





Review

Geography of Sustainability Transitions: Mapping Spatial Dynamics and Research Trends Between 1995 and 2024

Inácio Pinto Ribeiro ¹, Hélder Silva Lopes ^{2,3,*}, Maria Alzira Pimenta Dinis ^{4,5} and Paula C. Remoaldo ²

- ¹ Department of Geography, Institute of Social Sciences, University of Minho, 4800-058 Guimarães, Portugal; inaciopintoribeiro@gmail.com
- ² Lab2PT—Landscape, Heritage and Territory Laboratory, IN2PAST—Associate Laboratory for Research and Innovation in Heritage, Arts, Sustainability and Territory, Department of Geography/ICS—Institute of Social Sciences, University of Minho, 4800-058 Guimarães, Portugal; premoaldo@geografia.uminho.pt
- ³ Higher School of Education Paula Frassinetti, 4000-255 Porto, Portugal
- ⁴ Fernando Pessoa Research, Innovation and Development Institute (FP-I3ID), University Fernando Pessoa (UFP), 4249-004 Porto, Portugal; madinis@ufp.edu.pt
- ⁵ Marine and Environmental Sciences Centre (MARE), University of Coimbra, 3000-276 Coimbra, Portugal
- * Correspondence: helderlopes@geografia.uminho.pt

Abstract: The study of Sustainability Transitions (STs) has emerged as an interdisciplinary research field aimed at understanding and guiding societal transformations toward sustainability. While significant advancements have been made in analyzing socio-technical, economic, and policy dimensions, spatial aspects of STs have been largely overlooked. This study contributes to the field by conducting a systematic literature review and bibliometric analysis of academic research on the Geography of Sustainability Transitions (GST). Using the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) framework, this study identified and analyzed 63 scientific publications indexed in SCOPUS (1995–2024) to examine trends, regional distribution, author profiles, thematic focuses, and main advances. Results highlight a concentration of research in the Global North, with major contributions from Europe and North America, while studies from the Global South remain scarce. The analysis also reveals six dominant transition themes: urban transitions, energy transitions, industrial transitions, transport transitions, circular economy, and agri-food transitions. Each of these themes is discussed in terms of spatial dynamics, governance mechanisms, and the role of regional contexts in shaping transition pathways. The study underscores the need for a more spatially inclusive approach in transition research, advocating for greater integration of geographical perspectives in sustainability studies. Future research should emphasize the role of local and regional factors in transition processes, addressing disparities in transition capabilities between different territories. By doing so, this work contributes to a more comprehensive understanding of how STs unfold across diverse spatial contexts. Identifying the observed research gaps, the study acts as a catalyst for interdisciplinary analytical reasoning and reinforces the geospatial effect within the broader field of STs.

Keywords: sustainability transitions (STs); geography of sustainability transitions (GST); PRISMA framework; research trends; geographical scope



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1. Introduction

At the end of the 1990s, an interdisciplinary and transdisciplinary research field emerged, dedicated to anticipating and adapting transitions to sustainability challenges: Sustainability Transition studies (STs). This field resulted from the intersection between

transition research and sustainability science, which is defined by practical problems and theories on the interactions between natural and social systems. Over the past two decades, there has been a significant increase in academic interest in STs [1]. It is important to highlight that the coronavirus disease (COVID-19) pandemic had a significant impact on the dynamics surrounding ST. There has been a noticeable rise in the number of studies focusing on STs in recent years, reflecting growing academic interest and the field's expanding relevance across various disciplines. The still ongoing COVID-19 pandemic has contributed to growing interest in the resilience of social and environmental systems, highlighting the urgency of addressing global environmental and social challenges. However, until recently, the literature on this topic largely neglected the spatial dimensions of STs [2,3]. The influences of environmental changes on productive and social systems are a growing topic of interest in academic, business, and governmental circles worldwide. These repercussions manifest as ongoing transformations toward a reality in which environmental sustainability guides social and/or economic development. These change processes are referred to as ST, thus giving rise to a new research agenda in academia [4].

The decarbonization of energy and transport systems, agriculture that promotes biodiversity and ensures food security, waste and water management, and sustainable urban development are some examples of the transformations of STs on the agenda in academia [3,5]. Among the various research themes of this agenda is geography, and particularly, the geography of sustainability transitions (GST). Therefore, this study aims to map trends, author profiles, regional distribution, thematic focuses, and main advances within the theme of GST. Using the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) framework, this study identified and analyzed 63 scientific publications indexed in SCOPUS (1995–2024).

Currently, the STs field encompasses distinct approaches that seek to understand and operationalize the governance, which motivated a literature review to proceed with a bibliometric analysis aimed at understanding the academic production on GST. For its development, relevant scientific literature on GSTs was identified and analyzed, with the present study adopting a quantitative approach and focusing on publications in English. The process included three phases: (i) selection of the literature; (ii) bibliometric analysis; and (iii) discussion of the main areas of STs and directions for the future.

The paper is structured into several sections. Following this introductory section, there is a literature review on sustainability transitions and the GST. After the theoretical discussion, a section on the research methodology follows. Subsequently, the main GSTs are addressed. Finally, the discussion and conclusions of the research are presented.

2. Literature Review—From Sustainability Transitions to Geography of Sustainability Transitions

GSTs encompass the geographical concepts and methods that contribute to understanding these processes. Their emergence in the research agenda stems from the lack of a spatial approach in transition analysis. In this sense, the theoretical perspective of ST studies is strengthened by contributions from regional studies and economic geography [6]. Regional studies contribute to the discussion on specialization and regional diversification as foundations for regional development [7]. On the other hand, economic geography enriches the debate on transitions by understanding the nature, spatiality, and radicality of innovations [6]. By combining these approaches, it becomes possible to gain a deeper understanding of geographical inequalities and the spatial diversity of ST trajectories and their impacts [8].

Questions such as why transitions occur in certain places, how they develop in different geographical contexts, and the role of relationships across different spatial scales

have largely been ignored. Although there have been significant contributions on urban sustainability and low-carbon transitions, the GSTs have remained in the background [9]. Within this framework, questions arise, such as why do some regions manage to advance toward STs trajectories and socioeconomic development while others do not? What are the regional specificities that explain success in some regions and stagnation in others?

In this context, transition analysis benefits from conceptual tools such as related variety (the study of regional productive and technological diversification), resource-based enclaves, multi-level governance, value creation, and proximities (geographical, social, cognitive, organizational, and institutional) between agents [10]. Like sustainability science, ST studies are characterized more by their research purpose than by predefined methods or objectives, emphasizing action orientation, integrated assessment, and interdisciplinarity. The focus is to bring science closer to individuals, which requires significant changes in the organization and conduct of science. These studies seek to understand the dynamics and mechanisms of ST, considering the role of human action and the adoption of diverse approaches and perspectives.

According to Loorbach et al. (2017) [11], The concept of sustainability transitions has been a topic of debate in both academic and public spheres. It has developed through a diffuse international field of applied and fundamental research (. . .) that is increasingly global and encompasses a wide range of sectors, domains, and social issues (p. 601).

ST studies are now considered a socially relevant research field, considering the magnitude of global sustainability challenges. The growing academic interest reflects the perception of STs as processes of social change essential for addressing contemporary challenges [1,12–14].

3. Methods and Data

3.1. PRISMA Model to Conduct Literature Review in Geography of Sustainability Transitions

This section provides a review of various studies conducted at an international scale on GST. The literature review focused on international studies. The PRISMA guidelines [15] were followed, as they are recognized for improving the quality and transparency of systematic reviews (Figure 1).

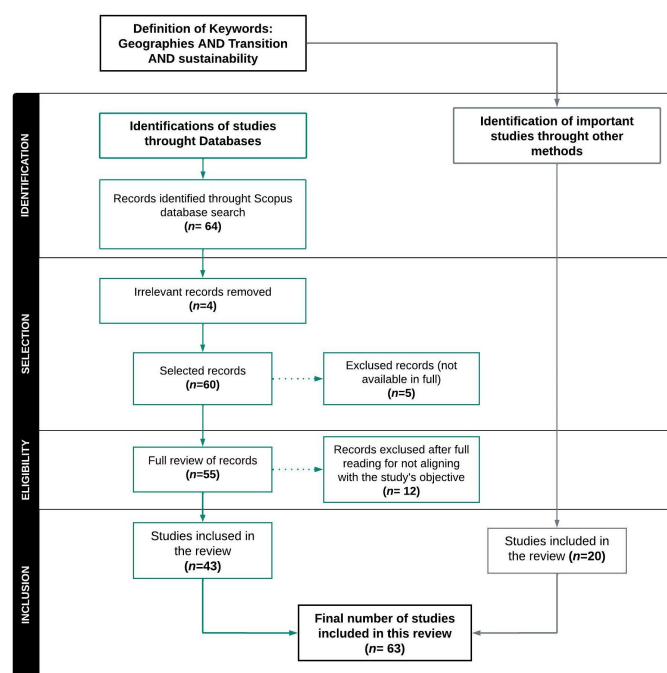


Figure 1. PRISMA flowchart of the literature selection and review process using keywords.

We adopted the latest version of PRISMA, which emphasizes transparency and quality in the selected studies. First, by mid-2024, a review of records in the SCOPUS database was conducted to identify relevant literature using the following keywords: “Geographies AND transition AND sustainability.” The Boolean method was used to include combinations of keywords appearing in the titles, keywords, or abstracts of the records. The term “Geography of Sustainability Transitions” (Figure 1) produced 64 records in Scopus (including unavailable records). The choice to use the SCOPUS database for the analysis is based on three main considerations: (i) the high quality of the indexed sources, such as peer-reviewed journals, which ensure reliable data; (ii) its global coverage, which allows for comparative and international analysis; and (iii) its academic recognition, being one of the most respected and reliable databases in the scientific community, ensuring the relevance and credibility of the obtained results. In addition to the records identified in the SCOPUS database, highly cited articles on Sustainability Transitions were included to ensure the comprehensiveness and relevance of the study.

The first stage of the review process was to define keywords to identify relevant sources of literature from the Scopus database for the period 2023 to 2024. This search resulted, as mentioned before, in 64 records (including unavailable records). In the second stage, after obtaining the relevant publications, records that were unavailable or not relevant based on the title were excluded ($n = 9$). Subsequently, the remaining 55 records were included in the list of potential articles for review. In the third stage, the literature selection process involved the selection and full review of the records, with 12 records being excluded for not being related to GST. Among these 12 records, 3 were not intrinsically linked to GSTs but rather to other types of transitions, as the keywords may have led to a divergence in the relevance of the information obtained, which falls outside the intended scope of analysis. Additionally, 9 were related to Evolutionary Economic Geography rather than ST. In the final stage, for inclusion in the systematic review, documents that were connected to the topic, considered the most relevant in the context of GST, and produced before 2023 were selected ($n = 20$). These documents correspond to the period from 1995 to 2019. The 20 included records formed the set of publications proposed for this study ($n = 63$).

3.2. Contextualization of the Various Studies: Bibliometric Analysis

This section analyzes various studies conducted at an international scale on GST. Research on STs has emerged as an approach to dealing with the uncertainty caused by climate change [16]. While it has primarily focused on countries in the Global North, the Global South has also witnessed significant development. There is a gap in the bibliometric analysis of the evolution of research on STs and its geographical distribution. Recognizing this gap, the following question arises, which this section aims to address:

RQ1: *How has research on GSTs evolved between 1995 and 2024, and how has this evolution been reflected in geographical dynamics?*

ST research saw its first publication in 1994, authored by Kemp [17]. However, until 2002, the growth of literature in this field remained stagnant.

Thus, we focused on analyzing 63 publications. A grid was developed to identify these works, presenting them based on the publication title, author(s), year, and where it was published. Additionally, the STs category addressed in the study and the geographical scale, when applicable, were categorized, along with some additional observations. The literature review on GSTs can be useful in addressing various dimensions related to sustainability and geographical development, such as the following:

- Understanding how GSTs impact economic models, including the development of green industries and the circular economy, e.g., refs. [18–20].

- Analyzing how they address natural resource management issues, considering conservation practices and efficient resource use, e.g., refs. [21–23].
- Examining how they approach equity and social justice issues, such as equitable access to resources and community participation in planning and decision-making processes, e.g., refs. [24–26].
- Understanding how they promote resilience in urban and rural areas, considering sustainable urban planning, urban agriculture, community resilience building, and climate change adaptation, e.g., refs. [27,28].
- Identifying governance systems and environmental policies that support GST, such as incentive policies, environmental regulations, public–private partnerships, and civil society participation, e.g., refs. [29–31].
- Understanding the role of technological innovation in advancing GST, including clean technologies, renewable energy, greener transportation, and green infrastructure development, e.g., refs. [32–35].
- Identifying the impact of this scientific field on population health and well-being, such as access to healthy food, air and water quality, the consideration of traditional sustainability practices, and respect for cultural diversity, e.g., refs. [36–38].

3.3. Variables for Analysis and Classification

The bibliometric analysis adopted in this study aims to provide a more detailed understanding of the relevant academic production on this topic. Thus, the section focuses on a quantitative-qualitative approach, identifying key patterns and relationships among the themes.

To enhance the analysis, we divided the variables into two distinct phases: (i) authorship profile and key authors; and (ii) classification of GSTs typologies.

Typically, studies using bibliometric analysis begin by examining the evolution over time. However, a recent article [16], along with other studies, indicates that there has been a significant increase in research addressing STs over time. Our study is not merely to demonstrate temporal evolution but to characterize the studies by analyzing academic support, the geographical gaps within GSTs that persist to this day—especially between the Global North and the Global South—and the various GSTs that have raised academic attention.

4. Results and Discussion

4.1. Background—Authors and Spatialisation of the Research

The main authors of the studies included in the literature review show a significantly concentrated geographical distribution, with a notable preponderance of authors and academic institutions located in the countries of the Global North (Table 1). Countries such as the Netherlands ($n = 10$), the United Kingdom (UK) ($n = 8$), and Norway ($n = 4$) are clearly represented as the main contributors to GST.

This geographical concentration raises important questions about the existing gap between the Global North and the Global South. The absence of authors from academic institutions in Global South countries suggests a disparity in representation and participation in these studies, which may limit the diversity of perspectives, experiences, and approaches reflected in the analyzed literature.

Due to the geographical disparities between the Global North and the Global South highlighted in Table 1, a cartographic representation was developed to illustrate the distribution of studies included in the literature review. This map represents the distribution of studies by country or locality, according to the adopted scale of analysis (Figure 2). The 20 included records formed the set of publications proposed for this study ($n = 63$).

Table 1. Main geography of Sustainability Transition authors included in the literature review.

Author	Studies' Number	Institution	Institution's Country	References
Coenen, L.	4	Applied University of Western Norway	Norway	e.g., refs. [10,28,39,40]
Truffer, B.	3	Utrecht University	The Netherlands	e.g., refs. [1,39,41]
Raven, R.	3	Monash Institute for Sustainable Development	Australia	e.g., refs. [1,34,42]
Frantzeskaki, N.	3	Utrecht University	The Netherlands	e.g., refs. [24,28,40]
Verbong, G.	2	Eindhoven University of Technology	The Netherlands	e.g., refs. [32,42]
Marvin, S.	2	University of Sheffield	UK	e.g., refs. [9,43]
Loorbach, D.	2	Erasmus University Rotterdam	The Netherlands	e.g., refs. [24,40]
Hodson, M.	2	University of Manchester	UK	e.g., refs. [9,43]
Hansen, T.	2	University of Copenhagen	Denmark	e.g., refs. [10,44]
Castán Broto, V.	2	University of Sheffield	UK	e.g., refs. [40,43]
Binz, C.	2	Swiss Federal Institute of Aquatic Science and Technology	Switzerland	e.g., refs. [23,45]
Berkhout, F.	2	King's College London	UK	e.g., refs. [29,42]

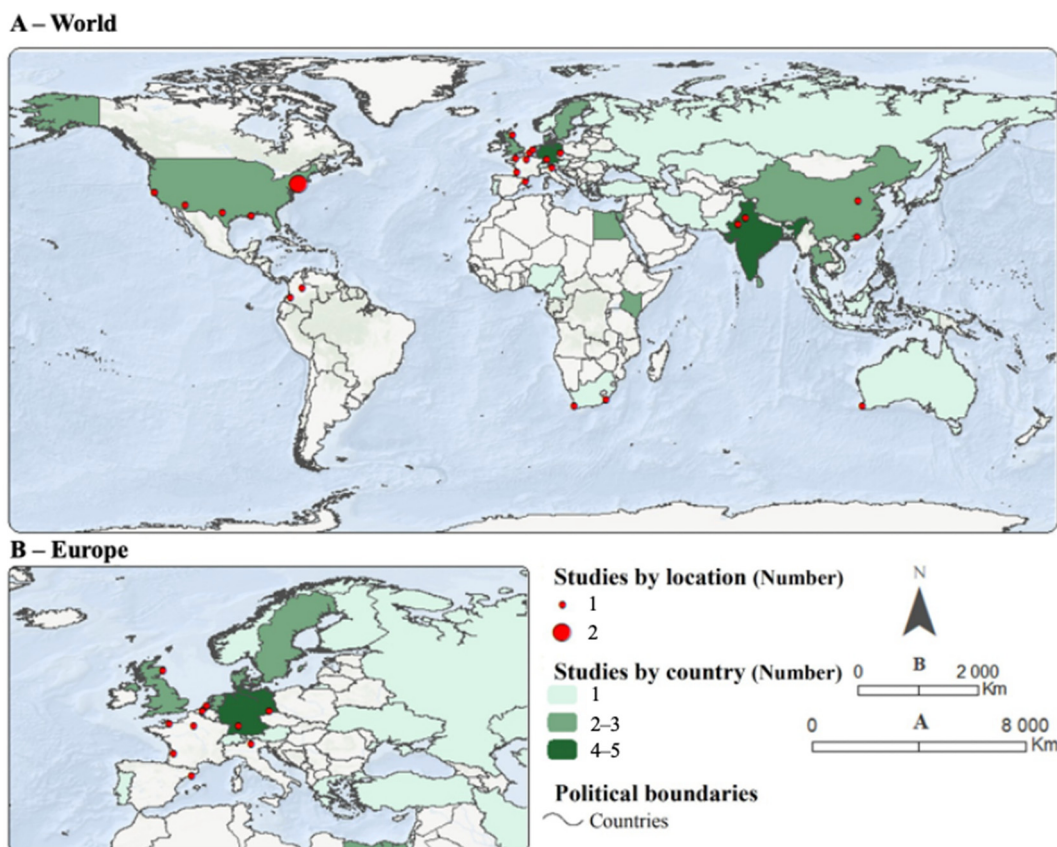


Figure 2. Spatial distribution of geography of Sustainable Transition studies worldwide by country and city.

As noted by the main authors of these studies, there is a marked predominance of studies and academic institutions located in the countries of the Global North. There is a significant concentration of the application of transitions in three specific areas: Northern

Europe (e.g., Germany, Denmark, Norway, and the Netherlands), North America (United States), and South and Southeast Asia (e.g., India, China, and Thailand).

4.2. Types of Geography of Sustainability Transitions

In the 64 studies in our database on which we based this bibliometric analysis, we identified several different types of GSTs. The most frequently covered GSTs are shown in Table 2, along with some studies that deal with these same transitions.

Table 2. Types of geography of Sustainability Transitions most addressed in the studies included in the literature review.

GSTs Type	Studies' Number	References
Urban	19	e.g., refs. [28,38,46]
Energy	14	e.g., refs. [19,30,47]
Industrial	8	e.g., refs. [20,48,49]
Transport	5	e.g., refs. [32,33,41]
Circular Economy	4	e.g., refs. [18,50]
Agri-food	4	e.g., refs. [51,52]

In the current context, where environmental concerns, social justice, and economic equity are at the forefront, these transitions represent essential pathways for building a more sustainable and resilient future for present and future generations. These transitions will be explored further, with an analysis of their distinct characteristics and geographical implications. Special attention is given to the identification and location of the main GSTs currently. This section aims to provide a comprehensive overview of the different approaches and ongoing initiatives, offering a contextualized understanding of the global landscape of GST.

4.2.1. Domains and Gaps in the Geography of Sustainability Transitions

STs are geographical processes—they are not generalized but occur in specific locations with distinct characteristics. Historically, the ST literature has neglected the importance of the geographical contextualization of these processes [10,53].

In a conceptual analysis, Shove and Walker (2007) [54] highlight the relevance of contextual factors, such as the political environment and the prior knowledge of local actors, in transition processes. Later, geographers emphasized the necessity of a detailed analysis of local specificity in STs [55].

Studies adopting the GSTs approach primarily focused on the experiences of European Union (EU) countries. Besides being a group of so-called developed countries with several global leaders, the debate on the impacts of climate change, as well as possible technological alternatives to address them, has been a key agenda in EU policies [8]. Several researchers in the GSTs field highlight that transitions should be analyzed through three key theoretical concepts: scales [56], places [56], and spaces [8,10].

The study of GST scales suggests the need to go beyond the formally defined boundaries of urban, regional, national, or global categories. As highlighted by Binz et al. (2020) [8], these territorial categories do not account for the fluidity, permeability, and multi-scale in which transitions are embedded. Thus, the structures that delineate transition processes, seemingly spatially confined, should be viewed through the lens of multiple coexisting scales. Consequently, the analysis of sociotechnical regimes (mesoscale), sociotechnical landscapes (macro trends), and technological niches (microscale)—the structures—should consider a multi-scalar perspective. The places of transitions emphasize the importance of local specificities in realizing transitions, highlighting the diversity of experiences in productive and technological transformation in each location [53].

The spatiality of GSTs underscores the relevance of spatial factors and processes for a better understanding. For example, emphasis can be placed on the diversification of spatial knowledge diffusion models, the unequal spatial distribution of skilled human resources, and the technological and institutional capacities of different regions [56]. Following these principles, the main geographical perspectives of transitions were synthesized.

While the six types of STs are often treated as distinct analytical categories, potential synergies and interdependencies among them can be identified. Recognizing these connections can clarify their individual roles, deepen understanding of each transition type, and underscore their specific relevance in practice. Urban transitions, for example, intersect significantly with energy and transport transitions, especially in the development of sustainable infrastructure and urban mobility systems. Likewise, industrial transitions are closely tied to circular economy initiatives and sustainable agri-food practices, particularly when framed within territorial innovation strategies. In environmental studies, acknowledging these synergies and interdependencies is essential. It reflects the understanding that effective sustainability transitions demand an integrated approach—one that treats the environment as a complex, interconnected ecosystem. Such an approach must account for the cumulative impact of human activities not just at the local scale, but also in terms of their broader influence on global environmental systems.

i. Agri-food transitions

The primary challenge faced by agriculture is the search for a balance between productivity and long-term sustainability. Agricultural soils exhibit the negative impacts of industrial farming practices: compaction adversely affects soil structure, nutrient and organic matter depletion reduces fertility, and wind and water erosion degrade arable land. Additionally, excessive runoff and nutrient removal from agriculture cause significant damage to aquatic environments [57]. Challenges in the agri-food system related to social aspects are also frequently highlighted, with specific concerns about unequal access to food and the exploitation of agricultural and food workers. Moreover, the negative economic effects of hunger and obesity are receiving increasing attention from policymakers. Focusing on this challenge, it is important to analyze organic agriculture, a specific set of agricultural practices that prioritize ecological sustainability [58]. Organic agriculture is characterized by lower dependence on non-agricultural inputs and more efficient integration with ecosystem service functions. Most publications highlight the positive impacts of organic farming on soil fertility, biodiversity conservation, and natural resource protection, e.g., refs. [59–61].

Some studies on agri-food transitions explore alternative food networks and how these networks contribute to social inclusion, economic resilience, and environmental conservation, e.g., refs. [52,62–64]. Similarly, the study by Banos (2023) [21] examines the STs to “new” forest products, addressing the relationship between resource geography and agri-food sustainability. It highlights how sustainable natural resource management can drive the transition toward more sustainable and resilient food systems.

Beyond more sustainable agricultural practices, some studies [65–67] emphasize the interconnection between human, animal, and environmental health and how this relationship influences food safety and quality. These studies promote more sustainable agricultural practices, ultimately contributing to the mitigation of the environmental impacts of food production.

For example, several cities have developed urban food strategies, leading to new alliances between consumers and food producers, as well as between urban centers and surrounding rural areas. Alternative Food Networks (AFN), urban food strategies, and other forms of civic regulatory assemblies are thus playing a critical role in addressing local and regional food insecurity and food sovereignty [68].

In Australia, the proposal for a national food policy resurfaced on the political agenda in 2009, catalyzed by coordinated efforts between public health and food industry stakeholders [69]. Organizations such as the Public Health Association of Australia (PHAA), the Dietitians Association of Australia (DAA), Dairy Australia, Meat & Livestock Australia (MLA), the National Farmers' Federation (NFF), and the Australian Food & Grocery Council (AFGC) played an active role in this process. Multiple meetings between public health and food industry representatives led to the development of key documents aimed at better understanding the impacts of food production on the environment and public health. Additionally, these discussions established guiding principles for implementing a new National Food and Nutrition Policy in Australia.

In Denmark, awareness of the social, economic, and environmental costs of food waste has grown in recent years, driven by both civil society and the government [70]. Efforts to combat food waste initially emerged as a consumer-driven movement. The organization "Stop Spild Af Mad" (Stop Wasting Food) has been at the forefront of this movement, aiming to raise awareness of food waste [71]. This movement is supported by Danish consumers, members of the European Parliament, Danish parliamentarians, chefs, and culinary personalities. The Danish Consumer Council also launched a campaign to increase consumer awareness of food waste.

Agri-food transitions seek to address the challenges of food production in a world with a growing population and limited natural resources, promoting more sustainable farming practices, reducing food waste, ensuring food security, and fostering more sustainable and resilient food systems.

ii. Industrial transitions

Industry, as the primary producer of essential goods for daily life, plays a central role in the global economy. However, its processes often rely on large amounts of energy, frequently derived from fossil fuels, resulting in high greenhouse gas (GHG) emissions [51,72,73].

In recent years, growing awareness of the intersection between economic and ecological crises has led many governments to develop plans for a New Green Deal. This new paradigm seeks to address systemic challenges by promoting social and industrial transformations toward more sustainable modes of production and consumption [49]. Industrial transitions to sustainability have emerged as one of the key challenges and opportunities for economies at all stages of development in the 21st century [7]. Some academic literature [2,74]. has been dedicated to understanding the necessary conditions for these transitions, examining the co-evolution of new technologies, market changes, user practices, political and cultural discourses, and governmental institutions from a systemic perspective. Historically, industrial growth has progressed through a series of phases, initially increasing resource intensity and pollution [75,76], followed by later industrialization phases that tend to consume fewer resources and generate less pollution [77,78]. This pattern often results in countries learning from more advanced economies' technologies and practices [42]. However, as sustainability concerns grow, simply imitating the practices of so-called developed countries may no longer be sufficient [42]. The pursuit of sustainable innovation must begin within individual countries. This requires a broader approach that considers not only technological innovation but also changes in social and technological practices [42].

The decarbonization of industry has become a critical goal in achieving net-zero emissions by 2050 [79]. However, this represents a complex sociotechnical challenge requiring radical changes in production, consumption, and regulatory systems. It also demands massive investments in technology [80,81], financing, and transformative policies [82,83].

Beyond the technical and economic challenges, industrial decarbonization has social implications, particularly for societies heavily dependent on industry [49]. Transitioning to a more sustainable economy may require significant economic and identity shifts in these societies [20].

The International Energy Agency [84] reports that direct industrial CO₂ emissions reached 8.5 Gt of carbon dioxide in 2020, accounting for nearly one-quarter (24%) of all global emissions [79]. Specifically in Europe, industry is one of the largest emitters, responsible for more than 20% of total emissions, including indirect emissions [85]. Sectors such as iron and steel, cement, and chemicals contribute significantly to these emissions [73].

Industrial decarbonization has become a priority for the EU, aiming at the decarbonization of the European economy [86]. Some countries, such as Germany and the UK, have already made progress in reducing industrial GHG emissions [73]. In 2018, these same countries managed to reduce their emissions by 30% and 46%, respectively, compared to 1990 levels [87]. This reduction is partly due to the UK's transition from a manufacturing-based economy to a service-oriented economy, leading to a decline in direct emissions [73]. Both the UK and Germany have set ambitious targets to reduce GHG emissions by 2030. For example, the UK launched the Clean Growth Strategy (CGS) and Industrial Strategy, making significant investments in industrial decarbonization and carbon storage technologies [73]. Similarly, Germany has established clear emission reduction targets, driven by the EU Emissions Trading System (ETS) [88]. As carbon prices increase and climate policies tighten, accelerating industrial decarbonization becomes crucial for maintaining the competitiveness of these countries. This requires substantial investments in clean technologies, infrastructure, and environmental policies to effectively address climate change [73].

iii. Economy transitions

The transition to a sustainable economy, with a focus on the circular economy, emerges as a critical response to the challenges posed by the prevailing economic rationality. The accumulation of capital over the years has eroded the ecological foundations of production, leading to overexploitation of natural resources and environmental degradation. However, there is now a vision that considers the values and potential of nature [18].

Environmental economics, represented by a neoclassical approach to natural resources and pollution, proposes integrating ecological costs and the preferences of future generations into the economic system [18]. The valuation of natural resources is subject to ecological temporalities that do not necessarily align with economic cycles, requiring a broader understanding of the social processes that underpin the value of nature. In this context, the concept of ecological distribution emerges as an attempt to address the unequal burden of ecological costs. However, its implementation often remains within the logic of dominant economic rationality, unable to transcend the limits imposed by this same rationality [89]. Ecological economics, on the other hand, challenges the notion of valuing nature as capital, recognizing the interdependence between economic and ecological processes. From this perspective, the environment is conceived not as productive potential but as a limit and a cost that must be acknowledged by the economic system [90]. The circular economy emerges as a fundamental approach to operationalizing this transition, particularly in the context of sustainable urban development [91].

The circular economy aims to retain the value of resources and avoid the use of virgin materials and waste, prioritizing recycling, reuse, and reducing resource consumption [92]. However, its implementation requires a profound shift in how industries manage their operations, seeking economic prosperity without depleting natural resources [93,94]. Through specific actions and practices, such as eco-design, reuse, and recycling, the circular economy has the potential to promote sustainability at local, national, and even global scales, presenting a viable alternative to the currently dominant economic paradigm [95,96]. In

China, the concept of the circular economy was introduced in the 1990s. It originated from cleaner production, industrial ecology, and ecological modernization thinking, inspired by implementation examples from Europe, the United States, and Japan [97].

iv. Energy transitions

Societies shape their economic structures, geographies, and international relations through the ways they secure and transform energy to perform useful activities [98]. Significant changes in energy fuels and technologies often drive broad social and geographical transformations, such as the transition from wood and waterpower to coal in the 19th century or from coal to oil in the 20th century [99].

Since the 19th century, global CO₂ emissions from fossil fuel combustion have risen from nearly zero to over 31 Gt per year [100]. This increase has made energy consumption the primary source of GHG emissions [72,84]. In the 21st century, the energy challenge is to promote a new transition toward a more sustainable energy system, ensuring universal access to energy services and a reliable supply from efficient and low-carbon sources [98].

The energy transition for sustainability involves the development of new forms—and new geographies—of energy production, consumption, and work to ensure the availability and accessibility of energy services in a carbon-constrained world [84]. This transition presents a variety of possible geographic futures, ranging from low-emission electricity production by large remote players (such as nuclear or offshore wind energy) to highly decentralized forms of domestic microgeneration [101,102]. Although the concept of energy transition is widely adopted in energy studies and energy policies in some countries, there is still no consensus on the desired final state [98]. In some parts of the Global South, energy transition may mean an increase in the availability and accessibility of modern energy services, potentially leading to higher carbon intensity in certain cases [102,103]. In Europe, the multi-level approach to socio-technical transitions has been essential in addressing structural changes in energy systems over time [2,32]. While this approach is valuable, its attention to geographical space is often limited. However, energy systems are inherently spatial, with infrastructures and activities geographically distributed. The geographies of energy transition involve both changes in the distribution of energy activities within a given space and geographical interactions between different territories [104]. Energy transitions also have significant implications for the spatial organization of local, regional, and global economies. The globalization of industrial activity since the 20th century has been driven by declining transport costs, which have resulted in the international division of labor and changes in the geographical location of economic production [105]. In the UK, this transition is defined in government policy as a shift toward a greener, low-carbon future, with a target of reducing CO₂ emissions by 80% by 2050 [98]. The primary political goal is initially to decarbonize the electricity sector (40% of electricity from low-carbon sources by 2020) and then to expand the use of electricity more broadly to meet the emission reduction target [106]. Energy policy is beginning to recognize the spatial dimensions of the energy transition, with initiatives such as the UK Renewable Energy Roadmap and the UK Foresight Programme on Sustainable Energy Management and the Built Environment [107], which analyzes geographic options for transitioning to sustainable energy systems [98,108].

Despite the progress achieved by pioneering countries such as Germany and the UK in decarbonizing their energy systems, there is still a long way to go to replace fossil fuel use on a global scale. Fossil fuels must remain an essential part of the transition strategy in the short to medium term [2].

v. Transport transitions

Transitions in transportation for sustainability are a vital component of global initiatives to mitigate climate change and promote environmentally responsible practices. Travel

plays a fundamental role in daily life, providing socioeconomic, cultural, and educational benefits [33]. However, as globalization advances and communication infrastructures expand, carbon emissions from the transport sector significantly contribute to the current climate crisis [109]. The shift towards a sustainable transport model has thus become an urgent necessity [110]. The challenge of achieving significant reductions in carbon emissions in the transport sector is a reality we face. However, there are examples of successful initiatives, particularly in urban areas, where demand management, investments in public transport, and incentives for cycling and walking have shown positive results. The priority has been to create accessible urban environments with services and facilities nearby, thereby reducing the need for individual car travel [33].

With his works entitled “Unsustainable Transport: City Transport in the New Century” [110] and “Cities, Mobility and Climate Change” [33], David Banister highlights the need for a paradigm shift in how we perceive urban mobility. The sustainable mobility paradigm proposes reducing the need for travel and promoting greater use of public transport and active transport modes, such as walking and cycling. This requires an integrated approach to urban planning, territorial development, and transport policies, with the goal of creating more compact, accessible, and less car-dependent areas [111]. Mobility management and territorial development policies play a crucial role in promoting more sustainable transport systems. Demand management, pricing strategies, investments in public transport infrastructure, and the creation of pedestrian-friendly urban spaces are essential strategies to achieve this goal [108]. Additionally, the integration of Information and Communication Technologies (ICT) into transport systems can improve efficiency and reduce the need for travel [109]. In the so-called developed countries, such as those in Europe, where the tradition of urban planning is stronger, there is greater acceptance of the interconnection between mobility and climate change [110]. However, challenges remain, especially regarding urban sprawl and continued dependence on private cars [111].

The sustainable mobility approach is not just about reducing car use but rather rethinking how we design and plan our territories [110]. The creation of more accessible, compact, and people-centered environments is essential to promote a successful transition to sustainable transportation.

vi. Urban transitions

Urban transitions have emerged as a key focus area, reflecting the growing concern with the development and sustainability of urban areas. Cities have become crucial hubs for implementing and advancing transitions toward sustainability, standing out as places where innovations in related systems have been particularly significant [40,112–119].

A literature review conducted by Marc Wolfram and Niki Frantzeskaki [120] on the urban role in STs highlights a growing focus on urban environments in transition studies and an increasing interest in urban studies to investigate the dynamics of these transitions. Urban transitions for sustainability have gained prominence, particularly in the transport sector, given its importance in reducing energy consumption and CO₂ emissions, and addressing the challenges posed by urban population growth [121].

Initiatives such as Urban Living Labs (ULL), featured in the book “Urban Living Labs: Experimenting with City Futures” by Marvin et al. (2018) [122], have emerged as experimental spaces for designing, testing, and learning how social and technical innovations in real-time contribute to a more sustainable approach in urban environments [122–124]. Similarly, Urban Transition Labs (UTL) have emerged as a promising approach to tackling these challenges, integrating research and innovation processes in collaboration with communities to develop sustainable solutions in urban settings [125–128].

The relationship between experimentation and institutional change has been under-explored in the context of urban transitions to sustainability. Experimentation is viewed

to induce changes that can lead to a fundamental transformation of existing systems, facilitating networking, collaboration, and learning processes [24,42]. On the other hand, STs are conceptualized as institutional change processes aimed at deinstitutionalizing existing configurations while institutionalizing new and more desirable ones [129]. Cities have emerged as key sites for transformative changes due to their complexity, stakeholder interrelations, resource concentration, and diversity of socio-economic actors [40].

An important initiative is the Basque Declaration [130], which outlined new pathways for European cities and towns to create productive, sustainable, and resilient urban areas for a livable and inclusive Europe. The Declaration aimed to support and accelerate socio-cultural, socio-economic, and technological transformation and was developed in 2016 in the Basque Country. The event gathered political representatives from 541 cities/regions and 221 organizations.

In October 2024, Aalborg, Denmark, will host the 10th European Conference on Sustainable Cities and Towns. The transformative actions of this platform focus on three key domains (Sustainable Cities Platform [130]):

- Socio-Cultural
 - Ensuring equal access to municipal services.
 - Engaging citizens through participatory implementation (citizen science).
 - Encouraging civic and private sector involvement at the local level.
 - Promoting social innovation by supporting inclusion.
 - Cultivating a shared economy.
- Socio-Economic
 - Capitalizing on local economies and production.
 - Creating and closing local value chains.
 - Applying innovative financing approaches.
 - Implementing sustainable procurement principles.
 - Advancing the transition to a circular economy.
- Technological
 - Wisely selecting and applying smart technologies.
 - Accelerating sustainability and innovation through public procurement.
 - Ensuring equal access to digital information/services.
 - Supporting open data standards.
 - Preparing policies for socio-cultural changes driven by innovation.
 - Challenges in Urban Transitions to Sustainability.

Despite the importance of cities in promoting ST, significant obstacles remain, including complexity, inertia, and perceptual and institutional barriers [27,131,132]. In the specific case of urban transitions to sustainability, where cities serve as the epicenter of this transition, an integrated approach to multiple transitions is required (e.g., transportation, energy, economy, and water management). Particular attention is given to current challenges, the measures needed for the transition from a modern to a contemporary city, and the importance of implementing solutions. This also includes a focus on the benefits provided by Nature-Based Solutions (NBSs) and the effectiveness of these solutions when urban planning integrates the city.

4.2.2. Evolution and Diversification of Sustainability Transitions Studies Considering the Sustainable Development Goals

A comparative analysis of the periods 1995–2014 and 2015–2024 reveals a substantial evolution in the scope and focus of STs research (Table 3). The establishment of this division is substantiated by the introduction of the 17 Sustainable Development Goals (SDGs) by

the United Nations in 2015. These goals have served as a unifying global framework for sustainable development, providing a comprehensive and coordinated approach to addressing environmental issues and achieving SDGs.

Table 3. Comparison between the periods 1995–2014 and 2015–2024 in studies on Sustainability Transitions and Geography of Sustainability Transitions.

Criteria	1995–2014	2015–2024
Number of identified types	7	11
Main types	Economy, Education, Energy, Industrial, Transport, Urban, Water.	Agri-food, Biodiversity and Conservation, Digital, Economy, Energy, Industrial, Tourism, Transport, Urban, Waste, Water.
Studies with territorial application	30%	80%
Predominant Scale	National	Local
Presence of the Global South (Countries)	India, South Africa, Thailand	Bangladesh, Cameroon, China, Colombia, Egypt, India, Indonesia, Iran, Kazakhstan, Kenya, Malaysia, Nigeria, Pakistan, Philippines, South Africa, Sri Lanka, Thailand, Vietnam
Theoretical Framework	Mostly conceptual	Theoretical-empirical integration

Between 1995 and 2014, studies on STs had a narrower thematic focus, with only seven types identified—primarily centered on urban, transport, and industrial transitions. In contrast, the period from 2015 to 2024 saw a marked broadening of scope, with eleven distinct transition types emerging. These include agri-food, biodiversity and conservation, digital technologies, economy, energy, industrial, tourism, transport, urban, waste, and water transitions. This expansion reflects the growing complexity and inclusivity of the sustainability agenda, as it increasingly addresses interconnected challenges across ecological, technological, and socio-economic domains. Additionally, a considerable shift was observed in the territorial application of these studies. From 1995 to 2014, approximately 70% of the studies did not include an applied case study, instead focusing on theoretical or generalized frameworks, often at the national level, e.g., refs. [28,36,43].

In the more recent period, this percentage dropped to 20%, indicating a stronger emphasis on empirical analysis and local-scale applications, e.g., refs. [20,23,49].

This trend has the potential to enhance the understanding of context-specific dynamics and the practical implementation of STs. A notable geographical broadening is also observed. Prior to the SDGs, ST studies were mainly concentrated in a few Global South countries—India, Thailand, and South Africa. However, in the post-2015 period, there has been a notable expansion in the representation of Global South contexts. This development can be attributed to an ongoing effort to address previous geographical imbalances and promote a more equitable global implementation of the SDGs.

In the field of the GST, the proliferation of transition typologies has expanded from the initially recognized seven to eleven types, reflecting the growing complexity and diversity of ST. The comparison of themes observed between the analyzed periods demonstrates not only the relevance of the field of STs and the maturation of scientific thinking within this discipline but also the consolidation of certain domains (STs types) that structure recent scientific production.

Among these, two already stand out, suggesting the theoretical maturation of their respective transitions—urban transitions (with 19 studies distributed across 19 localities, 7 of which are associated with the Global South) and Energy transitions (with 14 studies across 13 localities, 10 of which are associated with the Global South). Four others are

beginning to emerge—Industrial, Transport, Circular Economy and Agri-food transitions—each represented by a sparse number of four to eight studies, distributed across five to eight localities.

The prominence of studies on energy transitions in Global South contexts (with 10 out of 13 localities associated with the Global South) can be explained by several factors:

- i. Access to clean and affordable energy is a central priority of the 2030 Agenda, enshrined in SDG 7. This has led to a significant mobilization of resources, policies, and scientific attention at the global level, particularly directed toward areas where energy access remains limited or unequal.
- ii. Energy transitions are frequently operationalized through technologies adapted to local realities, such as off-grid solar systems, bioenergy, and mini-grids, which are widely implemented in Global South countries. These represent sustainable energy alternatives and serve as living laboratories for experimentation and scientific analysis of ongoing transitions.

These six ST domains have facilitated the growing inclusion of Global South countries in local case studies, offering rich empirical insights and contributing to theoretical development, while also reflecting increased attention to territorial dynamics beyond the traditional Europe-North America axis. Moreover, a methodological evolution is evident, with more studies articulating theoretical frameworks with local empirical analysis in various contexts, including sectoral planning [133]. This articulation is particularly visible in cases where sustainability is explored through local-scale initiatives, alternative food systems, or decentralized technologies—aligning with the SDGs and the increasing recognition of territorial specificity within the GST, thereby fostering a more nuanced understanding of STs across diverse social-political contexts [134,135].

5. Conclusions

The intersection between geographical science and ST studies has been fundamental in understanding the contemporary challenges of adapting to and anticipating transitions toward sustainability. This convergence highlights the importance of spatial approaches in analyzing the social, economic, and environmental changes needed to achieve a more sustainable future. ST studies emerged as an interdisciplinary and transdisciplinary field, resulting from the combination of transition research and sustainability science. The need to integrate the spatial dimension into these analyses is emphasized, recognizing the crucial role of geography in understanding regional specificities and the geographical contexts of transitions. A bibliometric analysis indicated a significant concentration of studies and authors in Global North countries, pointing to a scientific gap in Global South countries within STs studies. This geographical imbalance underscores the urgent need to promote greater interdisciplinarity in research on GST. The geographical distribution of studies reflects the predominance of regions such as Northern Europe, North America, and South and Southeast Asia. The studies included in the bibliometric analysis identified various types of GST, such as energy decarbonization, sustainable agriculture, and sustainable urban development.

STs are inherently geographical processes, occurring in specific locations with unique characteristics. Although the literature has previously overlooked the importance of geographical contextualization, more recent studies emphasize the significance of spatial and geographical factors such as scales, places, and spaces in STs analysis. Considering multiple scales, from technological niches to sociotechnical landscapes, is fundamental to understanding the complexity and specificity of transitions.

- (i) Agri-Food Transitions—in agriculture, balancing productivity and sustainability is a central challenge. Alternative food networks are emerging as important practices

- that promote ecological sustainability. Sustainable management of natural resources is essential for transitioning to resilient and sustainable food systems.
- (ii) Industrial Transitions—industry plays a central role in the global economy but is also a major GHG emitter. Industrial decarbonization is crucial to achieving net-zero emissions, requiring radical changes in production and consumption systems as well as investment in clean technologies. Examples from countries like Germany and the UK demonstrate significant progress in reducing industrial emissions.
 - (iii) Economic Transitions—the transition to a sustainable economy, particularly circular economy models, addresses the challenges posed by conventional economic rationality. The circular economy seeks to retain resource value through recycling and reuse, promoting sustainability without depleting natural resources. This approach requires deep changes in industrial operations and consumer practices.
 - (iv) Energy Transitions—involves the development of new energy production and consumption systems with low carbon emissions. A fundamental transition to reduce global CO₂ emissions and promote access to sustainable energy services. Specific geographic policies and initiatives, such as those in the UK, are essential to achieving these goals.
 - (v) Transport Transitions—vital for mitigating climate change and promoting sustainable mobility. Creating accessible urban environments, investing in public transport, and promoting active mobility, such as cycling and walking, are essential for reducing car dependency and associated carbon emissions.
 - (vi) Urban Transitions—cities are crucial hubs for STs due to their complexity and concentration of resources. Initiatives such as ULL and UTL demonstrate how social and technical innovations can be implemented in urban environments to promote sustainability. However, institutional barriers and complexity remain significant challenges.

Despite debates on their contribution to GHG emissions and vulnerability to climate change, cities are increasingly recognized as key actors in addressing these challenges. NBSs have emerged as essential approaches to generating social, environmental, and economic benefits, facilitating climate adaptation and ST. Humanity is currently facing a global polycrisis, arising from the uncontrolled interconnection of vital natural and social systems, posing a threat to human survival. The accelerated urbanization of recent decades has led to environmental impacts and diminished the quality of life in urban communities. Infrastructure expansion and population concentration have contributed to soil impermeabilization, exacerbating environmental issues. A predominantly anthropocentric approach limits understanding the interactions between urban systems and the environment. Given the environmental impacts, STs are imperative to achieve ecologically sustainable cities. The management of these transitions should foster social learning processes, with initiatives such as UTL offering an efficient approach. Another critical factor is land expropriation for the common good. These processes should be directed toward projects that benefit the community and preserve the environment, ensuring a balance between community needs and the protection of natural resources and biodiversity.

Several measures to promote urban sustainability align with NBSs. These solutions integrate natural elements to address urban challenges (e.g., flooding, pollution, and extreme weather events), enhancing urban resilience and sustainability. Green and blue infrastructures should be interconnected and multifunctional, fostering biodiversity while providing recreational spaces alongside addressing major urban issues. Additionally, these solutions contribute to the development of biophilic cities, improving quality of life and reconnecting communities with nature. NBSs enhance urban resilience and generate environmental, economic, and social benefits. Overall, they help create healthier and more inclusive environments by integrating natural elements into urban landscapes.

The geographical focus of the selected studies reveals an imbalance in global research production, especially concerning transitions in the Global South. Still, this points to clear directions for future research. One such direction is the inclusion of additional databases beyond Scopus to capture relevant work that might currently be excluded. While Scopus is a widely recognized and comprehensive database—often indexing everything found in Web of Science and more—it is not exhaustive. Broadening the database scope could help uncover underrepresented perspectives and contributions. As the target year of 2030 approaches, the expansion in the number and depth of analysis is particularly relevant in the context of the SDGs. The inclusion of additional sources may enable a more accurate identification of best practices implemented, distinguish the contexts where progress has been made towards achieving the SDGs, as well as georeference the territories where targets have not yet been met. The implementation of this strategy would facilitate the replication of effective methodologies in contexts that encounter elevated levels of complexity in the GST.

GSTs represent a relevant and necessary dimension to advance the sustainability agenda and can be seen as a potential next phase following the SDGs, given the growing concern over the intensification of climate change and its consequent impacts on society and the environment.

This work has assembled a series of studies that contribute to deepening the intrinsic relationship between STs and the spatial distribution of these processes, which is designated as GST. By integrating the fields of geography and transition studies, the necessity of incorporating the territorial dimension in the implementation of optimal practices and the identification of spatial patterns of sustainable innovation is accentuated.

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References

1. Markard, J.; Raven, R.; Truffer, B. Sustainability transitions: An emerging field of research and its prospects. *Res. Policy* **2012**, *41*, 955–967. [[CrossRef](#)]
2. Smith, A.; Voß, J.P.; Grin, J. Innovation studies and sustainability transitions: The allure of the multi-level perspective and its challenges. *Res. Policy* **2010**, *39*, 435–448. [[CrossRef](#)]
3. Coenen, L.; Benneworth, P.; Truffer, B. Toward a spatial perspective on sustainability transitions. *Res. Policy* **2012**, *41*, 968–979. [[CrossRef](#)]
4. Köhler, J.; Geels, F.W.; Kern, F.; Markard, J.; Onsongo, E.; Wieczorek, A.; Alkemade, F.; Avelino, F.; Bergek, A.; Boons, F.; et al. An agenda for sustainability transitions research: State of the art and future directions. *Environ. Innov. Soc. Transit.* **2019**, *31*, 1–32. [[CrossRef](#)]
5. Dinis, M.A.P.; Neto, B.; Begum, H.; Vidal, D.G. Editorial: Waste Challenges in the Context of Broad Sustainability Challenges [Editorial]. *Front. Environ. Sci.* **2022**, *10*, 964366. [[CrossRef](#)]

6. Boschma, R.; Coenen, L.; Frenken, K.; Truffer, B. Towards a theory of regional diversification: Combining insights from evolutionary economic geography and transition studies. In *Transitions in Regional Economic Development*, 1st ed.; Turok, I., Bailey, D., Clark, J., Du, J., Fratesi, U., Fritsch, M., Harrison, J., Kemeny, T., Kogler, D., Lagendijk, A., Eds.; Routledge: New York, NY, USA, 2018; pp. 55–81.
7. Coenen, L.; Truffer, B. Places and Spaces of Sustainability Transitions: Geographical Contributions to an Emerging Research and Policy Field. *Eur. Plan. Stud.* **2012**, *20*, 367–374. [[CrossRef](#)]
8. Binz, C.; Coenen, L.; Murphy, J.T.; Truffer, B. Geographies of transition—From topical concerns to theoretical engagement: A comment on the transitions research agenda. *Environ. Innov. Soc. Transit.* **2020**, *34*, 1–3. [[CrossRef](#)]
9. Hodson, M.; Marvin, S. Cities mediating technological transitions: Understanding visions, intermediation and consequences. *Technol. Anal. Strateg. Manag.* **2009**, *21*, 515–534. [[CrossRef](#)]
10. Hansen, T.; Coenen, L. The geography of sustainability transitions: Review, synthesis and reflections on an emergent research field. *Environ. Innov. Soc. Transit.* **2015**, *17*, 92–109. [[CrossRef](#)]
11. Loorbach, D.; Frantzeskaki, N.; Avelino, F. Sustainability Transitions Research: Transforming Science and Practice for Societal Change. *Annu. Rev. Environ. Resour.* **2017**, *42*, 599–626. [[CrossRef](#)]
12. Grin, J.; Rotmans, J.; Schot, J. *Transitions to Sustainable Development: New Directions in the Study of Long Term Transformative Change*, 1st ed.; Routledge: New York, NY, USA, 2010; pp. 1–418. [[CrossRef](#)]
13. Wittmayer, J.M.; Hielscher, S.; Rogge, K.S.; Weber, K.M. Advancing the understanding of social innovation in sustainability transitions: Exploring processes, politics, and policies for accelerating transitions. *Environ. Innov. Soc. Transit.* **2024**, *50*, 100805. [[CrossRef](#)]
14. Scordato, L.; Gulbrandsen, M. Resilience perspectives in sustainability transitions research: A systematic literature review. *Environ. Innov. Soc. Transit.* **2024**, *52*, 100887. [[CrossRef](#)]
15. Moher, D.; Liberati, A.; Tetzlaff, J.; Altman, D.; Group PRISMA. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *Ann. Intern. Med.* **2009**, *151*, 264–270. [[CrossRef](#)] [[PubMed](#)]
16. Dhiman, S.; Singh, R.; Arjune, V.; Yadav, R.S.; Yadav, M.S.; Bansala, A. Mapping the Evolution of Sustainability Transitions Research: A Bibliometric Analysis. *J. Scientometr. Res.* **2023**, *12*, 522–533. [[CrossRef](#)]
17. Kemp, R. Technology and the transition to environmental sustainability: The problem of technological regime shifts. *Futures* **1994**, *26*, 1023–1046. [[CrossRef](#)]
18. Leff, E. ¿De quien es la naturaleza? Sobre la reapropiación social de los Recursos Naturales. Los Costos Ambientales y el Valor de la Naturaleza. *Gac. Ecológica* **1995**, *37*, 28–35.
19. Lewis, E.; Edwards, R.; Howe, J. Delivering the Industrial Decarbonisation Challenge: Geographical considerations for decarbonisation. *Geography* **2023**, *108*, 86–94. [[CrossRef](#)]
20. Sovacool, B.K.; Iskandarova, M.; Hall, J. Industrializing theories: A thematic analysis of conceptual frameworks and typologies for industrial sociotechnical change in a low-carbon future. *Energy Res. Soc. Sci.* **2023**, *97*, 102954. [[CrossRef](#)]
21. Banos, V. Which resource geography to which transition? Analytical insights from the “new” forest-based products. *Ann. De Géographie* **2023**, *754*, 84–107. [[CrossRef](#)]
22. Laddha, C. Biocatalysis Approach for Affordable and Sustainable Green Hydrogen Production. In Proceedings of the SPE Offshore Europe Conference & Exhibition, Aberdeen, UK, 5 September 2023; p. D021S004R005. [[CrossRef](#)]
23. Lesch, D.; Miörner, J.; Binz, C. The Role of Global Actors in Sustainability Transitions—Tracing the Emergence of a Novel Infrastructure Paradigm in the Sanitation Sector. *Environ. Innov. Soc. Transit.* **2023**, *49*, 100787. [[CrossRef](#)]
24. Nevens, F.; Frantzeskaki, N.; Gorissen, L.; Loorbach, D. Urban Transition Labs: Co-creating transformative action for sustainable cities. *J. Clean. Prod.* **2013**, *50*, 111–122. [[CrossRef](#)]
25. van Vulpen, B. The ‘right’ policy for regional development: Seeking spatial justice in the Dutch case of the region deals. *Eur. Plan. Stud.* **2022**, *31*, 1823–1841. [[CrossRef](#)]
26. Alessi, L.; Battiston, S.; Kvedaras, V. Over with carbon? Investors’ reaction to the Paris Agreement and the US withdrawal. *J. Financ. Stab.* **2024**, *71*, 101232. [[CrossRef](#)]
27. Ernstson, H.; van der Leeuw, S.E.; Redman, C.L.; Meffert, D.J.; Davis, G.; Alfsen, C.; Elmqvist, T. Urban transitions: On urban resilience and human-dominated ecosystems. *Ambio* **2010**, *39*, 531–545. [[CrossRef](#)]
28. Fuenfschilling, L.; Frantzeskaki, N.; Coenen, L. Urban experimentation & sustainability transitions. *Eur. Plan. Stud.* **2018**, *27*, 219–228. [[CrossRef](#)]
29. Smith, A.; Stirling, A.; Berkhout, F. The governance of sustainable socio-technical transitions. *Res. Policy* **2005**, *34*, 1491–1510. [[CrossRef](#)]
30. Liang, Y.; Galiano, J.C.; Zhou, H. The environmental impact of stock market capitalization and energy transition: Natural resource dynamics and international trade. *Util. Policy* **2023**, *82*, 101517. [[CrossRef](#)]

31. Nkwunonwo, U.C.; Ebinne, E.S. Sustainability Transitions of Cities in the Global South Experiencing Severe Plastic Pollution: A Geospatial Perspective BT. In *Selected Studies in Geotechnics, Geo-Informatics and Remote Sensing*, 3rd ed.; Ergüler, Z.R., Chaminé, H.L., Rodrigo-Comino, J., Kallel, A., Merkel, B., Eshagh, A., Hadji, M., Chenchouni, H., Grab, S., Karakus, M., et al., Eds.; Springer Nature: Cham, Switzerland, 2023; pp. 91–93.
32. Verbong, G.; Geels, F. The ongoing energy transition: Lessons from a socio-technical, multi-level analysis of the Dutch electricity system (1960–2004). *Energy Policy* **2007**, *35*, 1025–1037. [[CrossRef](#)]
33. Banister, D. Cities, mobility and climate change. *J. Transp. Geogr.* **2011**, *19*, 1538–1546. [[CrossRef](#)]
34. Nordt, A.; Raven, R.; Malekpour, S.; Sharp, D. Actors, agency, and institutional contexts: Transition intermediation for low-carbon mobility transition. *Environ. Sci. Policy* **2024**, *154*, 103707. [[CrossRef](#)]
35. Leal Filho, W.; Mbah, M.F.; Dinis, M.A.P.; Trevisan, L.V.; de Lange, D.; Mishra, A.; Rebelatto, B.; Ben Hassen, T.; Aina, Y.A. The role of artificial intelligence in the implementation of the UN Sustainable Development Goal 11: Fostering sustainable cities and communities. *Cities* **2024**, *150*, 105021. [[CrossRef](#)]
36. Sneddon, C.; Howarth, R.B.; Norgaard, R.B. Sustainable development in a post-Brundtland world. *Ecol. Econ.* **2006**, *57*, 253–268. [[CrossRef](#)]
37. Kangmin, W.; Yuyao, Y.; Xiangyu, W.; Zhengqian, L.; Hong’ou, Z. New infrastructure-lead development and green-technologies: Evidence from the Pearl River Delta, China. *Sustain. Cities Soc.* **2023**, *99*, 104864. [[CrossRef](#)]
38. Reiß, K.; Artmann, M. The role of spatial and relative proximity while transforming towards an edible city—The case of the City of the Future Dresden (Germany). *Environ. Innov. Soc. Transit.* **2023**, *49*, 100778. [[CrossRef](#)]
39. Truffer, B.; Coenen, L. Environmental Innovation and Sustainability Transitions in Regional Studies. *Reg. Stud.* **2012**, *46*, 1–21. [[CrossRef](#)]
40. Frantzeskaki, N.; Broto, V.C.; Coenen, L.; Loorbach, D. *Urban Sustainability Transitions*, 5th ed.; Routledge: New York, NY, USA, 2017; pp. 1–88.
41. Hoogma, R.; Kemp, R.; Schot, J.; Truffer, B. *Experimenting for Sustainable Transport*, 2nd ed.; Taylor & Francis: New York, NY, USA, 2002; pp. 1–228.
42. Berkhout, F.; Verbong, G.; Wieczorek, A.J.; Raven, R.; Lebel, L.; Bai, X. Sustainability experiments in Asia: Innovations shaping alternative development pathways? *Environ. Sci. Policy* **2010**, *13*, 261–271. [[CrossRef](#)]
43. Bulkeley, H.; Castán-Broto, V.; Hodson, M.; Marvin, S. *Cities and Low Carbon Transitions*, 1st ed.; Routledge: London, UK, 2010; pp. 1–61.
44. Jolly, S.; Steen, M.; Hansen, T.; Afewerki, S. Renewable energy and industrial development in pioneering and lagging regions: The offshore wind industry in southern Denmark and Normandy. *Oxf. Open Energy* **2023**, *2*, oiad010. [[CrossRef](#)]
45. Hacker, M.E.; Binz, C. Hybrid Governance Arrangements for Urban Infrastructure Transitions: Comparing the Adoption of Onsite Water Reuse in San Francisco and New York City. *ACS EST Water* **2023**, *3*, 3916–3928. [[CrossRef](#)]
46. Hodson, M.; Marvin, S. Can cities shape socio-technical transitions and how would we know if they were? *Res. Policy* **2010**, *39*, 477–485. [[CrossRef](#)]
47. Rohe, S.; Schmidt-Scheele, R.; Mattes, J. The embeddedness of companies in regional energy transitions. *Eur. Plan. Stud.* **2023**, *31*, 2590–2613. [[CrossRef](#)]
48. Friedrich, C.; Feser, D. Combining knowledge bases for small wins in peripheral regions. An analysis of the role of innovation intermediaries in sustainability transitions. *Rev. Reg. Res.* **2024**, *44*, 211–236. [[CrossRef](#)]
49. Zhou, Z.; Chung, C.K.L.; Xu, J. Geographies of green industries: The interplay of firms, technologies, and the environment. *Prog. Hum. Geogr.* **2023**, *47*, 680–698. [[CrossRef](#)]
50. Meili, R.; Stucki, T. Money matters: The role of money as a regional and corporate financial resource for circular economy transition at firm-level. *Res. Policy* **2023**, *52*, 104884. [[CrossRef](#)]
51. Lybæk, R.; Hauggaard-Nielsen, H. A Qualitative Investigation of European Grain Legume Supply Markets through the Lens of Agroecology in Four Companies. *Sustainability* **2023**, *15*, 6103. [[CrossRef](#)]
52. Shubalyi, O.; Stakhiv, O.; Tsaruk, D. The Ukrainian milk processing enterprises export orientations development in the martial law conditions and under the migration processes influence. *IOP Conf. Ser. Earth Environ. Sci.* **2023**, *1269*, 12027. [[CrossRef](#)]
53. Murphy, J.T. Human geography and socio-technical transition studies: Promising intersections. *Environ. Innov. Soc. Transit.* **2015**, *17*, 73–91. [[CrossRef](#)]
54. Shove, E.; Walker, G. Caution! Transitions Ahead: Politics, Practice, and Sustainable Transition Management. *Environ. Plan. A Econ. Space* **2007**, *39*, 763–770. [[CrossRef](#)]
55. Lawhon, M.; Murphy, J.T. Socio-technical regimes and sustainability transitions: Insights from political ecology. *Prog. Hum. Geogr.* **2011**, *36*, 354–378. [[CrossRef](#)]
56. Tartaruga, I.G.P.; Sperotto, F.Q. Geografia das Transições de Sustentabilidade. In *Dicionário de Desenvolvimento Regional e Temas Correlatos*, 2nd ed.; Griebeler, M.P.D., Santos, V., Eds.; Editora Conceito: São Paulo, RS, Brasil, 2021; pp. 404–407. [[CrossRef](#)]

57. Kristensen, D.K.; Kjeldsen, C.; Thorsøe, M.H. Enabling Sustainable Agro-Food Futures: Exploring Fault Lines and Synergies Between the Integrated Territorial Paradigm, Rural Eco-Economy and Circular Economy. *J. Agric. Environ. Ethics* **2016**, *29*, 749–765. [[CrossRef](#)]
58. Niggli, U. Sustainability of organic food production: Challenges and innovations. *Proc. Nutr. Soc.* **2015**, *74*, 83–88. [[CrossRef](#)]
59. Gerbens-Leenes, P.W.; Moll, H.C.; Schoot Uiterkamp, A.J.M. Design and development of a measuring method for environmental sustainability in food production systems. *Ecol. Econ.* **2003**, *46*, 231–248. [[CrossRef](#)]
60. Bale, J.S.; van Lenteren, J.C.; Bigler, F. Biological control and sustainable food production. *Philos. Trans. R. Soc. B* **2008**, *363*, 761–776. [[CrossRef](#)]
61. Grunert, K.G.; Hieke, S.; Wills, J. Sustainability labels on food products: Consumer motivation, understanding and use. *Food Policy* **2014**, *44*, 177–189. [[CrossRef](#)]
62. Grunert, K.G. Sustainability in the Food Sector: A Consumer Behaviour Perspective. *Int. J. Food Syst. Dyn.* **2011**, *2*, 207–218. [[CrossRef](#)]
63. Cvijanović, D.; Ignjatijević, S.; Vapa Tankosić, J.; Cvijanović, V. Do Local Food Products Contribute to Sustainable Economic Development? *Sustainability* **2020**, *12*, 2847. [[CrossRef](#)]
64. Maysels, R.; Figueroa Casas, A.; Otero Sarmiento, J.D.; Zuñiga Meneses, S.M. Conceptualization of alternative food networks in Latin America: A case study of a local food system in Southwestern Colombia. *Front. Sustain. Food Syst.* **2023**, *7*, 1216116. [[CrossRef](#)]
65. Smith, P.; Gregory, P.J. Climate change and sustainable food production. *Proc. Nutr. Soc.* **2013**, *72*, 21–28. [[CrossRef](#)]
66. Garcia, S.N.; Osburn, B.I.; Jay-Russell, M.T. One Health for Food Safety, Food Security, and Sustainable Food Production. *Front. Sustain. Food Syst.* **2020**, *4*, 1. [[CrossRef](#)]
67. Green, A.; Nemecek, T.; Chaudhary, A.; Mathys, A. Assessing nutritional, health, and environmental sustainability dimensions of agri-food production. *Glob. Food Secur.* **2020**, *26*, 100406. [[CrossRef](#)]
68. Maye, D. Agri-food sustainability transitions: Food geographies, governance and ethical foodscapes. In *Rural-Urban Linkages for Sustainable Development*, 1st ed.; Kratzer, A., Kister, J., Eds.; Routledge: London, UK, 2020; pp. 30–48.
69. Ridgway, E.M.; Lawrence, M.A.; Woods, J. Integrating Environmental Sustainability Considerations into Food and Nutrition Policies: Insights from Australia’s National Food Plan. *Front. Nutr.* **2015**, *2*, 29. [[CrossRef](#)]
70. Halloran, A.; Clement, J.; Kornum, N.; Bucatariu, C.; Magid, J. Addressing food waste reduction in Denmark. *Food Policy* **2014**, *49*, 294–301. [[CrossRef](#)]
71. Stop Wasting Food. Available online: <https://stopwastingfoodmovement.org/> (accessed on 8 March 2025).
72. IPCC. *Climate Change 2014 Mitigation of Climate Change Working Group III Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*; Edenhofer, O., Pichs-Madruga, R., Sokona, Y., Farahani, E., Kadner, S., Seyboth, K., Adler, A., Baum, I., Brunner, S., Eickemeier, P., et al., Eds.; Cambridge University Press: Cambridge, UK; New York, NY, USA, 2014.
73. Koasidis, K.; Nikas, A.; Neofytou, H.; Karamaneas, A.; Gambhir, A.; Wachsmuth, J.; Doukas, H. The UK and German Low-Carbon Industry Transitions from a Sectoral Innovation and System Failures Perspective. *Energies* **2020**, *13*, 4994. [[CrossRef](#)]
74. Geels, F.W.; Hekkert, M.P.; Jacobsson, S. (Eds.) The dynamics of sustainable innovation journeys. In *The Dynamics of Sustainable Innovation Journeys*, 1st ed.; Routledge: London, UK, 2013; pp. 1–16.
75. Rostow, W.W. The stages of economic growth. In *Sociological Worlds*, 1st ed.; Sanderson, S.K., Ed.; Routledge: New York, NY, USA, 2013; pp. 130–134.
76. Berkhout, F.; Angel, D.; Wiczorek, A.J. Asian development pathways and sustainable socio-technical regimes. *Technol. Forecast. Soc. Change* **2009**, *76*, 218–228. [[CrossRef](#)]
77. Bernardini, O.; Galli, R. Dematerialization: Long-term trends in the intensity of use of materials and energy. *Futures* **1993**, *25*, 431–448. [[CrossRef](#)]
78. Marcotullio, P.J.; Williams, E.; Marshall, J.D. Faster, Sooner, and More Simultaneously: How Recent Road and Air Transportation CO₂ Emission Trends in Developing Countries Differ From Historic Trends in the United States. *J. Environ. Dev.* **2005**, *14*, 125–148. [[CrossRef](#)]
79. Sovacool, B.K.; Geels, F.W.; Iskandarova, M. Industrial clusters for deep decarbonization. *Science* **2022**, *378*, 601–604. [[CrossRef](#)]
80. Hayashi, D. Harnessing innovation policy for industrial decarbonization: Capabilities and manufacturing in the wind and solar power sectors of China and India. *Energy Res. Soc. Sci.* **2020**, *70*, 101644. [[CrossRef](#)]
81. Rissman, J.; Bataille, C.; Masanet, E.; Aden, N.; Morrow, W.R.; Zhou, N.; Elliott, N.; Dell, R.; Heeren, N.; Huckestein, B.; et al. Technologies and policies to decarbonize global industry: Review and assessment of mitigation drivers through 2070. *Appl. Energy* **2020**, *266*, 114848. [[CrossRef](#)]
82. Meckling, J.; Sterner, T.; Wagner, G. Policy sequencing toward decarbonization. *Nat. Energy* **2017**, *2*, 918–922. [[CrossRef](#)]
83. Meckling, J. Making Industrial Policy Work for Decarbonization. *Glob. Environ. Politics* **2021**, *21*, 134–147. [[CrossRef](#)]
84. IEA. *World Energy Outlook 2008*; International Energy Agency: Paris, France, 2008.

85. Åhman, M.; Nilsson, L.J. Decarbonizing Industry in the EU: Climate, Trade and Industrial Policy Strategies. In *Decarbonization in the European Union: Internal Policies and External Strategies*, 1st ed.; Dupont, C., Oberthür, S., Eds.; Palgrave Macmillan: London UK, 2015; pp. 92–114. [[CrossRef](#)]
86. Gerres, T.; Chaves Ávila, J.P.; Llamas, P.L.; San Román, T.G. A review of cross-sector decarbonisation potentials in the European energy intensive industry. *J. Clean. Prod.* **2019**, *210*, 585–601. [[CrossRef](#)]
87. Minx, J.C.; Lamb, W.F.; Andrew, R.M.; Canadell, J.G.; Crippa, M.; Döbbeling, N.; Forster, P.M.; Guizzardi, D.; Olivier, J.; Peters, G.P.; et al. A comprehensive and synthetic dataset for global, regional, and national greenhouse gas emissions by sector 1970–2018 with an extension to 2019. *Earth Syst. Sci. Data* **2021**, *13*, 5213–5252. [[CrossRef](#)]
88. Zeng, B.; Zhu, L. Market Power and Technology Diffusion in an Energy-Intensive Sector Covered by an Emissions Trading Scheme. *Sustainability* **2019**, *11*, 3870. [[CrossRef](#)]
89. Min, S.; Roath, A.S.; Daugherty, P.J.; Genchev, S.E.; Chen, H.; Arndt, A.D.; Glenn Richey, R. Supply chain collaboration: What's happening? *Int. J. Logist. Manag.* **2005**, *16*, 237–256. [[CrossRef](#)]
90. Georgescu-Roegen, N. *The Entropy Law and the Economic Process*; Harvard University Press: Cambridge, MA, USA; London, UK, 1971; pp. 365–438. [[CrossRef](#)]
91. Singh, S.K.; Singh, A.P. Interplay of organizational justice, psychological empowerment, organizational citizenship behavior, and job satisfaction in the context of circular economy. *Manag. Decis.* **2019**, *57*, 937–952. [[CrossRef](#)]
92. Joensuu, T.; Edelman, H.; Saari, A. Circular economy practices in the built environment. *J. Clean. Prod.* **2020**, *276*, 124215. [[CrossRef](#)]
93. Rajala, R.; Hakanen, E.; Mattila, J.; Seppälä, T.; Westerlund, M. How Do Intelligent Goods Shape Closed-Loop Systems? *Calif. Manag. Rev.* **2018**, *60*, 20–44. [[CrossRef](#)]
94. Kristoffersen, E.; Mikalef, P.; Blomsma, F.; Li, J. The effects of business analytics capability on circular economy implementation, resource orchestration capability, and firm performance. *Int. J. Prod. Econ.* **2021**, *239*, 108205. [[CrossRef](#)]
95. European Commission (EC). *Closing the Loop—An EU Action Plan for the Circular Economy*; European Commission: Brussels, Belgium, 2015; 21p.
96. Lacy, P.; Long, J.; Spindler, W. Disruptive technologies. In *The Circular Economy Handbook: Realizing the Circular Advantage*, 1st ed.; Lacy, P., Long, J., Spindler, W., Eds.; Palgrave Macmillan: London, UK, 2020; pp. 43–71.
97. Shi, L.; Xing, L.; Bi, J.; Zhang, B. Circular economy: A new development strategy for sustainable development in China. In *Proceedings of the 3rd World Congress of Environmental and Resource Economists*, Kyoto, Japan, 3–7 July 2006.
98. Bridge, G.; Bouzarovski, S.; Bradshaw, M.; Eyre, N. Geographies of energy transition: Space, place and the low-carbon economy. *Energy Policy* **2013**, *53*, 331–340. [[CrossRef](#)]
99. Jiusto, S. Energy transformations and geographic research. In *A companion to Environmental Geography*, 1st ed.; Castree, N., Demeritt, D., Liverman, D., Rhoads, B., Eds.; Blackwell Publishing Ltd.: Hoboken, NJ, USA, 2009; pp. 533–551.
100. Heubaum, H.; Biermann, F. Integrating global energy and climate governance: The changing role of the International Energy Agency. *Energy Policy* **2015**, *87*, 229–239. [[CrossRef](#)]
101. Watson, J. Co-provision in sustainable energy systems: The case of micro-generation. *Energy Policy* **2004**, *32*, 1981–1990. [[CrossRef](#)]
102. Bradshaw, M.J. Global energy dilemmas: A geographical perspective. *Geogr. J.* **2010**, *176*, 275–290. [[CrossRef](#)]
103. Bouzarovski, S. East-Central Europe's changing energy landscapes: A place for geography. *Area* **2009**, *41*, 452–463. [[CrossRef](#)]
104. Emmerson, C.; Stevens, P. *Maritime Choke Points and the Global Energy System: Charting a Way Forward*; Chatham House Briefing Paper; Chatham House: London, UK, 2012.
105. Dicken, P. *Global Shift: Mapping the Changing Contours of the World Economy*; SAGE Publications Ltd.: Thousand Oaks, CA, USA, 2007.
106. Foxon, T.; Hammond, G.P.; Pearson, P.J. Transition pathways for a low carbon energy system in the UK: Assessing the compatibility of large-scale and small-scale options. In *Proceedings of the 7th BIEE Academic Conference*, Oxford, UK, 24–25 September 2008.
107. Chilvers, J.; Foxon, T.J.; Galloway, S. Realising transition pathways for a more electric, low-carbon energy system in the United Kingdom: Challenges, insights, and opportunities. *Proc. Inst. Mech. Eng. Part A J. Power Energy* **2017**, *231*, 440–477. [[CrossRef](#)]
108. Howard, D.C.; Wadsworth, R.A.; Whitaker, J.W.; Hughes, N.; Bunce, R.G.H. The impact of sustainable energy production on land use in Britain through to 2050. *Land Use Policy* **2009**, *26* (Suppl. S1), S284–S292. [[CrossRef](#)]
109. Ahmed, Z.; Le, H.P. Linking Information Communication Technology, trade globalization index, and CO2 emissions: Evidence from advanced panel techniques. *Environ. Sci. Pollut. Res.* **2021**, *28*, 8770–8781. [[CrossRef](#)]
110. Banister, D. *Unsustainable Transport: City Transport in the New Century*, 1st ed.; Routledge: Abingdon, UK, 2005. [[CrossRef](#)]
111. Banister, D. The sustainable mobility paradigm. *Transp. Policy* **2008**, *15*, 73–80. [[CrossRef](#)]
112. Kennedy, C.; Miller, E.; Shalaby, A.; Maclean, H.; Coleman, J. The Four Pillars of Sustainable Urban Transportation. *Transp. Rev.* **2005**, *25*, 393–414. [[CrossRef](#)]
113. Banister, D.; Stead, D. Impact of information and communications technology on transport. *Transp. Rev.* **2004**, *24*, 611–632. [[CrossRef](#)]

114. McCormick, K.; Anderberg, S.; Coenen, L.; Neij, L. Advancing sustainable urban transformation. *J. Clean. Prod.* **2013**, *50*, 1–11. [[CrossRef](#)]
115. Lyons, G.; Kenyon, S. Social participation, personal travel and Internet use. In Proceedings of the 10th International Conference on Travel Behaviour Research, Lucerne, Switzerland, 10–14 August 2003.
116. Bulkeley, H.; Castán Broto, V.; Hodson, M.; Marvin, S. (Eds.) *Cities and Low Carbon Transitions*; Routledge: Abingdon, VA, USA, 2011.
117. Loorbach, D.; Wittmayer, J.M.; Shiroyama, H.; Fujino, J.; Mizuguchi, S. *Governance of Urban Sustainability Transitions*; Springer: Berlin/Heidelberg, Germany, 2016. [[CrossRef](#)]
118. Hodson, M.; Geels, F.W.; McMeekin, A. Reconfiguring Urban Sustainability Transitions, Analysing Multiplicity. *Sustainability* **2017**, *9*, 299. [[CrossRef](#)]
119. Moore, T.; de Haan, F.; Horne, R.; Gleeson, B. *Urban Sustainability Transitions: Australian Cases-International Perspectives*; Springer: Singapore, 2018.
120. Wolfram, M.; Frantzeskaki, N. Cities and Systemic Change for Sustainability: Prevailing Epistemologies and an Emerging Research Agenda. *Sustainability* **2016**, *8*, 144. [[CrossRef](#)]
121. UN DESA. *World Urbanization Prospects: The 2018 Revision*; United Nations: New York, NY, USA, 2019.
122. Marvin, S.; Bulkeley, H.; Mai, L.; McCormick, K.; Palgan, Y.V. *Urban Living Labs: Experimenting with City Futures*; Routledge: London, UK, 2018.
123. Evans, J.; Karvonen, A.; Raven, R. *The Experimental City*; Routledge: London, UK, 2016.
124. Voytenko, Y.; McCormick, K.; Evans, J.; Schliwa, G. Urban Living Labs for Sustainability and Low Carbon Cities in Europe: Towards a Research Agenda. *J. Clean. Prod.* **2016**, *123*, 45–54. [[CrossRef](#)]
125. Von Hippel, E. Lead users: A source of novel product concepts. *Manag. Sci.* **1986**, *32*, 791–805. [[CrossRef](#)]
126. Chesbrough, H.W. *Open Innovation: The New Imperative for Creating and Profiting from Technology*; Harvard Business School Press: Boston, MA, USA, 2003.
127. Bilgram, V.; Brem, A.; Voigt, K.-I. User-Centric Innovations in New Product Development—Systematic Identification of Lead Users Harnessing Interactive and Collaborative Online-Tools. *Int. J. Innov. Manag.* **2008**, *12*, 419–458. [[CrossRef](#)]
128. Pallot, M. Engaging Users into Research and Innovation: The Living Lab Approach as a User-Centred Open Innovation Ecosystem. Webergence Blog. 2009. Available online: http://www.cwe-projects.eu/pub/bscw.cgi/715404?id=715404_1760838 (accessed on 21 November 2024).
129. Fuenfschilling, L.; Binz, C. Global Socio-Technical Regimes. *Res. Policy* **2018**, *47*, 735–749. [[CrossRef](#)]
130. Sustainable Cities Platform. Available online: <https://sustainablecities.eu/sustainable-cities-platform/> (accessed on 5 February 2025).
131. Bulkeley, H.; Betsill, M. Rethinking sustainable cities: Multilevel governance and the ‘urban’ politics of climate change. *Environ. Politics* **2005**, *14*, 42–63. [[CrossRef](#)]
132. Bai, X. Integrating global environmental concerns into urban management: The scale and readiness arguments. *J. Ind. Ecol.* **2007**, *11*, 15–29. [[CrossRef](#)]
133. Remoaldo, P.; Freitas, I.; Matos, O.; Lopes, H.S.; Silva, S.; Sánchez Fernández, M.D.; Cadima Ribeiro, J.; Ribeiro, V. The Planning of Tourism on Rural Areas: The Stakeholders’ Perceptions of the Boticas Municipality (Northeastern Portugal). *Eur. Countrys.* **2017**, *9*, 504–525. [[CrossRef](#)]
134. Lup, A.N.K.; Soni, V.; Keenan, B.; Son, J.; Taghartapeh, M.R.; Morato, M.M.; Montañés, R.M. Sustainable energy technologies for the Global South: Challenges and solutions toward achieving SDG 7. *Environ. Sci. Adv.* **2023**, *2*, 570–585. [[CrossRef](#)]
135. Minas, A.M.; García-Freites, S.; Walsh, C.; Mukoro, V.; Aberilla, J.M.; April, A.; Mander, S. Advancing sustainable development goals through energy access: Lessons from the global south. *Renew. Sustain. Energy Rev.* **2024**, *199*, 114457. [[CrossRef](#)]

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