses introduction	2013	82	1

Source Own elaboration

concept of ecosystem services, in particular. Other papers rather more widely discuss low-carbon governance or integrate different topics (e.g., integrated water resource management, sustainability, and environmental governance).

Table 4 shows the assumed impact on knowledge not only of single publications but of journals, particularly those that published more than two papers of our datasets. They account for almost one-third of the entire set of investigated publications included in the three datasets. Energy policy is overall the most predominant journal in our dataset and is also listed among the most relevant international peer-reviewed journal in energy research. It investigates the policy implications of energy

Table 4 Overview of the most productive journals of our dataset. Source: Own elaboration

Journal	TA ^a	IF 2018 ^b	Categories ^c
Energy Policy	9	4.880	Economics; Energy and Fuels; Environmental Engineering and Energy; Environmental Sciences; Environmental Studies; Social Sciences, General
Energy Research and Social Science	7	5.525	Environmental Studies; Environmental Studies, Geography and Development; Social Sciences, General
Sustainability (Switzerland)	6	2.592	Environment/Ecology; Environmental Sciences; Environmental Studies; Environmental Studies, Geography and Development; Green and Sustainable Science and Technology
Energy, Sustainability and Society	4	1.901	Energy and Fuels; Engineering; Green and Sustainable Science and Technology
Journal of Cleaner Production	4	6.395	Engineering; Engineering, Environmental; Environment/Ecology; Environmental Engineering and Energy; Environmental Sciences; Green and Sustainable Science and Technology
Environmental Science and Policy	3	4.816	Environment/Ecology; Environmental Sciences
45th International Conference on Large High Voltage Electric Systems 2014	2	–	
Climate Change Management	2	–	
Current Opinion in Environmental Sustainability	2	4.258	Environment/Ecology; Environmental Sciences; Green and Sustainable Science and Technology
Ecological Economics	2	4.281	Ecology; Economics; Economics and Business; Environment/Ecology; Environmental Sciences; Environmental Studies
Environmental Politics	2	3.827	Environmental Studies; Environmental Studies, Geography and Development; Political Science; Social Sciences, General
Global Environmental Change	2	10.427	Environment/Ecology; Environmental Sciences; Environmental Studies; Environmental Studies, Geography and Development; Geography; Social Sciences, General

(continued)

Table 4 (continued)

Journal	TA ^a	IF 2018 ^b	Categories ^c
Journal of Environmental Policy and Planning	2	4.195	Development Studies; Environmental Studies, Geography and Development; Regional and Urban Planning; Social Sciences, General
Journal of Environmental Studies	2	–	
Review of European, Comparative and International Environmental Law	2	2.125	Environmental Studies; Law; Social Sciences, General
Social Innovation: Solutions for a Sustainable Future	2	–	

^aTotal of Articles in the three datasets

^bSource 2018 Journal Impact Factors, Master Journal List, Web of Science

^cSource Master Journal List, Web of Science

issues by economic, social, planning, and environmental perspective. According to the investigation, it comprises articles belonging to all three sub-datasets and therefore covers all the concepts studied in this work. Other predominant journals are Energy Research and Social Science, which focuses on the relationship between energy systems and society, and Sustainability (Switzerland), which has a broader scope, not focusing exclusively on energy.

In order to enable an inter-journal comparison, the study relies on the Impact Factor (IF), which is commonly used to measure the importance of a journal, in its field, meant as the assumed impact on knowledge that it has had during a fixed period of time and included as a reference each journal's influence on the scientific discussion. The higher the IF is, the better the journal ranking, compared to others of its own discipline. In order to enable such a comparison, the study looked at the discipline categorization of journals provided by Web of Science. For the most common categories in our list, Environmental Sciences and Environmental Studies, the most prominent journal is Global Environmental Change (IF of 10.427), which includes a few of the listed articles. Excluding this broadly labeled journal, the most influencing journal in Environmental Sciences is the Journal of Cleaner Production (IF of 6.395), comprising four articles of our dataset. Energy Research and Social Science (IF of 5.525), comprising seven publications, seems to be the predominant journal in Environmental Studies.

The previous analysis of the scientific literature's discussion of the topics of governance and social innovation in the energy transition is thought of foremost importance to understand its state of the art and its evolution. Focusing on the content of the papers is necessary to understand the potential empirical implications of the changing and developing discussion on energy governance. Table 5 lists the eight publications that have been identified by the literature datasets to be the basis of the initial investigation, based on specific keywords as described in Sect. 2.2. They were selected because of the empirical information they provide, in particular the case studies they describe and the examples of social innovation initiatives they present. They not only

Table 5 Selected publications for snapshot interpretive analysis

References	Research subject	Form of social innovation	Country
Fuchs and Hinderer (2014)	New governance structures for decentralized electricity generation—four local initiatives	100% bio-regions: energy independent, generation of electricity only from RES, resulting from citizen action groups or hosted by public and private actors	Germany
Chatfield and Reddick (2016)	Smart community projects which use informal social governance mechanisms for effective smart city implementation	Smart community and testing of citizen-centric e-governance in Kitakyushu City, Fukuoka Prefecture, Kyushu	Japan
da Silva et al. (2018)	Energy Living Lab implemented at the University of Campinas, model for sustainable campuses in Latin America	Living Lab installed for University Campus Campina, as an open innovation ecosystem through the integration of users, academia and the market	Brazil
Hewitt et al. (2019)	Role of Citizen-driven Renewable Energy (RE) projects, community energy, in the worldwide transition to cleaner energy systems	Historic development of community energy initiatives in eight selected countries, by energy type (e.g.. wind power, biomass) and organization type (e.g.. most often renewable energy cooperatives, local government + citizen participation, public–private partnerships)	Belgium, France, Germany, Italy, Poland, Spain, Sweden, and United Kingdom
(Van Veelen 2018)	Assessment of the complex and varied ways in which communities in Scotland practice energy governance	15 energy community groups across Scotland, sorted into five broad categories: “Small Is Beautiful,” “Community Developers,” “Innovators,” “Energy cooperatives,” “Transition Towns”	United Kingdom

(continued)

Table 5 (continued)

References	Research subject	Form of social innovation	Country
Reinsberger et al. (2015)	Identification of critical factors, which foster or hinder the development of bottom-up initiatives—social innovation—in the diffusion of photovoltaics	PV bottom-up initiatives, including voluntary associations, social enterprises, co-operatives, informal community groups, farmer societies, or municipal public buildings for PV plants	Austria
Nolden (2013)	Analysis of the development of community energy in the UK by comparing it to Germany in relation to decentralization, scales and ownership structures particularly of wind energy	Wind energy communities, either actively engaged in technological diffusion through community-led projects, or through the (part-)ownership of municipal utilities, or benefitting through co-ownership, business taxes, community funds and/or share offers from commercial developments	United Kingdom
Heldeweg et al. (2015)	Collaboration of government with private sector organizations toward a proper “energy transition” through regional and local projects	“Biogas grid Noordoost Fryslân,” public–private partnership (PPP)	The Netherlands

Source Own elaboration

describe European initiatives, but also experiences from Latin America and Japan, reflecting the results of the geographical distribution of the scientific discussion in energy research. Most of the energy/governance/social innovation initiatives refer to energy communities that produce electricity from renewable energy sources (RES), although they vary in size, territorial level and kind of stakeholders involved. They also mostly focus on describing contextual barriers and opportunities that drive the development of such initiatives. Two publications go beyond the concept of energy community and refer to more integrated experiences, such as living labs and smart city projects. However, it remains surprising the limited extent to which the living lab

concept seems to have entered the scientific discussion in relation to energy governance and social innovation. This might be linked to one of the main challenges regarding the implementation of the concept: a stable and effective participation of various stakeholders throughout energy governance and ICT processes and the creation of a community beyond the framework of timely limited smart city projects (Nesti 2018). The application of the concept is currently further explored by the authors in the framework of the EU Horizon 2020 project STARDUST (Tomasi et al. 2019).

Finally, an analysis of the keywords frequency has been performed. Keywords analysis can highlight the research focus and direction of an article (Wu et al. 2020) and therefore sheds further light on its content. The keywords frequency analysis has been performed with the software NVivo, treating similar words, i.e., stemmed words (e.g., policy, policies), as one keyword. Datasets 2 and 3 appear to be more heterogeneous than dataset 1, since in both cases around 60% of the keywords only appear once. Interesting, in all three sub-datasets, the keyword *city/urban* appears within the 20 most recurring, and in datasets 2 and 3 within the first four, meaning that the research about social innovation in energy research occurs for the moment mainly at the urban level. Moreover, the keyword *planning* is also one of the most frequently occurring ones in all three datasets, suggesting that (urban, spatial) planning is closely interlinked with energy governance and social innovation.

4 Discussion and Conclusions

This study combines bibliometrics with content analysis to mainly quantitatively but also qualitatively analyze the interplay of the concepts of governance and social innovation in the context of energy transition, by exploring the relevant discussion in the existing scientific literature to the present and the extent and impact of such discussion. The size of the three obtained literature datasets was constrained by the choice of resorting to the two main scientific search engines. Thus, future research should consider including Google Scholar as a publication source: A recent article highlighted that, on the one hand, Scopus and Web of Science are quite reliable, but only partially cover the relevant literature. On the other hand, Google Scholar is more comprehensive but its automatized approach to select documents may lead to duplicates, errors and a high amount of gray literature (Martin et al. 2018). Moreover, the criteria used for publication source could bias the datasets obtained. Relaxing the search parameters could lead to a more comprehensive review of the status quo of knowledge about social innovation and governance in the energy transition. In addition, the selection of the search keywords could be further refined (e.g., by including selected social innovation or energy governance types) to gain more specific insights into the concepts and reduce inaccuracies linked to the screening of mainly abstracts and keywords.

All things considered, this study makes a first attempt to investigate the role of new approaches of energy governance in the current energy transition, as perceived

by the scientific community and reflected in the current scientific knowledge about the topic. With the rapid changes that the current energy transition requires, the scientific discussion in energy research literature is increasingly focusing on the governance aspects of new energy systems, and innovative social innovation initiatives are receiving growing attention. As the analysis of the various dimensions of the three literature datasets has shown, social innovation individually is yet less often discussed. However, the research about new energy governance has been increasing over the last two decades, and it now covers each continent, with Europe being the frontrunner. And, as the content analysis revealed, practitioners increasingly take into consideration energy governance in local and regional energy planning. At the same time, it needs to be highlighted that most of the papers discussing concrete examples or case studies focus on identifying barriers and opportunities that might further drive the development of new forms of energy governance or social innovation. They highlight that still a major gap exists between existing policy targets, e.g., in further fostering energy communities, and the actual implementation (e.g., big utilities as major national and regional players). In addition, the scientific literature discussion on governance seems strongest where wider environmental aspects or the development of integrated solutions is studied, likely hinting that governance and social innovation play a particular important role with regard to the solving of complex problems. However, this needs to be subject to further scrutiny in upcoming research.

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