




Here comes the sun...? A systematic literature review of factors supporting or opposing solar energy initiatives

Stefania Benetti ^a , Daniel Delatin Rodrigues ^b , Marco Grasso ^{b,*} 

^a Università del Piemonte Orientale, Dipartimento per lo Sviluppo Sostenibile e la Transizione Ecologica (DISSTE), Italy

^b Università degli Studi di Milano-Bicocca, Dipartimento di Sociologia e Ricerca Sociale, Italy

ARTICLE INFO

Handling editor: Dr. Mark Howells

Keywords:

Solar energy initiatives
Systematic review
Thematic analysis
Support
Opposition

ABSTRACT

The diffusion of solar energy initiatives is shaped by a dynamic interplay of actions supporting and opposing them, influenced by governance structures, socio-economic conditions, environmental concerns, and public perception. This systematic review synthesizes findings from 150 studies published since 2015, identifying twenty key factors that determine the support or opposition to solar energy initiatives. While regulatory frameworks, financial incentives, and community participation by and large enhance support, challenges such as land-use conflicts, economic inequities, and fossil fuel incumbency contribute to opposition. Our review highlights the necessity of integrated policy approaches, participatory governance, and equitable economic models to mitigate opposition and ensure inclusive approaches to solar energy. By providing a comprehensive analysis of the mechanisms behind support and opposition, this systematic review informs policymakers, industry stakeholders, and researchers on strategies to facilitate a sustainable and socially responsible expansion of solar energy.

1. Introduction

The 2015 Paris Agreement was a turning point in the fight against climate change, promoting a global transition to more sustainable energy sources, including solar energy. The agreement has stimulated numerous initiatives in the solar energy sector internationally and is expected to triple installed capacity and increase production by 25 % annually by 2030 [1,2]. In 2024, indeed, the International Renewable Energy Agency [3] has recorded that solar power alone accounted for over three-quarters of renewable additions. This rapid expansion underscores the urgency of understanding the different factors that shape both support and opposition to solar initiatives. Solar energy initiatives are not limited to the simple installation of photovoltaic panels but involve an entire supply chain from research and development to production, from transport to installation, to end-of-life management and material recycling [4]. This is complemented by policy and legislative initiatives such as government incentives, environmental regulations, and strategies to ensure fair access to renewable energy [5,6].

The transition to solar energy is a pivotal element in the global shift toward renewable energy sources, yet its adoption is neither uniform nor uncontested (see for instance, Ref. [7]; [8]). While solar energy

initiatives are often promoted as solutions to climate change, energy security, and economic development, they also face significant opposition stemming from political, economic, environmental, and social concerns. The diffusion of solar energy is thus shaped by a complex interplay of supportive and oppositional actions that influence policy implementation, market development, and public perception.

This systematic review examines the factors driving both support and opposition to solar energy initiatives, drawing on an analysis of literature from 2015 onward, coinciding with the adoption of the Paris Agreement. A linguistic specification is in order: we use the umbrella words and concepts ‘support’ and ‘opposition’ (to solar energy initiatives) to include both in substantive and formal terms all the different manifestations through which such initiatives are promoted and resisted. It is also worth noting that it is exactly the support and opposition perspective that in our knowledge makes this work unique and distinguishes it from other reviews on solar energy (e.g., Ref. [5,9–11]) whose scope generally covers its policies, scope, and potential. Moreover, recent scholarship highlights that positions toward environmental initiatives are not only shaped by material or institutional factors but also by underlying normative orientations regarding how humans relate to nature, what values are prioritized, and who is considered a legitimate

* Corresponding author.

E-mail address: marco.grasso@unimib.it (M. Grasso).

<https://doi.org/10.1016/j.esr.2025.102018>

Received 27 April 2025; Received in revised form 28 November 2025; Accepted 21 December 2025

Available online 6 January 2026

2211-467X/© 2025 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

decision-maker [12]. This suggests that support or opposition to solar energy initiatives may similarly reflect deeper factors, beyond immediate economic or technical concerns. Thus, our review focuses explicitly on support and opposition to solar energy initiatives, by analysing 150 studies across different regions and contexts and identifying twenty key factors that shape public and institutional attitudes toward solar energy initiatives, including governance structures, socio-economic impacts, regulatory frameworks, environmental considerations, and community involvement.

In order to guide the identification and analysis of supporting and opposing factors, our study is based on the conceptual framework of complex systems. A complex system is a network of interconnected elements whose interactions give rise to outcomes that cannot be fully explained by analysing each element in isolation [13,14]. In the case of solar energy, the factors described in this manuscript (e.g., technological innovation, policy frameworks, financial mechanisms, market dynamics, environmental constraints, and social acceptance) interact as such a system. Each factor influences and is influenced by the others: for example, supportive policies stimulate investment, investment accelerates technological learning, falling costs expand markets, and broader adoption reshapes social and political expectations. These nonlinear feedback loops and adaptive co-evolutionary processes are consistent with socio-technical transition theory, which emphasizes that energy innovations emerge through multi-level interactions between niches, regimes, and broader landscape pressures [15]; [16]. From this perspective, the emergence of solar energy cannot be attributed to any single driver. Instead, it is the result of a dynamic, adaptive system in which diverse forces reinforce and transform one another over time, giving rise to emergent patterns of technological adoption and societal change [17]; [18].

Our review highlights how these factors intersect, demonstrating that support for or resistance to solar energy is rarely the result of a single motive, but rather a complex dynamic from both a spatial and temporal perspective. Thus, we can treat the dynamics of transition as a combination of factors that generate different areas of contention. Understanding the mechanisms behind support and opposition to solar energy is critical for designing policies that promote equitable, efficient, and sustainable energy transitions. By synthesizing part of the current research, this analysis provides insights into how solar energy initiatives can overcome political, economic, and social barriers, as long as they act through various instruments, considering not only technological or market constraints. Thus, identifying the critical points of each case can serve to outline interventions that are technically effective and politically acceptable.

2. Materials and methods

The first step of the systematic review [19] was the article collection process.

We employed the Scopus database [20] as a search tool [21] to look for contributions that referenced support and opposition to solar energy initiatives (including projects, policies, plans, strategies, and provision), using combinations of 'solar energy' and terms related to 'support' ('opportunity', 'diffusion', 'justice'¹) and 'opposition' ('resistance', 'protest', 'conflict') within the article's title, abstract, and keywords (see the specific strings in Appendix I). Moreover, we limited the search string excluding from it the fields 'engineering', 'chemistry', 'biochemistry', or 'physics', not to include articles focused on technical issues outside our social and political sciences scope. In addition, we considered articles published since 2015, the year of the United Nations

Framework Convention on Climate Change Paris Agreement, to today (June 2024).

These choices delimited an initial sample of 750 records. The second step was to review all abstracts (June–August 2024) using the Cadima tool [22] [23], which provides assistance throughout the systematic review process, by highlighting specific terms we selected in the text with different colours (e.g., 'solar' in yellow, 'support' in light blue, and 'opposition' in red), reducing the reading time of abstracts. Our selection criteria of abstracts were as follows: (1) it must be evident from the abstract that the article is about or includes solar energy initiatives; (2) it must be evident from the abstract that there were reasons to support the initiative; (3) it must be evident from the abstract that there were reasons to oppose the initiative. We also excluded conceptual documents or literature reviews, as well as the remaining investigations into technical aspects of facilities or scenario analyses. This phase was crucial to limit our work to case studies focusing on one or more solar initiatives, exploring social support and opposition.

Through this procedure, we could select 187 records for article analysis which was followed by a double reading phase of the entire articles (September 2024). Following the same three criteria on a first skimming-reading of the entire articles, we selected 176 potentially relevant records. In a second thorough reading we carried out qualitative content analysis [24] and restricted the final sample to 150 relevant articles (this process is reported in detail in Appendix II, while the list of articles considered in Appendix III).

After the data collection process, we moved on to the analysis phase (October–December 2024). We selected some categories of the article to obtain its bibliographic information and scope (year of publication, journal, and keywords). Moreover, contributions were examined to explore the geographical areas (continent and country of case studies) and typology of initiatives (solar; solar and another source; more than one source, including solar) and to identify the factors influencing the support or the opposition to solar energy initiatives using qualitative content analysis of the results and discussion sections of the articles. In particular, our approach to qualitative data analysis of documents was thematic analysis [24], which is based on the search of central themes throughout text content. The thematic analysis process was carried out by two analysts (two of the coauthors), who scrutinized half of the sample each. During the definition of the preliminary results, the analysts and the entire research team have had several occasions to discuss the entire process [25], and the support and opposition factors evinced, leading to the final identification of 20 supportive and oppositional factors.

1. Policy and governance;
2. Socio-economic impacts;
3. Technology and infrastructures;
4. Regulatory framework;
5. Markets' structure;
6. Environmental impacts;
7. Citizens' involvement;
8. Spatial issues;
9. Utilities' role;
10. Finance;
11. Communication;
12. Power of energy companies;
13. Bureaucracy;
14. Colonialism and extractivism;
15. Research and development;
16. Landscape issues;
17. Values and beliefs;
18. Agricultural issues;
19. Media;
20. Climate actions.

A subsequent step was to count in how many documents the factors

¹ Although the term 'justice' is not directly related to the concept of 'support', we felt it necessary to include it in the search string since support for a solar energy initiative is often linked to issues of environmental justice (distributive, recognition and procedural).

selected were included, in supportive and oppositional meaning. The count of articles mentioning a certain factor will first be expressed as a percentage of the total sample ($n = 150$). Then, within each individual factor, we explored the cases in which that factor was a reason for support or opposition to solar energy initiatives. Considering that the same article may refer to both cases of support and opposition in relation to a single factor, the total percentage count of cases clearly does not correspond to 100 %. These frequencies helped us to map how the literature describes and analyses the dynamics of solar energy support and opposition.

Our sampling process had some inevitable limitations. First, the identification of factors may suggest a segmented analysis; as already explained, our intention was to construct a matrix that could serve as an analytical grid for the cases examined. In the literature we reviewed, both support for and opposition to solar energy initiatives result from the interaction of several factors. However, some articles focus exclusively on specific factors, such as environmental conservation, without considering that other factors may be present to support or oppose the expansion of solar energy initiatives. Cases such as these demonstrate the need for broader analysis, regardless of the researcher's field of expertise. In problematic situations such as solar expansion, selecting only one factor as a determinant risks simplifying the approach to the process and neglecting the interconnection between multiple factors over time. Despite the biases and limitations inherent in our review, it is important to emphasise that our aim was not so much to cover as many articles as possible, but rather to offer a systemic analysis of a sufficient number of cases (considering the reading of all 150 articles) to capture emerging trends in the dynamics of solar energy expansion (such as support and opposition) and, therefore, provide a comprehensive overview of the issues at stake. In a highly conflictual scenario regarding the expansion of renewable energy, we consider this effort to be fundamental, albeit not exhaustive.

3. Results

3.1. Trends in solar energy support and opposition research

Starting from 2015 the number of publications on solar energy support and opposition ($n = 150$) has clearly exploded, especially in the latest years (Fig. 1). Leaving aside the pandemic hiatus, it is evident how interest in the topic has grown also in the academic world. The two-year decline could be justified by the fact that our data extraction was carried out in April 2024 (considering that some articles from the end of 2023 might not yet have been entered into the system).

The time distribution and the types of scientific journals that published the articles in our sample (Appendix IV) show that interest in this theme is multidisciplinary and interdisciplinary. Although, as explained above, we decided to exclude physical disciplines, there is no main trend in the journals for a specific discipline in the social sciences. In fact, these journals generally deal with energy, the energy transition to renewables, and sustainability, often from a multidisciplinary and interdisciplinary perspective. What is relevant from our point of view is that the trend is often linked to the political and economic aspects of solar energy initiatives, leaving a research gap in other social sciences, such as geography. This predominance is also evident from an analysis of the keywords (Fig. 2): excluding the multidisciplinary term 'sustainability', words such as 'policy', 'justice', 'distributed' (or 'distribution'), 'management', 'economy', are the most recurrent, but also words related to the impact of solar projects on the 'social' sphere and local 'communities'. Less relevant are, for instance, keywords related to environmental aspects, acceptance, as well as the scope of communication of such solar energy initiatives.

Regarding the content of our selected sample, a first point is the geographic areas included in terms of continents (Fig. 3) and countries (Fig. 4) covered by the international literature. The most analysed contexts are Europe ($n = 42$) and Asia ($n = 38$). They are followed by

North America ($n = 27$), Africa ($n = 19$), Central and South America ($n = 11$), and Oceania ($n = 7$). A further 11 articles considered multiple continents. Unsurprisingly, the countries with the largest number of studies are the United States ($n = 24$), India ($n = 13$), China ($n = 9$), and Germany ($n = 7$), as they are among the world's largest producers of solar energy [26]. In the European context, Germany is followed by Sweden and the UK (both $n = 4$), Portugal and Switzerland (both $n = 3$), and Spain ($n = 2$). Outside the European context, other relevant countries are Australia ($n = 5$), Pakistan ($n = 4$), and Brazil ($n = 3$).

Moreover, the analysis of contents allowed us to differentiate the sample by initiative type. 65 % of the articles focus exclusively on solar energy initiatives, which may be inherent to urban or rural contexts, but also to industrial projects and agricultural parks. In this context, 'agricultural parks' refers to rural industrial clusters or agro-processing zones (i.e., areas devoted to storage, packaging, and transformation of agricultural products, sometimes powered by renewable energy facilities) rather than to agri-PV or agrivoltaic systems. 13 % of the works compare solar energy initiatives and another type of renewable energy initiatives, usually wind power. This group of studies often juxtapose energy transition policies and highlights their strengths and weaknesses. Finally, 22 % of the studies analyse various energy initiatives (renewables and non-renewables), including solar ones, giving further information on the factors influencing their support or opposition. Thus, the variety of solar energy initiatives is very broad and includes policies promoted at different scales (local, regional, national), market price regulation strategies, or specific projects related to: the installation of photovoltaic panels for domestic use, the production of panels, the use of solar energy in power plants, the use of solar energy in agriculture, solar-powered means of transport, as well as the process of disposing of waste from solar energy. In this sense, the diversity of our sample is relevant as it covers the entire spectrum of solar energy initiatives. Moreover, spatial and economic considerations further enrich the picture. Evidence suggests that strategic deployment - such as combining urban photovoltaic installations with rural wind projects - can effectively meet energy demands, as observed in Germany [27], for instance. However, similar approaches in other regions, especially parts of Africa, may inadvertently recreate patterns of economic dependency similar to the natural resource curse [28].

3.2. Key factors

The content analysis identifies 20 factors that can influence the support and opposition of a solar energy initiative (Table 1). The order of the factors is from the most analysed to the least mentioned by the articles in our sample². Before proceeding to the description of the individual factors, it is necessary to emphasise that the literature distinguishes between sector-specific analyses - which focus on technological, regulatory and economic challenges - and systemic approaches that situate renewable energy transitions within broader socio-political and economic transformations. This broader perspective integrates local conflicts over land and community resistance (142) with regional spatial planning challenges and national policy frameworks, as well as recognising the influence of global economic trends and geopolitical disputes (e.g. 28, 95, 73, 102). Another important insight is the tension between incremental adaptation and the need for systemic transformation (130). Some scholars argue that renewable energy can be effectively integrated into existing structures through strategies such as circular business models and adaptive urban planning, thus mitigating sector-specific barriers without causing a radical turnaround (e.g. 30, 142). Conversely, other perspectives assert that deeply entrenched prejudices and geopolitical inequalities require a deeper reconfiguration of socio-

² For the sake of readability, references to the literature in this section of the results will be indicated in round brackets where the numbers correspond to the list of articles considered in Appendix III.

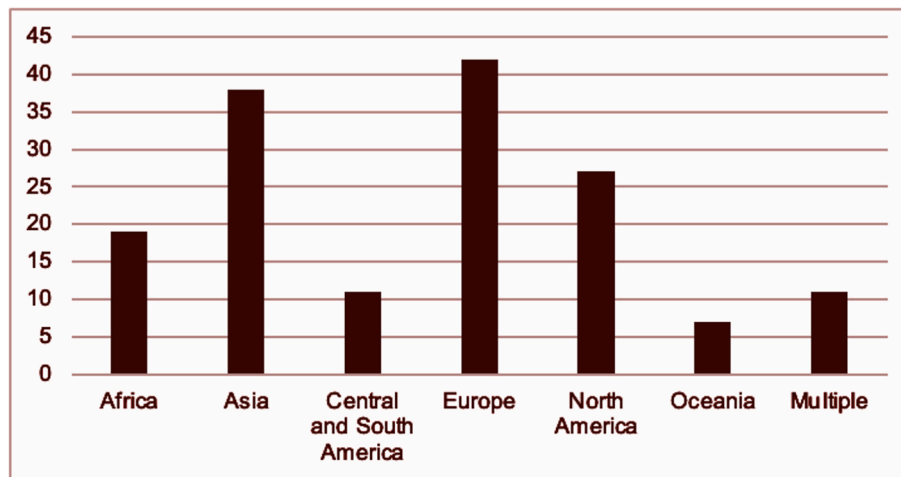


Fig. 3. Geographical distribution (continents) of case studies analysed by articles about solar energy support and opposition (n = 150).

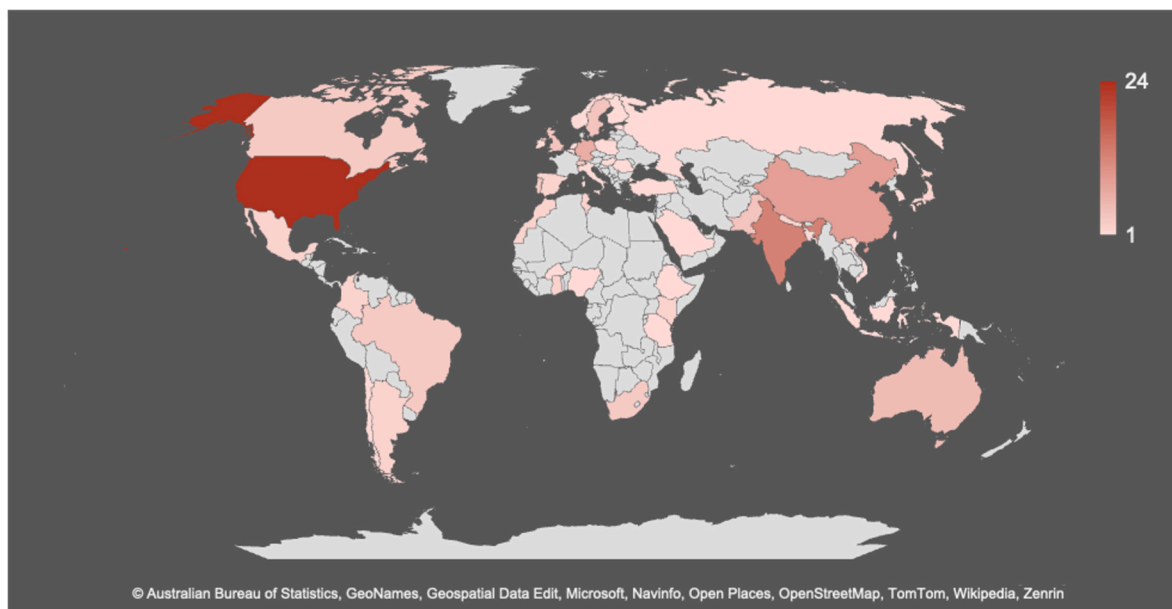


Fig. 4. Geographical distribution (countries) of case studies analysed by articles about solar energy support and opposition (n = 150).

Despite our choice to exclude purely technical elements from our review, several studies (37 %) highlight material systems that enable the generation and distribution of energy services as an influencing factor in the support or opposition to solar energy initiatives. Few supporting cases (38 %) include, for example, the presence of direct electric heating or heat pump technology in homes that is more likely to be invested in and adopted towards solar (27). Or, the presence of technologies that allow the combination of solar energy production with another renewable source (e.g. tidal) allows the energy load to be supported more reliably, for more hours per year (21). In cases of opposition (75 %) we mention, for instance, at the housing level, the advanced age of a house may negatively influence the adoption towards solar panels (27), or people's concerns or doubts as to whether solar photovoltaic systems can meet their expectations mainly due to issues of sunlight variability (5). Beside the housing issue, other studies underline issues such as technological immaturity, but also obsolescence, degradation, and high maintenance costs for power distribution infrastructure (such as marine cables) (e.g. 21, 71).

4) Regulatory framework

Other relevant factors (35 %) are the legal mechanisms at local, regional, national and international level, i.e. the set of instruments that can be compulsory and coercively (for instance, laws, regulations, contractual obligations) or voluntary (such as, integrity pacts, codes of conduct) regarding the regulation of solar energy initiatives. In some of these cases (25 %) more detailed regulations facilitate solar electricity initiatives or some regulatory adjustments enable solar expansion (e.g. 4, 50, 105). However, the majority of these studies (75 %) identifies regulatory aspects as an obstacle to the diffusion of solar power. This is the case with the establishment of taxes for the supply and generation of solar power, which do not favour the diffusion of photovoltaic panels, resulting in a decrease in the production of electricity from solar power (57). Or the inadequate regulation of solar generation waste (e.g. 10, 123).

5) Markets' structure

In accordance with the keywords of the articles that we analysed in Fig. 2, economic aspects are relevant. Here we refer, in particular, to an important number of questions (31 %) that relate to how companies

Table 1

Articles (absolute and percentage values of the total number of our sample, $n = 150$) analysing factors in support of or in opposition to solar initiatives (A). Based on the total number of studies that take a certain factor into account (A), the respective proportion for support (B) or opposition (C) is shown in absolute and percentage values.

Factors	A. Articles		B. Support		C. Opposition	
	n	%	n	%	n	%
Policy and governance	88	59 %	44	50 %	57	65 %
Socio-economic impacts	70	47 %	24	34 %	57	81 %
Technology and infrastructures	56	37 %	21	38 %	42	75 %
Regulatory framework	52	35 %	13	25 %	39	75 %
Markets' structure	47	31 %	14	30 %	40	85 %
Environmental impacts	46	31 %	13	28 %	35	76 %
Citizens' involvement	41	27 %	26	63 %	16	39 %
Spatial issues	36	24 %	19	53 %	22	61 %
Utilities' role	35	23 %	9	26 %	28	80 %
Finance	28	19 %	5	18 %	24	86 %
Communication	23	15 %	12	52 %	13	57 %
Power of energy companies	22	15 %	2	9 %	21	95 %
Bureaucracy	17	11 %	2	12 %	15	88 %
Colonialism and extractivism	15	10 %	1	7 %	14	93 %
Research and development	12	8 %	8	67 %	4	33 %
Landscape issues	11	7 %	4	36 %	8	73 %
Values and beliefs	10	7 %	6	60 %	8	80 %
Agricultural issues	10	7 %	1	10 %	10	100 %
Media	5	3 %	3	60 %	2	40 %
Climate actions	3	2 %	3	100 %	0	0 %

differ in the type of products and the way they are sold or how their operations are delimited by external issues, also in relation to the geographical scale. In fact, the market structure can reduce the price of different solar energy initiatives (30 %), either by being more open to competition or by a positive renewable energy auction performance (e.g. 44, 129). Conversely, barriers that hinder the decision to operate in the sector (85 %) include a market structure that by and large favour the fossil fuel industry as it benefits more from government subsidies and price distortion (5), or the presence of market distortions in the form of protectionist measures (97), but also the unequal treatment of private and quasi-public entities when entering the market in a specific recycling case (26).

6) Environmental impacts

In contrast to the keyword analysis of Fig. 2, many studies (31 %) consider the environmental impacts of solar energy initiatives, i.e. changes in the environment resulting from an activity, directly or indirectly related to solar energy projects, that may have visible or potential effects on air, soil, water, biodiversity, and human health. Thus, on the one hand, we have a number of studies (28 %) that have identified how projects do not negatively affect the environment, and instead stress positive aspects, such as reduced carbon emissions (131), reduced use of fossil fuels (75), absence of odour pollution (36), achievement of sustainability goals (5), good management that also allows for the conservation of biodiversity (60), etc. On the other hand, many studies (76 %) point to various negative effects, including deforestation for large solar installations (43), the problem of panel and e-waste disposal (10), the impact on habitats and wildlife (in particular, there are studies on panthers and birdlife) (e.g. 46, 60), the risk of disasters due to land changes (22), etc.

7) Citizens' involvement

In accordance with the keyword analysis of Fig. 2, a factor of particular relevance (27 %) is environmental justice: it includes the recognition and/or participation of stakeholders and the acknowledgment of their objectives in the decision-making and management processes of solar energy initiatives. We underline that these are often cases

involving indigenous communities (e.g. 46, 64, 67). Several of these studies (63 %) show that the consultation and inclusion of communities in the decision-making process is a key element for the acceptance and informed management of projects (e.g. 4, 33). On the other hand, some studies (39 %) highlight different cases of injustice related to solar energy projects: decisions are made without the full knowledge and acceptance of community members (70); concerns about the operation of the plants with respect to nature, culture, and the community itself are not taken into account (64); some communities are involved in the processes while others are not (73); the people are only involved in the last part of the process when everything has already been decided (64); stakeholders are consulted, but without being substantially informed (102).

8) Spatial issues

Another factor considered in the literature (24 %) is the availability of space and the geomorphological characteristics of an area. In addition to weather conditions or average levels of solar radiation (e.g. 84, 148), this requires taking into account favourable conditions (53 %), such as the existence or need for space (think for example to roofs in urban areas or to the availability of land suitable for solar parks) (e.g. 63, 137), as well as particular geomorphological features, in order to install the infrastructure and technology required to generate solar energy (e.g. 1, 32, 39, 62). Moreover, one positive case highlights how solar power plants can be supported by being adapted to already developed spaces (former landfills or industrial sites) (77). In many cases (61 %), this is a contributing factor to opposition. This occurred, for example, when the presence of solar installations affects rainwater runoff due to imperfect earth movements and the topographical location of solar installations (36). Or, in urban contexts, when photovoltaic systems are installed without considering differences in housing type, also creating cases of distributive or procedural injustice (17).

9) Utilities' role

A further factor is related to the role of the energy services sector (23 %), that is of the public or private companies responsible for the generation, transfer, and supply of electricity. Only a few of these contributions (26 %) show cases where electricity companies have initiated proactive collaborations with solar companies and cases of actually productive knowledge exchanges (e.g. 11, 147). In this context, a lot of articles (80 %) underline utility issues that have impeded the deployment of solar, such as high costs in the production of prefabricated solar panels (26), utilities that have also developed strategies to curb small-scale photovoltaics (18), energy equipment companies whose construction work is often carried out by temporary workers with low skills and awareness of energy efficiency or clean energy (19), or the absence of electricity grid connections for the local population (36).

10) Finance

Financial processes include the raising of funds or investment in solar energy, as well as the channelling of various funds in the form of credit, loans, or invested capital for activities related to the generation, distribution, and consumption of solar energy. Not many articles (19 %) focus on the financial factor, although the keywords of Fig. 2 often referred to the economic world. Very few (18 %) highlight the role of development finance institutions as decisive in providing financial support for solar energy projects (e.g. 70, 131). On the other hand, other contributions (86 %) identify cases where perceived threats to the financial sustainability of solar energy utilities or the lack of incentives related to PV recycling created opposition to the development of the sector (e.g. 26, 54, 86, 127).

11) Communication

Agents implementing, promoting, or financing solar energy initiatives should take into account communication aspects. This requires the private or public agents involved to have fair communication practices, transparency, and that they guarantee the access to environmental information. The studies highlighting this component are only 15 %. As suggested by the 52 % of these articles, the information available on solar energy initiatives increases understanding and intention to adopt the technology (e.g. 5, 63). Conversely, lack of information, as well as lack of transparency in the approval phase of the initiative, implementation or financing processes, slow down or completely prevent its acceptance and adoption, as identified by 57 % of these articles (e.g. 36, 86). For example, when information on solar options is unclear, a gap is created between those who can afford accessing solar energy and those who cannot (119).

12) Power of energy companies

One factor that emerged from 15 % of the studies concerns the power that energy companies hold in defining, promoting, or blocking solar energy expansion. In some of these cases (9 %) the power of solar companies find support in different political factions and build alliances with other companies and sectors, influencing greater development towards solar expansion (e.g. 18, 118). On the other hand, some of these contributions show a strong power of the fossil or nuclear industry (95 %), sometimes in monopolistic contexts, which prevent the entry of other energy sources, contributing to consolidate the dependence of the fossil-based system (e.g. 68, 128, 148).

13) Bureaucracy

Among the factors that have been little emphasised in the literature surveyed (11 %) are those relating to routine procedures, the division of administrative work, professional management, hierarchical coordination and control, the chain of command, and judicial authority. Only 12 % of these articles point to a simplification of bureaucracy (52, 141). Put simply, in this group of articles, the bureaucratic aspects almost always create grounds for opposition to solar energy initiatives (88 %). Some authors refer to 'administrative bottlenecks' (115) that create liquidity problems for energy companies. Others, on the other hand, emphasise that the fragmentation between different government agencies created a barrier to the development of solar initiatives (19).

14) Colonialism and extractivism

The specific cases of colonialism and extractivism (10 %), i.e. those practices aimed at gaining total or partial political control over another country, occupying and economically exploiting it, need to be considered. Clearly, given the nature of these socio-political, economic, and cultural frameworks that involve the expropriation of land and the displacement of entire populations, these cases generate opposition (93 %) towards solar energy initiatives (e.g. 51, 64, 130, 146). Research in diverse settings illustrates how solar projects can provoke conflicts over land expropriation and resource allocation, disproportionately affecting marginalized communities and raising fundamental questions of environmental equity (e.g. 8, 103, 132). However, there are rare cases (7 %) in which the development of renewable energy initiatives has instead represented an attempt to gain political and material autonomy and spark a new phase of decolonisation (115).

15) Research and development (R&D)

In addition to technological and infrastructural aspects, some studies (8 %) highlight the role of (the presence or absence of) R&D investments in the application of available knowledge to solar energy expansion. In fact, some of these papers (67 %) identify a positive relation between R&D subsidies and the growth of energy production (e.g. 54, 97). On the

other hand, other of these contributions (33 %) emphasise that either too little R&D expenditure in the solar energy sector or the choice to invest in R&D in another energy sector (such as nuclear) negatively influence solar development (e.g. 26, 102, 147).

16) Landscape issues

A small proportion of studies (7 %) point to the direct and indirect, potential or visible impacts that solar energy initiatives could have on the quality of the landscape as a factor in opposing these projects. The landscape is considered from a cultural, environmental or productive point of view, with direct impacts on agricultural and tourist activities. Only 36 % of these studies underline the positive local perception of an installation, in which the interviewees believe that the landscape would be improved by the installation or that the presence of panels would have no impact on the landscape (e.g. 36, 116). However, the majority of this group of articles (73 %) highlight the negative impact of solar energy initiatives on the landscape (e.g. 96, 134), disfigurement or landscape obstruction.

17) Personal values and beliefs

A small percentage of studies (7 %) identify a further relevant factor supporting or opposing solar energy initiatives: people's values and beliefs. For example, 60 % of the studies highlight that people with an environmentalist tendency, linked to concern for the environment and pollution, will be more likely to adopt alternative energy solutions to fossil fuels and support decarbonisation policies (e.g. 27, 116). The remaining 80 %, on the other hand, emphasise that those with a more consumerist tendency will tend to oppose decarbonisation, also in view of possible increases in energy costs (e.g. 75, 111). Moreover, some cases (e.g. 70, 82) showed that a lack of trust in institutions and politicians hinder the adoption of solar energy.

18) Agricultural issues

In rural environments, the installation of solar energy infrastructure can have direct impacts on the availability of arable land and on the use of agricultural land, as shown by 7 % of the studies. Only one (10 %) of these shows that the implementation of solar energy initiatives does not compromise agriculture (36). However, all cases falling under this 7 % (100 %) generally refer to the dynamics of the expansion of large solar energy production infrastructures that come into competition with agricultural activities - for example, farmers choose to rent their land rather than continue with agricultural activities (e.g. 10, 41, 132). Although it remains marginal in our review, the impacts of the expansion of solar energy production in rural areas has - in both the Global South and North - raised concerns about the loss of agricultural land, the negative impact on harvests, and, consequently, engenders food security.

19) Media

Only a few studies (3 %) consider the role of the media in introducing or perpetuating stereotypes and ideas about energy transitions and/or renewables, influencing people's perceptions of solar energy initiatives. This means that such initiatives also enjoy public support through the narrative conveyed by the press, social media and other dissemination channels, as in 60 % of the cases identified in our review (e.g. 36, 54). Or an unfavourable media environment, recognised by 40 % of the studies, is an oppositional factor for the realisation of solar energy projects, creating a gap in awareness and/or acceptance in the socially constructed landscape (e.g. 98, 102).

20) Climate actions

One factor that has been largely underestimated (2 %) concerns all efforts to combat climate change and its impacts, such as the reduction of greenhouse gas emissions from the use of fossil fuels. The only cases (2, 137, 144) referring to this factor show support for solar initiatives through petitions, demonstrations or protests.

4. Discussion

Our review confirms several well-established findings in previous studies on solar energy diffusion, notably the centrality of governance structures, economic conditions, technological limitations, environmental concerns, and social acceptance. Within this complex system, the expansion of solar energy cannot be understood solely as a matter of technological feasibility or economic viability; it is deeply embedded in political, social, and environmental systems. Therefore, our work advances the existing literature by explicitly integrating supportive and oppositional dynamics within a unified analytical framework, identifying not only the enabling but also the constraining mechanisms that shape solar energy transitions across scales and contexts. Differently from other reviews, our study did not aim to provide a comparative analysis of certain factors (e.g., the regulatory environment) across a set of articles, but rather to highlight the various combination of factors along the solar energy chain. The following sections discuss the key points emerging from our analysis. References are cited for illustrative purposes, exemplifying broader thematic trends identified through the systematic review rather than serving as an exhaustive list.

4.1. Governance structures and multi-level opposition

Governance emerges as a defining factor in shaping the level of support or opposition to solar energy initiatives. Well-established policy frameworks, transparent regulatory structures, and financial incentives contribute significantly to acceptance, as exemplified by Germany, where structured governance mechanisms have facilitated widespread integration of solar energy [27]. However, opposition frequently arises in contexts where governance structures fail to ensure an equitable distribution of benefits or where decision-making processes exclude local communities. The literature suggests that resistance is not necessarily a rejection of solar energy itself but rather a response to how initiatives are planned, financed, and implemented. When solar energy is perceived as a top-down initiative that primarily benefits external investors while offering little to local communities, resistance tends to be stronger, particularly in cases involving land-use conflicts [29]. In this regard, Eitan [30] further conceptualises solar governance as a negotiated process involving trade-offs among regulatory stability, environmental protection, and market liberalisation.

This evidence is not new in the literature, but what has emerged here is that resistance is not purely local: it is often reinforced by multi-level obstruction networks that strategically mobilize narratives of land preservation, socio-economic protection, and cultural heritage to slow the pace of renewable energy expansion [31,32]. The literature suggests that these networks, while helping to organize and frame legitimate local concerns, can also serve as a defence mechanism for fossil fuel incumbents seeking to maintain the *status quo* [33]; [34]. At the national level, governance structures determine whether solar expansion is integrated into broader energy policies or remains a fragmented initiative subject to market fluctuations [35]. The systemic perspective adopted here of governance in solar energy reveals that institutional resistance from fossil fuel incumbents remains a significant challenge, even in countries with strong commitments to renewable energy. The lack of cohesive territorial planning and inclusive governance structures exacerbates resistance, reinforcing perceptions of solar energy expansion as an extractive, rather than participatory, process. For instance, Sareen et al. [36] show how governance fragmentation, power asymmetries, and incumbent control shape solar rollout across spatial scales. This suggests that support and opposition to solar energy must be analysed within a

complex economic, political, and cultural network where actors and their interdependent relationships shape the dynamics of energy transitions [37].

Moreover, as the global energy transition proceeds, solar energy is increasingly framed within a 'phase-in' rather than a 'phase-out' perspective aimed at overcoming the current carbon-centric socio-economic systems. While phase-in policies receive institutional backing, phase-out efforts encounter resistance from entrenched energy interests, delaying the transition [38]. This highlights the structural inertia of current dominant fossil fuel-based systems: rather than directly replacing fossil fuels, solar energy is introduced through policy incentives, market mechanisms, and technological advancements, allowing fossil-based systems to persist even as solar and other renewables gain traction [39]. Energy policies often favour continuity rather than disruptive change, reinforcing incremental adaptation over transformation [40]. This institutional inertia is exacerbated by regulatory capture and widespread fossil fuel subsidies that limit the competitiveness of solar energy.

One of the most important key points of our analysis is that the development of local solar energy is largely influenced by global economic trends, political frameworks, and broader geopolitical dynamics, reinforcing the idea that the deployment of solar energy cannot be analysed in isolation from the global energy system. The relationship, for example, between institutional opposition dynamics in several countries in the Global North, sometimes explicitly associated with climate denialism, cannot be explored in this paper; however, current developments confirm the need to situate this expansion within contentious political and discursive fields. Similarly, the role of the fossil fuel industry, whether in promoting solar energy or in discrediting its effectiveness, was also not made explicit in most of the articles analysed.

4.2. Institutional and social dimensions of acceptance

According to a different, analytical, yet complementary, perspective of discussion the types of solar energy initiatives attract various institutional and social positions based on their scale, purpose, and impact on local communities.

Economic structures and market conditions, for instance, play a significant role in shaping public and institutional attitudes toward solar energy. Recent meta-analyses confirm that social acceptance depends not only on economic or environmental factors but also on adaptive policy learning and reflexive governance frameworks [41]. While the cost of solar technology has declined substantially, financial barriers persist, particularly in lower-income regions, where high upfront investment costs limit adoption [42]. Many studies emphasise how market dependencies, government subsidies, and the structure of energy industries contribute to an exceedingly slow transition to solar energy (Yadav, Davies, Abdullah, 2018). The economic viability of solar initiatives depends on financial incentives, state subsidies, and investment frameworks, which create conditions for adoption but also reinforce economic dependencies on existing energy systems [39]. In regions where solar energy is framed as an opportunity for job creation, local economic development, and reduced energy costs, public support is stronger [43]. However, when economic benefits are unevenly distributed, resistance arises, particularly when revenues generated by solar initiatives flow to large corporations – most of the time multinational corporations – rather than benefiting local communities [2]. This issue is especially pronounced in large-scale solar projects that are promoted as sustainable solutions but fail to integrate equitable economic redistribution mechanisms. International investments in solar energy also play a key role in shaping national policies and local implementation, reinforcing the interconnected nature of global and local energy markets [44].

Environmental concerns present another dual-edged factor influencing support and opposition to solar energy. Although solar energy is widely recognised by scientific literature and the media for its benefits in

terms of sustainability, large-scale installations often generate resistance due to land use conflicts, biodiversity loss, and ecological disruptions [45]. The impact of solar farms on agricultural land has become a major source of contention, particularly in rural areas where concerns about food security and long-term land management persist [46]. The trade-off between energy production and agricultural viability is likely to become an increasing field of conflict as solar energy infrastructure expands [47]. Agrivoltaics solutions, which integrate solar energy production with farming activities, offer a potential compromise, but their implementation remains limited compared to conventional large-scale solar farms (Leskova et al., 2022). It is important to note that none of the studies included in our review explicitly addressed agrivoltaics (agri-PV). This absence is partly a consequence of our research criteria, which focused on social science perspectives and excluded primarily technical or engineering-oriented analyses, where agrivoltaics has been more extensively discussed. Therefore, the lack of evidence in our sample highlights both the limitations of our methodological approach and the need for future interdisciplinary research to investigate agrivoltaics as a potential means of reconciling solar energy production and agricultural land use, and possibly even greater social cohesion. In this regard, emerging perspectives propose more integrated models of solar development that combine energy generation with ecological and social functions, for instance, solar parks designed as multifunctional systems supporting biodiversity and grazing, reconciling solar energy production with the social justice of land use transformations [48]; [49].

Another emerging environmental concern is solar panel waste and the challenges of end-of-life disposal. The issue of recycling outdated photovoltaic systems remains largely overlooked in policy discussions, raising questions about the long-term sustainability of solar energy technologies. While climate action is often invoked as a justification for solar energy expansion, our approach suggests that it should not be considered an independent factor driving adoption. Instead, climate action efforts are mediated by governance structures, regulatory frameworks, and economic incentives, making it a secondary rather than a primary driver of solar transitions [50]. Landscape concerns also shape opposition to solar energy, particularly in regions where solar farms are perceived as altering cultural or natural heritage. However, the research suggests that the form and model of solar energy production, rather than landscape aesthetics alone, should be the focus of analysis [51].

Considering technological and infrastructural challenges, distributed solar energy systems (such as rooftop photovoltaic panels) tend to receive strong support as they provide households and businesses with greater energy independence, reduce reliance on centralized grids, and lower long-term energy costs [43]. In contrast, large-scale solar farms often generate resistance, particularly in rural areas where they compete with agricultural land, alter landscapes, and fail to deliver direct economic benefits to local populations [2]. Additionally, projects focused on solar panel production and disposal raise environmental concerns, as the issue of solar waste management and recycling remains largely unaddressed in policy discussions. These findings suggest that while solar energy is widely regarded as an environmentally beneficial alternative, localized ecological impacts and sustainability challenges must be proactively managed to prevent opposition. Moreover, our findings resonate with recent attempts to map the diversity of normative positions in conservation sciences, which demonstrate that debates around sustainability are underpinned by heterogeneous views on human-nature relationships, moral values, agency, and knowledge systems [12]. This perspective helps to explain why factors such as values, beliefs, and community involvement emerge as cross-cutting: opposition to solar projects may not simply reflect local economic or spatial concerns, but also deeper normative positions regarding the legitimacy of interventions, the acceptable degree of human influence on ecosystems, and the recognition of different types of knowledge.

Taken together, these insights largely confirm what previous studies have suggested about the importance of socio-economic conditions and governance arrangements for public acceptance of renewable energy (e.

g., Ref. [2,40]). However, our review adds a novel layer by systematically juxtaposing drivers of support and sources of opposition within the same analytical framework. This dual reading enables a more nuanced understanding of how acceptance is not merely the absence of resistance but the outcome of negotiated, and often contested, social processes. In doing so, we move beyond the descriptive identification of barriers or enablers and instead highlight their interdependence within the broader socio-technical system. References cited in this section should thus be interpreted as illustrative examples of these intertwined dynamics rather than as exhaustive evidence of their occurrence.

4.3. Geographical implications and future directions

The geographical distribution of support and opposition to solar energy reflects differences in policy environments, economic structures, and social perceptions. A limitation of our study is that it is based on academic literature in English, resulting in poor representation of perspectives from the Global South. This choice, linked both to the authors' linguistic limitations and to a decision not to use artificial intelligence tools in the data collection and analysis processes, nevertheless allowed us to gain a more general overview of case studies around the world and reflect on various aspects.

In a general overview of the articles analysed, solar energy enjoys strong support due to well-established policy frameworks, though opposition emerges when large-scale projects disrupt local land use or fail to distribute economic benefits equitably in the European context [27]. In North America, particularly in the U.S., solar energy remains highly politicized, with progressive states promoting aggressive solar policies while others maintain regulatory frameworks favouring fossil fuels [44]. In Asia, particularly in China and India, government-led solar initiatives have driven large-scale adoption, though opposition emerges in cases of land dispossession and lack of local economic inclusion [52]. In Africa and Latin America, solar energy is often framed as a solution to energy access challenges, yet resistance can arise when projects are perceived as externally controlled and as reinforcing economic dependencies rather than fostering local energy sovereignty [28].

Despite the increasing body of research on support and opposition to solar energy, several gaps remain. The literature is heavily concentrated in Europe, North America, and parts of Asia, with significantly less focus on Africa, Latin America, and Oceania [28]. Given that solar energy is frequently framed as a solution for energy access in developing regions, more research is needed to assess how local communities in these areas perceive solar projects and whether these initiatives align with regional development needs (Barragan-Contreras, 2021). This reflects recent calls to situate solar expansion within multi-scalar governance and land-tenure frameworks that recognize the interplay between global energy markets and local rights [36]; [53]. The intersection of solar energy expansion with social justice issues, particularly in relation to marginalized communities, indigenous land rights, and gender disparities in energy access, remains underexplored [33]. The role of media and public narratives in shaping perceptions of solar energy is also an area that requires further investigation, as misinformation and lack of transparency can significantly influence public acceptance [44].

From a policy perspective several recommendations emerge from the literature review carried out. Greater community involvement, financial accessibility, and environmental accountability appear to be key to fostering support to solar energy and mitigating resistance, as public perception and trust in the fairness of transitions significantly influence acceptance [54]. Transparent decision-making processes, participatory planning, and equitable distribution of economic benefits can help prevent opposition and build local trust [33]. Financial mechanisms should be designed to make solar energy more accessible to lower-income households and small businesses, ensuring that the transition to renewable energy is inclusive rather than exacerbating existing inequalities [55]. Environmental regulations must address concerns related to land use and biodiversity, integrating sustainability measures

into large-scale solar development and promoting strategies for recycling and disposal of solar panel waste [2]. Additionally, correcting market distortions that favour fossil fuels seems essential to ensuring that solar energy can compete fairly in global energy markets [56]. As this review demonstrates, several factors are crucial for the adoption of solar energy. However, unlike most previous studies that examined these factors in isolation, our analysis highlights that successful expansion depends on their cross-cutting interaction over time and across spatial scales. This integrated and relational perspective represents one of the distinctive contributions of our study.

Looking ahead, support and opposition to solar energy will likely be shaped by technological advancements, evolving policy frameworks, and shifts in public awareness. Innovations in energy storage, smart grids, and hybrid renewable systems have the potential to address some of the current barriers to solar adoption, improving reliability and reducing concerns about intermittency [57]. As more governments commit to decarbonisation goals, increased political and financial support for solar energy is expected, which could further enhance public acceptance. However, the success of these initiatives will depend on ensuring that transitions to solar energy are not only technologically and economically viable but also socially inclusive and environmentally responsible. Future research should focus on closing existing knowledge gaps, particularly in underrepresented regions, and on understanding how solar energy transitions can be designed to maximize both public support and long-term sustainability. In this sense, we suggest that one of the directions of comparative work on the dynamics of energy transition should be to compare the various combinations of factors in a contextualized way, thus avoiding the assumption that some contexts (e. g., solar energy in the U.S.) can serve as exemplary cases for evaluating other cases or mirroring themselves as models. By addressing these challenges proactively, solar energy can continue to expand as a key component of the global energy transition while minimizing the resistance that has accompanied its development in certain contexts.

5. Conclusions

Ten years after the Paris Agreement, instead of attempting to provide an exhaustive review of the literature on the subject, our study aims to systematically examine the factors driving support for and opposition to solar energy initiatives. Based on the literature published since 2015, this study takes a contextual approach to the problem, without advocating a pre-established hierarchy of factors (such as the importance of the market and technology, which dominate the field of transition studies). Rather than an evolutionary analysis of this expansion, we opt for a relational perspective of a contentious field.

The systemic perspective adopted here for the review reveals the complex and multidimensional nature of support for and opposition to solar energy initiatives, demonstrating that their diffusion is not simply determined by technological or economic feasibility, but is deeply rooted in broader sociopolitical, environmental, and governance contexts. Although the expansion of solar energy is often framed as an essential step towards a sustainable future, its implementation is constrained by a combination of factors that constitute elements of support or opposition to its adoption. Addressing these constraints is a prerequisite for reducing potential barriers to expansion.

Based on evidence from our systemic perspective, it seems safe to say that overcoming opposition to solar energy initiatives requires a multifaceted and combinatorial approach that allows for contextual assessment and treatment of critical points of opposition; combining participatory governance, equitable economic policies, environmental responsibility, and effective communication may be appropriate in cases where these aspects appear as barriers to expansion—but it certainly cannot be considered a model to be followed in all contexts. It is up to researchers to delve deeper into the contextual aspects and situated contestations to outline where and why this opposition consolidates and gains strength.

The evidence gathered in this review suggests that opposition is rarely due to outright rejection of solar energy itself but rather stems from concerns over how initiatives are planned, financed, and implemented. Ensuring that these initiatives are designed with the active involvement of local communities, particularly those directly affected by large-scale projects, can help reduce resistance and enhance the social legitimacy of renewable energy transitions. Transparent governance, fair economic distribution, and proactive environmental safeguards are all critical elements in fostering greater public acceptance and minimizing conflict.

We believe that the insights derived from this review have important practical applications for policymakers, industry stakeholders, and researchers in the renewable energy sector. By identifying the key factors influencing support and opposition, decision-makers can design more effective policies that address economic, social, and environmental concerns in a holistic manner. For governments and regulators, the findings emphasise the importance of stable policy environments, clear legal frameworks, and financial mechanisms that make solar energy accessible to a broader range of stakeholders. For industry leaders, understanding the sources of opposition can inform better engagement strategies, ensuring that solar initiatives are not only technically and economically viable but also socially inclusive and environmentally responsible. The review also contributes to the academic discourse on energy transitions, highlighting the need for interdisciplinary research that integrates political science, economics, environmental studies, and social sciences to develop a more comprehensive understanding of the challenges and opportunities associated with solar energy deployment.

Further research is needed to address the geographical imbalances in the literature, as the majority of studies analysed in this review focus on Europe, North America, and parts of Asia, with relatively little attention given to Africa, Latin America, and Oceania. Given that solar energy is frequently promoted as a solution for energy access in developing regions, understanding how different socio-economic and political contexts influence its adoption is essential. Future studies should also explore the intersection of solar energy expansion with social justice issues, including the impacts on marginalized communities, indigenous land rights, and gender disparities in energy access. Additionally, the evolving role of digital and social media in shaping public attitudes toward renewable energy remains an underexplored area that could provide valuable insights into communication strategies for promoting solar energy transitions.

Technological advancements in energy storage, smart grids, and hybrid renewable systems are likely to play an increasingly important role in shaping the future of solar energy. Addressing concerns about intermittency and grid reliability through innovations in energy storage and distribution can further enhance the feasibility of large-scale solar adoption. As governments and industries continue to refine their approaches to energy transition, integrating technological, economic, and social dimensions into policy frameworks will be crucial for ensuring a just and sustainable shift toward solar energy.

In conclusion, the expansion of solar energy is a complex process that requires balancing multiple interests and addressing various challenges. Although opposition remains a significant barrier, our analysis suggests some directions from both an analytical and political perspective: first, it seems necessary to start from the complex nature of these dynamics; this means avoiding attributing primary importance to one factor without considering in concrete terms how other aspects (factors) may play a crucial role in opposition/acceptance; from a political point of view, this means greater sensitivity to the tangle of interests present, as well as the need for cross-cutting action that can hold these interests together (such as inclusive governance, fair economic policies, environmental responsibility, etc.). Ensuring that the expansion of solar energy is not only technologically and economically viable, but also socially equitable and environmentally responsible, will be critical to securing a future in which renewable energy plays a central role in meeting global energy demands. By proactively addressing concerns that generate opposition

and promoting greater public engagement, the path to a solar-powered future can become more inclusive, resilient, and sustainable.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

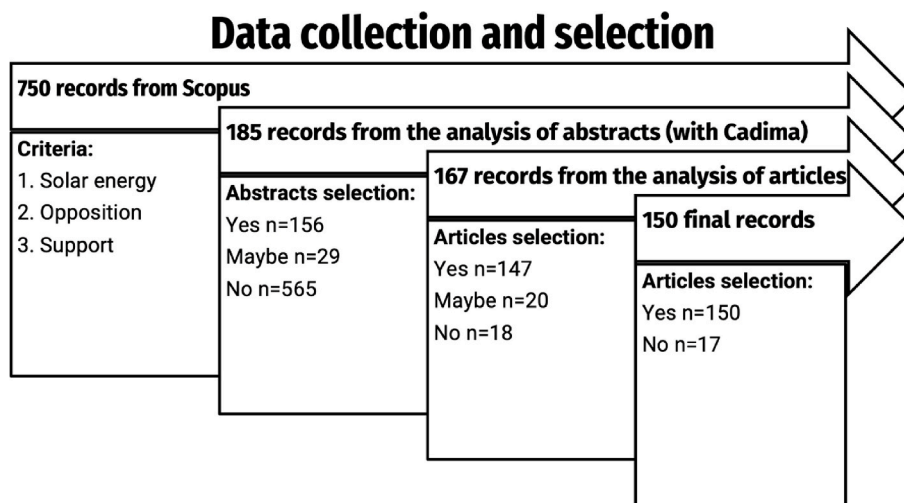
The research activities leading to this contribution were carried out

within the framework of the project of major national interest (Progetti di Rilevante Interesse Nazionale, PRIN) Solar ENergy Expansion Strategies (ScENES), protocol number 20224HPEJP - CUP H53D23004890006. Although the design, analysis and drafting are the result of a joint effort, for the purposes of scientific evaluation, the paragraphs are to be attributed as follows: section 1 was written by Daniel Delatin Rodrigues, sections 2 and 3 by Stefania Benetti, sections 4 and 5 by Daniel Delatin Rodrigues and Marco Grasso. The authors declare that artificial intelligence (ChatGPT) was used solely for linguistic review purposes.

Appendix I. Search strings used on Scopus

TITLE-ABS-KEY (“solar” AND “energ*”) AND (“transition*” OR “transformation*”) AND (“support*” OR “opportunit*” OR “justic*” OR “diffusion*”) OR (“opposition*” OR “resistance*” OR “protest*” OR “conflict*”)) AND PUBYEAR >2015 AND PUBYEAR <2025 AND (LIMIT-TO (DOCTYPE, “ar”) OR LIMIT-TO (DOCTYPE, “re”)) AND (LIMIT-TO (PUBSTAGE, “final”)) AND (EXCLUDE (LANGUAGE, “Korean”) OR EXCLUDE (LANGUAGE, “Russian”) OR EXCLUDE (LANGUAGE, “Chinese”)) AND (EXCLUDE (SUBJAREA, “ENGI”) OR EXCLUDE (SUBJAREA, “MATE”) OR EXCLUDE (SUBJAREA, “CHEM”) OR EXCLUDE (SUBJAREA, “PHYS”) OR EXCLUDE (SUBJAREA, “CENG”) OR EXCLUDE (SUBJAREA, “EART”) OR EXCLUDE (SUBJAREA, “COMP”) OR EXCLUDE (SUBJAREA, “BIOC”) OR EXCLUDE (SUBJAREA, “MEDI”) OR EXCLUDE (SUBJAREA, “PHAR”) OR EXCLUDE (SUBJAREA, “DENT”) OR EXCLUDE (SUBJAREA, “NURS”) OR EXCLUDE (SUBJAREA, “NEUR”) OR EXCLUDE (SUBJAREA, “IMMU”))

Appendix II. Process of data collection and selection.



Appendix III. List of final references

N	AUTHOR	TITLE	YEAR	JOURNAL
1	Betancur, S.; Ortega-Avila, N.; López-Vidaña, E.C.	Strengths, Weaknesses, Opportunities, and Threats Analysis for the Strengthening of Solar Thermal Energy in Colombia	2024	Resources
2	Fan, M.-F.	Reclaiming energy justice in Taiwan? Insights on deliberation democracy from the Thao Tribe’s renewable energy initiative	2024	Energy Research & Social Science
3	Hampp, J.	Flexing with lines or pipes: Techno-economic comparison of renewable electricity import options for European research facilities	2024	PLoS One
4	Khadka, M.; Uprety, L.; Shrestha, G.; Shakya, S.; Mitra, A.; Mukherji, A.	Can water, energy, and food policies in support of solar irrigation enable gender transformative changes? Evidence from policy analysis in Bangladesh and Nepal	2024	Frontiers in Sustainable Food Systems
5	Kyere, F.; Dongying, S.; Bampoe, G.D.; Kumah, N.Y.G.; Asante, D.	Decoding the shift: Assessing household energy transition and unravelling the reasons for resistance or adoption of solar photovoltaic	2024	Technological Forecasting and Social Change
6	Leduchowicz-Municio, A.; Domenech, B.; Ferrer-Martí, L.; Udaeta, M.E.M.; Gimenes, A.L.V.	What are the key strategies for a successful and fair energy transition for all? Multi-criteria assessment of isolated case studies in São Paulo	2024	Environmental Innovation and Societal Transitions

(continued on next page)

(continued)

N	AUTHOR	TITLE	YEAR	JOURNAL
7	Lohani, S.P.; Gurung, P.; Gautam, B.; Kafle, U.; Fulford, D.; Jeuland, M.	Current status, prospects, and implications of renewable energy for achieving sustainable development goals in Nepal	2024	Sustainable Development
8	Nilson, R.S.; Stedman, R.C.	Reacting to the Rural Burden: Understanding Opposition to Utility-Scale Solar Development in Upstate New York	2023	Rural Sociology
9	Scovell, M.; McCrear, R.; Walton, A.; Poruschi, L.	Local acceptance of solar farms: The impact of energy narratives	2024	Renewable and Sustainable Energy Reviews
10	Stock, R.; Sovacool, B.K.	Blinded by sunspots: Revealing the multidimensional and intersectional inequities of solar energy in India	2024	Global Environmental Change
11	Altunay, M.; Bergek, A.	Interaction between energy incumbents and solar entrants: Relationship status complicated	2023	Environmental Innovation and Societal Transitions
12	Ascensão, F.; Chozas, S.; Serrano, H.; Branquinho, C.	Mapping potential conflicts between photovoltaic installations and biodiversity conservation	2023	Biological Conservation
13	Best, R.; Chareunsy, A.; Taylor, M.	Changes in inequality for solar panel uptake by Australian homeowners	2023	Ecological Economics
14	Brown, M.A.; Kale, S.; Anthony, R.	Rescaling energy burden: Using household surveys to examine vulnerabilities and consequences in the Southeastern United States	2023	Energy Research & Social Science
15	Cranmer, Z.; Steinfield, L.; Miranda, J.; Stohler, T.	Energy distributive injustices: Assessing the demographics of communities surrounding renewable and fossil fuel power plants in the United States	2023	Energy Research & Social Science
16	Grubert, E.	Results from a survey of life cycle assessment-aligned socioenvironmental priorities in US and Australian communities hosting oil, natural gas, coal, and solar thermal energy production	2023	Environmental Research: Infrastructure and Sustainability
17	Hartvigsson, E.; Nyholm, E.; Johnsson, F.	Does the current electricity grid support a just energy transition? Exploring social and economic dimensions of grid capacity for residential solar photovoltaic in Sweden	2023	Energy Research & Social Science
18	Hess, D.J.	Conflict and uneven development in the multidecade distributed solar energy transition in the United States	2023	Proceedings of the National Academy of Sciences
19	Hove, A.	Synergies between China's Whole County photovoltaic program and rural heat pump adoption	2023	Wiley Interdisciplinary Reviews: Energy and Environment
20	Hu, Z.	Towards solar extractivism? A political ecology understanding of the solar energy and agriculture boom in rural China	2023	Energy Research & Social Science
21	Kazmierczuk, K.; Henderson, C.; Duffy, K.; Hanif, S.; Bhattacharya, S.; Biswas, S.; Jacroux, E.; Preziuso, D.; Wu, D.; Bhatnagar, D.; Tarekne, B.	A socio-technical assessment of marine renewable energy potential in coastal communities	2023	Energy Research & Social Science
22	Kohsaka, R.; Kohyama, S.	Contested renewable energy sites due to landscape and socio-ecological barriers: Comparison of wind and solar power installation cases in Japan	2023	Energy and Environment
23	Koutra, S.; Bouillard, P.; Becue, V.; Cenci, J.; Zhang, J.	From 'brown' to 'bright': Key issues and challenges in former industrialized areas	2023	Land Use Policy
24	Lindberg, M.B.; Inderberg, T.H.J.	Just sharing? Energy injustices in the Norwegian solar policy mix for collective prosuming	2023	Energy Research & Social Science
25	Nguyen, T.D.; Le, H.T.H.; Bui, H.M.	The Development of Solar Electric Power in Vietnam From Economy and Policy Analysis	2023	Polish Journal of Environmental Studies
26	Niekurzak, M.; Brelik, A.; Lewicki, W.	Economic potential of recovery and recycling of Silicone photovoltaics cells and non-ferrous metals as part of the transition towards a circular economy	2023	Economics and Environment
27	Ruokamo, E.; Laukkanen, M.; Karhinen, S.; Kopsakangas-Savolainen, M.; Svento, R.	Innovators, followers and laggards in home solar PV: Factors driving diffusion in Finland	2023	Energy Research & Social Science
28	Saleh, M.N.; Upham, P.	Sociotechnical misalignments and micro-renewables adoption: The case of distributed solar PV in Pakistan	2023	Renewable and Sustainable
29	Stock, R.; Sovacool, B.K.	Left in the dark: Colonial racial capitalism and solar energy transitions in India	2023	Energy Research & Social Science
30	Van Opstal, W.; Smeets, A.	When do circular business models resolve barriers to residential solar PV adoption? Evidence from survey data in Flanders	2023	Energy Policy
31	Zhang, Y.; Chang, R.; Zuo, J.; Shabunko, V.; Zheng, X.	Regional disparity of residential solar panel diffusion in Australia: The roles of socio-economic factors	2023	Renewable Energy
32	Akçaba, S.; Eminer, F.	Sustainable energy planning for the aspiration to transition from fossil energy to renewable energy in Northern Cyprus	2022	Heliyon
33	Barbosa-Gómez, L.; Cañizo, C.D.; Revuelta, G.	Participatory citizen science in solar energy research: going beyond data collection to promote the energy transition	2022	Journal of Science Communication
34	Brunet, C.; Bouchard, M. A.; Baptiste, P.; Savadogo, O.; Sokona, Y., & Merveille, N.	Will solar energy escape the natural "resource curse"?	2022	Energy Strategy Reviews
35	Brunet, C.; Bouchard, M.A.; Baptiste, P.; Savadogo, O.; Sokona, Y.; Merveille, N.	Will solar energy escape the natural "resource curse"?	2022	Energy Strategy Reviews
36	Brunet, C.; Savadogo, O.; Baptiste, P.; Bouchard, M.A.; Cholez, C.; Rosei, F.; Gendron, C.; Sinclair-Desgagné, B.; Merveille, N.	Does solar energy reduce poverty or increase energy security? A comparative analysis of sustainability impacts of on-grid power plants in Burkina Faso, Madagascar, Morocco, Rwanda, Senegal and South Africa	2022	Energy Research & Social Science
37	Butu, A.I.; Strachan, P.	Navigating Pathways for Community Renewable Electricity in Rural Areas: Stakeholders' Perspectives on the Shape Community Project, Nigeria	2022	International Journal of Sustainable Energy Planning and Management
38	Dutt, D.; Ranjan, A.	Towards a just energy transition in Delhi: Addressing the bias in the rooftop solar market	2022	Energy Policy
39	Forget, M.; Bos, V.	Harvesting lithium and sun in the Andes: Exploring energy justice and the new materialities of energy transitions	2022	Energy Research & Social Science

(continued on next page)

(continued)

N	AUTHOR	TITLE	YEAR	JOURNAL
40	Gaman, F.; Iacoboaia, C.; Aldea, M.; Luca, O.; Stănescu, A.A.; Boteanu, C.M.	Energy Transition in Marginalized Urban Areas: The Case of Romania	2022	Sustainability
41	Kanger, L.; Sovacool, B.K.	Towards a multi-scalar and multi-horizon framework of energy injustice: A whole systems analysis of Estonian energy transition	2022	Political Geography
42	Keady, W.; Panikkar, B.; Nelson, I.L.; Zia, A.	Energy justice gaps in renewable energy transition policy initiatives in Vermont	2022	Integrated Research on Energy, Environment and Society
43	Kim, J.; Park, E.; Song, C.; Hong, M.; Jo, H.-W.; Lee, W.-K.	How to manage land use conflict between ecosystem and sustainable energy for low carbon transition?: Net present value analysis for ecosystem service and energy supply	2022	Frontiers in Environmental Science
44	Kitzing, L.; Siddique, M.B.; Nygaard, I.; Kruger, W.	Worth the wait: How South Africa's renewable energy auctions perform compared to Europe's leading countries	2022	Energy Policy
45	Lee, J.; Jun, S.-P.; Lee, C.	Does demand-side innovation policy drive lock-in? Global evidence from solar energy in 155 countries	2022	Energy Research & Social Science
46	Leskova, O.V.; Frakes, R.A.; Markwith, S.H.	Impacting habitat connectivity of the endangered Florida panther for the transition to utility-scale solar energy	2022	Journal of Applied Ecology
47	Li, J.; Chen, C.-F.; Walzem, A.; Nelson, H.; Shuai, C.	National goals or sense of community? Exploring the social-psychological influence of household solar energy adoption in rural China	2022	Energy Research & Social Science
48	Löhr, K.; Matavel, C.E.; Tadesse, S.; Yazdanpanah, M.; Sieber, S.; Komendantova, N.	Just Energy Transition: Learning from the Past for a More Just and Sustainable Hydrogen Transition in West Africa	2022	Land
49	Lucchi, E.	Integration between photovoltaic systems and cultural heritage: A socio-technical comparison of international policies, design criteria, applications, and innovation developments	2022	Energy Policy
50	Nilson, R.S.; Stedman, R.C.	Are big and small solar separate things?: The importance of scale in public support for solar energy development in upstate New York	2022	Energy Research & Social Science
51	Nuru, J.T.; Rhoades, J.L.; Sovacool, B.K.	Virtue or vice? Solar micro-grids and the dualistic nature of low-carbon energy transitions in rural Ghana	2022	Energy Research & Social Science
52	Palm, A.	Innovation systems for technology diffusion: An analytical framework and two case studies	2022	Technological Forecasting and Social Change
53	Saleh, N.; Upham, P.	Socio-technical Inertia: Understanding the Barriers to Distributed Generation in Pakistan	2022	Economics of Energy and Environmental Policy
54	Schaube, P.; Ise, A.; Clementi, L.	Distributed photovoltaic generation in Argentina: An analysis based on the technical innovation system framework	2022	Technology in Society
55	Sovacool, B.K.; Barnacle, M.L.; Smith, A.; Brisbois, M. C.	Towards improved solar energy justice: Exploring the complex inequities of household adoption of photovoltaic panels	2022	Energy Policy
56	Stewart, F.	Friends with benefits: How income and peer diffusion combine to create an inequality "trap" in the uptake of low-carbon technologies	2022	Energy Policy
57	Tomasi, S.	The (Non) impact of the Spanish "Tax on the Sun" on photovoltaics prosumers uptake	2022	Energy Policy
58	Wang, H.-W.; Dodd, A.; Ko, Y.	Resolving the conflict of greens: A GIS-based and participatory least-conflict siting framework for solar energy development in southwest Taiwan	2022	Renewable Energy
59	Wilson, S.	Hacking the Techno-Transition: The Possibilities of Deep Energy Literacy	2022	SociálnÍ studia/Social Studies
60	Zaplata, M.K.; Dullau, S.	Applying Ecological Succession Theory to Birds in Solar Parks: An Approach to Address Protection and Planning	2022	Land
61	Andersson, J.; Hellsmark, H.; Sandén, B.	Photovoltaics in Sweden – Success or failure?	2021	Renewable and Sustainable Energy Reviews
62	Avila, S.; Deniau, Y.; Sorman, A.H.; McCarthy, J.	(Counter)mapping renewables: Space, justice, and politics of wind and solar power in Mexico	2021	Environment and Planning E: Nature and Space
63	Balta-Ozkan, N.; Yildirim, J.; Connor, P.M.; Truckell, I.; Hart, P.	Energy transition at local level: Analyzing the role of peer effects and socio-economic factors on UK solar photovoltaic deployment	2021	Energy Policy
64	Barragan-Contreras, S.J.	Procedural injustices in large-scale solar energy: a case study in the Mayan region of Yucatan, Mexico	2021	Journal of Environmental Policy & Planning
65	Bedi, H.P.	Solar power for some? Energy transition injustices in Kerala, India	2021	Environment and Planning E: Nature and Space
66	Erat, S.; Telli, A.; Ozkendir, O.M.; Demir, B.	Turkey's energy transition from fossil-based to renewable up to 2030: milestones, challenges and opportunities	2021	Clean Technologies and Environmental Policy
67	Fathoni, H.S.; Boer, R.	Battle over the sun: Resistance, tension, and divergence in enabling rooftop solar adoption in Indonesia	2021	Global Environmental Change
68	Fraser, T.	Does social capital boost or block renewable energy siting? South African solar politics in comparison	2021	Energy Research & Social Science
69	Haarbosch, S.W.; Kaufmann, M.; Veenman, S.	A Mismatch in Future Narratives? A Comparative Analysis Between Energy Futures in Policy and of Citizens	2021	Frontiers in Sustainable Cities
70	Haque, A.N.; Lemanski, C.; de Groot, J.	Why do low-income urban dwellers reject energy technologies? Exploring the socio-cultural acceptance of solar adoption in Mumbai and Cape Town	2021	Energy Research & Social Science
71	Huang, P.	When government-led experimentation meets social resistance? A case study of solar policy retreat in Shenzhen, China	2021	Energy Research & Social Science
72	Lo, K.	Can authoritarian regimes achieve just energy transition? Evidence from China's solar photovoltaic poverty alleviation initiative	2021	Energy Research & Social Science
73	Martiskainen, M.; Sovacool, B.K.; Hook, A.	Temporality, consumption, and conflict: exploring user-based injustices in European low-carbon transitions	2021	Technology Analysis and Strategic Management
74	McManamay, R.A.; Vernon, C.R.; Jager, H.I.	Global Biodiversity Implications of Alternative Electrification Strategies Under the Shared Socioeconomic Pathways	2021	Biological Conservation

(continued on next page)

(continued)

N	AUTHOR	TITLE	YEAR	JOURNAL
75	Miniard, D.; Attari, S.Z.	Turning a coal state to a green state: Identifying themes of support and opposition to decarbonize the energy system in the United States	2021	Energy Research & Social Science
76	Nordholm, A.; Sareen, S.	Scalar Containment of Energy Justice and Its Democratic Discontents: Solar Power and Energy Poverty Alleviation	2021	Frontiers in Sustainable Cities
77	Oyewo, A.S.; Solomon, A.A.; Bogdanov, D.; Aghahosseini, A.; Mensah, T.N.O.; Ram, M.; Breyer, C.	Just transition towards defossilised energy systems for developing economies: A case study of Ethiopia	2021	Renewable Energy
78	Pandey, P.; Sharma, A.	Knowledge politics, vulnerability and recognition-based justice: Public participation in renewable energy transitions in India	2021	Energy Research & Social Science
79	Qaisrani, M.A.; Wei, J.; Khan, L.A.	Potential and transition of concentrated solar power: A case study of China	2021	Sustainable Energy Technologies and Assessments
80	Sareen, S.; Haarstad, H.	Decision-making and scalar biases in solar photovoltaics roll-out	2021	Current Opinion in Environmental Sustainability
81	Sovacool, B.K.; Hess, D.J.; Cantoni, R.	Energy transitions from the cradle to the grave: A meta-theoretical framework integrating responsible innovation, social practices, and energy justice	2021	Energy Research & Social Science
82	Sovacool, B.K.; Turnheim, B.; Hook, A.; Brock, A.; Martiskainen, M.	Dispossessed by decarbonisation: Reducing vulnerability, injustice, and inequality in the lived experience of low-carbon pathways	2021	World Development
83	Wiehe, J.; Thiele, J.; Walter, A.; Hashemifarzad, A.; Zum Hingst, J.; von Haaren, C.	Nothing to regret: Reconciling renewable energies with human wellbeing and nature in the German Energy Transition	2021	International Journal of Energy Research
84	Zhuang, M.; Lu, X.; Peng, W.; Wang, Y.; Wang, J.; Nielsen, C.P.; McElroy, M.B.	Opportunities for household energy on the Qinghai-Tibet Plateau in line with United Nations' Sustainable Development Goals	2021	Renewable and Sustainable Energy Reviews
85	Do, T.N.; Burke, P.J.; Baldwin, K.G.H.; Nguyen, C.T.	Underlying drivers and barriers for solar photovoltaics diffusion: The case of Vietnam	2020	Energy Policy
86	Dutt, D.	Understanding the barriers to the diffusion of rooftop solar: A case study of Delhi (India)	2020	Energy Policy
87	Hess, D.J.; Lee, D.	Energy decentralization in California and New York: Conflicts in the politics of shared solar and community choice	2020	Renewable and Sustainable Energy Reviews
88	Johannsen, R.M.; Østergaard, P.A.; Hanlin, R.	Hybrid photovoltaic and wind mini-grids in Kenya: Techno-economic assessment and barriers to diffusion	2020	Energy for Sustainable Development
89	José de Castro Vieira, S.; Tapia Carpio, L.G.	The economic impact on residential fees associated with the expansion of grid-connected solar photovoltaic generators in Brazil	2020	Renewable Energy
90	Kla, A.B.	Regulating the energy "free riders"	2020	Boston University Law Review
91	Nicholls, J.	Technological intrusion and communicative renewal: The case of two rural solar farm developments in the UK	2020	Energy Policy
92	Ransan-Cooper, H.; Lovell, H.; Watson, P.; Harwood, A.; Hann, V.	Frustration, confusion and excitement: Mixed emotional responses to new household solar-battery systems in Australia	2020	Energy Research & Social Science
93	Rehbein, J.A.; Watson, J.E.M.; Lane, J.L.; Sonter, L.J.; Venter, O.; Atkinson, S.C.; Allan, J.R.	Renewable energy development threatens many globally important biodiversity areas	2020	Global Change Biology
94	Salim, A.M.; Alsyouf, I.	Development of renewable energy in the GCC region: status and challenges	2020	International Journal of Energy Sector Management
95	Sareen, S.	Metrics for an accountable energy transition? Legitimizing the governance of solar uptake	2020	Geoforum
96	Sharpton, T.; Lawrence, T.; Hall, M.	Drivers and barriers to public acceptance of future energy sources and grid expansion in the United States	2020	Renewable and Sustainable Energy Reviews
97	Xu, Q.; Dhaundiyal, S.; Guan, C.	Structural conflict under the new green dilemma: Inequalities in development of renewable energy for emerging economies	2020	Journal of Environmental Management
98	Yadav, P.; Davies, P.J.; Khan, S.	Breaking into the photovoltaic energy transition for rural and remote communities: challenging the impact of awareness norms and subsidy schemes	2020	Clean Technologies and Environmental Policy
99	Allen, E.; Lyons, H.; Stephens, J.C.	Women's leadership in renewable transformation, energy justice and energy democracy: Redistributing power	2019	Energy Research & Social Science
100	Alrashoud, K.; Tokimatsu, K.	Factors influencing social perception of residential solar photovoltaic systems in Saudi Arabia	2019	Sustainability
101	Aly, A.; Moner-Girona, M.; Szabó, S.; Pedersen, A.B.; Jensen, S.S.	Barriers to Large-scale Solar Power in Tanzania	2019	Energy for Sustainable Development
102	Antal, M.	How the regime hampered a transition to renewable electricity in Hungary	2019	Environmental Innovation and Societal Transitions
103	Bedi, H.P.	"Lead the district into the light": Solar energy infrastructure injustices in Kerala, India	2019	Global Transitions
104	Benasla, M.; Hess, D.; Allaoui, T.; Brahami, M.; Denai, M.	The transition towards a sustainable energy system in Europe: What role can North Africa's solar resources play?	2019	Energy Strategy Reviews
105	Boute, A.; Zhikharev, A.	Vested interests as driver of the clean energy transition: Evidence from Russia's solar energy policy	2019	Energy Policy
106	Brown, M.A.; Soni, A.; Lapsa, M.V.; Southworth, K.; Cox, M.	Low-income energy affordability in an era of U.S. energy abundance	2019	Progress in Energy
107	Carstens, D.D.D.S.; Cunha, S.K.D.	Challenges and opportunities for the growth of solar photovoltaic energy in Brazil	2019	Energy Policy
108	Curtin, J.; McInerney, C.; Gallachóir, B.; Salm, S.	Engaging local communities—What motivates Irish citizens to invest in distributed renewables?	2019	Energy Research & Social Science
109	Kamran, M.; Mudassar, M.; Abid, I.; Fazal, M.R.; Ahmed, S.R.; Abid, M.L.; Khalid, R.; Hussain, S.	Reconsidering the power structure of Pakistan	2019	International Journal of Renewable Energy Research
110	Kumar, A.; Ferdous, R.; Luque-Ayala, A.; McEwan, C.; Power, M.; Turner, B.; Bulkeley, H.	Solar energy for all? Understanding the successes and shortfalls through a critical comparative assessment of Bangladesh, Brazil, India, Mozambique, Sri Lanka and South Africa	2019	Energy Research & Social Science
111	Lee, D.; Hess, D.J.	Incumbent resistance and the solar transition: Changing opportunity structures and framing strategies	2019	Environmental Innovation and Societal Transitions

(continued on next page)

(continued)

N	AUTHOR	TITLE	YEAR	JOURNAL
112	Lukanov, B.R.; Krieger, E.M.	Distributed solar and environmental justice: Exploring the demographic and socio-economic trends of residential PV adoption in California	2019	Energy Policy
113	Mainzer, S.P.; Cole, C.A.; Flohr, T.	Deep decarbonisation and renewable energy in the Appalachian Mountains (DDREAM): a socio-ecological systems approach to evaluating ecological governance	2019	Socio-Ecological Practice Research
114	Mirzania, P.; Ford, A.; Andrews, D.; Ofori, G.; Maidment, G.	The impact of policy changes: The opportunities of Community Renewable Energy projects in the UK and the barriers they face	2019	Energy Policy
115	Rocher, L.; Verdeil, E.	Dynamics, tensions, resistance in solar energy development in Tunisia	2019	Energy Research & Social Science
116	Sherrin, K.; Parkins, J.R.; Owen, T.; Terashima, M.	Does noticing energy infrastructure influence public support for energy development? Evidence from a national survey in Canada	2019	Energy Research & Social Science
117	Shum, R.Y.	Heliopolitics: The international political economy of solar supply chains	2019	Energy Strategy Reviews
118	Sovacool, B.K.; Hook, A.; Martiskainen, M.; Baker, L.	The whole systems energy injustice of four European low-carbon transitions	2019	Global Environmental Change
119	Sovacool, B.K.; Lipson, M.M.; Chard, R.	Temporality, vulnerability, and energy justice in household low carbon innovations	2019	Energy Policy
120	Yadav, P.; Davies, P.J.; Sarkodie, S.A.	The prospects of decentralised solar energy home systems in rural communities: User experience, determinants, and impact of free solar power on the energy poverty cycle	2019	Energy Strategy Reviews
121	Yadav, P.; Malakar, Y.; Davies, P.J.	Multi-scalar energy transitions in rural households: Distributed photovoltaics as a circuit breaker to the energy poverty cycle in India	2019	Energy Research & Social Science
122	Zapata, S.; Castaneda, M.; Franco, C.J.; Dyrner, I.	Clean and secure power supply: A system dynamics based appraisal	2019	Energy Policy
123	Cross, J.; Murray, D.	The afterlives of solar power: Waste and repair off the grid in Kenya	2018	Energy Research & Social Science
124	De Onís, C.M.	Energy Colonialism Powers the Ongoing Unnatural Disaster in Puerto Rico	2018	Frontiers in Communication
125	Hill, D.; Connelly, S.	Community energies: Exploring the socio-political spatiality of energy transitions through the Clean Energy for Eternity campaign in New South Wales Australia	2018	Energy Research & Social Science
126	Huang, P.; Castán Broto, V.; Liu, Y.	From “transitions in cities” to “transitions of cities”: The diffusion and adoption of solar hot water systems in urban China	2018	Energy Research & Social Science
127	Knuth, S.	“Breakthroughs” for a green economy? Financialization and clean energy transition	2018	Energy Research & Social Science
128	Mayer, A.	The Fiscal Impacts of Energy: Perspectives from local governments in the Mountain West, USA	2018	Energy Policy
129	Sareen, S.	Energy distribution trajectories in two Western Indian states: Comparative politics and sectoral dynamics	2018	Energy Research & Social Science
130	Schmitt, T.M.	(Why) did Desertec fail? An interim analysis of a large-scale renewable energy infrastructure project from a Social Studies of Technology perspective	2018	Local Environment
131	Sica, D.; Malandrino, O.; Supino, S.; Testa, M.; Lucchetti, M.C.	Management of end-of-life photovoltaic panels as a step towards a circular economy	2018	Renewable and Sustainable Energy Reviews
132	Späth, L.	Large-scale photovoltaics? Yes please, but not like this! Insights on different perspectives underlying the trade-off between land use and renewable electricity development	2018	Energy Policy
133	Steffen, B.	The importance of project finance for renewable energy projects	2018	Energy Economics
134	Stephens, J.C.; Burke, M.J.; Gibian, B.; Jordi, E.; Watts, R.	Operationalizing Energy Democracy: Challenges and Opportunities in Vermont’s Renewable Energy Transformation	2018	Frontiers in Communication
135	Urban, F.; Siciliano, G.; Wallbott, L.; Lederer, M.; Dang Nguyen, A.	Green transformations in Vietnam’s energy sector	2018	Asia & the Pacific Policy Studies
136	Yadav, P.; Davies, P.J.; Abdullah, S.	Reforming capital subsidy scheme to finance energy transition for the below poverty line communities in rural India	2018	Energy for Sustainable Development
137	Cherp, A.; Vinichenko, V.; Jewell, J.; Suzuki, M.; Antal, M.	Comparing electricity transitions: A historical analysis of nuclear, wind and solar power in Germany and Japan	2017	Energy Policy
138	Ferroni, F.; Guekos, A.; Hopkirk, R.J.	Further considerations to: Energy Return on Energy Invested (EROEI) for photovoltaic solar systems in regions of moderate insolation	2017	Energy Policy
139	Irfan, M.; Iqbal, J.; Iqbal, A.; Iqbal, Z.; Riaz, R.A.; Mehmood, A.	Opportunities and challenges in control of smart grids – Pakistani perspective	2017	Renewable and Sustainable Energy Reviews
140	López Prol, J.; Steininger, K.W.	Photovoltaic self-consumption regulation in Spain: Profitability analysis and alternative regulation schemes	2017	Energy Policy
141	McEwan, C.	Spatial processes and politics of renewable energy transition: Land, zones and frictions in South Africa	2017	Political Geography
142	Rizzo, A.	Managing the energy transition in a tourism-driven economy: The case of Malta	2017	Sustainable Cities and Society
143	Cucchiella, F.; D’Adamo, I.; Gastaldi, M.	A profitability assessment of small-scale photovoltaic systems in an electricity market without subsidies	2016	Energy Conversion and Management
144	Hess, D.J.	The politics of niche-regime conflicts: Distributed solar energy in the United States	2016	Environmental Innovation and Societal Transitions
145	Mills, E.	Job creation and energy savings through a transition to modern off-grid lighting	2016	Energy for Sustainable Development
146	Rignall, K.E.	Solar power, state power, and the politics of energy transition in pre-Saharan Morocco	2016	Environment and Planning A
147	Rogers, T.	Development of innovation systems for small island states: A functional analysis of the Barbados solar water heater industry	2016	Energy for Sustainable Development

(continued on next page)

(continued)

N	AUTHOR	TITLE	YEAR	JOURNAL
148	Sgouridis, S.; Abdullah, A.; Griffiths, S.; Saygin, D.; Wagner, N.; Gielen, D.; Reinisch, H.; McQueen, D.	RE-mapping the UAE's energy transition: An economy-wide assessment of renewable energy options and their policy implications	2016	Renewable and Sustainable Energy Reviews
149		The construction of technology and place: Concentrating solar power conflicts in the United States	2016	Energy Research & Social Science
150	Calvert, K., & Mabee, W.	More solar farms or more bioenergy crops? Mapping and assessing potential land-use conflicts among renewable energy technologies in eastern Ontario, Canada	2015	Applied Geography

Appendix IV. Results: scientific journals of articles about solar energy support and opposition (n = 150)

Journal	N
Energy Research & Social Science	35
Energy Policy	22
Renewable and Sustainable Energy Reviews	8
Energy for Sustainable Development	5
Energy Strategy Reviews	5
Environmental Innovation and Societal Transitions	5
Renewable Energy	4
Global Environmental Change	3
Political Geography	3
Biological Conservation	2
Clean Technologies and Environmental Policy	2
Environment and Planning E: Nature and Space	2
Frontiers in Communication	2
Frontiers in Sustainable Cities	2
Land	2
Sustainability	2
Technological Forecasting and Social Change	2
Applied Geography	1
Asia & the Pacific Policy Studies	1
Boston University Law Review	1
Current Opinion in Environmental Sustainability	1
Ecological Economics	1
Economics and Environment	1
Economics of Energy and Environmental Policy	1
Energy and Environment	1
Energy Conversion and Management	1
Energy Economics	1
Environment and Planning A	1
Environmental Research: Infrastructure and Sustainability	1
Frontiers in Environmental Science	1
Frontiers in Sustainable Food Systems	1
Geoforum	1
Global Change Biology	1
Global Transitions	1
Heliyon	1
Integrated Research on Energy, Environment and Society	1
International Journal of Energy Research	1
International Journal of Energy Sector Management	1
International Journal of Renewable Energy Research	1
International Journal of Sustainable Energy Planning and Management	1
Journal of Applied Ecology	1
Journal of Environmental Management	1
Journal of Environmental Policy & Planning	1
Journal of Science Communication	1
Land Use Policy	1
PLoS One	1
Polish Journal of Environmental Studies	1
Proceedings of the National Academy of Sciences	1
Progress in Energy	1
Renewable and Sustainable Energy Transition	1
Resources	1
Rural Sociology	1
Sociální studia/Social Studies	1
Socio-Ecological Practice Research	1
Sustainable Cities and Society	1
Sustainable Development	1
Sustainable Energy Technologies and Assessments	1
Technology Analysis and Strategic Management	1
Technology in Society	1
Wiley Interdisciplinary Reviews: Energy and Environment	1
World Development	1

Data availability

Data will be made available on request.

References

- [1] IEA, Solar PV is set to become the largest renewable energy source by 2029. <https://www.iea.org/reports/solar-pv>, 2022.
- [2] R. Stock, B.K. Sovacool, Blinded by sunspots: revealing the multidimensional and intersectional inequities of solar energy in India, *Glob. Environ. Change* 84 (2024) 102796.
- [3] IRENA, Renewable Capacity Statistics 2025, International Renewable Energy Agency, Abu Dhabi, 2025. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2025/Mar/IRENA_DAT_RE_Capacity_Statistics_2025.pdf.
- [4] L. Zhang, S. Fu, J. Tian, J. Peng, A review of energy industry chain and energy supply chain, *Energies* 15 (23) (2022) 9246.
- [5] K.H. Solangi, M.R. Islam, R. Saidur, N.A. Rahim, H. Fayaz, A review on global solar energy policy, *Renew. Sustain. Energy Rev.* 15 (4) (2011) 2149–2163.
- [6] G.R. Timilsina, L. Kurdgelashvili, P.A. Narbel, Solar energy: markets, economics and policies, *Renew. Sustain. Energy Rev.* 16 (1) (2012) 449–465.
- [7] G.I. Iacobuță, C. Brandi, A. Dzebo, S.D.E. Duron, Aligning climate and sustainable development finance through an SDG lens. The role of development assistance in implementing the Paris Agreement, *Glob. Environ. Change* 74 (2022) 102509.
- [8] A. Roos, Global asymmetries in the rise of solar power: an LCA-based account of ecologically unequal exchange between Germany and China 2002–2018, *Ecol. Econ.* 199 (2022) 107484.
- [9] E. Kabir, P. Kumar, S. Kumar, A.A. Adelodun, K.H. Kim, Solar energy: potential and future prospects, *Renew. Sustain. Energy Rev.* 82 (2018) 894–900.
- [10] H.H. Pourasl, R.V. Barenji, V.M. Khojastehzad, Solar energy status in the world: a comprehensive review, *Energy Rep.* 10 (2023) 3474–3493.
- [11] L. Treasure, S.P. Sharp, S.S. Smart, G. Parker, A. Armstrong, Global assessment of solar park impacts on ecosystem services, *Progress in Energy* 7 (3) (2025) 032002.
- [12] R.C. Gbedomon, K.V. Salako, D. Delorme, M.A. Schlaepfer, Quantifying the diversity of normative positions in conservation sciences, *Conservation* 5 (3) (2025) 38.
- [13] D.H. Meadows, *Thinking in Systems: a Primer*, Chelsea Green Publishing, 2008.
- [14] J.H. Holland, *Complexity: a Very Short Introduction*, Oxford University Press, 2014.
- [15] F.W. Geels, Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study, *Res. Pol.* 31 (8–9) (2002) 1257–1274.
- [16] F.W. Geels, J. Schot, Typology of sociotechnical transition pathways, *Res. Pol.* 36 (3) (2007) 399–417.
- [17] C. Folke, Resilience: the emergence of a perspective for social–ecological systems analyses, *Glob. Environ. Change* 16 (3) (2006) 253–267.
- [18] C.A. Miller, J. Richter, J. O’Leary, Socio-energy systems design: a policy framework for energy transitions, *Energy Res. Social Sci.* 6 (2015) 29–40.
- [19] J.D. Harris, C.E. Quatman, M.M. Manring, R.A. Siston, D.C. Flanigan, How to write a systematic review, *Am. J. Sports Med.* 42 (11) (2014) 2761–2768.
- [20] Scopus. <https://www.scopus.com/home.uri>, 2024.
- [21] F. Nisha, S. Katara, Scopus: a tool for scholarly discovery, in: A. Festschrift (Ed.), *Management of Digital Information Resources*, 2024, pp. 385–395.
- [22] Cadima. <https://www.cadima.info>, 2024.
- [23] C. Kohl, E.J. McIntosh, S. Unger, N.R. Haddaway, S. Kecke, J. Schiemann, R. Wilhelm, Online tools supporting the conduct and reporting of systematic reviews and systematic maps: a case study on CADIMA and review of existing tools, *Environ. Evid.* 7 (2018) 1–17.
- [24] A. Bryman, *Social Research Methods*, Oxford University Press, New York-Oxford, 2016.
- [25] S. Benetti, D. Delatin Rodrigues, G. Grasso, Memorie Geografiche “Geografia E Patrimonio, in: S. Benetti, S. Cerutti, G. Pettenati, S. Benetti, S. Cerutti, G. Pettenati (Eds.), *Fattori Che Influenzano Le Transizioni Verso L’Energia Solare. Il Processo Di Una Revisione Sistemática Della Letteratura vol. 27, Società di Studi Geografici, Firenze*, 2025, pp. 655–661. https://iris.uniupo.it/retrieve/10657657-2940-40dd-ab09-5da6d0d94caf/Benetti%2c%20Delatin%20Rodrigues%2c%20Grasso%20%282025%29_SSG%20Patrimonio.pdf.
- [26] IEA, Renewables 2024. Analysis and forecast to 2030. <https://iea.blob.core.windows.net/assets/17033b62-07a5-4144-8dd0-651c6b6caa24/Renewables2024.pdf>, 2024.
- [27] J.A. Rehbein, J.E. Watson, J.L. Lane, L.J. Sonter, O. Venter, S.C. Atkinson, J. R. Allan, Renewable energy development threatens many globally important biodiversity areas, *Glob. Change Biol.* 26 (5) (2020) 3040–3051.
- [28] C. Brunet, M.A. Bouchard, R. Baptiste, O. Savadogo, Y. Sokona, N. Merveille, Will solar energy escape the natural “resource curse”, *Energy Strategy Rev.* 44 (2022) 101010.
- [29] E. Hartvigsson, E. Nyholm, F. Johnsson, Does the current electricity grid support a just energy transition? Exploring social and economic dimensions of grid capacity for residential solar photovoltaic in Sweden, *Energy Res. Social Sci.* 97 (2023) 102990.
- [30] A. Eitan, Negotiating the energy transition: governance trade-offs in solar deployment, *Energy Strategy Rev.* 61 (2025) 101854.
- [31] D. Lee, D.J. Hess, Incumbent resistance and the solar transition: changing opportunity structures and framing strategies, *Environ. Innov. Soc. Transit.* 33 (2019) 183–195.
- [32] D. Delatin Rodrigues, M. Grasso, The resistance to solar energy expansion in Italy: a systemic perspective, *Sustain. Sci.* 20 (2025) 1329–1342.
- [33] M. Martiskainen, B.K. Sovacool, A. Hook, Temporality, consumption, and conflict: exploring user-based injustices in European low-carbon transitions, *Technol. Anal. Strat. Manag.* 33 (7) (2021) 770–782.
- [34] C. McEwan, Spatial processes and politics of renewable energy transition: land, zones and frictions in South Africa, *Polit. Geogr.* 56 (2017) 1–12.
- [35] L. Rocher, É. Verdeil, Dynamics, tensions, resistance in solar energy development in Tunisia, *Energy Res. Social Sci.* 54 (2019) 236–244.
- [36] S. Sareen, S. Shokrgozar, J. McCarthy, S. Wolf, The dawn of solar photovoltaics: emergent political economies at the solar-agri-land nexus, *Sustain. Sci.* 20 (2025) 1271–1276.
- [37] L. Barbosa, C.D. Cañizo, G. Revuelta, Participatory citizen science in solar energy research: going beyond data collection to promote the energy transition, *Journal of Science Communication* 21 (2) (2022) N06.
- [38] M. Blondeel, J. Price, M. Bradshaw, S. Pye, P. Dodds, C. Kuzemko, G. Bridge, Global energy scenarios: a geopolitical reality check, *Glob. Environ. Change* 84 (2024) 102781.
- [39] W. Van Opstal, A. Smeets, When do circular business models resolve barriers to residential solar PV adoption? Evidence from survey data in Flanders, *Energy Policy* 182 (2023) 113761.
- [40] B.K. Sovacool, A. Hook, M. Martiskainen, A. Brock, B. Turnheim, The decarbonisation divide: contextualizing landscapes of low-carbon exploitation and toxicity in Africa, *Glob. Environ. Change* 60 (2020) 102028.
- [41] J. Osei, K. Brown, M. Nejati, Understanding the factors affecting social acceptance of solar energy technologies, *Energy Strategy Rev.* 61 (2025) 101861.
- [42] M.A. Brown, A. Soni, M.V. Lapsa, K. Southworth, M. Cox, Low-income energy affordability in an era of US energy abundance, *Progress in Energy* 1 (1) (2019) 012002.
- [43] E. Ruokamo, M. Laukkanen, S. Karhinen, M. Kopsakangas-Savolainen, R. Svento, Innovators, followers and laggards in home solar PV: factors driving diffusion in Finland, *Energy Res. Social Sci.* 102 (2023) 103183.
- [44] C. Brunet, O. Savadogo, P. Baptiste, M.A. Bouchard, C. Cholez, F. Rosei, N. Merveille, Does solar energy reduce poverty or increase energy security? A comparative analysis of sustainability impacts of on-grid power plants in Burkina Faso, Madagascar, Morocco, Rwanda, Senegal and South Africa, *Energy Res. Social Sci.* 87 (2022) 102212.
- [45] M.K. Zaplata, S. Dullau, Applying ecological succession theory to birds in solar parks: an approach to address protection and planning, *Land* 11 (5) (2022) 718.
- [46] R.S. Nilson, R.C. Stedman, Reacting to the rural burden: understanding opposition to utility-scale solar development in upstate New York, *Rural Sociol.* 88 (2) (2023) 578–605.
- [47] L. Späth, Large-scale photovoltaics? Yes please, but not like this! insights on different perspectives underlying the trade-off between land use and renewable electricity development, *Energy Policy* 122 (2018) 429–437.
- [48] M.K. Zaplata, Solar parks as livestock enclosures can become key to linking energy, biodiversity and society, *People Nat.* 5 (5) (2023) 1457–1463.
- [49] R. Vezzoni, Farming the sun: the political economy of agrivoltaics in the European Union, *Sustain. Sci.* 20 (2025) 1519–1534.
- [50] A. Aly, M. Moner-Girona, S. Szabó, A.B. Pedersen, S.S. Jensen, Barriers to large-scale solar power in Tanzania, *Energy Sustain. Dev.* 48 (2019) 43–58.
- [51] R. Kohsaka, S. Kohyama, Contested renewable energy sites due to landscape and socio-ecological barriers: comparison of wind and solar power installation cases in Japan, *Energy Environ.* 34 (7) (2023) 2619–2641.
- [52] P. Yadav, Y. Malakar, P.J. Davies, Multi-scalar energy transitions in rural households: distributed photovoltaics as a circuit breaker to the energy poverty cycle in India, *Energy Res. Social Sci.* 48 (2019) 1–12.
- [53] J. McCarthy, To own the land is to own the sunlight: the significance of land tenure for solar power, *Sustain. Sci.* 20 (2025) 1535–1539.
- [54] D. Petrovics, D. Huitema, M. Giezen, B. Vis, Scaling mechanisms of energy communities: a comparison of 28 initiatives, *Glob. Environ. Change* 84 (2024) 102780.
- [55] B.K. Sovacool, D.J. Hess, R. Cantoni, Energy transitions from the cradle to the grave: a meta-theoretical framework integrating responsible innovation, social practices, and energy justice, *Energy Res. Social Sci.* 75 (2021) 102027.
- [56] F. Kyere, S. Dongying, G.D. Bampoe, N.Y.G. Kumah, D. Asante, Decoding the shift: assessing household energy transition and unravelling the reasons for resistance or adoption of solar photovoltaic, *Technol. Forecast. Soc. Change* 198 (2024) 123030.
- [57] K. Kazimierczuk, C. Henderson, K. Duffy, S. Hanif, S. Bhattacharya, S. Biswas, B. Tarekegne, A socio-technical assessment of marine renewable energy potential in coastal communities, *Energy Res. Social Sci.* 100 (2023) 103098.