



Balancing sustainability and circular justice: The challenge of the energy transition

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ABSTRACT

The shift to renewable energy is no longer an option but a critical need for addressing climate change. Nevertheless, it frequently culminates in exacerbating existing socioeconomic disparities, disproportionately affecting already vulnerable communities. This study examines the intersection of the circular economy (CE), the energy transition, and justice concerns through a literature review of 169 publications. By employing a comprehensive approach to analyse the environmental and social implications of renewable energy generation, distribution, and waste treatment, it advocates for circular justice as a framework to mitigate the disparities that arise from such a shift. The findings emphasise the necessity of an inclusive strategy that incorporates distributive, procedural, and recognitional justice into circular energy practices. Additionally, the study highlights the importance of developing evaluation tools that balance sustainability with social equity, thereby promoting a decarbonised future that is equitable for all, globally inclusive, and resilient. Policymakers and industry leaders should advocate for social frameworks that guarantee equitable participation and outcomes, moving beyond an exclusive focus on resource efficiency. Looking ahead, future research should concentrate on advancing technologies that support sustainable, inclusive energy transitions on a global scale. Aligning technological innovation with justice is essential to ensure that the transition to a carbon-free future benefits all, particularly those who have been historically marginalised.

1. Introduction

The era of 'take, make, waste' is definitely over (Isenhour et al., 2023), and the traditional industrial linear paradigm promoting excessive consumerism and private ownership of commodities otherwise shared, is obsolete and unsustainable by now (MacArthur, 2013). This prevailing 'business as usual' model (Andersson and Gyberg, 2024), consisting of unfairly distributing the environmental and social costs associated with energy and primary material supply, and exacerbating issues such as waste, environmental pollution, and energy poverty (Ashton et al., 2022; Hickel and Slamersak, 2022), is being replaced by a new paradigm, which is circular by design. The concept of waste itself, which was historically meant as a solution to otherwise unsolvable problems, has evolved into an emblematic symbol of the dysfunctions of a system that produces beyond the Earth's regenerative capacity and is now forced to reckon with its own limitations. Similarly, from a societal perspective, the circular human sphere framework has recognised

poverty as a mismanaged consequence of societal systems (Schröder et al., 2020; Jaeger-Erben et al., 2021).

In alignment with the European Union's commitments specified in the 2030 Agenda for Sustainable Development, the European Commission launched the action plan "Closing the Loop" (European Commission, 2015), designed to promote sustainable consumption and production through a circular economy (CE). The EU promotes the transformation of waste management into sustainable material management, incorporating the concepts of the CE. This method seeks to improve energy efficiency, diminish dependence on imported resources, promote the extensive adoption of renewable energy, and provide economic opportunities and sustained competitiveness (Malinauskaitė and Jouhara, 2019). As suggested by Ghisellini et al. (2023), the CE transition incorporates the renewable energy transition, regarded as a crucial and advantageous strategy for fostering more sustainable, resilient, and potentially equitable economies and communities. The energy value chain is indeed widely recognised as being essential for ensuring the

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maintenance of environmental balance, economic development, and societal well-being (Szép et al., 2022). However, Martínez-Alier (2022) asserts that the industrial economy lacks circularity. Conversely, it is fundamentally entropic, leading to waste production and the necessity for new supplies of energy and materials from both old and novel 'commodity frontiers' (Martínez-Alier, 2022). Moreover, the environmental, social, and economic impacts encountered during the pursuit of sustainable development often present significant obstacles to attaining a sustainable energy transition, particularly in developing nations where infrastructural deficiencies are well-documented challenges (Preston and Lehne, 2017; Schröder et al., 2020).

Adopting a CE paradigm of 'borrow, use, return' offers a unique opportunity to alleviate these disparities by closing, slowing, and narrowing material and energy loops (Ellen MacArthur Foundation, 2021; Baiani et al., 2024; Multani and Bachus, 2024). This transition is not merely a technological shift to meet the demand for new products and services; it represents an ongoing social-ecological transformation that goes beyond growth-oriented and technology-driven solutions in favour of bottom-up social innovations (Stahel, 2016).

Notably, policy aims are frequently aligned with broad societal advantages, including enhanced energy supply, reduced consumption costs, and, more recently, the transition towards decarbonisation. However, Alford-Jones (2022) observes a propensity to overlook the 'uncomfortable linkage' between clean energy and project-specific injustices, including the neglect of local concerns, inequitable resource distribution and rights violations, generally recognised as inevitable externalities of successful development. By way of example, Repp et al. (2021) forecast that even if the implementation of circular processes in the textile industry will generate around 85,000 employment possibilities in the EU, such transition could also result in the elimination of around 756,000 employment opportunities in nations classified as low to upper-middle income.

Concerns regarding justice have received considerable attention in recent years, underscoring the pressing necessity to confront what numerous authors have defined the 'dark side' of the energy transition (e.g., Canelas and Carvalho, 2023; Wolters and Brusselaers, 2024). New ethical values and economic models that prioritize human well-being over profit are essential for preventing the continuation of existing inequalities and facilitating a successful transition to a CE. The potential of the CE to create new employment possibilities and improve human welfare is encouraging; nevertheless, it requires a comprehensive consideration of the distribution of costs and benefits across various social groups (Fratini et al., 2019). Incorporating social justice into the CE framework requires addressing diverse socio-cultural needs and impacts across different regions (Bhugra, 2016), including the marginalisation of disadvantaged groups in policy and planning processes, as well as acknowledging the significance of their implicit knowledge and lived experiences in formulating effective CE solutions to facilitate localised circular economies (Carenzo, 2017; Soliz Torres and Acosta, 2017; Ashton et al., 2022; Wuys and Marin, 2022). Moreover, the importance of considering social and institutional aspects when implementing CE principles presents a unique strategy for achieving sustainability, offering tangible answers for the attainment of many UN Sustainable Development Goals (SDGs) (Moreau et al., 2017).

Although many literature reviews have been published with the aim to systematize existing findings on this topic, to the best of our knowledge, none of them has adopted a comprehensive approach for encouraging a homeostasis between the CE, the energy transition and their impacts on social justice. As countries accelerate this shift, ensuring that these concerns are tackled as integral components of the such transition is a crucial priority (Wewerinke-Singh, 2022; Aydin et al., 2024) to prevent injustices from derailing renewable energy development (Alford-Jones, 2022). Thus, drawing upon these premises, this paper aims to explore the environmental and social impacts of energy throughout its entire life cycle, encompassing material and mineral extraction, production, distribution, utilisation, and the disposal of by-products and waste from

this industrial sector. The objective is to enhance research on this subject, inform legal and policy frameworks, and ultimately support the overarching aim of attaining sustainable development in the EU and worldwide (Sovacool, 2016; dos Santos et al., 2022). By examining a broad variety of contributions, we outlined our perspective on a key issue.

RQ1 To what extent does the transition to renewable energy fairly distributes benefit at the community level?

The continuation of the paper is organized as follows. In section 2, we delineate the theoretical background, the objective of the research and its innovative contributions aimed at addressing the current research gaps. In section 3, we discuss the methodology adopted for the collection and selection of relevant papers for review. Results are then discussed in detail in section 4, examining their significance for the CE models, while section 5 provides a summary of our conceptual effort, its implications and potential limitations, as well as delineates reasonable routes for future research.

2. Theoretical background

2.1. CE overview: definition and evolution

The notion of the CE was first introduced in the 1960s, and thereafter, over one hundred definitions have been suggested (Millar et al., 2019). By means of design, reduction, recovery, repurposing, remanufacturing, refurbishing, repairing, reuse, rethinking, sharing and innovation strategies (Geissdoerfer et al., 2017; Shobande et al., 2024), its foundational principles aim to optimise resource utilisation at the micro, meso, and macro levels (Kirchherr et al., 2017). At the micro-level, enterprises are actively involved in prolonging the life cycle of materials and reducing material usage. At the meso-level, characterised by industrial symbiosis, industrial ecology, and industrial metabolism, enterprises interchange materials and reuse scraps as raw materials (Wang et al., 2022). Ultimately, at the macro level, CE tenets are more comprehensively integrated into national, local, and regional strategic plans (Cheng, 2024).

As far as concerns this subject, most of the CE literature has typically concentrated on industrialised nations and consumer societies (Schröder et al., 2019), while overlooking concerns and priorities pertinent to a holistic view of the three dimensions of sustainability (i.e., economic, environmental, and social). An extensive analysis conducted by Kirchherr et al. (2017) indicated that only 13% of the 100 definitions of CE embraced a holistic perspective. Moreover, current research often lacks precision in discussing social issues like equity and justice (Millar et al., 2019; Chen, 2021). Research demonstrates that the CE possesses significant potential to generate new employment opportunities, reduce pollution, and enhance the quality of life in low and middle-income countries (Gower and Schröder, 2016), which urgently require innovative approaches to mitigate pollution, improve health, and foster economic development (Schröder et al., 2020).

For these reasons, the subsequent sections of this paper will examine the fundamental theoretical foundations and conceptual frameworks that elucidate the interrelations among CE, energy transitions, and justice concerns. This examination encompasses an overview of research across various disciplines, including geography, political ecology, energy and climate justice, environmental science, political economy, and the notion of the circular human sphere, which integrates human considerations into the CE paradigm.

2.2. Social concerns in CE practises: the need of justice

The CE framework encompasses several critical components, including the enhancement of sustainable resource management within production and consumption systems (Beamer et al., 2021), the recovery

of energy from food waste via anaerobic digestion (Malinauskaite and Jouhara, 2019), the management of municipal waste (Mateus et al., 2023; Valencia et al., 2023; Kopp et al., 2024), and the recycling of electronic and electrical waste (Thapa et al., 2023). Notwithstanding, despite the widespread recognition of the CE as a framework for advancing sustainable development, the mere implementation of a CE does not guarantee sustainability (Chen, 2021). Significantly, a growing body of research has focused on analysing the social implications of the CE, especially its effects on the labour force, human development, and overall well-being (Schröder et al., 2020). Indeed, regulatory challenges and market-specific barriers are merely two of the numerous obstacles that renewable energy technology investments must overcome (Van Opstal and Smeets, 2022). Significant effort has been dedicated to understanding community acceptance of renewable energy technologies and policies, uncovering cases where the deployment of renewable energy faces social opposition, insufficient awareness, or negative social and environmental impacts, including concerns regarding aesthetics, noise (Ren et al., 2016), and local ecosystems (Levenda et al., 2021). These concerns often appear as an opposition from local communities, sometimes referred to as the Not In My Backyard (NIMBY) issue (Devine-Wright, 2012). Carenzo (2017) indicates that these groups often lack representation in policy formulation, thus resulting in their frequent exclusion from decision-making processes. This omission highlights a more profound concern in environmental justice (EJ) study, which has focused on the inequitable distribution of environmental responsibilities across regional and social dimensions since the late 1980s (Bickerstaff and Agyeman, 2009).

An expanding corpus of research on justice in the context of the CE is examining the ramifications of fairness and equity in CE activities, particularly focusing on their disproportionate impact on low-income and marginalised populations. Power dynamics are essential in decision-making processes related to CE, primarily aimed at improving profitability through enhanced resource utilisation (Isenhour et al., 2019; Paiho et al., 2020). This emphasis on economics frequently overlooks the significance of justice, which encompasses not only equitable distribution of benefits and burdens (distributive justice), but also the fairness of decision-making processes (procedural justice) and the acknowledgement and respect for the identities of diverse stakeholders, including social, cultural, ethnic, racial, and gender differences, along with their perspectives without fear of repercussions (recognition justice) (Schlosberg, 2007; McCauley et al., 2013; Bailey and Darkal, 2018). Distributive justice is essential for promoting social acceptance, as it directly influences the perceived equity of costs and benefits for local economies and environments (Gupta et al., 2015; Bearth and Siegrist, 2016). The advantages may encompass economic benefits, heightened employment prospects, and community improvements (Cowell et al., 2011), so underscoring the necessity for equitable results in the energy transition (He et al., 2018).

The notions of justice are essential for comprehending Ecological Distribution Conflicts (EDCs) (Martinez-Alier, 2022), which stem from the inequitable access to natural resources and the disproportionate allocation of pollution-related burdens (Alier and O'Connor, 1995). The theoretical basis for justice evaluations is rooted in overarching social justice theories, including Rawls's (1971) theory of justice, Sen's capability approach (1999), and Fraser's framework of recognition and redistribution (2008). The field of EJ has developed over the past four decades to clarify the disproportionate effects of environmental costs on impoverished, racialised, and other marginalised communities (Levenda et al., 2021). Early EJ studies mostly focused on distributive justice, whereas modern literature recognises the necessity for a more profound comprehension of justice that transcends mere distribution (Schlosberg, 2007; Deacon and Baxter, 2013). The notion of justice as capability emphasises the need of providing all individuals with the potential to have healthy, secure, and dignified lives, while recognising their interconnectedness with functional ecosystems (Sen, 1999; Fraser, 2008; Schlosberg, 2013).

2.3. Energy transition: on the route toward sustainability

The considerable impact of energy supply, distribution, and utilisation on the environment and various essential facets of human existence (Fuso Nerini et al., 2018) renders affordable and clean energy a prominent issue within the SDGs (Sovacool, 2016), especially concerning food security, health, infrastructure, cities, and community development. Hillerbrand (2018) underscores that energy is not just a vital element of SDG7, which focusses on affordable and sustainable energy, but also significantly contributes to two more SDGs. Indeed, target 12.C of SDG 12, focused on sustainable consumption and production, seeks to rationalise inefficient fossil-fuel subsidies that result in wasteful energy consumption. In contrast, indicator 4.a.1 of SDG 4, which aims to ensure inclusive and equitable quality education for all, emphasises the provision of electricity in educational institutions.

The CE paradigm promotes the utilisation of renewable energy sources as the principal method of power generation, advocating a progressive transition away from reliance on fossil fuels and nuclear energy (Ellen MacArthur Foundation, 2023). This shift entails significantly more than merely substituting fossil fuels with renewable energy sources (Szép et al., 2022). It involves enduring and systemic alterations in energy systems, motivated by the necessity to diminish greenhouse gas emissions, improve energy security, and promote energy conservation (Chen et al., 2019). Therefore, it is essential for research and policy considerations to account for the comprehensive life cycle impacts of energy and electricity sources, encompassing material extraction, production, distribution, usage, disposal, and the decommissioning of power plants (Ulgiati and Ghisellini, 2006) across all three segments of the energy sector: power, heat, and transportation (Hillerbrand, 2018).

Prominent theoretical frameworks for analysing energy transitions encompass the Multi-Level Perspective (MLP) on socio-technical transitions and the Technological Innovation Systems (TIS) approach (Geels, 2002; Markard and Truffer, 2008), both of which emphasise the complex interrelations among diverse actors, institutions, and technologies across multiple tiers, from niche innovations to extensive socio-technical systems. A crucial aspect of this transition is the concept of energy citizenship, which entails a heightened awareness of individuals' roles as consumers and active participants in the energy system, as well as their engagement in shaping the development of energy policies and practices. Consequently, energy citizenship is a crucial element in addressing energy poverty and advancing both local and global initiatives aimed at achieving carbon neutrality (Wolsink, 2006; Sadik-Zada and Gatto, 2023).

2.4. Addressing the burdens of energy transition: the call for circular justice

The advancement of renewable energy sources, while crucial for achieving sustainable development, often leads to conflicts that may threaten other facets of environmental health. Green-green conflicts arise when the pursuit of a specific environmental goal, such as reducing carbon emissions via renewable energy, inadvertently undermines other ecological or societal ideals. For instance, Hillerbrand (2018) contends that the implementation of onshore wind power in Germany results in the annual mortality of over 250,000 bats, illustrating the adverse ecological consequences of renewable technology. Furthermore, the establishment of renewable energy infrastructure, including hydroelectric dams, can lead to lasting modifications of natural landscapes and provoke conflicts regarding water use (Siqueira and dos Santos, 2021). Such scenarios underscore the inherent tension between inter-generational justice, which prioritizes the long-term conservation of the environment, and intra-generational justice, focusing on equitable distribution of resources and repercussions within the present generation (Glottbach and Baumgartner, 2012). Energy justice studies address these discrepancies by utilising core principles from EJ, fair transition, and climate justice (McCauley et al., 2013; Sovacool, 2016). Key

considerations encompass the notion of distributional justice, which emphasises rectifying disparities in energy access and the challenge of energy poverty (Sovacool and Dworkin, 2015). Sovacool and Dworkin (2015) suggest the concept of ‘cosmopolitan justice’, advocating for the implementation of justice principles on a global scale. Similarly, the principle of restorative justice, as articulated by McCauley and Heffron (2018), seeks to guarantee equity across each phase of the energy lifecycle.

2.5. Moving forward: integrating circular justice and energy transition

Building upon energy justice literature, the concept of circular justice has been introduced by Kirchherr (2021) as an essential framework for guaranteeing that the focus of the transition toward circularity is not solely on resource efficiency, waste reduction, nor even on verbal gymnastics; rather, it is on the proactive prevention and correction of social and economic inequalities that may be perpetuated or exacerbated within such a process. This concept aligns with energy justice, seeking to motivate the CE community to enhance social responsibility. Based on the three main dimensions of justice, i.e. recognitional, procedural, and distributive, it aims to acknowledge the local expertise and particular issues of the many groups impacted by the transition to a CE, particularly those in the Global South, definitively acknowledging that the so called one-size-fits-all approach is inapplicable (Samarakoon, 2019). Furthermore, its conceptualisation recognises that procedural fairness has a direct impact on the fairness of the outcome, suggesting that the transition to a CE should purposefully incorporate concepts of equity and fairness into all aspects of the system. This necessitates a unified commitment from all stakeholders, including governments, enterprises, and civil society, to transcend a singular emphasis on economic objectives and to concurrently address both social and environmental challenges. The path towards a socially sustainable CE begins with recognition, advances through participation, and culminates in an equitable allocation of advantages and costs (Kirchherr, 2021).

Through the integration of these concepts into our analytical framework (Fig. 1), we aim to explore the intricate relationships between CE, energy transition and justice to properly understand how actions in the energy transition may exacerbate or mitigate disparities and injustices. Examples of disruption encompass modifications in land

utilisation for wind farm development, resource extraction for batteries and solar panels, and methane emissions during hydrogen manufacture. For instance, low-wage manufacturing workers in nations such as China and Malaysia, who are routinely subjected to toxic fumes and dangerous substances in factories, frequently encounter detrimental health consequences and environmental degradation because of manufacturing practices aimed at climate change mitigation (Elling, 2020). Furthermore, indigenous peoples like the Sami of Sweden, the Adivasis of India, and the Saharaui of Morocco are among the 61 minority groups targeted by climate mitigation efforts, as per Sovacool’s (2021) findings. Other examples include Aboriginal communities like the Wayuu of Colombia and the Penan of Malaysia, and Indigenous populations in Indonesia and Morocco. This broad perspective underscores the urgent need to address the social and environmental costs associated with the transition to more sustainable energy systems, as steadily represented by circular justice.

3. Methodology

3.1. Sampling

The systematic literature review methodology presented by Tranfield et al. (2003) was employed to investigate the conceptual framework proposed in Fig. 1. This methodology advocates for the formulation of explicit criteria in the review protocol to be met all at once when selecting the publications to review and delineates the stages to be followed when planning the review to adopt a replicable, scientific, and transparent process.

An initial set of keywords and search terms was developed in alignment with the literature review’s objective. The keywords were identified by conducting a comprehensive review of key documents delineating CE features. We restricted our search to papers containing "circular economy", "energy transition," and "justice" in their title, abstract, or keywords. To consider an article in a systematic literature review, it is necessary for one of the keyword combinations in the title, abstract, or keywords to be included (Ardito et al., 2022). In addition to the literature review, the development of this conceptual framework has been informed by the combined professional experiences of the authors in international development, environmental protection and sustainable business development. The search ended on May 21st, 2024, and was performed by using the esteemed Scopus database, recognised as one of the largest abstract and citation databases, as noted by Bolden (2011).

Apart from any other potential domain, the publishing journals were required to address at least one of the following principal fields: business, management and accounting, decision sciences, engineering, and economics. In such a way, the range of articles producing instrumental insights for managers and policy-makers has been extended to other fields. The review was confined to peer-reviewed journal papers, excluding book chapters and conference proceedings, except for studies obtained by using snowball sampling. An initial sample of 440 articles was derived by adhering to these selection criteria. Then, to further confine the review, two rounds of content analysis were made by following the recommendations of Duriau et al. (2007). In the initial round, selection resulted in a sample of 293 publications, the titles and abstracts of which were scrutinised to eliminate those deemed irrelevant to our study. Then, a collection of 196 articles was assembled and thoroughly examined. A total of 158 publications were identified as very pertinent for the period 2015–2024.

The content analysis for sample selection was directed by explicit inclusion and exclusion criteria, including coverage period, language, document type, research area, and categories, to ensure the analysis focused solely on papers directly pertinent to the topic under investigation, as is standard practice in systematic literature reviews. Furthermore, the decision to incorporate solely English language publications is attributable to its status as the international language of study. More in detail, the selected publications had to emphasise the interrelationship among renewable energy policies, environmental

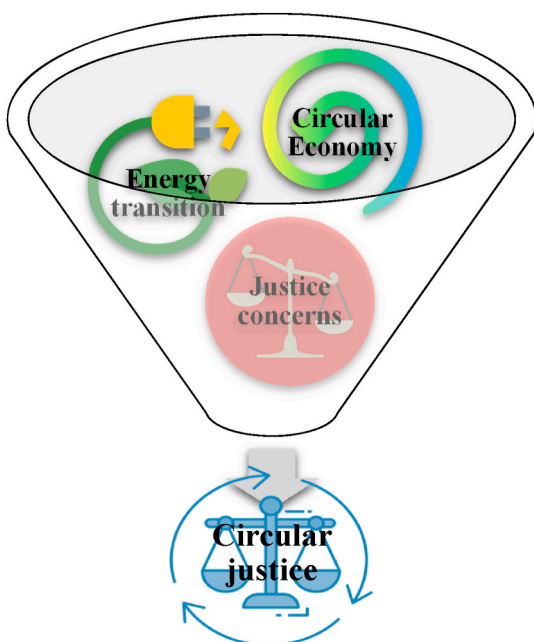


Fig. 1. Conceptual framework.

gains, social burdens, and issues of environmental injustice, as shown by the focus of their abstracts. Secondly, by examining the article’s topic, they were required to offer practical insights in the domains of engineering, management and policymaking. Third, any article that provided traditional insights on CE and decision-making without offering a thorough perspective on the chosen inclusion criteria, as per the authors’ opinion, was eliminated. Several papers addressing economic and social sustainability aspects, while offering useful insights, were excluded from the sample as they do not explore the justice issues related to energy transition, which is the subject of our study. Comprehensive reading was employed to thoroughly examine the articles’ content and exclude those not pertinent to the research topic. A snowball technique was implemented as an additional inclusion criterion to identify possibly relevant papers (Greenhalgh and Peacock, 2005). Notably, snowballing is the process of identifying new pertinent articles by reviewing a paper’s reference or citation list (Abbate et al., 2023). Consequently, we incorporated 11 additional papers into the sample. Discussions were promoted when papers were considered insufficiently aligned with all criteria, and the entire selection process was collaborative (Combs et al., 2010). Ultimately, we grouped the gathered papers according to the relevance of their content to our study parameters, resulting in a final sample of 169 publications, as summarised in Fig. 2.

Ultimately, bibliometric techniques were applied through VOSviewer software to enrich the content analysis and further strengthen the methodological framework (van der Have and Rubalcaba, 2016). These techniques enabled a quantitative assessment of the scientific publications within the specific study domain (Zhi and Ji, 2012). Science mapping, a crucial bibliometric tool (Dzikowski, 2018), was utilised to determine the research field structure of a given topic. Specifically, we sought to construct and display co-occurrence networks of keywords and paper terms, depicting the principal subjects and research trajectories (Abbate et al., 2024). Keyword co-occurrence analysis is an effective method for discerning research themes based on the correlations between a paper’s content and idea co-occurrence. The co-occurrence network of abstract terms is employed to identify research clusters derived from commonly occurring words. Van der Have and Rubalcaba (2016) found that keywords and paper terms have increased interconnectedness when they co-occur, as they relate to the same research subfield.

3.2. Descriptive statistics

This study conducts a thorough review of 169 scientific publications published in 82 academic journals, demonstrating a growing scholarly interest in the relationship between circular economy, energy transition, and justice based on an initial examination. According to our results, 22 of the papers that examined the social implications of energy transitions were published in Energy Research & Social Science, establishing it as the most productive journal in this area. Energy Policy represents the subsequent portion, which comprises 8 papers that expressly analyse the policy implications of energy supply and utilisation. Likewise, Applied Energy has published 8 papers that cover many domains related to energy conversion, efficiency, and sustainable systems, aimed at integrating research, development, and deployment in energy technology. Considerable attention is placed on the sustainable management of resources, as seen by the publication of 7 papers in Resources, Conservation & Recycling and 6 papers in Local Environment, which are committed to promoting equity, justice, and addressing local environmental issues. The contributions from Economic Change and Restructuring (5 articles) and Ecological Economics (4 papers) underscore the economic and structural transformations linked to energy systems and their broader implications for the economy and ecology. In contrast, publications in the Journal of Cleaner Production (4 papers) and Business Strategy and the Environment (2 papers) offer critical insights into the interplay between industrial practices, sustainability, and environmental strategies. The diverse selection of journals, encompassing legal publications like the Journal of Energy & Natural Resources Law (3 papers) and specialised impact assessment journals such as Environmental Impact Assessment Review (1 paper), illustrates a comprehensive approach to the subject matter. Appendix 1 provides a detailed overview of the publications for each journal, highlighting the growing focus on this significant topic.

The bar chart in Fig. 3 depicts the distribution of articles across diverse topic domains associated with CE, energy transition, and justice. Most of literature, comprising 69 papers, focusses on the relationship between energy transition and justice, indicating that a significant portion of academic research is dedicated to exploring the social and distributive ramifications of energy transition, underscoring concerns of equity, fairness, and the societal impacts of transitioning to sustainable energy systems.

The second-largest thematic subject, consisting of 47 articles, explores the connection between CE and justice. This indicates a growing

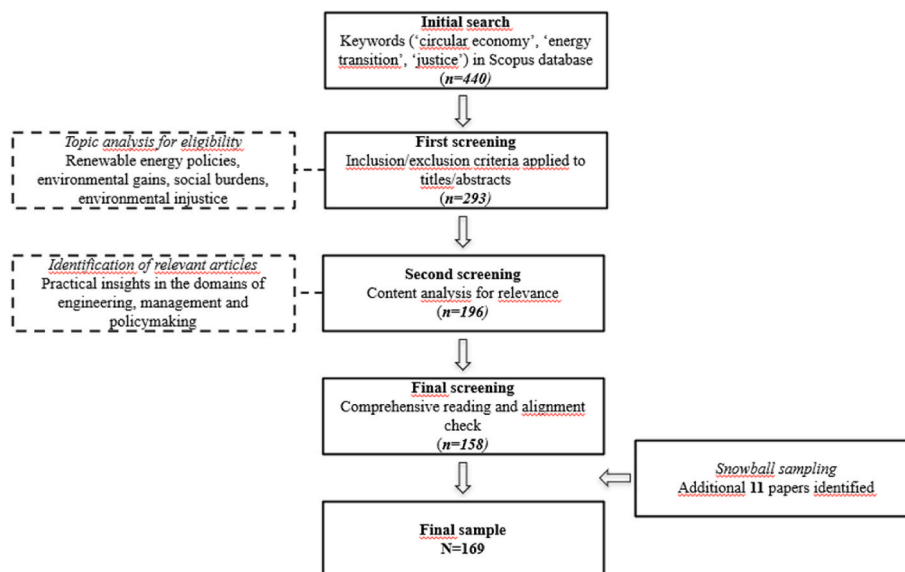


Fig. 2. Screening and selection process for literature review.

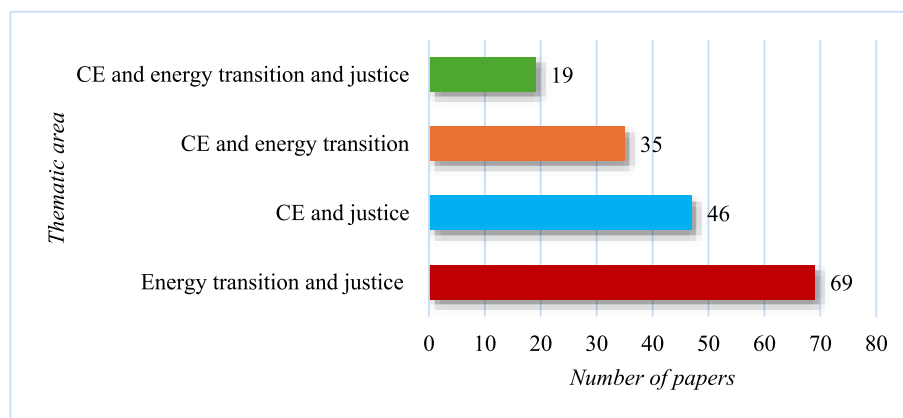


Fig. 3. Distribution of articles for thematic area.

recognition of the need to tackle justice-related issues, especially regarding resource distribution, impacts on marginalised communities, and the fair implementation of circular business models.

Concerning the third thematic area, i.e. the integration of CE and energy transition, the collected sample consist of 35 contributions, reflecting a moderate academic interest in the potential of CE principles to support or align with the primary goals of energy transition. In such a field, improved integration of the two disciplines may yield substantial insights, especially concerning the minimization of resource consumption and emissions during the shift to renewable energy.

Just 19 papers are included in the less representative sample, which covers the connected subjects of CE, energy transition and justice. This relatively low statistic implies that holistic techniques, which simultaneously address circularity, energy transition, and justice, are yet underexplored. Current study in this domain suggests a potential gap in the literature, suggesting that more integrated studies could provide a comprehensive understanding of the synergies and trade-offs among these critical aspects of sustainability.

Fig. 4 illustrates the publication trends from 2015 to 2024. Significant increases have been observed in 2018 and from 2021 to 2023, highlighting the increasing importance of this topic in academic research.

More precisely, in the realm of CE and energy, there has been a gradual rise in the volume of published literature over the years, with increased interest from 2021 culminating in a peak of 11 publications in 2024. Likewise, the topic of CE and justice has garnered considerable academic attention since 2021, reflecting a notable surge in attention and significance in 2023, as seen by the release of 13 articles. Since 2017, the number of publications concerning the integration of energy

transition and justice has steadily increased, culminating in a notable peak in 2024 with the publication of 17 articles. Ultimately, regarding the comprehensive integration of CE, energy transition, and justice issues, our sample covered 19 papers, 9 of which were published in 2024.

Broadly speaking, the data reveals a consistent increase in publications across all disciplines since 2018, indicating an increasing emphasis by the academic community on this issue. The notable rise of publications regarding CE and justice, especially in 2021 and 2023, highlights the growing necessity to integrate justice into discussions about sustainability and energy transition. The year 2024 is notable for its significant abundance of publications across various fields, reflecting an era of peak in scholarly engagement.

4. Analysis and results

Although the CE is commonly perceived as a strategy to promote sustainability by increasing resource efficiency and minimising waste (Di Fraia et al., 2024), our findings suggest that its implementation, especially when dealing with the energy transition, may lead to unintended consequences (Purvis and Genovesi, 2023). For instance, even if CE seeks to reduce resource consumption and promote a more sustainable economy, the infrastructures required to support its implementation, such as recycling, remanufacturing, and resource recovery facilities, may exacerbate existing inequalities if not properly managed (Yang et al., 2024). These encompass pollution, a lower quality of life for nearby communities, and even social conflicts.

Rebound effects denote the occurrence in which improvements in energy efficiency are offset by heightened consumption and supplementary energy demand (Schröder et al., 2019). More precisely, direct rebound effects occur when decreased costs of products or services lead to heightened consumption; indirect effects indicate that savings from a product or service are allocated to the consumption of alternative goods (Ziegler et al., 2023). Within the framework of CE, material recovery procedures such as recycling may provide a perception of resource plenty, hence promoting increased consumption rates instead of diminishing overall resource extraction (Zink and Geyer, 2017). This encompasses both environmental and social rebound effects, wherein initial benefits are counterbalanced by ensuing issues, including heightened resource use, social injustices, and worldwide disparities (Purvis et al., 2023). For example, the health and safety of workers handling hazardous materials, especially in countries like India, China, and Pakistan, represent a major concern due to their exposure to unsafe working environments and considerable health risks (Annamalai, 2015; Li et al., 2022). Such occupational hazards represent social rebound effects, which undermine the environmental gains that CE seeks to achieve. While CE emphasises resource recovery, waste that cannot be recycled or remanufactured is frequently exported to the Global South, exacerbating environmental degradation while also reinforcing global

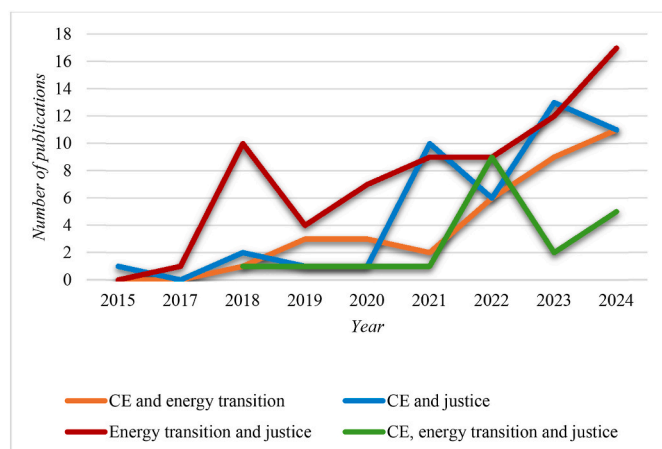


Fig. 4. Trend of publications over time.

inequalities (Campbell-Johnston et al., 2020; Chen, 2021). These inverse correlation between the repercussions of the transition to circularity and long-term responsibilities is obscured by a much-needed research gap regarding North-South relations (Genovese et al., 2017; Pansera et al., 2024). The primary differences between the Global North and Global South are reported in Table 1, demonstrating how distinct socio-economic, technological, and governance aspects affect the methods and consequences of CE across many different regions. This comparison underscores the need for tailored approaches to address the distinctive conditions and justice-related issues in both areas of the world.

The co-occurrence analysis of keywords and abstract terms are complementary bibliometric techniques that assist in the identification of the primary themes of the corpus under examination (Abbate et al., 2024). The thematic analysis performed by using VOSviewer identified 1132 distinct keywords among the sample of 169 publications through the co-occurrence analysis of keywords. By concentrating on terms with a minimum of eight occurrences, 22 distinct keywords were selected. The term "circular economy" was the most frequently mentioned, appearing 47 times, followed by "energy justice" at 43 occurrences, "energy transition" at 36 and "environmental justice" at 34. Distinguishing by colour, Fig. 5 illustrates the interrelations among these terms, providing a comprehensive insight into the three main categories examined during our research. The red cluster emphasises the "circular economy", which encompasses topics such as "environmental policy" "recycling" and "sustainability". The green cluster emphasises the connections between concepts such as "just transition", "renewable energy" and "climate change" by concentrating on "energy justice" and "energy transition". Finally, the blue cluster denotes concerns regarding "environmental justice" indicating a convergence between "energy" and "justice".

These three main thematic clusters have been observed also in the co-occurrence network of abstract terms, represented in Fig. 6. In this case, the "circular economy" is the focal point of the first cluster in green, which emphasises its interconnections with governance, social justice, and sustainability. The second cluster is centred on "energy justice" (in red), which underscores the social and procedural components of energy transitions. It demonstrates the connections between renewable energy, energy democracy, procedural and restorative justice. Lastly, the "environmental justice" cluster (in blue) interconnects concepts such as ecological distribution conflicts, just energy transition and climate change.

4.1. CE and energy transition

The body of literature focusing on the intersection of the CE and energy transitions emphasises how integrating CE principles into renewable energy systems can significantly enhance both efficiency and sustainability. By closing material loops, reducing waste, and lowering emissions, CE practices promote self-sustaining energy systems. For example, Mateus et al. (2023) demonstrate how minimising material waste improves resource efficiency, subsequently decreasing emissions and promoting more sustainable energy systems. Likewise, Ghisellini et al. (2023) emphasise the capacity of CE to enhance the resilience of energy infrastructures.

An increasing volume of research concentrates on specific types of renewable energy, especially biofuels. Rishanty et al. (2024) investigate zero-waste bioenergy methodologies, including methane recovery from palm oil mill effluent (POME) in Indonesia. They demonstrate that CE not only reduces trash but also converts potential pollutants into viable energy supplies, hence diminishing dependence on fossil fuels, which is a vital component in global energy transitions. Concerning biomass, Chen and Wang (2024) examine its incorporation into China's CE framework, showing how biomass might reduce the negative effects on the environment caused by energy production. Their findings indicate that, when linked with CE concepts, biomass can function as a

Table 1
Comparing CE and energy transition from a northern and southern perspective.

Theme	Global North	Global South
Main drivers behind the energy transition	Decarbonisation and mitigation of greenhouse gas emissions, propelled by climate goals and environmental policies (Canelas and Carvalho, 2023).	Economic development, energy accessibility, and enhancement of living standards, frequently prioritizing immediate decarbonisation to a lesser extent (Shobande et al., 2024).
CE priorities	Resource efficiency, recycling, and waste management, frequently emphasising technology and innovation (Calisto Friant et al., 2023).	Reuse and repair, commonly found in informal behaviours, offer the potential to foster the development of a social and solidarity economy (Ziegler et al., 2023).
Energy justice	Increased emphasis on procedural justice and participation in decision-making, but with potential gaps in distributive justice (Sumarno et al., 2024).	A greater emphasis on distributive justice to guarantee the recognition of marginalised communities and the availability of affordable energy (Aryal et al., 2024).
Impact of CE policies	Potential for the creation of new employment opportunities in the green sector, alongside potential job losses in traditional sectors (Baiani et al., 2024).	Risk of 'sacrifice zones' where resource extraction for "green" technologies may result in exploitation, displacement, and environmental degradation (Elmallah et al., 2022).
Extractivism	Reliance on resources obtained from the Global South to facilitate energy transition and CE (Saleth and Varov, 2023).	Resource exploitation leads to adverse effects on the environment, local populations, and human rights. Potential for the resurgence of neo-colonialism trends (Kalt et al., 2023).
Power relations	Shape global decision-making by establishing regulations and policies, as well as setting benchmarks for sustainable products and technologies (Purvis and Genovese, 2023).	Marginalisation in decision-making processes, resulting in restricted capacity to influence global policy and frequent exclusion from participation in CE advantages (Repp et al., 2021).
Funding opportunities	Easier access to funding for the research, development and implementation of CE projects (Hoffman et al., 2021).	Dependence on Northern funding with associated conditionality risks and lending rates often misaligned with local economic conditions (Anantharajah and Setyowati, 2022).
Technology and Innovation management	Enhanced capacity to create innovative materials and complex technologies for CE, including research and innovation in the energy recovery from waste sector via anaerobic digestion (Malinauskaite and Jouhara, 2019).	Implementation and maintenance can be challenging when imported technologies necessitate infrastructure and expertise that are not readily accessible in the local area. As such, it is imperative that these technologies are customised to the local resources, contexts, and expertise (Abe and Azubike, 2024).
Availability of data and standards	Greater accessibility of data and criteria for evaluating and measuring sustainability and circularity (Friant et al., 2020).	Insufficient data availability and standards often hinder the assessment and evaluation of the impacts of circular economy plans. Risks of utilising Eurocentric standards (Apergi et al., 2024).

the energy sector.

Circular strategies facilitate industries in operating more sustainably and cost-effectively. [Andrade and Selosse \(2024\)](#) highlight the economic advantages of circular supply chains in energy systems, asserting that these chains enhance resource efficiency and bolster economic viability in energy-intensive industries. On the other hand, [Su and Urban \(2021\)](#) explore how circular economy principles can be utilised to tackle global challenges, revealing new opportunities for transitioning to renewable energy within the COVID-19 pandemic.

The global implications of CE practices are further highlighted by [Cao et al. \(2024\)](#), who argue that international trade must align with CE principles to reduce the carbon footprint of energy transitions. They advocate for trade policies that integrate CE frameworks to facilitate a more seamless global transition to sustainable energy systems. Nonetheless, despite these advantages, such initiatives may encounter opposition from local communities. The NIMBY phenomenon, characterised by community opposition to proximate renewable energy initiatives, underscores the importance of ensuring community engagement and procedural justice in decision-making processes ([Shobande et al., 2024](#)). As a matter of fact, raw materials for renewable technology are commonly mined from low- and middle-income countries, which frequently experience considerable environmental degradation. [Shobande et al. \(2024\)](#) examined these implications, emphasising critical issues of recognitional justice, which underscores the acknowledgement and respect for the voices and rights of these populations within the global energy discourse. This discrepancy outlines the necessity of implementing energy policies that are considerate of both intra-generational and inter-generational justice, thereby preventing future generations from being penalised by the energy decisions made today ([Tan, 2024](#)).

Policy and governance are key to CE and energy transition project success or delay. Fiscal decentralisation, which delegates financial and decision-making powers to lower tiers of government, is recognised as a key strategy for advancing regional renewable energy efforts ([Camilleri, 2020](#)). Especially in BRICS countries (Brazil, Russia, India, China, and South Africa), fiscal decentralisation can play a pivotal role. [Tan \(2024\)](#) shows how local governments can implement CE policies tailored to their unique energy needs, thus not only promoting regional sustainability but also contributing to global energy transition objectives. However, although theoretically beneficial, its practical use in BRICS countries remains challenging due to varying energy issues such as rising consumption, energy security, environmental degradation, and climate change impacts ([Adebayo and Samour, 2024](#)). [Tiwari et al. \(2024\)](#) underscore the significance of rigorous environmental laws in mitigating CO₂ emissions, illustrating how these policies can facilitate the implementation of carbon capture technology and other energy transition plans.

A truly equitable energy transition requires policies that include distributional, procedural, and recognitional justice. The advantages and costs of energy systems are shared through distributional justice, while procedural justice ensures fair decision-making. Recognitional justice guarantees that the cultural and socioeconomic needs of marginalised communities are recognised and reflected in energy governance ([Tiwari et al., 2024](#)). Incorporating these concepts into energy policy enables governments and international organisations to steer clear of the mistakes of previous transitions, which favoured economic efficiency at the expense of social equality. The significance of ensuring that the benefits and burdens of this transition are distributed equitably, particularly for communities that have historically confronted economic and social marginalisation, is underscored by the concept of circular justice, as introduced by [Tiwari et al. \(2024\)](#).

4.2. CE and justice

The notion of justice within the CE framework is closely linked to equity, fairness, and the distribution of benefits and costs among various

social groups to guarantee that these activities do not disproportionately impact marginalised individuals.

The current research elucidates how CE can either promote or hinder justice, highlighting the imperative for an inclusive approach that integrates socio-economic and environmental components. [Pansera et al. \(2024\)](#) assert that whereas CE programs generally aim to improve sustainability, they may unintentionally intensify existing disparities to account for the diverse socio-economic contexts in which they operate. Their research investigates the relationships among labour, environmental, and gender justice, highlighting the essential need to tackle gender inequalities and enhance working conditions to guarantee that circular economy initiatives foster genuine equity. Similarly, [Härri and Levänen \(2024\)](#) investigate the potential of CE practices to perpetuate existing inequalities in India, especially regarding the textile sector's shift to circular methodologies. Their findings indicate that, although CE programs might foster beneficial transformation, they may intensify social inequities if not meticulously undertaken ([Remme and Jackson, 2023](#)). Indeed, despite Japan's advanced CE policies, [Arai et al. \(2024\)](#) contend that they frequently fail to adequately address equity concerns, particularly for marginalised populations.

In their examination of the role of digital ecosystems and CE startups, [Roshan et al. \(2024\)](#) propose that inclusive design has the potential to alleviate justice-related concerns. Similarly, [Uekert et al. \(2024\)](#) call for the prompt incorporation of justice considerations in CE technologies to mitigate their adverse social and environmental effects, thereby preventing the perpetuation of existing inequities and ensuring that marginalised communities receive due attention. This methodology aligns with [Stephenson and Furman's \(2024\)](#) notion of climate-just entrepreneurship, which advocates for structural reforms that incorporate social equity into CE policies, ensuring that marginalised communities are not overlooked in the pursuit of sustainability.

Several researchers have presented case studies on waste management and social provisioning, highlighting the importance of fair transition strategies. [Amorim de Oliveira \(2021\)](#) analysis of waste pickers in Fortaleza, Brazil, alongside [Valencia et al.'s \(2023\)](#) discussion of rubbish picking as social provisioning, highlight the imperative for equitable practices in CE initiatives. [Thapa et al. \(2024\)](#) examine the trade of plastic waste from Europe to Vietnam, highlighting the global aspects of justice in CE practices and demonstrating how waste management processes perpetuate environmental injustices when wealthy nations offload their waste onto developing countries. [Kopp et al. \(2024\)](#) critique municipal CE indicators, questioning their efficacy in assessing cities' true environmental ambitions and social justice considerations. The significance of aligning ecological and social justice objectives to achieve holistic sustainability is also underscored by [Chang et al. \(2024\)](#), who further investigate the impact of ecological perceptions and adaptations on sustainable development and CE goals.

Different perspectives on justice and circularity are offered by [Beamer et al. \(2021\)](#) and [Schlezak and Styer \(2023\)](#). [Beamer et al. \(2021\)](#) examine Hawaiian circular systems and their implications for formulating universal CE policies that foster justice, whereas [Schlezak and Styer \(2021\)](#) advocate for inclusive urban mining as a means to include justice into engineering practices. Their research indicates that indigenous and localised traditions can offer significant insights into enhancing CE policies to better assist marginalised people and foster equity. Indeed, the indigenous Hawaiian concept of *aloha ʻāina*, meaning "love for the land", cultivates a profound connection between humanity and the earth, facilitating the socio-psychological shifts essential for sustainability ([Beamer et al., 2023](#)).

In conclusion, while the CE has the capacity to advance social justice, the literature indicates that a truly equitable CE requires a comprehensive and inclusive strategy to guarantee that the transition to circular systems is grounded in principles of social fairness. The energy transition is not merely a technical or economic process but a profound social transformation ([Lima, 2022](#)).

4.3. Energy transition and justice

Within the framework of the energy transition, the rebound effects of CE become increasingly evident. The scientific literature reveals that enhancements in energy efficiency, albeit aimed at decreasing total consumption, frequently result in heightened demand and novel resource utilisation patterns, undermining the original environmental advantages. Direct rebound effects occur when reduced prices from more efficient technologies lead to increased usage, whereas indirect rebound effects happen when savings are allocated to the consumption of other goods and services (Schröder et al., 2019).

The social components, such as labour market disruption and potential community marginalisation, have garnered far less attention in academic literature (Friant et al., 2020). For instance, the utilisation of biodegradable materials, intended to close material loops, can reduce the durability of products, leading to an overall increase in production and resource consumption (Chen et al., 2020). This, in turn, increases energy consumption and emissions, hindering the pursuit of true sustainability in the energy transition. In other words, although CE has the potential to significantly influence the energy transition by enhancing resource efficiency and minimising waste, its overall effect remains ambiguous due to rebound effects. Policymakers and stakeholders must embrace a more holistic approach that considers not only the environmental outcomes of CE initiatives but also the social and economic dimensions to ensure a just and sustainable energy transition (Chen, 2021). Developing renewable energy programs is crucial for the energy transition, but the mere implementation of green technologies does not inherently guarantee a fair outcome: if the power dynamics, requirements, and rights of the communities involved are not carefully considered, it can even create new forms of vulnerability. Numerous authors have reported on the case of renewable energy initiatives in India that reveal a profound need for social justice (Heffron et al., 2021; Pandey and Sharma, 2021; Apergi et al., 2024; Velasco-Herrejón and Bauwens, 2024). The economy and food security of rural populations may be jeopardised by the construction of large solar parks, which threaten the availability of agricultural land and natural resources. This leads to the displacement of communities, which in turn impacts their traditional practices and behaviours, resulting in the loss of employment. There, procedural and distributive issues become a common concern, resulting in a disparity between the local communities that are most affected and the investors who benefit from these initiatives. The necessity of a recognition-based approach is one of the critical aspects that numerous studies have identified. Local communities' refusal to engage in renewable energy initiatives becomes a form of resistance, thereby establishing their autonomy and their right to self-determination. The recognition-based justice approach is essential for an equitable transition, as it emphasises the recognition and appreciation of the unique identities and specific requirements of local communities. Specific procedures must be implemented to mitigate social and economic disparities and guarantee an equitable energy transition. For such a purpose, Standal et al. (2024) and van der Wel et al. (2024) promote inclusive frameworks that account for the varied effects on communities in areas like Tanzania and Mexico. In a similar vein, Velasco-Herrejón and Bauwens (2024) examine how energy transitions in Mexico may intensify pre-existing disparities, emphasising power dynamics and social stigma. On the other hand, McKenna et al. (2024) delineate specific problems and solutions for equitable transitions in cold climates, whereas Sumarno et al. (2024) investigate the complexity of enhancing female engagement in the energy sector across diverse geographies. Mósesdóttir (2024) underscores the contradictions between Norway's Fosen wind farms and local justice issues, exemplifying the struggle between renewable energy initiatives and social injustice. This motif of conflict between energy infrastructure and justice concerns is also illustrated by Tarasova (2024), who underscores the significance of recognition-based justice in Poland's coal phase-outs. Likewise, Libertson (2024) and Grimley et al. (2024) examine justice concepts in

energy projects in Minnesota and Sweden, respectively, offering pragmatic insights into the application of these frameworks to actual infrastructure projects. Aryal et al. (2024) provide empirical findings regarding clean cooking transitions in India, highlighting social class differences in energy access. Sefa-Nyarko (2024) concentrates on West Africa, specifically investigating Ghana's energy transition framework and the conflict between national ambitions and global doubts over justice and equity. Opoku-Mensah et al. (2024) examine the same region, analysing the interplay between democracy, energy justice, and structural modifications, while emphasising the necessity for holistic measures to tackle both emissions and equality. By extending the geographic focus to energy projects in China, Wang et al. (2024) evaluate the nation's decarbonisation plans and justice strategy, Kong et al. (2023) investigate the impact of public participation, whereas Tafon et al. (2023) adopt an innovative perspective by broadening justice considerations to encompass both human and non-human entities.

In Europe, Canelas and Carvalho (2023) examine the adverse dimensions of energy transitions, namely the extractivist violence associated with lithium mining in Portugal. Korsnes et al. (2023) elucidate the paradoxes inherent in Norway's energy transition, emphasising the intricate and frequently opposing forces involved, whereas Kaandorp et al. (2024) advocate for novel 'commoning practices' in Amsterdam's heat transition, demonstrating that community-driven strategies can provide more equal results in energy justice. Responsible sourcing and natural resource justice in energy transitions have been examined by Kügerl et al. (2023), whereas Baard et al. (2023) provided a Swedish viewpoint on energy policy and justice. Ayllón and Jenkins (2023) base their ideas of energy justice on Scottish energy policy, while Nsafon et al. (2023) analyse renewable energy transitions in Africa via a justice and policy lens.

As far as concerns Africa, Abe and Azubike (2024) provide a critical re-evaluation of energy justice and transition policies, promoting a more sophisticated comprehension of regional dynamics. In a similar vein, Marshall and Pearse (2024) contend that regional energy transitions, particularly those in Africa, should be addressed through practical justice politics. Kalt et al. (2023) examine the conflict between green extractivism and justice in South Africa's hydrogen transition, whereas Karim (2023) assesses Islamic financing instruments in relation to energy justice. By focusing on issues unique to the Global South, Apergi et al. (2024) offer an energy justice index.

Focusing on the U.S., Greenleaf et al. (2023) examine community choice aggregation in New Hampshire as a means to enhance energy equity, whereas Romero-Lankao et al. (2023) advocate for a justice-oriented paradigm for innovations in energy transition.

This rich body of research underscores the intricate challenge of incorporating justice into energy transitions, highlighting the necessity for advanced and interdisciplinary methodologies. The global transition to renewable energy is crucial for sustainable development, yet it is inextricably linked to its socioeconomic consequences. As the globe shifts from fossil fuels, it is essential to guarantee that the advantages and disadvantages of renewable energy are distributed fairly throughout regions and socio-economic groups. Tiwari et al. (2024) integrate the concepts of CE and energy transition, suggesting novel ways for decarbonisation while tackling essential issues of equality in resource allocation. Their circular justice concept underscores that a shift to renewable energy is inadequate if it leads to the perpetuation of existing inequalities or the creation of new forms of exclusion.

4.4. Triangulating CE, energy transition and justice concerns

Recent studies emphasise the importance of intersecting environment, climate, energy and justice issues from a truly interdisciplinary perspective for long-term solutions (McCauley and Heffron, 2018; Raman et al., 2024). Achieving a truly sustainable energy transition requires regulatory pathways that balance human rights and economic factors, ensuring that environmental progress does not come at the cost

of social equity (Aydin et al., 2024).

For instance, the EU's growing reliance on lithium-ion batteries is central to achieving its climate neutrality goals by 2050 as well as to increase domestic sourcing to enhance supply chain security, resulting in a prediction to climb 18-fold by 2030 and 60-fold by 2050 (van Meer and Zografos, 2024). However, such energy transitions offer paradoxes, including environmental and social constraints that show the trade-offs of renewable energy (Wolters and Brusselsaers, 2024). Despite significant progress, lithium mining still threatens local ecosystems and communities, destroying local industries, causing water stress that harms natural environments and biodiversity, and damaging the nervous system, kidneys, and thyroid of local communities (Agusdinata et al., 2018), including in well-regulated countries (Wolters and Brusselsaers, 2024). Better governance and differentiation between sustainably and unsustainably supplied lithium are needed to promote sustainable mining.

Multani and Bachus (2024) observe that the CE enhances sustainability but frequently necessitates a reassessment of employment and social equity. The research conducted by Andersson and Gyberg (2024) on climate change mitigation in Sweden supports this assertion, indicating that policy implementation is inconsistent with sustainability and justice. Sovacool (2021) reports numerous cases of police abuse and torture of Mapuche community members in Chile opposing hydropower (Carruthers and Rodriguez, 2009), the murder of activists protesting hydroelectric dams in Borneo (Sovacool and Bulan, 2011) and France (Dunlap et al., 2020), the assassination of individuals opposing copper mining in Peru, a critical material for low-carbon technologies (Dunlap, 2019) and deaths related to industrial tree plantations worldwide (Gerber, 2011). Villavicencio Calzadilla and Mauger (2018) found that the Lake Turkana Wind Project in Kenya increased drunkenness and prostitution in host towns and job-seeker camps, while Gorayeb et al. (2018) documented the rise of wind farms-related child prostitution in northern Brazil. Similarly, Green et al. (2015) warn that prostitution among Grand Inga Dam construction workers in central Africa may spread HIV.

This collection of these episodes reflecting rebound effects (Chen, 2021) shows the darker side of energy transitions, emphasising the need for social and EJ together with technological advances in renewable energy. Modern lifestyles, especially in carbon-intensive sectors, contribute to these pressures (Wolfe et al., 2014).

Levenda et al. (2021) identified that EJ studies predominantly characterise it as a distributional issue, a finding corroborated by our findings. Consequently, our recognition that local communities are frequently identified as victims of environmental injustice corresponds with the distributive justice framework, which emphasises the disproportionate impacts of renewable energy technologies on local communities, including low-income groups, ethnic minorities, and rural and indigenous populations, as commonly addressed in the literature.

Over the years, rising energy costs have exacerbated energy poverty, a condition in which households are unable to afford the costs of heating and cooling. High prices are not the sole barrier to the transition; currently, sustainable alternatives are frequently more expensive, resulting in 'eco-elitism' (Keesstra et al., 2022). Debnath et al. (2022) outline a people-centric energy revolution as one in which households serve as change agents.

To help vulnerable groups afford electricity, energy literacy, public engagement, and energy transition involvement are essential (DellaValle, 2019; Streimikiene and Kyriakopoulos, 2023). Energy communities that involve vulnerable populations can play a pivotal role in protecting the environment while boosting local economies (Sadik-Zada and Gatto, 2023). Civic participation drives long-term technology transitions and balances system maintenance and disruptive development (Geels, 2002).

Research by Golubchikov and O'Sullivan (2020) within the field of transitology, which emphasises geographical variables in energy systems and transitions, found that uneven development typically reinforces spatial inequities. Instead of a uniform, spatially blind diffusion

of energy transitions, they emphasise how regional and local factors, socio-spatial formations, and dynamics affect them. Their energy periphery concept shows how antiquated energy systems and lack of infrastructure make communities, especially in economically and politically marginalised places, more vulnerable. The concentration of low-income people in these areas is one factor, but the nature, status, and limitations of local energy systems (e.g., many residents depend on off-grid fuels), housing conditions (e.g., a large proportion of poorly insulated homes), mobility and accessibility requirements (reliance on cars, frequent fuel delivery disruptions), and, most importantly, the externally enforced renewable energy initiatives often displace and exclude these regions. EJ studies also show how energy developments from distant decision-making centres can convert some regions into 'sacrifice zones' that benefit the 'greater whole' but marginalise those places and their populations (Zografos and Robbins, 2020; Niskanen et al., 2021).

Governance alone cannot reduce corruption and geopolitical conflicts, but key findings show its importance. Participatory governance has been shown to increase social capital and reduce disparities (Alford-Jones, 2022; Sieminski, 2022). Civic involvement, inclusive governance, behavioural change among transition participants and justice-oriented frameworks are needed to distribute energy transition advantages fairly and protect vulnerable communities (Aramyan et al., 2021). Debnath et al. (2022) emphasises the potential of media and digital tools to influence public attitude and engagement, creating a more inclusive and just transition through social media platforms. The study emphasises the importance of social media in democratising climate action and warns of environmental and social inequities if public perspectives are excluded from policy deliberations.

Beyond education and research, universities are becoming key agents of change in the energy transition (Sidiropoulos, 2018; Kopnina and Bedford, 2024). By fostering energy citizenship, they encourage citizens to actively engage in energy transitions whether as consumers, activists, and prosumers (Boeri et al., 2024). Indeed, SDG 11 states that culture is essential to achieving inclusive, safe, resilient, sustainable cities and human settlements (United Nations, 2015). In fact, the UI GreenMetric ranking shows how universities lead by example in embracing sustainable practices and integrating them into broader policy frameworks by producing and disseminating sustainability knowledge, embracing sustainable solutions, design, and policies on campus, and strengthening the bridge between governmental, international, and local environments (Gültekin et al., 2024). In their case study of Bologna and its Cesena Campus, Boeri et al. (2024) highlight the university's efforts to promote sustainable practices and social fairness, making them living labs and energy citizenship enablers.

Systemic thinking and multi-criteria decision analysis are needed to balance ecological limits and social foundations in theoretical models like Raworth's (2017) Doughnut Economics framework. Acosta (2022) employed it to balance resource consumption, environmental, and social justice by rethinking the economy between concentric rings: a social foundation and an ecological ceiling (Allouche et al., 2019). More precisely, it consists of an inner social foundation ring with twelve social indicators including food, health, education, sanitation, energy, housing, peace and justice, and an outer planetary ceiling ring with nine environmental indicators. Its scientific foundation has become a trans-disciplinary model for a sustainable future. Furthermore, Keesstra et al. (2022) suggest the potential of linking the doughnut economy and sustainability transitions to the smallest and most personal unit within which people interact, i.e. the household. Starting with the family, one of the smallest social units, humans use natural resources for heating, eating, and clothing and produce waste. Thus, the household is the best scale for visualising how behavioural and systemic changes may affect a whole community. Finally, Malinauskaite and Jouhara (2019) address the waste-to-energy (WtE) trilemma, highlighting that WtE plays a pivotal role for achieving the CE since, in addition to waste management, it aligns with EU climate and energy goals, particularly in

renewable energy and energy efficiency. Nonetheless, achieving justice requires more than just technological solutions.

4.5. The contribution of circular justice in advancing an equitable transition

Throughout millennia of sustainable traditions, the indigenous worldview has fostered ideologies like aloha 'āina, which signify a profound connection to the land, considered as an essential component of communal identity and well-being (Beamer et al., 2021). This eco-centric perspective acknowledges the inherent worth of the environment and non-human entities, contesting the hierarchy established by prevailing Western ideologies, and emphasising the environment as kin rather than merely a resource (Tafon et al., 2023). The attribution of sanctity to natural resources exemplifies this spiritual bond between humanity and nature, positioning the environment as a cohesive entity worthy of reverence and parenting, a kind of "extended self" (Beamer et al., 2023). Beamer et al. (2023) elucidated the significance of the Hawaiian 'ōlelo no'ēau "hānai a 'ai," which can be translated as "feed [the fish], and [you may] eat", illustrating a circular relationship in the resource management that fosters abundance through targeted human interventions aimed at augmenting natural resources. Conversely, contemporary approaches frequently embody an eco-modernist perspective, framing nature as a commodifiable asset to be utilised via environmentally sustainable commercial strategies (Krüger, 2022). Western anthropocentric development approaches frequently prioritize human demands and economic progress, often to the detriment of natural resources and marginalised populations, isolating nature from the human. Examining indigenous behaviours, including the stewardship of communal resources and reverence for ecosystems, might yield significant insights for developing more comprehensive and harmonious strategies for circular justice. Aloha 'āina currently signifies a movement aimed at attaining social, cultural, and ecological justice by incorporating ancestral knowledge and practices into modern initiatives (Kealiikanakaoleohailani and Giardina, 2016). The ethical ramifications of indigenous viewpoints on EJ are significant to harmonize human endeavours with the vitality and welfare of ecosystems. Indigenous approaches transcend anthropocentrism, fostering a comprehensive sense of responsibility and stewardship for all living entities and the environment. They articulate the perspectives of nonverbal communicating nonhuman nature, acknowledging that while humans can verbally convey their experiences of injustice, nonhumans are unable to do that directly (Tafon et al., 2023). As Schlosberg (2007) observes, referencing Dryzek's (1995) concept of ecological reflexivity, the institutional acknowledgement and representation of nonhumans in environmental governance necessitate an expansion of our understanding of communication to encompass the nonverbal expressions of entities deserving of attention and respect. It involves attuning to signals, such as species loss, droughts, and climate change that the natural world conveys through nonverbal communication. Moreover, as suggest Tafon et al. (2023), article 71 of the Constitution of the Republic of Ecuador (2008) states explicitly: "Nature ... has the right to exist, persist, maintain and regenerate its vital cycles, structure, functions and its processes in evolution", institutionalising a framework that recognises ecosystem and nature rights. These perspectives expand the scope of justice to encompass the natural world, promoting the preservation and development of nonhuman life as a component of a more comprehensive ethical obligation. Through the exploitation of this intrinsic link, more-than-human justice seeks to ensure that the needs and rights of nature are taken into account in decision-making processes and environmental policies (Rask, 2022). For such a purpose, when analysing conflicts between renewable energy development (such as offshore wind) and human and non-human justice, Tafon et al. (2023) introduced the concept of multispecies blue justice (MBJ), which broadens the community of justice to include nonhuman entities, such as ecosystems and plants. This viewpoint is seen in the notion of recognition-based

justice, which emphasises the necessity of incorporating varied narratives, knowledge frameworks, and rhetorical approaches in decision-making processes. Moving forward, restorative justice aims to repair relationships affected by past, current, and future injustices (Malinauskaite and Jouhara, 2019).

Contemporary society is observing a resurgence of ancestral sustainability practices rooted in natural cycles and indigenous knowledge. Indeed, although the CE emphasises the optimization of resource use and waste minimization, its broader implications for social equity are often insufficiently addressed. The concept of circular justice presents a comprehensive framework for tackling the social dimensions of energy transitions and ensuring that sustainability initiatives do not exacerbate existing social inequalities but instead promote a just transition. In many cases, the shift towards renewable technologies can lead to job losses and reduced income for workers in traditional energy sectors, particularly in the Global South, where industries reliant on fossil fuels are often central to local economies. As Sovacool and Dworkin (2015) argue, distributive justice ensures that the economic gains from energy transitions, such as increased employment in the renewable energy sector and reduced energy costs, are fairly distributed among different social groups, particularly marginalised communities. Procedural justice is equally essential to circular justice, as it ensures that decision-making processes are inclusive and participatory. In the context of energy transitions, it is crucial that communities most affected by the shift to renewable energy are actively involved in the planning and implementation of projects (Kirchherr, 2021). By ensuring community engagement, decision-makers can address local concerns, foster support, and ensure that renewable energy projects are not only technically sound but also socially accepted. Recognition justice, the third pillar of circular justice, emphasises the importance of acknowledging and respecting the identities, values, and knowledge of marginalised groups (Schlosberg, 2007; Schröder et al., 2020). This is particularly relevant in energy transitions, where the extraction of materials for renewable energy technologies, such as lithium and cobalt, often takes place in regions inhabited by indigenous and marginalised populations. As Romero-Lankao et al. (2023) suggest, a justice-oriented paradigm for innovations in energy transitions must prioritize the inclusion of diverse cultural perspectives to ensure that sustainability initiatives are aligned with broader goals of social equity.

In addition to the core dimensions of circular justice, it is important to properly handle the unintended consequences of CE practices, particularly in relation to rebound effects. Friant et al. (2020) explain that rebound effects occur when efficiency gains, such as those achieved through energy-saving technologies or material recycling, lead to increased consumption, thereby negating the initial environmental benefits. For instance, the recycling of materials in energy production, while reducing waste, can lead to a perception of resource abundance, encouraging higher levels of consumption and resource extraction. Circular justice addresses these challenges by advocating for policy measures that integrate social and environmental dimensions, ensuring that efficiency improvements do not come at the expense of vulnerable communities. Finally, it is worth noting that the implications of circular justice are particularly evident in discussions of global energy justice, which examines the social and economic impacts of energy transitions on different regions and social groups. Sefa-Nyarko (2024) provides a valuable case study of Ghana's energy transition, highlighting the tensions between national ambitions for renewable energy and the global concerns of justice and equity. Similarly, Velasco-Herrejón and Bauwens (2024) explore how energy transitions, while promoting environmental sustainability, can reproduce social inequalities, particularly in regions with deep socio-economic disparities. These studies underscore the importance of addressing both intra-generational and inter-generational justice in energy transitions.

Table 2 summarises the key themes identified in the literature regarding the intersection between CE, energy transition, and justice, thus delving into the importance of adopting a circular justice

Table 2
Overview of key themes.

Themes	Theme 1: <i>CE and energy transition</i>	Theme 2: <i>CE and justice</i>	Theme 3: <i>Energy transition and justice</i>	Theme 4: <i>Circular Justice framework</i>
Definitions and key concepts	CE aim to optimise resource utilisation, decrease pollution, and close material loops (Pansera et al., 2024). The energy transition involves switching from fossil fuels to renewables. Incorporating CE principles into energy systems improves sustainability and efficiency by reducing resource dependency and fostering the adoption of renewable energy.	Within the framework of energy transitions, justice is described as a principle of fairness and equity regarding the allocation of advantages and liabilities, decision-making processes, and the acknowledgement of all individuals and societal groups (van der Wel et al., 2024). CE can either facilitate or hinder justice, disproportionately impacting low-income and marginalised groups (Lima, 2022).	The energy transition frequently results in an unequal distribution of benefits (green jobs) and burdens (mining impacts on vulnerable groups) (Sovacool, 2021; Wang et al., 2024). Neglecting local issues, resource inequality, and violations of rights produces project-specific injustices (Abe and Azubike, 2024), whereas the integration of justice promotes fair resource distribution and community involvement in decision-making (Ayllón and Jenkins, 2023).	Circular justice addresses CE and energy transition societal aspects through distributive, procedural, and recognitional justice. Distributive justice involves equitable sharing of benefits and costs; procedural justice is inclusive decision-making, and recognitional justice acknowledges marginalised groups' rights, values, and expertise (Sumarno et al., 2024). In this realm, restorative justice seeks to mend damaged relationships from past, present, and future injustices (Malinauskaitė and Juhara, 2019).
Main challenges	The initial environmental benefits are neutralised by rebound effects, which result in increased resource consumption and emissions (Cheng, 2024). Furthermore, the emphasis on technology may result in the neglect of social and ethical considerations (Arai et al., 2024). Inequalities may be further exacerbated by the negligent management of CE infrastructures (Murray et al., 2017).	The emphasis on the economic aspects frequently neglects justice, encompassing the allocation of benefits and costs, the equity of decision-making, and the acknowledgement of multiple identities and viewpoints (Repp et al., 2021; Sumarno et al., 2024). Furthermore, it has the potential to exacerbate existing inequities if social factors are overlooked. Power dynamics in decision-making should be taken into account (Grimley et al., 2024).	The energy transition frequently results in conflicts, environmental health hazards, and inequalities in energy access and energy poverty (Mósesdóttir, 2024; Opoku-Mensah et al., 2024). Transition may exacerbate pre-existing disparities, adversely affecting health and contributing to environmental degradation (Grant et al., 2021; Canelas and Carvalho, 2023).	Energy transitions can affect communities in ways that go beyond job losses and retraining, frequently marginalising specific groups in discussions about the energy transition and recognition justice (Tarasova, 2024). Environmental challenges and social issues are inextricably linked and require integrated solutions to address the climate crisis (Kong et al., 2023).
Opportunities and benefits	Circular solutions can enhance the sustainability and economic efficiency of industries (Kaandorp et al., 2024). CE can enhance energy security and diminish dependence on foreign resources (Rishanty et al., 2024).	CE has the capacity to improve the quality of life in low- and middle-income countries, reduce pollution, and create new employment opportunities (Shobande et al., 2024). Inclusive design has the potential to alleviate concerns regarding equity. Indigenous circular systems can offer valuable insights for policies that promote justice (Romero-Lankao et al., 2023).	The transition to renewable energy is closely linked to the achievement of the SDGs. Access to affordable and clean energy for all (SDG 7) is connected to poverty eradication (SDG 1), reducing inequalities (SDG 10), gender equality (SDG 5), job creation (SDG 8: Decent work and economic growth), and combating climate change (SDG 13), among others (Heffron et al., 2021; Cao et al., 2024; Chen and Wang, 2024). For such reason, SDG 7 is often regarded as a key enabler for achieving all other SDGs.	Circular justice aims to establish that the shift to circular systems is based on principles of social equity (Kirchherr, 2021). It seeks preserve marginalised communities from disproportionate adverse effects and facilitate an equitable transition for everyone (Tiwari et al., 2024). A circular justice framework must heal the environmental and social damage created by the linear economic paradigm, especially in the global South.
Solutions and policy recommendations	To mitigate CO2 emissions and advance energy transition strategies, it is necessary to enact robust environmental legislation. Equitable management of CE infrastructure to mitigate disparities and policies that incorporate justice for a fair energy transition (Libertson, 2024).	Structural reforms taking into account the social and economic aspects of CE in addition to the environmental outcomes are required to implement this plan (Amorim de Oliveira, 2021; Gatto, 2023). For instance, integrating Indigenous and local viewpoints may improve CE policies.	Energy policy must include consultation tables and participatory mechanisms to include all stakeholders in decision-making. Policy should distribute energy transition benefits including clean energy, affordability, and mitigation of negative impacts on vulnerable areas fairly (Greenleaf et al., 2023). Using a place-based approach, policies must be tailored to local communities' needs and respect their traditional knowledge and customs (Elmallah et al., 2022).	Especially in the Global South, a circular justice framework should support local and community CE projects through decentralisation and bottom-up approaches (Schröder et al., 2019). CE technology and activities should start with justice assessment and monitored to promote social and environmental fairness. Life Cycle Assessment (LCA) approaches that consider all life cycle stages should be encouraged to assess CE technologies and processes' environmental and social impacts (Cerchione et al., 2024).
Practical examples	The textile sector's transition to a CE necessitates modifications to its production and consumption models, which influence global value chains. Despite the intention to minimise environmental impact and emissions, it is crucial to assess the social and economic repercussions of such changes. Indeed, this circular transition could generate employment in Europe while concurrently resulting in job losses in other	The establishment of eco-industrial parks is based on the notion of industrial symbiosis, in which the waste generated by one firm functions as a resource for another. The transition to a CE requires the cultivation of new skills and professions, with eco-industrial parks acting as centres for innovation and workforce development. For instance, Insertech is an organisation that repairs and refurbishes electronic devices while offering employment opportunities to young adults facing	Case studies in Tanzania and Mexico advocate for inclusive frameworks to address varied impacts on communities derived from the energy transition and infrastructures development (Standal et al., 2024; Velasco-Herrejón and Bauwens, 2024). Enhanced community engagement and respect for local groups knowledge and traditions are essential.	The ancestral notion of CE illustrates how traditional indigenous Hawaiian traditions work as a model for circularity, shaping global circular economy policies. This method recognises the importance of traditions and indigenous knowledge in the development of sustainable economic systems. This concept emphasises that a successful circular economy must include cultural and social values alongside economic and environmental factors. Social

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Table 2 (continued)

Themes	Theme 1: CE and energy transition	Theme 2: CE and justice	Theme 3: Energy transition and justice	Theme 4: Circular Justice framework
	regions (Härrilä and Levänen, 2024).	challenges in obtaining work (Ziegler et al., 2023).		justice is an essential component of these behaviours (Beamer et al., 2023).

framework. It categorizes the core concepts, challenges, opportunities, and solutions related to these interconnected topics, highlighting how they intersect and the implications for both industry and policy.

4.6. Psychological biases and their impact on implementing circular justice

Although the findings of this study support the implementation of the circular justice framework, it is imperative to acknowledge that its implementation may be significantly impacted by psychological biases. The perceptions and attitudes toward the adjustments required for a fair and inclusive transition can be distorted by these biases, which influence decision-making at the individual, organizational, and policy levels (Romero-Lankao et al., 2023). The perception of justice itself is susceptible to bias, as individuals may be influenced by personal values, interests, and political affiliations, and the equity of interventions may be influenced by the distinct interpretations of justice, including distributive, recognitional, and procedural justice. As depicted in Table 3, an inclusive approach that actively engages stakeholders and local communities in decision-making processes and incorporates diverse perspectives is necessary to effectively address these biases. This

Table 3
Psychological bias potentially impacting Circular justice adoption.

	Definition	Justice dimension at risk	Potential impact on circular justice	Mitigation strategies
Status quo bias	A propensity to favour the current state of things, thereby avoiding alterations or new initiatives. This bias can be observed as resistance to change.	<i>Distributive justice:</i> Even if they are inequitable, the status quo bias may induce decision-makers to preserve their current resource allocation patterns. This can impede the equitable distribution of benefits from the circular economy and the energy transition, resulting in marginalised communities being left behind.	It could impede the adoption of new circular business models and more sustainable energy practices, thereby perpetuating existing disparities. Decision-makers may favour current solutions, even if they are not yet established, because they perceive them as less risky.	Information campaign to demonstrate the advantages of transitioning to circular justice. Participatory processes to address resistance to change and incorporate diverse voices. Provide tangible benefits for the implementation of appropriate and circular practices.
Optimism bias	A propensity to overestimating the positive outcomes and underestimating the associated risks.	<i>Distributive justice:</i> Optimism bias may result in an underappreciation of the expenses and difficulties linked to the transition to renewable energy, hence causing insufficient resource distribution for at-risk populations and an erroneous assessment of project viability.	It could lead to overlooking energy transition policy concerns and their effects on marginalised people and the environment. It may overestimate recycling or material reuse, creating a "false" perfect circle (Gregson et al., 2015).	Assess potential concerns using comprehensive impact and risk analysis. Establish methods to adapt to unexpected scenarios. Monitor policy outcomes, including community displacement and land-use conflicts.
Loss aversion	A propensity to avoid losses rather than obtain equivalent advantages.	<i>Procedural justice:</i> Loss aversion may induce stakeholders to oppose procedural changes, even if they lead to more inclusive and transparent decision-making, like renewable technology adoption. Fossil fuel-dependent firms and communities may prioritize short-term economic gains, undermining circular justice.	It could lead decision-makers to refrain from implementing policies that require initial costs or changes in practices, even if these policies would result in long-term benefits in terms of justice (Ayllón and Jenkins, 2023).	Highlight the potential advantages of circular justice policies, emphasising their ability to mitigate long-term losses. Prioritize benefits over losses. Offer incentives and funding programs to encourage the adoption of more sustainable and equitable practices.
Framing effect	A propensity to react differently to the same facts depending on the way they are communicated.	<i>Procedural justice:</i> The framing effect can distort public perception, resulting in unbalanced involvement and obstructing real consultation, particularly when information is conveyed in a manner that prioritizes individual losses over collective advantages.	The communication or reporting of justice policies can result in varied interpretations, potentially yielding outcomes that are misinterpreted, e.g. policies prioritizing the economic or technological aspects of the energy transition may disregard social fairness.	Avoid presenting facts in a way supporting a particular viewpoint. Ensure that all individuals have a consistent understanding of justice policies and objectives.
Confirmation bias	A propensity to seek and interpret information that validates one's preexisting beliefs.	<i>Recognition Justice:</i> Confirmation bias might ignore underrepresented communities' needs. Instead of considering many different perspectives, decision-makers may choose solutions that match their own beliefs.	Decision-makers may overlook evidence that contradicts their beliefs about justice, perpetuating unjust policies.	Encourage belief evaluation. Actively seek diverse perspectives, especially from marginalised groups. Avoid preconceptions and carefully evaluate the evidence.

participatory approach, can assist in reducing the influence of psychological biases, thereby promoting greater equity in energy transition policies and the implementation of circular justice principles.

5. Conclusions

By conducting a systematic literature review of 169 articles concerning the intricate relationship among CE, energy transitions, and justice, the main finding of this paper is that the shift towards renewable energy is not only a technological imperative but a profound social transformation. While CE has great promise for promoting sustainability, our results reveal that its advantages are not fairly distributed throughout communities, often exacerbating existing social disparities. Key findings underscore the necessity for an inclusive approach that incorporates environmental and social justice issues within CE and energy transition frameworks (Solomonian and Di Ruggiero, 2021).

Achieving a carbon-free electric sector and a net-zero emissions economy by 2050 will not only require important advances in science, innovation, and technology, but also important and increasingly inclusive processes to address social and EJ concerns (Arent et al., 2022). The principles of circular justice emphasise the importance of addressing

inequalities in resource accessibility, decision-making processes, and the allocation of environmental costs. It becomes imperative to guarantee that vulnerable communities, especially those in marginalised areas, are not left behind in the transition to decarbonisation. Further, the paper reveals that achieving a just transition requires the active involvement of local communities in decision-making processes and a comprehensive policy approach that prioritizes both procedural and recognitional justice. Localised decision-making and community involvement are essential to guarantee equitable distribution of sustainability benefits and to amplify the voices of marginalised populations. Only through a multi-dimensional framework, which includes environmental, social and governance considerations, we can advance toward truly sustainable and just energy systems.

The CE is inspired by natural ecosystems, aiming to regenerate resources and close economic loops. This strategy represents not only a practical answer to waste but also an ethical and philosophical shift towards sustainability, consistent with indigenous eco-centric views that perceive nature as an extension of the self. Unlike the anthropocentric European tradition that often emphasises individual economic growth, indigenous philosophies such as *aloha ʻāina* (i.e. love of the land) highlight the interconnectedness between individuals and the environment. Incorporating these perspectives into CE frameworks could foster a more equitable and holistic form of development. This integration also highlights cultural sustainability as an essential, yet often overlooked, fourth pillar of sustainable development (Beamer et al., 2021).

While the promise of CE is clear, future research should focus on developing more holistic assessment tools that evaluate the social implications of CE initiatives, ensuring they contribute to equitable outcomes. Policymakers must balance technological innovation with robust social frameworks to prevent the reinforcement of inequalities, particularly in marginalised regions in the Global South.

5.1. Limitations and future research avenues

This study emphasises the need for an inclusive and justice-oriented energy transition, but its efficacy may be restricted by many psychological biases. Strategies to mitigate potential prejudices should encompass: promoting critical thinking to avoid the reinforcement of unjust practises; utilising participatory governance models that integrate the perspectives of all stakeholders in decision-making (Kaandorp et al., 2024); developing communication strategies that deliver information clearly and transparently; employing incentives and support systems to encourage the adoption of circular practices while minimising the risks related to change; establishing monitoring and evaluation frameworks that assess outcomes and enable adjustments based on empirical evidence; and ensuring access to education and information to empower individuals and communities to make informed choices.

Our study has outlined several gaps in literature, each suggesting a possible direction for future research. First, future research should prioritize marginalised populations, especially in low-income and resource-dependent areas, to enhance awareness of the disparities in unjust energy transitions. Evaluating the impact of renewable energy efforts on these areas is crucial for formulating more fair energy policy. Second, given the comprehensive scope of our research, a significant contribution would be the development of a multidimensional assessment tool integrating CE principles, energy transition models, and justice frameworks to evaluate both existing and emerging CE initiatives. A comprehensive examination of the impact of gender on such transitions is also necessary, given that environmental injustices often exacerbate gender inequality. Furthermore, future study should examine the impact of digitalisation and enabling technologies on promoting fair energy transitions. Understanding how digital tools can enhance community engagement in CE efforts and promote energy democracy is crucial for advancing social inclusion (Cerchione, 2024). Finally, comparative evaluations of policy frameworks among nations and regions may reveal

best practices and innovative governance models to successfully integrate CE principles with social equality. By addressing these research gaps, scholars and policymakers can work together to guarantee that energy transitions may be both environmentally sustainable and socially equitable.

5.2. Implications and concluding remarks

The study's findings indicate that policymakers and practitioners should implement a more inclusive and justice-oriented approach in integrating CE principles within the energy transitions. Shifting to renewable energy sources has huge potential to promote sustainable development but also poses serious threats to marginalised and vulnerable communities.

From an industry standpoint, firms should extend their implementation of CE practices beyond mere resource efficiency to encompass the social aspects of their operations, guaranteeing fair employment approaches and equitable economic benefits across all sectors and demographics. Innovations in product design could enhance durability and reusability, thus mitigating excessive consumption and rebound effects.

Rebound effects represent a significant challenge to achieving just transition objectives and therefore should be guided by policies that extend beyond technology advancements and handle the complex social dimensions of energy justice. Targeted strategies may encompass progressive pricing models for energy consumption to deter misuse; public awareness campaigns to inform consumers about the environmental consequences of increased usage; the implementation of assessment tools that assess environmental, social, and economic factors to identify rebound effects early in a project's lifecycle, alongside regulations focused on LCA; and the provision of targeted subsidies or financial incentives for low-income households to enhance their access to renewable energy technologies such as solar panels. To mitigate conflicts and resistance to projects, policymakers should establish participatory frameworks, such as Energy Transition Councils, that welcome members from marginalised and disadvantaged communities (Sadik-Zada and Gatto, 2023). Additionally, the implementation of benefit-sharing agreements that allocate a portion of the revenue from energy projects to community development initiatives, such as the provision of essential public infrastructure, healthcare, and other critical services to residents, could be an effective approach. It is equally essential to prioritize job training and reskilling initiatives to improve social fairness, particularly for workers in conventional fossil fuel sectors who are at risk of displacement (Repp et al., 2021). In other words, the integration of circular justice principles into energy governance could facilitate the equitable distribution of economic benefits among affected populations and promote equitable decision-making (Van der Wel et al., 2024).

CRediT authorship contribution statement

Roberto Cerchione: Writing – review & editing, Validation, Supervision, Methodology, Formal analysis. **Mariarosaria Morelli:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Data curation, Conceptualization. **Renato Passaro:** Writing – review & editing, Validation, Supervision, Methodology, Formal analysis, Conceptualization. **Ivana Quinto:** Writing – review & editing, Validation, Supervision, Methodology, Formal analysis, Conceptualization.

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.

Appendix 1. Distribution of publications across journals

Publishing journal	N. of papers
Energy Research & Social Science	22
Applied Energy	8
Energy policy	8
Sustainability	8
Resources, Conservation and Recycling	7
Local Environment	6
Economic Change and Restructuring	5
Ecological Economics	4
Journal of Cleaner Production	4
Energies	3
Journal of Energy & Natural Resources Law	3
Renewable and Sustainable Energy Reviews	3
Business Strategy and the Environment	2
Circular Economy and Sustainability	2
Climate Policy	2
Climatic Change	2
Discover Sustainability	2
Ecology and Society	2
Environmental Innovation and Societal Transitions	2
Frontiers in Environmental Science	2
Frontiers in Sustainability	2
Global Environmental Politics	2
International Journal of Sustainable Energy Planning and Management	2
Journal of Environmental Management	2
Science of the Total Environment	2
Sustainability: Science, Practice and Policy	2
Sustainable Development	2
The Extractive Industries and Society	2
ACS Sustainable Chemistry & Engineering	1
AGATHÓN International Journal of Architecture, Art and Design	1
Agroecology and Sustainable Food Systems	1
Assessment	1
Australian Journal of Environmental Education	1
BioEnergy Research	1
Business and Human Rights Journal	1
Business strategy & Development	1
CIRIEC-Espana Revista de Economía Publica, Social y Cooperativa	1
Canadian Foreign Policy Journal	1
Economics and Sociology	1
Economy and society	1
Energy and Buildings	1
Energy & Environment	1
Environment, Development and Sustainability	1
Environmental Impact Assessment Review	1
Environmental Politics	1
Estudios de economía aplicada	1
Etikk i praksis-Nordic Journal of Applied Ethics	1
Forest Policy and Economics	1
Futures	1
Geoscience Frontiers	1
Global Environmental Change	1
Heliyon	1
International Journal of Gender and Entrepreneurship	1
International Journal of technology management & sustainable development	1
Journal of Innovation Management	1
Journal of Political Ecology	1
Journal of Responsible Innovation	1
Land	1
Landscape Research	1
Latvian Journal of Physics and Technical Sciences	1
Maritime Studies	1
Mining	1
NEW SOLUTIONS: A Journal of Environmental and Occupational Health Policy	1
Nature Energy	1
Ocean & Coastal Management	1
Plos one	1
Politics and Governance	1
Proceedings of the Indian National Science Academy	1
Recycling	1
Renewable Energy Focus	1
Resources	1
Review of African Political Economy	1

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Publishing journal	N. of papers
Scientific Reports	1
Socio-Economic Planning Sciences	1
Statistics in Transition new series	1
Structural Change and Economic Dynamics	1
Sustainable Cities and Society	1
Sustainable Production and Consumption	1
Technology in Society	1
The Canadian Geographer/Le Géographe canadien	1
The Journal of World Energy Law & Business	1
Utilities Policy	1
WMU Journal of Maritime Affairs	1

Data availability

Data will be made available on request.

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