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Review

Public Policies for Renewable Energy: A Review of the Perspectives for a Circular Economy

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Abstract: The development and implementation of public policies towards renewable energies are crucial in order to address the contemporary challenges faced by humanity. The 3Rs (reduce, reuse, and recycle), as a circular economic practice, are often cited as one of the best solutions for sustainable development. Therefore, this study analyzed public policies for renewable energy from the perspective of the circular economy. Accordingly, a systematic review of the literature was carried out with respect to the beneficiaries and convergences of circularities, with a focus on public policies for renewable energies. The sample had public policies classified into three types (distributive, redistributive, and regulatory policies). The results showed that the first studies began in 1999, with a significant increase in publications during the 2010s, in which Germany was the country with the greatest contribution. The analyses associated with space showed the countries committed to the use of renewable energies and the 3Rs of the circular economy to reduce greenhouse gas emissions. The economic analyses revealed that the circular economy for the generation of renewable energy has a positive economic return in terms of social well-being and the mitigation of environmental degradation. There is a barrier to the circular economy's development posed by the cost of its implementation in the private sector and the resistance to raising awareness in society, requiring strong public sector engagement in decision making and the constant evaluation of public policies. It is concluded that the circular economy facilitates more efficient, productive structures and public policies, promoting alternatives for energy security and sustainability for the world energy matrix.

Keywords: bio economy; clean energy; sustainable development; circularity; bibliometrics; energy transition

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1. Introduction

Policy analysis plays an important role in the acquisition of knowledge regarding government action and helps policy-makers contribute to the quality and elaboration of public policies [1]. Some authors [2–4] claim that policy analysis can be both descriptive and prescriptive. Its descriptive role constitutes an element of immediate adjustment, guidelines, or assertive practices. Its prescriptive role is intended to function as a planning tool to mitigate existing or potentially existing problems. Wildavsky [5] showed that the

role of policy analysis is to find problems where solutions can be promoted. Failure to promote public policies in the promotion of renewable energies results in economic weakening. Policies that support renewable energy are crucial to face environmental challenges [6]. Technological progress in the use of renewable sources is a positive instrument and constitutes a paradigm shift in the face of the growing energy demand, aiming to mitigating climate change by reducing greenhouse gas emissions [7].

The promotion of public policies within heterogeneous communities tends to improve well-being, which is tied to economic development [8]. The Circular Economy (CE) is based on a transdisciplinary discussion with the aim of achieving circularity in the process of managing natural resources. It is essential to use policies to encourage innovative practices in the life cycle of materials, which is the challenge to be faced by the public and private sectors in accordance with the available technologies for mitigating environmental impacts. The adoption of circular practices within environmental management has been gaining worldwide recognition due to the advances of Industry 4.0, which is associated with the rapid depletion of resources and negative effects on climate change [9].

The valorization of the extracted resources used in the elaboration of a product or service and the maintenance of these in circulation through integrated production chains are the tasks to be addressed by the CE. The design is based on overcoming the concept of the end of utility and waste and visualizing the purpose of each material within a cyclic flow, enabling its trajectory 'from origin to origin'—from product to product—and thus preserving and transmitting its value [10].

The relationship between public policies and the benefits of sustainability remains underexplored in the social sciences [11]. Policy instruments are essential for the insertion of circularity in the generation of renewable energy in the short and long terms [6]. The economic impact of an energy matrix with a predominance of renewable sources and a greater degree of circularity of its products and processes implies social development that leverages the generation of jobs and the simultaneous growth of GDP, in addition to supporting cultural modernization based on sustainability [12,13].

However, renewable energies need to be modified through public policies and require broad contributions to the development of their related projects, whether in the public or private sphere, to stimulate well-being such that it is aligned with social and environmental benefits [14,15]. Although there are studies regarding renewable energies and the CE in the field of innovation, it is necessary to expand research concerning the addressal of the lack of public policies and governmental and private interventions to effectively overcome the emerging challenges of sustainability [16,17].

This systematic review presents a framework that illustrates the existing interfaces between the concepts and benefits identified in the use of the CE for the development of renewable energy sources and its insertion in the cycle of public policies, identifying the stakeholders of greatest interest in the studies carried out who are responsible for the promotion of innovation and the generation of jobs and income. This review incorporates essays that present perspectives from theoretical studies such as Giezen [18], who introduced public policy propositions to renewable energies; Unal and Shao [19], who approached the topic from an empirical perspective, employing the prior analysis of public policies for implementation; and West et al. [20], who carried out an evaluation and readjustment of implemented policies, exploring ways in which public policies for renewable energies can be adapted to generate greater public support and participation.

Given the above discussion, the objective of this article was to present a systematic review of the literature to explore and categorize the benefits of the circular economy with respect to the development of renewable energies. This work will highlight the main approaches to public policies worldwide, establishing the frontier of knowledge on the subject. The results will also serve to support new policies and public and private investments in the renewable generation sector in accordance with EC practices.

Studies related to the development of renewable energies through circularity project companies, investors, the public sector, and society to obtain benefits that can be assured and expanded to decision making are discussed herein.

Accounting for this introductory section (Section 1), the article has four sections; the base data for the study and the methodology applied are in Section 2. Section 3 presents the results and discussion, which are subdivided into a bibliometric analysis and a systematic review, incorporating analysis and categorization of public policies. Finally, Section 4 presents the conclusions and identifies gaps to be addressed in future research.

2. Materials and Methods

A Systematic Literature Review (SLR) is used to identify, evaluate, and interpret available and relevant studies on a specific research question [21]. SLRs differ from traditional exploratory reviews as they are based on scientific, transparent, and replicable processes [22,23]. The development of this SLR followed the activities recommended by the literature [24]: formulation of research questions, identification of relevant studies, evaluation of the quality of the articles, summary of evidence, and interpretation of results. The guidelines of the PRISMA statement were followed throughout these activities whenever applicable [25].

In view of the discussion above, Figure 1 presents the descriptive summary of the systematic literature review of public policies for renewable energies from a CE perspective. The SLR was organized into three stages: research planning (exploratory), the performance of the review (development), and reporting (analysis).

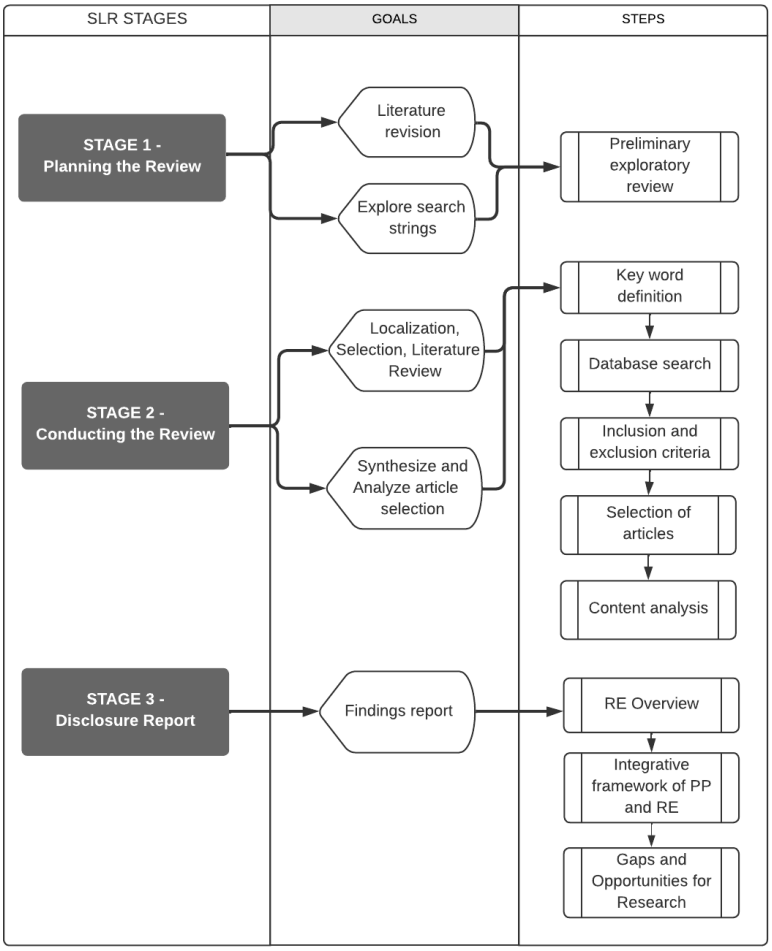

Figure 1. Descriptive summary of the systematic literature review. Source: Adapted from Tranfield et al. [22].

2.1. Stage 1—Review Planning

In the first stage, an unstructured exploratory review was carried out, which assessed the initial perception of the research objective in order to create a systematization of the main articles published over the last forty years regarding public policies in renewable energies and the use of CE concepts. Tranfield al. [22] highlight the importance of a previous studies in the exploratory phase for assessing the relevance of the subject to be researched, as well as delimiting the study area and the research platform to be selected.

As a strategy to increase the efficiency and quality of the research, strings of words were used as a set of snowballs (snowball sampling), thereby reducing the chances of bias in the sampling process [26]. The keywords Renewable Energies, Public Policies, and CE were present in most of the reference chains of the preliminary research.

2.2. Stage 2—Conducting the Review

The ISI Web of Knowledge—WOS platform was used to carry out the research, with publications available from 1970 to 2020. WOS is a more consolidated and older citation database, with strong coverage of citation and bibliographic data and that considers the base with greater depth and quality [27–31]. To carry out the systematic literature review, three keywords were defined, namely, "public policy", "renewable energy", and "circular economy", using the combinations in two stages of the research. Figure 2 presents the planning scheme for the systematic literature review using these keywords. Search 1 employed "public policy" and "renewable energy", both searched by Title, which resulted in 32 works. In Search 2, the words "renewable energy" were used for Topic and "circular economy" for Title. This chosen structure intends to cast the Titles as the central figure of its search and correlate them with the Topics, which resulted in the acquisition of 63 works. The sum of the research was a final sample with 65 articles.

Regarding the selection of a sample, Ensslin et al. [32] and Tranfield et al. [22] recommended performing analyses seeking consonance with the research theme with respect to the titles, abstracts, and complete alignment of the articles. Only studies that met the specified inclusion criteria were part of the sample, highlighting the importance of documenting the included and excluded studies at each stage and providing reasons for exclusions. The following criteria were used for exclusion: type of document, considering only articles and review studies; category, with the exclusion of 22 articles from areas unrelated to the topic proposed by the search, such as computer science, automation control systems, mathematics, food technology, and information science; repetition, with no repeated articles as a result of the two searches; the reading of the abstracts, in which 6 articles were excluded that were not related to the objective of the research; and, finally, the reading of the articles, with the exclusion of 1 article, using the same considerations used in the reading of the abstracts. The final sample consisted of 65 articles. To extract relevant information, data necessary to design summary tables and perform data synthesis in the systematic literature review were considered [22].

The tabulation of the selected articles was essential for content analysis, bibliographic survey, and the systematic classification of the article. Information on the technical files of the article available in the database (title, authors, periodicals, and specific technical details of the publication) was used to prepare the selected articles. A spreadsheet in the "WIN tab" format was generated by WOS, exported to MS Excel, and manually supplemented with information necessary for a complete analysis of content studies and bibliometrics, such as year, number of citations, objectives, theories, methods, gaps, types of public policy, research objective, public policy benefits, and CE perspective. Content analysis provides a very flexible and widely used research strategy for a systematic and rigorous approach to analyzing data obtained or generated during a study and can have qualitative and quantitative applications [33]. From the surveys of this information, a bibliometric and systematic summary of the methodologies and research carried out was generated.

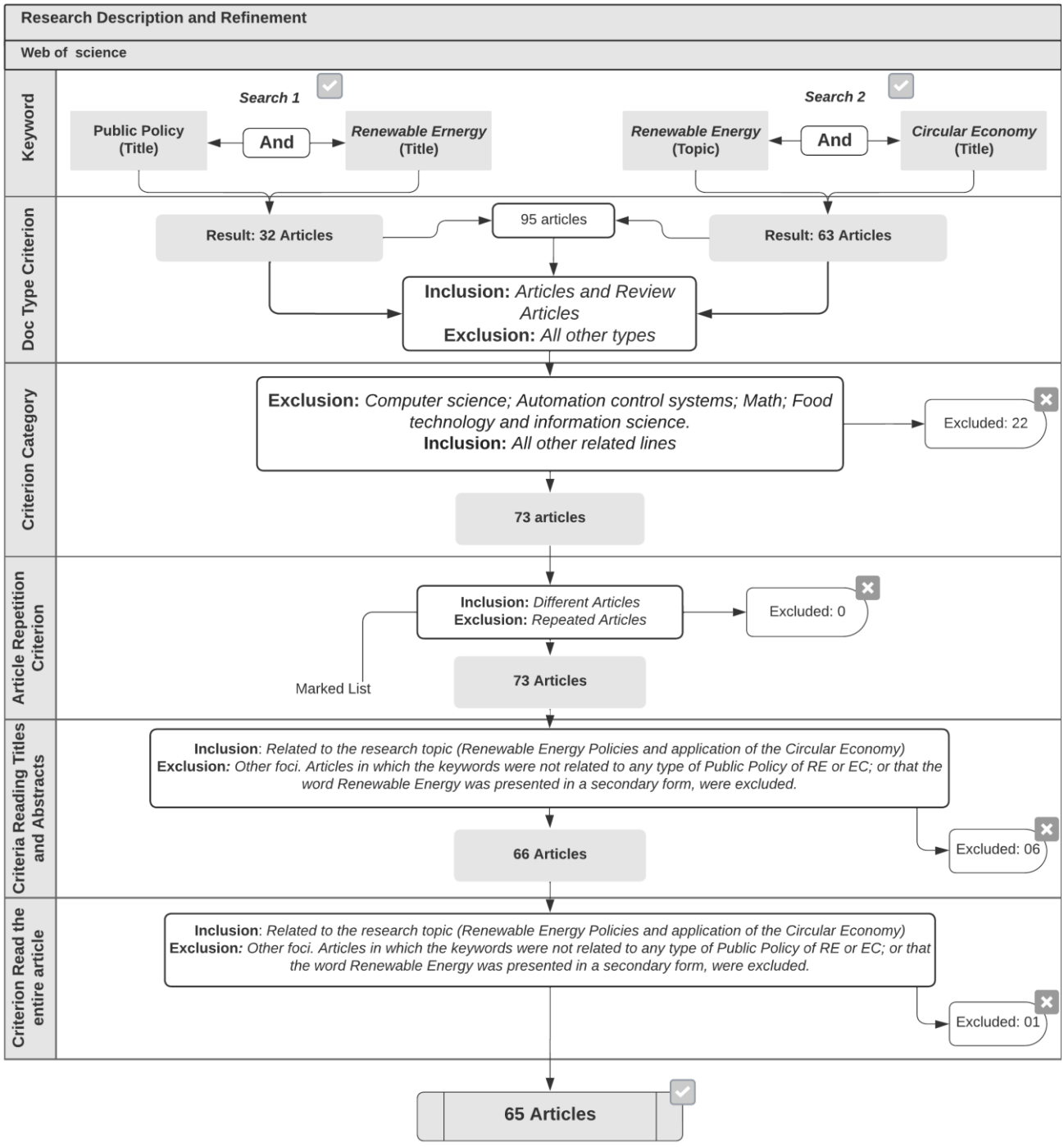

Figure 2. Sampling scheme for a systematic literature review of public policies concerning renewable energies from a CE perspective.

2.3. Step 3—Disclosure Report

A world map will be presented showing the distribution of publications in the countries through the QGIS software version 3.4.14. The spatial distribution of works in the countries was performed by quartiles (Equation (1)) [34]:

$$Q_k = \frac{k \sum f_i}{4} \quad (1)$$

where k is the quartile rank number; $\sum f_i$ is the sum of the number of publications per country.

The annual and cumulative evolution of publications and citations were observed and the journals with the greatest impact were classified. Progress was verified by type of method used in the research, empirical or theoretical, linked to the purpose of public policy, and by type of publications, articles, and review studies in the areas of knowledge. A Venn diagram was built, which directly portrayed the benefited groups (public sector, companies, and society) according to the proposed studies. The development of the network of keywords associated with public policies with respect to renewable energies from the perspective of the CE across the globe was presented using VosViewer software.

This SLR seeks to obtain a framework for the expansion of renewable energy sources via the practices that underlie the CE, which is correlated with the cycle of public policies that these studies promote among stakeholders [22]. The development of SLR was approached as follows: regarding renewable energy sources and public policies, the 1st grouping accounted for the renewable energy sources that were classified in a systematic and objective matching that of the articles, which allowed for the correlation of the cycle, type, or trends of public policies. The systematic review not only presented the research related to renewable energies and their evolution in the circular economic model but also a robust and effective contribution to the elaboration of public policies and to progressing solutions towards economic, social, and environmental order.

It is essential to identify the facts, social actors, benefits, trends, etc., in relation to this study. Figure 3 illustrates the process of analyzing public policies and the steps for classifying articles. Publications were submitted to the analytical process and evaluated with respect to their apprehension of reality and understanding of the need for public policy. For better dimensioning of the policy, the apprehension of reality had to have been arrived at through research, whether for the elaboration of a public policy or the analysis of an existing one. Research, when inserted in the cycle of public policies, was classified according to the stages that the policies are in, namely, prior analysis, prospection or implementation, and evaluation of public policies.

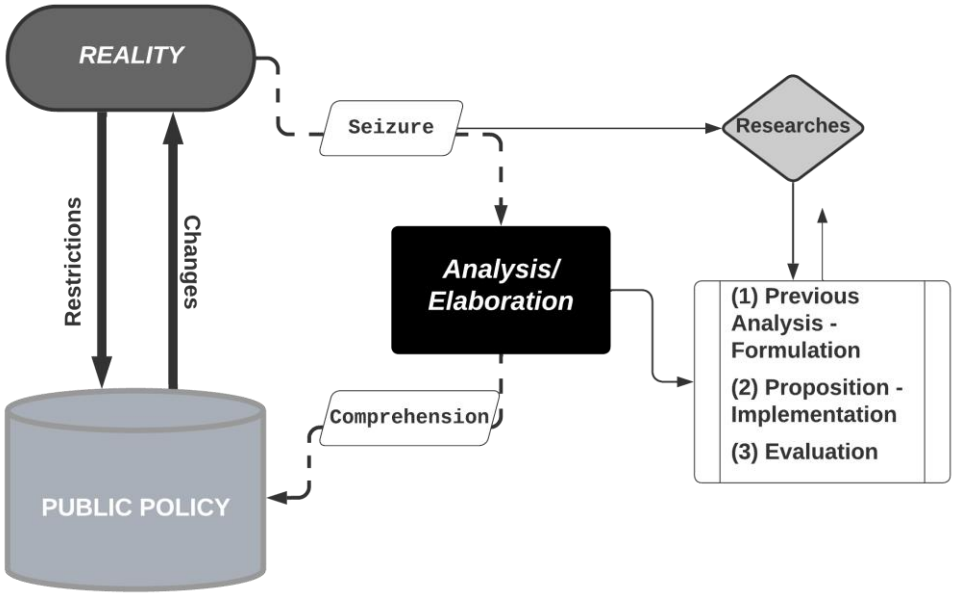

Figure 3. Process of analyzing public policies and steps for classifying articles.

The bibliometric review and the systematic literature review present an alternative and simplified proposal for classifying public policies, contributing to the consolidation of a heuristic model for decomposing the political process into sequences or stages for analytical and systematic purposes. From the conceptualization of the steps indicated by Lasswell [2], some phases were brought together and synthesized in a cycle consisting of three steps: Preliminary Analysis, Prospecting, and Evaluation, as shown in Figure 4. Each of the articles in the "final sample" are identified in the stages of the cycle during which

the proposed policies were inserted, thereby systematizing the perspectives regarding the formulation and evaluation of policies for renewable energies. This process employed the inductive method with the application of the SPIN Selling methodology, which is a lead qualification created by Neil Rackham in the 70's and 80's in the search for the correct way to ask investigative questions, and which involves selecting the situation, the problem, the implication, and the required solution [35].

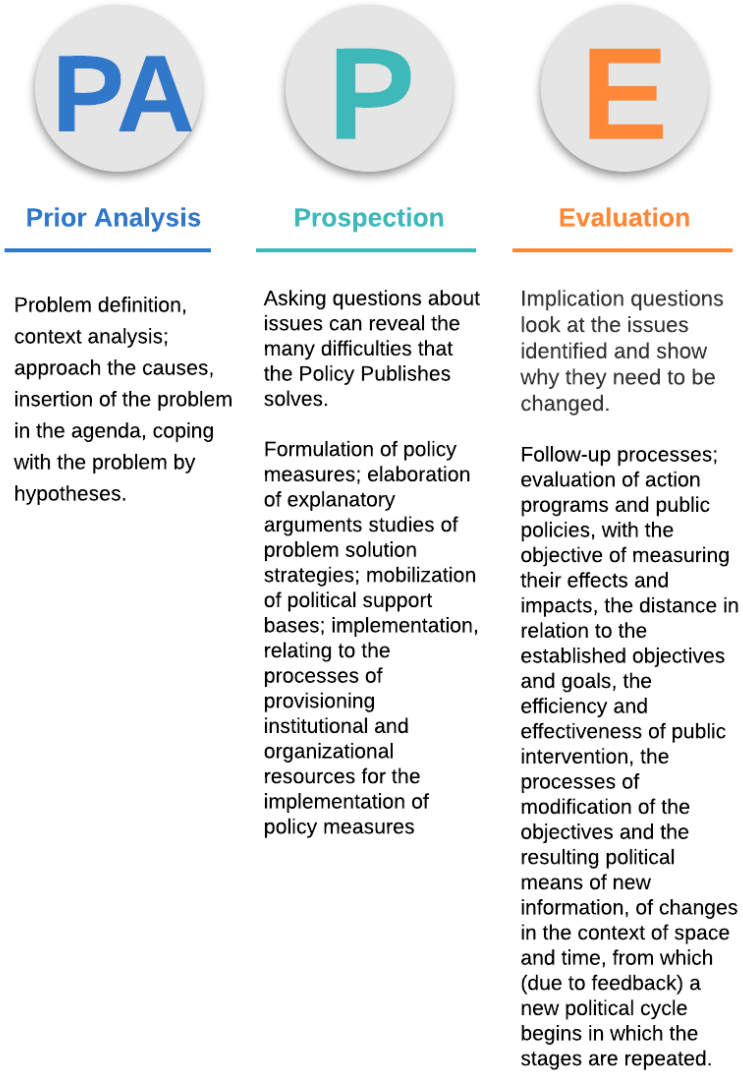

Figure 4. Pre-Analysis, prospecting, and evaluation Stages.

Like all heuristic models, the classification presented herein should be used with caution, as it is only a simplified representation of reality, with the function of providing an analytical framework that facilitates the understanding of the political process. It is essential to understand policies as a continuous flow of decisions and procedures, for which it is necessary to find a meaning. The development of the policy cycle system complemented the decision-making and analysis processes that involve answering the following questions [2]: who wins what, why, and what difference does it make?

The articles are grouped into categories considering concepts and definitions related to renewable energy sources, the benefits of the CE, and the identified public policies [36]. The 2nd grouping systematized and visualized the categories of Public Policies for Renewable Energies (PPRE). Through the taxonomy of public policies described by Lowi [8], Table 1 identifies the common aspects among the phenomena that could aid the decision making regarding the prospection or evaluation of existing policies. The 3rd grouping related the

study methodology (practical or theoretical) to the public policy cycle and identified the benefits of the CE and the stakeholders that will benefit from the studies developed. The 4th grouping was performed to carry out an integrative analysis, envisioning the PPRE panorama, CE practices, and observed trends.

Table 1. Overview of public policy categories corresponding to their social aspects according to Lowi's classification [8].

PPRE Categories	Definition	Target Audience
PPRE 1 Distributive	They have specific objectives for the provision of state services and/or equipment.	Small groups or individuals from different social strata.
PPRE 2 Redistributive	Redistribute income in the form of financing for services and equipment and in the form of resources.	The higher strata of society are responsible for financing—through incentives—people with lower incomes.
PPRE 3 Regulatory	Regulatory policies are created to evaluate some sectors in order to create standards or implement services and equipment	All civil society.

With the categories of public policies identified, a similar procedure was carried out to identify the main benefits of the studies and whether they were based on technological development and innovation or the investigation of results and mechanisms for implementing PPREs. These benefits were also grouped into broader categories, e.g., "Relationships between Public Renewable Energy Policies and CE Perspectives". Each identified benefit was related to the article from which it was extracted.

Despite having a narrative character, this systematic review is based on the application of methods with conceptual, technical rigor in order to develop frameworks used in the classification, achieve robust results, and mitigate errors [37]. The purpose of the classification is to enable the development of public policies for renewable energies and circular practices, extract social needs from research, and provide the systematization of methodological support when there are no articles that present the evaluation of public policies for renewable energies as results. Thus, elements are presented to carry out a study focused on relating the research developed regarding renewable energies, which is capable of providing insights and research clues that allow for the initiation of the study in a methodical way through the interrelated use of the specific concepts of the types of policies and evaluation. Based on the analyses collected, it was possible to develop a systematic literature review, thus integrating public policy and CE studies into the expected benefits of renewable energies, in addition to providing an overview of research gaps on the subject.

3. Results and Discussion

3.1. Bibliometric Analysis

3.1.1. Spatial Distribution of Research

Figure 5 shows the spatial distribution of the countries, by quartiles, from which the publications originated over the period from 1999 to April 2020. The authors of 65 publications were incorporated into this research, who were distributed in 37 countries. Q4 is formed by countries that have eight to ten publications, represented by Germany with ten and Italy with eight publications. This quartile holds 27% of all the publications. Q3 was composed of England with seven publications and the United States with six studies, representing 22% of all the publications. Brazil is a component of Q2, with four publications, ahead of the Netherlands, Poland, Romania, South Korea, and Ireland, which presented three publications. Q1 was composed of 27 countries, of which 9 had 2 publications each and 18 countries had 1 publication each. Q1 highlights the discrepancy in the dispersion of

the studies on the subject, demonstrating the universalization of the theme, which is part of the international agenda for mitigating the effects of climate change and the importance of the CE for the supply of renewable energy.

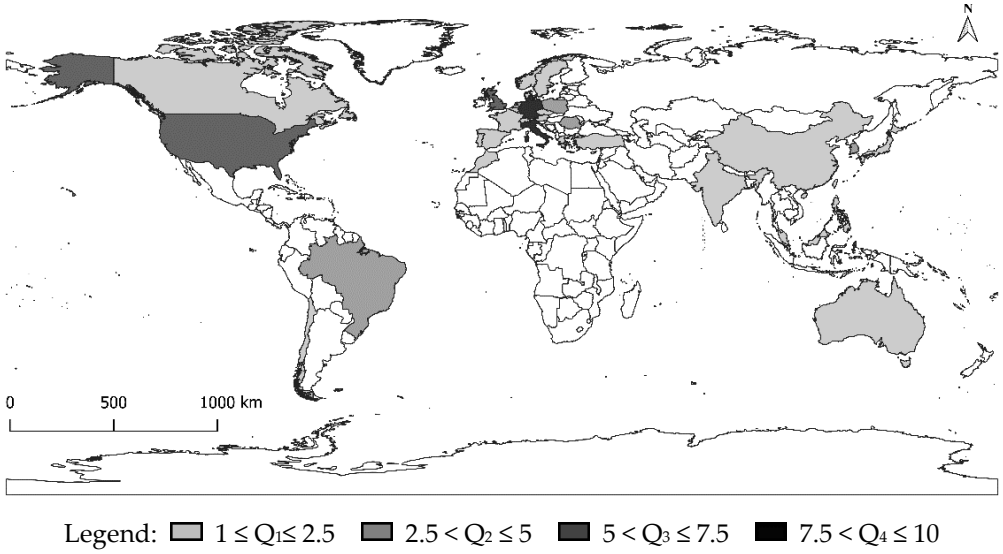

Figure 5. Spatial distribution of countries, by quartiles, from which public policy publications on renewable energies from the perspective of the CE originated.

3.1.2. Impact Analysis of Publications

Figure 6 shows the global evolution of the publications and citations (Research Articles and Review Studies) concerning public policies on renewable energies from CE perspectives—presenting the publications annually and in a an accumulated manner—over the period from 1999 to 2020.

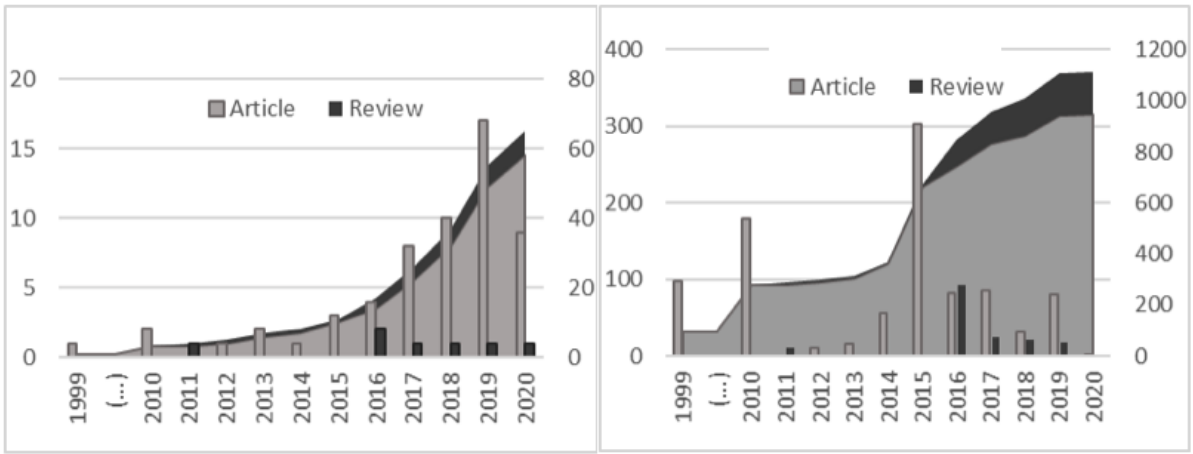

Figure 6. The annual and accumulated global evolution of publications and citations (research articles and review studies) concerning public policies on renewable energies from the perspective of the CE.

The first article in the sample is dated from 1999; it is the third most-cited article in the selection, and presents a study of wind-energy development policy in the United States based on incentive policies not only of energy wind diffusion but of technological innovation as well, since concentrating policies only on the supposed demand for wind energy would run the risk of spending public resources on energy programs that could be doomed to failure, making it interesting to develop innovative energy policies with the creation of a market for renewable energy in the US. This study also demarcated the development of wind energy in the late 1990s [38].

This conception permeates the objectives of the selected studies. After a decade without studies with a defined theme, in 2010, two articles were published: West et al. [20] with the policy and public perceptions of renewable energies in the cultural theory approach, and the important contribution of Barradale [39], analyzing the impact of uncertainty in public policy on renewable energy investments, wind energy, and the tax credit of production. Such studies totaled 180 citations, marking the year with promising and relevant discussions for the energy sector. From 2015 onwards, there was a gradual growth in the number of publications, reaching a greater number in 2019 with 18 publications of articles that totaled 99 citations. However, the year 2015 was highlighted by relevant research, totaling 304 citations. Haas et al. [12] directly address the CE and renewable energy in a global assessment of the European Union and the world in 2005, with the evaluation of policies adopted to increase the degree of circularity in products and process flows due to the generation of ER; this was the most-cited article and reached the first place in the ranking with 199 citations, which shows researchers' greater propensity for studies on the CE in recent years.

From the years 2016 to 2020, there were publications on the subject. Notably, in 2020, the span of publications only covers five months and accounted for 10 publications, indicating intensification and relevance in the current context. Priyadarshini and Abhilash [9] developed the last article included in the review, which addressed the adoption of practices for the integration of waste management policies into strategies for increasing energy generation, inserted in an umbrella policy to promote the CE, which comes to corroborate the transformations inherent to sustainable development. The articles were published in 39 different journals. As their main scope, some of these journals concern topics related to energy, policies, and environmental issues, while others have a diverse scientific scope, which indicates that different fields are linking their research approaches to CE practices in the energy sector to the promotion of public policies.

Table 2 presents the ranking of the journals with the greatest impact, with more than nine citations, for the publications from 1999 to April 2020. The most significant journal in the sample was Energy Policy, with 9 articles and 460 citations, followed by Bioresource Technology, from the Journal of Cleaner Production and Sustainability, with 5 publications each. The Journal of Industrial Ecology, despite only accounting for two articles, had the highest average impact of citations per article, which was 102.5.

Table 2. Classification of journals with the greatest impact, with more than nine citations, and organized with more than two citations.

Journal	Quantity	Citations
Energy policy	9	460
Journal of industrial ecology	2	205
Bioresource technology	5	112
Journal of cleaner production	5	63
Energy	1	57
Renewable and sustainable energy reviews	3	41
Nature energy	1	40
Resources conservation and recycling	2	18
Sustainability	5	15
Sustainable energy technologies and assessments	1	11
Entrepreneurship and regional development	1	10
Renewable energy	1	10
Sustainability science	1	10
Other journals	28	63
Total	65	1115

3.1.3. Analysis of the Purpose of the PP

Table 3 presents the studies that were carried out using the empirical and theoretical approach methods and their correlations with the three stages of the public policy cycle

that comprise prior analysis, evaluation, and prospection. Regarding theoretical articles, 12 articles were identified, representing 13% of the total number of publications. The empirical ones presented a greater number—53 articles. This corroborates the fact that this topic is the object of recent research and still requires exploration, especially in the field of social sciences. Theoretical articles address concepts, perspectives of implementing sustainability in territories with practices for the engagement of energy policies, and the analysis of economic or technological scenarios, which favor the development of renewable energies.

Table 3. Evolution of articles regarding the type of linked method and the objective of public policies identified in the studies.

		1999	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Empirical	Previous Analysis								1	3	1	4		9
	Evaluation		2	1	1	1		3	3	1	4	5	3	24
	Prospection	1					1		2	4	2	5	5	20
	Subtotal	1	2	1	1	1	1	3	6	8	7	14	8	53
Theoretical	Previous Analysis										2	3		5
	Evaluation										1		1	2
	Prospection					1				1	1	1	1	5
	Subtotal					1				1	4	4	2	12
	Total	1	2	1	1	2	1	3	6	9	11	18	10	65

Among the articles with a theoretical approach, only two works propose an evaluation of the public policies implemented, which were the Sherwood article [40], which provides an evaluation of a scenario of the sustainable production of biomass and praises its function as a raw material from the perspective of European politics, and the article by Maciel et al. [41], which proposes the diversification of the energy matrix in Brazil with renewable sources in order to replace the existing energy model—predominantly employing fossil fuels—based on some public policies that the Federal Government has implemented in Federal Higher Education Institutions to encourage the use of renewable energies.

Theoretical research in the review articles was observed in the studies by Sherwood [40], Sassanelli et al. [42], and Stiles et al. [43]. However, none of the articles aimed to develop an integrative framework that would relate energy policies, innovation policy, or social policy and the benefits of the CE, which confirms the importance of this study.

Among the empirical studies, some of them have a longitudinal approach, such as the study by Dalmazzo-Bermejo et al. [44], which presents contributions to the guidance of public policies that promote the production of non-traditional renewable energy based on the analysis of energy production in Latin America over the period from 1995–2007. It is not clear whether there is a trend in the use of this method over time. However, the case study was used in all years of publication, which demonstrates the validity of this method with respect to this research topic.

3.1.4. Research Areas

Table 4 shows the evolution of publications by research areas from 1999 to April 2020. The area of economics and business stands out with 21 articles; no review articles were presented in this selection. This area included the first publication by Loiter and Norberg-Bohm [38] and was the only area to present studies in the years 1999, 2010, 2013, and 2014. The area of science and technology assumed second place in the ranking with 20 publications, wherein three of these articles are review articles, and this group published their papers in the years 2011, 2016, and 2019. The year 2017 had the largest number of publications in this area and its only review article was that by Wall et al. [45], who presented the European Union's legislation on incentives for the production and use of third-generation biofuels and the integration of advanced technologies and raw materials, thus signifying the spread of the reduce, reuse, and recycle concept.

Table 4. Evolution of publications in research areas.

	1999	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Science and technology			1	1			1	2	2	4	7	2	20
Research Article				1			1	1	2	4	6	2	17
Review			1					1			1		3
Agricultural Sciences								1	1	1		2	5
Research Article												1	1
Review								1	1	1		1	4
Environmental Sciences									2	1	3	4	10
Research Article									2	1	3	4	10
Social Sciences									1		1		2
Research Article									1		1		2
Economy and Business	1	2			2	1	2	2	1	4	5	1	21
Research Article	1	2			2	1	2	2	1	4	5	1	21
Energy and Fuels								1	2	1	2	1	7
Research Article								1	2	1	2	1	7
Total	1	2	1	1	2	1	3	6	9	11	18	10	65

The area of environmental sciences started with two publications in 2017 by Budzianowski [46] and Lausselet et al. [47], both highlighting the use of the CE as a way of developing and propagating renewable energy sources and the application of carbon capture, use, and storage. In 2020, this area was responsible for the largest number of publications, accounting for four articles out of the ten published that year. The energy and fuels area presented seven articles and did not publish any review articles. The area of agrarian sciences had the largest number of review articles, namely, four articles. The other areas of concentration are distributed by fields that support CE studies, such as energy and fuels, technological sciences, thermodynamics, engineering, and biotechnology, among others, which proves the interdisciplinarity of the subject, and which reveals works with social and planning-related approaches and the publication of articles with innovations in processes and products.

3.1.5. Analysis of Areas Impacted by PP

Figure 7 presents a Venn diagram of the groups that directly benefited from the studies. As this field is related to the generation of renewable energies from both renewable sources as well as through the use of new, renewable forms of energy, together with the application of circularity in finite resources, the studies benefit the following actors: society, the public sector, and companies.

The public sector (with 49 articles), also referred to in the literature as the state sector, is represented by the state, which deals with the production, delivery, and distribution of goods and services by and for the government or society (64 articles), which, in turn, is represented by a collective of people, groups, and associations. Companies (46 articles) constitute the main representation of the private sector, which manages actions to survey public policies for economic development—whether through fiscal, extra-fiscal, technological development-related, industrial, or employment policies—that links benefits to society and the public sector.

Through our systematic analysis, the studies have revealed possible policies for strengthening renewable energies through circular practices, which must be propagated among all stakeholders, namely, society, companies, and the public sector. Public policies help decision making with respect to the energy sector and are instruments for social transformation and economic modeling, which are used by the state for society and the private sector, such as in energy policies to achieve efficiency and market planning [48].

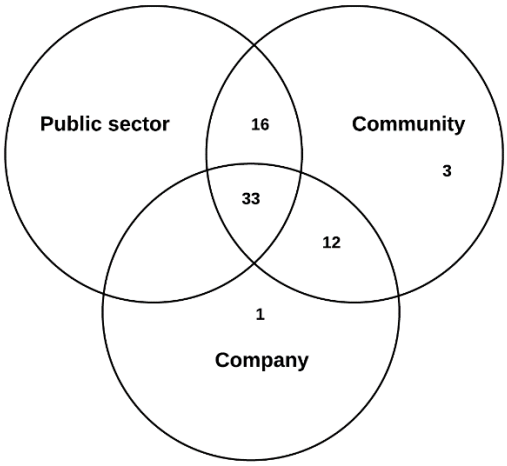

Figure 7. Venn diagram of the groups directly that benefit from the studies.

The private sector benefited from 46 articles that disseminate development with technological, ecological, sustainable, and innovation-related practices with feasibility studies for the use of CE precepts, such as the study by Hao et al. [49] that discusses the economic conditions for the growth of the industry and recommend the reuse of carbon fibers extracted from the blades of wind turbines to close the material cycle in the design of circularity, thereby reducing the value of investments in the wind sector, which is characterized by high deployment costs.

Innovation policies, based on the 3Rs principle of the CE, i.e., reduce, reuse and recycle, have guided CE studies with respect to achieving pollution reduction and low-carbon development through the use of renewable sources [50]. Despite public policies being issued by the public sector, society is driving and most benefited by these policies, which can be visualized by the intersection between the three groups in the Venn diagram.

Incentives and technological development (corporate), economic gains (public sector and society), and social well-being (society) constitute the materialization of the strengthening of positive standards of sustainability and the preservation of the environment and space, as demonstrated by the authors Liebe and Dobers [51], who present an acceptance-mapping system for the construction of new renewable energy plants and the implementation of policies for more positive attitudes, with fewer protest intentions that weaken the movement to developing energy policies for the expansion of the renewable matrix.

3.1.6. Indexing Terms

Figure 8 shows the global evolution of the network of keywords associated with public policies related to renewable energies from the perspective of the CE from 2017 to 2019. Among the 65 publications, some articles had a wide coverage and contemplated more than one cluster thematic. Their main observations concerned the following themes: climate change; public policy; renewable energy and consumption, with a greater intensity in 2017; the CE; efficiency; sustainability; sustainable development; and recycling. These observations were present in publications from 2018; currently, there is a greater occurrence of the words sustainable development, biomass, life cycle assessment, and waste energy.

Ecological and sustainable development-related discussions were the ones that presented the highest number of keywords, showing a broad field of research, although one less dense than the others. It is important to highlight that although these are not topics directly related to the theme of this research, it is indicative that these themes are similar to renewable energies and the CE. These discussions highlighted the studies on renewable energies (biomass and renewable energy), climate change (climate change), and the CE (efficiency, recycling, sustainability, and life-cycle assessment).

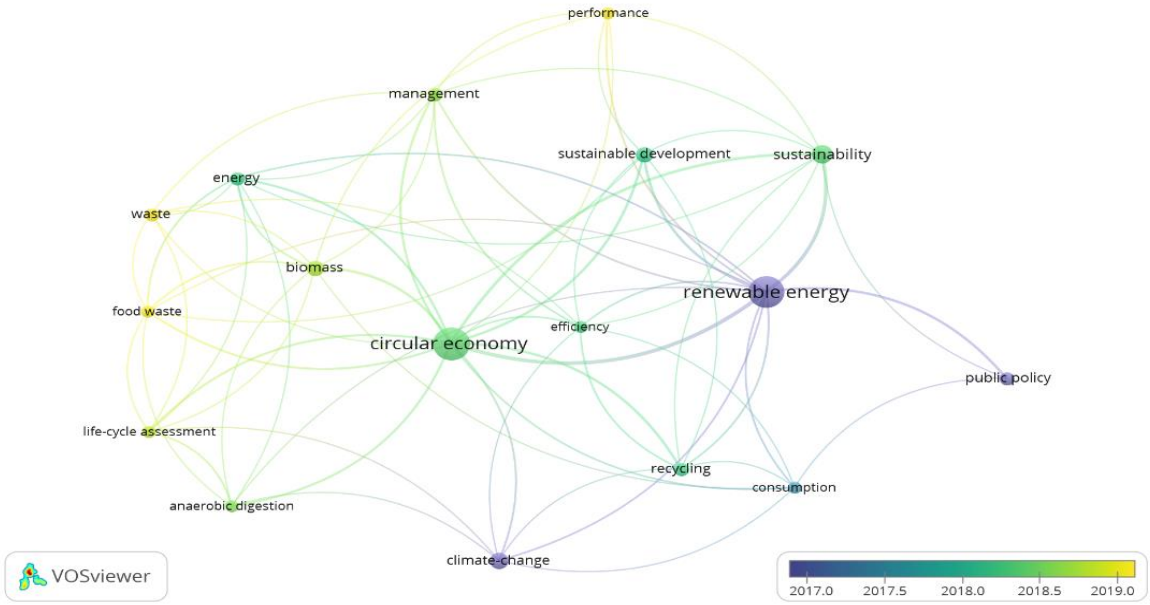

Figure 8. Global evolution of the network of keywords associated with public policies related to renewable energies from the perspective of the CE.

3.2. Systematic Literature Review

3.2.1. Renewable Energy Sources and Public Policies

Energy, an essential asset to human existence, is a point of interest and concern on the world agenda, because the energy sources in use across the globe still assume non-renewable predominance, a factor that signals a lack of research and planning in terms of the quality, energy efficiency, and technology associated with renewable energy sources.

The environmental concern was the starting point for the occurrence of a growing number of studies, mainly in developed countries, which started in 2005 with the Kyoto Treaty, according to which the developed countries assumed commitments to achieve the goals of reducing the emission of pollutant gases, especially carbon dioxide (CO_2).

The concern with respect to energy issues, especially the security of supply, and the consequent economic and regulatory repercussions, integrated important studies in order to adapt the guidelines of the world agenda. The European Community began the discussion on the matter within the scope of environmental policy, with a thematic and sectoral focus via directives, which gave rise to the first Action Programs of the European Communities on Environmental Matters.

Among the measures taken to achieve these goals, Gawel et al. [52] points out the increase in energy efficiency, as well as the promotion of the research, development, and increased use of new, renewable forms of energy. The Paris Agreement, which is premised on strengthening global mechanisms to address the threat of climate change and boosting the ability of countries to combat the impacts arising from these changes, established Nationally Determined Contributions (NDCs), wherein countries have committed to reducing greenhouse gas (GHG) emissions by up to 45% below 2005 levels by 2025. The diversification of the energy matrix is a crucial aspect to address in order to guarantee quality and reliability in energy, which is a strategic characteristic of an efficient energy sector. On the other hand, the diversification of a country's energy matrix based on non-renewable sources generates high risks to the sustainability of the planet, which is a relevant point with respect to transforming an undeveloped country into a developed one.

For the development of solutions for rapid adaptation, in their review, Dalmazzo-Bermejo et al. [44] highlight the importance of public policies in promoting renewable sources in order to overcome barriers that may vary depending on the weakness found in each country in terms of the (a) regulatory; (b) economic; (c) technological; or (d) technical

scope. Despite the lack of review articles in the sample that list countries and their respective public policies for renewable energies, Table 5 presents a systematic classification of the articles by their renewable energy sources with their respective countries and authors, which assess the countries capable of dedicating themselves to the study of renewable energies and the CE for public policy decision making in the energy sector. The sources highlighted in the studies were identified through the reading of the articles. The classification of the source "Renewable energies" is related to the strict sense of the word, without any identification of a specific source in the study, but rather the importance of renewable energies and their different forms of generation.

Table 5. Systematic classification of public policies by renewable energy sources and their respective countries.

Sources	Countries	Authors
Renewable energy (*Lato sensu*)	Germany; Latin America; Australia; Austria; Brazil; Canada; Chile; China; South Korea; Croatia; Spain; United States; South Korea; Greece; France; Italy; India; Ireland; Japan; Malaysia; Philippines; Czech Republic; Mexico; Portugal; Poland; Portugal; UK; Romania; Romania/Europe; Taiwan; Turkey; Switzerland; Turkey; Norway.	Marques et al. [6]; Gallagher et al. [7]; Priyadarshini and Abhilash [9]; Haas et al. [12]; Mihai et al. [13]; Ngan et al. [15]; Batista et al. [16]; Ünal and Shao [19]; West et al. [20]; Maciel et al. [41]; Sassanelli [42]; Dalmazzo-Bermejo et al. [44]; Lausselet et al. [47]; Gawel et al. [52]; Cascone et al. [53]; Desing et al. [54]; Katz-Gerro and Sintas [55]; Kılkış and Kılkış [56]; Stokes and Warshaw [57]; Bassi and Dias [58]; Doblinger et al. [59]; Antoniou et al. [60]; Aranda-Uso et al. [61]; Arnette and Zobel [62]; Arrese and Wells [63]; Baran [64]; Bertsch et al. [65]; Burger et al. [66]; Carfora et al. [67]; Chen and Kim [68]; Di Fraia et al. [69]; Fobissie [70]; Groh and Mollendorff [71]; Lee et al. [72]; Mavi and Mavi [73]; Nedelea et al. [74]; Olson-Hazboun et al. [75]; Polzin et al. [76]; Samperio and Acosta [77]; Skrinjaric [78]; Sung and Song [79]; Suwa and Jupesta [80]; Tsai [81]; Walker et al. [82]; Wysokinska [83]; Zamfir et al. [84]; Deutz et al. [85].
Biogas	Brazil, Togo, Germany, Czech Rep.	Ribeiro et al. [86]; Azouma et al. [87]
Biomass	India; Ireland; Italy; UK; Brazil	Sherwood [40]; Stiles et al. [43]; Wall et al. [45]; Liguori and Faraco [88]; Sharma et al. [89]; Silva et al. [90]
Wind	Germany; United States; China	Loiter and Norberg-Bohm [38]; Barradale [39]; Hao et al. [49]; Schoden et al. [91]
Solar	South Korea	Kim and Park [92]
Solar, wind, biomass, natural gas	Germany	Liebe and Dobers [51]
Other sources	Netherlands; Poland	Meyer et al. [93]; Giezen [18]; Budzianowski [46].

Biomass studies are common in developing countries, which often seek the use of viable sources in rural areas for energy production. Brazil presented studies on forest biomass and biogas, as well as renewable energy, which demonstrates its commitment to expanding renewable energies and places it among the three most attractive emerging markets for investments in the renewable energy sector [94], whether via a renewable source of energy or material reuse with circularity concepts.

The use of biomass was basically reduced to agricultural regions. However, with the increase in environmental discussions, most countries, to a greater or lesser extent, have been making efforts to use sufficiently mature technologies, and the biomass that is used in processes with high efficiency stands out for having the flexibility to supply both the

production of electricity and mobility in the transport sector [95] when an area is observed that lacks governmental incentives for expansion.

Therefore, Silva et al. [90] present a policy for forest biomass based on an industrial agreement that favors the application of a circular economic model, thus reducing the use of virgin resources and encouraging the generation of waste in the forest sector, which has the advantage of enabling the high exploitation of materials, providing clean and renewable energy, and reducing the need for landfills. Ribeiro et al. [86] discuss biogas with the generation of less-pollutant energy from the use of poultry manure for the benefit of society and the public sector, which has the capacity to generate up to 1277 TWh/year, thus scientifically proving the capacity of the circular model to be a propellant of transformation and reuse for electricity generation.

Most of the studies on renewable energies from the perspective of the circular economy are concentrated in the European Union, which represents a range of developed countries that seek efficient and economically viable strategies to achieve the goals established in the Paris Agreement based on the cultural adequacy that sustainability can provide for society. To this end, the reduction in the input of virgin materials and the control of the output of waste are essential to achieve a pragmatic cycle in energy generation and complement the supply of electricity. According to Haas et al. [12], all material generated by society worldwide (approximately 62 Gt/year) has a flow for disposal (41 Gt/year processed). In the European Union (EU-27), materials are traced from extraction to disposal, but they also maintain a low degree of circularity for two reasons: 1) 44% of processed materials are used to provide energy and, therefore, are not available for recycling and 2) socio-economic actions are still growing at a high rate.

Germany was the country that presented the most incisive studies regarding policies for renewable energies, whether in the evaluation or prospection of public policies, in both economic and social contexts, which marks it as the country with the third highest level of renewable electricity generation. Due to its status as a developed country and a pioneer in technological development in constant innovation, Germany focuses its research on the theme of circularity to strengthen its regulatory policies, with respect to the following main aspects: (1) the assessment of the impacts of energy measures and policies implemented and investments in electricity generation capacity by institutional investors [76]; (2) the analysis of the public acceptance of energy infrastructure [65]; (3) increasing the overall efficiency and effectiveness of climate and energy policies, process improvements, and the CE [52]; (4) increasing the capacity for innovation and partnerships with research associations [59]; (5) process improvement—the development of products with half the renewable energy of their counterparts in order to achieve zero CO2 emissions and achieve net zero emissions from the circular model [72,93]; and (6) increasing public awareness regarding renewable energy technology/circular economy and compensating for the negative consequences of the transition process, thereby raising awareness among the public for their own participation in the emission of greenhouse gases [71,91].

Public policies are of fundamental importance in the expansion of renewable energies and the purposes set forth in the global climate agenda, as they are instruments that improve social well-being and economic development. The analysis of public policies has as its object the political decisions and action programs of governments, identifying the origin of the problems that policies need to solve and the conditions for their implementation.

3.2.2. Analysis of Public Policies Concerning Renewable Energies

In order to assess the contribution of the collected studies to the formulation or evaluation of public policies on renewable energies, our systematic analysis of the studies used the classification of the Public Policy Cycle, which constitutes the chaining of phases or stages of the political cycle for the formulation of public policies, seeking to rationalize the alleged actions. Table 6 presents the classification of articles regarding the benefits associated with the stages of the public policy cycle, that is, prior analysis, prospection or implementation, and evaluation, thereby allowing for the visualization of the trends and

the actions of governments and stakeholders involved according to the benefits identified in the publications.

Table 6. Classification of articles in terms of associated benefits at each stage of the public policy cycle.

Description	Authors
Previous Analysis	Unal and Shao [19]; Sassanelli [42]; Stiles et al. [43]; Budzianowski [46]; Lausselet et al. [47]; Desing et al. [54]; Kılkış and Kılkış [56]; Antoniou et al. [60]; Burger et al. [66]; Chen and Kim [68]; Olson-Hazboun et al. [75]; Walker et al. [82]; Zamfir et al. [84]; Azouma et al. [87].
Prospection	Gallagher et al. [7]; Priyadarshini and Abhilash [9]; Ngan et al. [15]; Batista et al. [16]; Giezen [18]; Loiter and Norberg-Bohm [38]; Dalmazzo-Bermejo et al. [44]; Wall et al. [45]; Hao et al. [49]; Gawel et al. [52]; Cascone et al. [53]; Katz-Gerro and Sintas [55]; Bassi and Dias [58]; Fobissie [70]; Lee et al. [72]; Samperio and Acosta [77]; Deutz et al. [85]; Ribeiro et al. [86]; Liguori and Faraco [88]; Sharma et al. [89]; Silva et al. [90]; Schoden et al. [91]; Kim and Park [92]; Meyer et al. [93]
Evaluation	Marques et al. [6]; Haas et al. [12]; Mihai et al. [13]; West et al. [20]; Barradale [39]; Sherwood [40]; Maciel et al. [41]; Liebe and Dobers [51]; Stokes and Warshaw [57]; Doblinger et al. [59]; Aranda-Uso et al. [61], Arnette and Zobel [62]; Arrese and Wells [63]; Baran [64]; Bertsch et al. [65]; Carfora et al. [67]; Di Fraia et al. [69]; Groh and Mollendorff [71]; Mavi and Mavi [73]; Nedelea et al. [74]; Polzin et al. [76]; Skrinjaric [78]; Sung and Song [79]; Suwa and Jupesta [80]; Tsai [81]; Wysokinska [83].

The Prior Analysis stage takes place before any decision is made, within the field of action, and seeks the collective interest, providing broad effects for society [96]. It is the first phase in the public policy cycle and was verified in 14 publications. In these studies, it considered that the potential expansion of renewable energy combined with the implementation of circular economic practices through public policies may promote the following benefits: (1) enable the analysis of the opportunities and risks to employment, skills, and education that are related to a CE in the United States, as well as provide a base for future research on public policies for the development of renewable energy projects; (2) support the development of renewable energy in Romania; (3) contribute to the literature on strategy/managers achieving a higher degree of circularity; (4) decrease the consumption of fossil fuels by facilitating the effective employment of a simple system for biogas production and a two-stage drying system; (5) involve students in public policy and its dimensions, create processes, and encourage environmental sustainability; (6) increase the production of secondary raw materials and the recovery of new waste streams that occur in material recycling; (7) aid the measurement and assessment of the degree of circularity of a company; (8) improve material efficiency; (9) reduce environmental impacts and resource scarcity, promote product circularity, and improve material efficiency; (10) mitigate possible regional excesses, and replace conventional high-impact products with bio-resources, thereby reinforcing sustainability within a CE; (11) predict the response of different locations towards the use of renewable sources and a CE; (12) greatly reduce CO_2 emissions and improve their capture and storage processes; (13) regarding technology and Innovation, promote the CE among industries, enhance the mitigation of additional greenhouse gases, and support process improvement in the evaluation and consideration of the design of sustainable circular products and systems; and (14) increase the availability of renewable energies given the growth in population demand.

Lausselet et al. [47] classified their study as a prior analysis due to the questions asked in the study objectives, from which the research results can unfold into policies to be implemented. Given these factors, the authors analyzed Norway's potential energy waste generated in a decade. Accordingly, the following question was asked: what threats and opportunities are anticipated? In an attempt to answer this question, the study combines an analysis based on four situations: (1) the current situation of the Norwegian sector; (2) the implications of the CE; (3) the addition of circularity to the current system; and (4) a landfill waste disposal scenario. Climate change is considered a major global challenge, and the decarbonization of the energy sector requires transformation and involves an increase in renewable actions and the incorporation of carbon capture and storage processes.

The mapping of the 'public problem' in the previous analysis established the structure of the problem from its origin, and the possibilities of different solutions were presented. If diverging from a technical, scientific study, the solutions may only consider momentary political ideologies and the interests at stake of the groups involved. Thus, decisions will be made based on the solutions presented that have greater technical certainty for future implementation, which characterizes the second stage of the public policy cycle [97].

The second stage, called prospection, presented 25 publications that analyzed the structure of the problem and provided the alternatives to be implemented. The main benefits, according to the authors, were cataloged and divided into two thematic groups: Efficiency Policies and Innovation Policies.

In the studies that addressed renewable energy Efficiency Policies and the CE, the following benefits that promote cost reduction, energy efficiency, and the expansion of renewables were recorded: (1) facilitating the analysis of the efficiency and effectiveness of a combination of policies, increasing the global efficiency of climate and energy policies, and increasing public awareness of renewable energy technology/the CE; (2) decreasing resource consumption, stimulating the adoption of CE, supporting sustainable development, and providing guidance at different stages of the industry cycle for the transition to the CE; (3) improving the analysis, planning, and implementation of policies for the CE in the European Union, as well as improving processes and products to achieve net zero CO2 emissions; (4) optimizing the CE system and industry growth; (5) enabling wind energy development policies in the United States; (6) supporting the commercial viability of renewable energy policies, the integration of waste management policies, and sustainable development; (7) promoting CE practices, resource recovery, and waste management, practices, and policies with a lasting impact on resource recovery; and (8) reducing the cost of electricity, supporting the investment in education, and creating awareness of the benefits of renewable energy.

The group composed of innovation policies for renewable energy and the CE in the prospection stage presented benefits towards the promotion of research and use of technology, such as: (1) alternative, economic, renewable, and green sources of energy such as hydrogen, employing commercially viable hydrogen production through viable sources in the rural area of the state; (2) cleaner energy generation through the use of manure to generate energy, which would enable the generation of 1277 TWh/year, constituting a path that the biomethane industry could materialize; (3) innovation in the production and use process, as well as the development of a PV module for easier recycling or reuse-focused integration of different systems; (4) promoting the minimization of waste, the re-planning of energy use, the redesigning of products and services, and the approval of interdependent CE activities; (5) providing high material exploitation, reducing the need to extract virgin resources, providing clean and renewable energy, and reducing the need for landfills; (6) reducing the harmful effects of fossil fuels on the climate and reducing resource intensity to mitigate climate change; (7) facilitating the use of biological treatment for energy production, biorefinery, and process improvement, and reducing dependence on fossil fuels; (8) reducing the exploitation of non-renewable energy resources and GHG emissions; and (9) supporting waste management and the sustainable use of agricultural plastic.

After these two stages are over, the manager/researcher will be able to evaluate the results of the public policy, observing its impacts and whether it was possible to achieve the expected results. If deemed unsatisfactory or negative, readjustment or replacement by other actions or public policies may be promoted.

For the evaluation phase, 26 publications were identified, incorporating the following discussions: (1) the manufacture of a design and framework for encouraging public opinion to strengthen the measures taken towards integrate public policies concerning renewable energies; (2) analysis of public acceptance of the energy infrastructure; (3) raising awareness of CE issues; (4) compensation for the negative consequences of the transition process, enacting confidence measures, and raising the public's level of awareness of their own participation in the emission of greenhouse gases; (5) the determination of what has been hampering the implementation of renewable energies in Japan; (6) the way in which to achieve considerable CO2 reductions, job growth, product exports, green growth, and important economic effects; (7) how to allow companies to increase their capacity for innovation, the formation of partnerships with research associations, and innovative product portfolios; (8) the export of raw materials and employment of the population in the CE; (9) the generation of greater public support and participation; (10) policy implementation implications based on studies, the development of policy instruments to allow diffusion in the short market, and the maintenance of investment in renewable energies in the long term; (11) acceptance mapping for the construction of new renewable energy plants; (12) policies for more positive attitudes and fewer protest intentions; (13) the improvement of the growth of social stock due to the generation of renewable energies; (14) the improvement of the security of the domestic energy supply and waste recovery. (15) reducing greenhouse gases and improving institutional investment conditions, advisable policy instruments, and economic and fiscal incentives; (16) the improvement of knowledge regarding financial resource management, the minimization of environmental degradation, the encouragement and use of renewable energies, the monitoring of energy and environmental efficiency for OECD cooperation, climate change as an object of international policy, and the development of NCR projects; (17) the use of alternatives to prioritize renewable energy sources (petrochemical industry and the production of renewable fertilizers; the use of abundant biomass to give priority to other renewable energy sources; and agriculture returning to an economy based on stakeholder cooperation between value chains; and (18) the programming of the global bio economy to achieve the main premise of the CE.

West et al. [20] presented an assessment of renewable energy expansion policy by identifying public dissatisfaction with the location of facilities and public reluctance to invest in renewable energy, making this factor one of the main obstacles to the expansion of the renewable energy sector in the UK and other European countries. However, the research was undertaken to explore ways in which government policies for renewable energy can be adapted to generate greater public support and participation. The issues discussed include the granting of economic incentives and societal awareness of climate change that links renewable energy to global energy behavior and the preservation of the environment.

3.2.3. Types of Public Policies

There are infinite possibilities with respect to public policy typologies, which makes it difficult to build a unified language. Therefore, the definition of concepts and classifications in the analysis of the benefits identified in the 65 articles was carried out. The common aspects were grouped and based on three of the categories of Lowi's [8] typology: regulatory (monitoring and control); distributive (aid or subsidies); and redistributive (related to the economy and well-being, as well as restructuring).

The distributive policies are premised on enabling subsidies and stimuli for the adoption of policies. Two (2) articles were identified; one of them from Stokes and Warshaw [57] that suggests the design and implementation of an economic framework of society to

encourage public opinion with respect to strengthening the measures that integrate public renewable energy policies in the United States.

The redistributive policies presented 23 (twenty-three) contributions aimed at the economy, well-being, and restructuring; for example, Arnette and Zobel [62] carried out an analysis in the southern and eastern Appalachians of the United States due to the strong dependence of coal for electricity in the region and its potential for increasing the use of wind and solar energy. The results were analyzed to determine the impact that these policies have on the cost of generating and emitting pollutants in the region, seeking an economic resizing and greater well-being in the region with decarbonization.

Figure 9 presents a telegraphic systematization, wherein the objective of the research is related to the types of public policies. Regulatory public policies were found in 40 studies. The relevant proportion reveals the moment of transition experienced in large economies, which achieve a CE and seek development mechanisms, such as the approach based on the monitoring and control of the energy sector, carried out by Doblinger et al. [59], in Germany, who presented the effects of public policies towards stimulating the demand for technology and the increase in innovation capacity through partnerships with research associations.

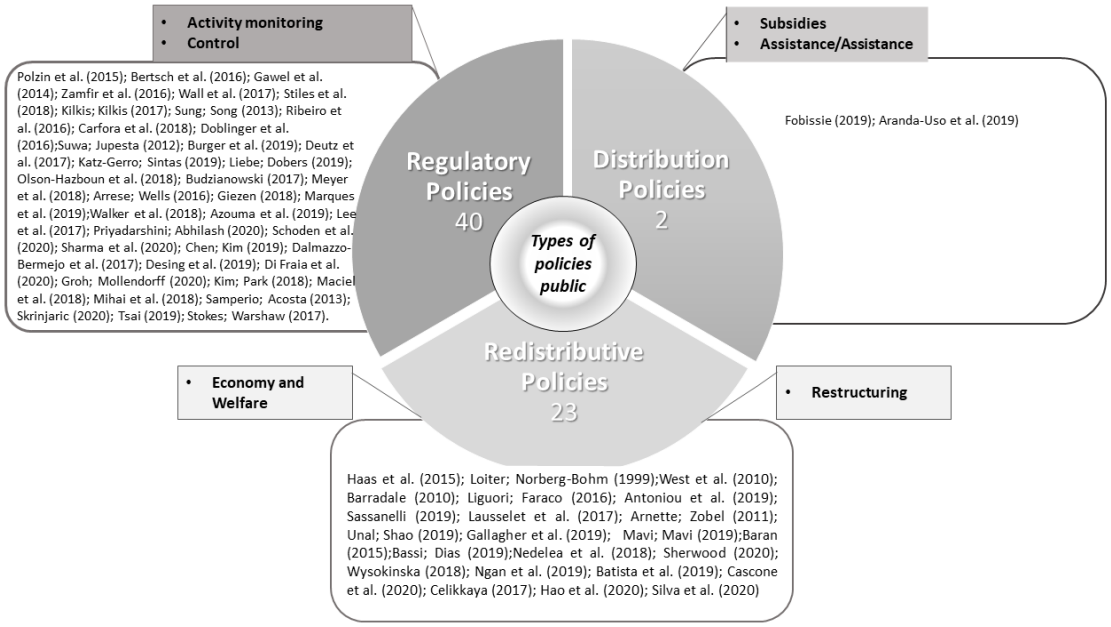

Figure 9. Telegraphic systematization of the research objective with the types of public policies ([6,7,9,12,13,15,16,18–20,38–47,49,51–63,65–93]).

3.2.4. CE and Renewable Energy

Products and services are adapting their purposes, seeking not to exhaust their material, with great interest in the renewal of a product's life cycle. The traditional model of production and services was based on the linear logic or "take-make-dispose", which is, in turn, based on the modification of products from the extraction of raw materials from an exhaustible source and that do not have a correct form of treatment for the waste generated. The pollution generated from population growth will require more products, more food, more water, and more energy, which, in turn, will require concrete measures in order to mitigate this scenario [98].

In developing and emerging countries, renewable energies are considered essential elements for economic evolution and growth, as well as for equality, social well-being, and economic insertion. Governments and companies around the world adopt the CE concept as an intelligent management tool, as it reveals challenges with respect to end-of-life and product quality [99]. Murray et al. [100] describes the CE as "an eco-economic model in which resources, procurement, production and reprocessing are designed to

consider environmental performance and human well-being". The CE arose from the need for an alternative model with which to achieve sustainability that seeks to maintain the flow of materials and products in their greatest utility and value through the re-design of products and the development of new business models [101]. In a holistic approach, the CE transforms waste into new resources, supports the use of renewable energy, and promotes the elimination or minimization of toxic components [102]. The Ellen MacArthur Foundation [103] stated that the CE became more visible in the 1990s, and was propagated in several schools of thought, such as Regenerative Design [104], Industrial Ecology [105], and Performance Economics [106].

Geissdoerfer et al. [107] define CE as "a regenerative system in which the input of resources and the emission of waste and energy leakage is minimized by decelerating, closing and narrowing energy circuits". The CE regulates practical strategies and plans at different levels [108,109] to achieve the more efficient use of energy, water, and material natural resources, on the one hand, while restricting the disposal of waste into the environment on the other hand [110]. The CE's value relates to the scarcity of resources and the taxes levied on them. Therefore, the CE can reflect social and environmental externalities. From the perspective of the CE, materials and resources can be recovered and reused in a seemingly endless process that guarantees the realization of economic value [99].

In the energy sector, initiatives range from the development of cleaner sources of energy from organic waste and new business models to energy management. Therefore, a classification procedure was performed considering the EC perspectives and relating the premises identified in the articles of the systematic review. Thus, the interfaces were identified among the conceptual characteristics described in the literature for each of the analyzed terms, based on reverse logistics practices, closed loop, double loop, upcycle, industrial symbiosis, life-cycle analysis, cradle to cradle, and the CE. Table 7 presents the correlations made between the perspectives of the CE and its premises, associating the studies with the authors identified from the benefits made possible in the articles that make up the review.

Table 7. Classification of CE perspective-associated assumptions found in SLR articles.

CE Perspectives	Associated Assumptions in the Articles	Authors
Lifecycle analysis (focus on operations management)	– Quantifies the environmental impacts associated with a product or process; – Compiles input of energy and relevant materials entered and environmental emissions; – Develops more sustainable products; – Evaluates strategic products against competitors; – Analyzes use of alternatives in order to reduce impacts within the value chain; – Knowledge of the production process; – Manages impacts on the production chain; – Meets environmental laws and policies (eg National Solid Waste Policy) – Improves the image of the sector in the eyes of society (green marketing); – Prepares sustainability reports (eg Global Initiative Reporting–GRI); – Creates environmental labels (eg Environmental Product Declarations–DAP).	Barradale [39]; Liebe and Dobers [51]; Aranda-Uso et al. [61]; Arnette and Zobel [62]; Carfora et al. [67]; Groh and Mollendorff [71]; Mavi and Mavi [73]; Walker et al. [82]; Ribeiro et al. [86]

Table 7. *Cont.*

CE Perspectives	Associated Assumptions in the Articles	Authors
Closed loop (focus in the operations management)	– Appreciates the circularity of resources; – Recycle materials.	Marques et al. [6]; Gallagher et al. [7]; Mihai et al. [13]; Ngan et al. [15]; Maciel et al. [41]; Budzianowski [46]; Polzin et al. [76]; Deutz et al. [85]; Meyer et al. [93].
Cradle to cradle (focus on operations management)	– Resources are managed in a circular logic of creation and reuse, in which each passage of the cycle becomes a new cradle for a given material; – Introduces cyclical systems, allowing resources to be reused indefinitely and to circulate in safe and healthy flows for humans and nature.	Antoniou et al. [60]; Silva et al. [90]
Double loop (emphasis on system management)	– Uses new conceptual models and patterns; – Analyzes waste and seeks to create new alternatives in order to reintroduce it into the production chain.	Stiles et al. [43]; Wall et al. [45]; Desing et al. [54]; Kılkış and Kılkış [56]; Stokes and Warshaw [57]; Bassi and Dias [58]; Baran [64]; Burger et al. [66]; Fobissie [70]; Sung and Song [79]; Suwa and Jupesta [80]; Zamfir et al. [84]; Kim; Park [92]
CE (focus on system management)	– Emphasizes the biological cycle and technical cycle in – materials; – Provides pressure for product maintenance; – Reuses/redistributes used product; – Updates/remanufactures the product; – Recycles product.	Priyadarshini and Abhilash [9]; Haas et al. [12]; Sassanelli [42]; Gawel et al. [52]; Katz-Gerro and Sintas [55]; Chen and Kim [68]; Lee et al. [72]; Nedelea et al. [74]; Olson-Hazboun et al. [75]; Wysokinska [83]; Liguori and Faraco [88]; Sharma et al. [89]
Reverse logistics (focus on operations management)	– Provide pressure for the collection and return of waste to the industry so that it can be reintroduced into the production chain or reused; – Assigns shared responsibility between manufacturers, importers, distributors, traders, consumers, and the holders of public services and urban cleaning for reverse destinations of packaging and products; – Focus on reuse; – Products are recycled and remanufactured by manufacturers.	Sherwood [40]; Dalmazzo-Bermejo et al. [44]; Lausselet et al. [47]; Cascone et al. [53]; Bertsch et al. [65]; Di Fraia et al. [69]; Samperio and Acosta [77]; Tsai [81]; West et al. [20]
Industrial symbiosis	– Focuses on mutualism, cooperation, and – sharing.	Batista et al. [16]; Giezen [18]; Loiter and Norberg-Bohm [38]; Doblinger et al. [59]; Hao et al. [49]; Azouma et al. [87]
Upcycle (emphasis on system management)	– Uses creativity and innovation; – Uses new conceptual models and patterns; – Emphasizes contemporary sustainability.	Arrese and Wells [63]

Complementary perspectives are understood to be those that have interfaces with each other, are often applied concomitantly in industrial activities, and produce effective results for the sustainability of the planet. The complexity of the practices necessary for the effectiveness of a CE is applied throughout the production chain, in such a way as to enable investments and the formulation of innovation policies that make sustainable development possible. The existing overlap between such perspectives contributes to creating a systemic conjuncture of a production chain, in which gains can be shared between all links, generating results for companies and society either autonomously or through incentives.

In addition to clarifying the conceptual aspects related to the technical terms of the CE, which are used in the high-level academic and business environments, it is necessary to disseminate ideas of reuse that should mainly reach areas of society that are burdened with the effects of the greater generation and accumulation of waste. Thus, the framework

built illustrates the existing interfaces and suggests topics for future studies that could be developed to research, identify, and analyze the various methodologies and tools that can be used to operationalize the described perspectives, as well as trigger organizations to commit to the sustainability guidelines promulgated by the UN (redistributive and distributive public policies) and help those countries that adopt sustainable guidelines in a reactive way under the aegis of punishment (regulatory public policies).

This systematic review correlating CE perspectives and their respective assumptions can allow managers and consultants to disseminate the contributions from the literature to companies in order to implement decision making related to adopting the best techniques and practices in the production chain so as to promote sustainability [111]. The framework applied herein enabled the mapping of the authors and their respective countries for each of the discussed practices, thereby enabling future studies concerning the impacts on operational efficiency within the organizations that adopt said practices. Public managers can use the different typologies presented herein to propose public policies towards renewable energies that contribute to the progress of sustainability in organizations and to the expansion of the circularity of resources in the transition processes of the electricity matrix. Energy production is a critical issue in the CE. Thus, the recovery stage of the 4Rs approach—reduction, reuse, recycling, and recovery—is related to energy recovery through waste recycling.

4. Conclusions

From the analyses carried out and provided herein, it was verified that the studies concerning policies for renewable energy began in 1999; however, from 2010 onwards, there was a greater impact on the publication of the theme, involving renewable energy and the growth of the wind market from energy policies in the United States. The main sources of this study were biomass, wind, hydrogen, solar, and lato sensu renewables.

The countries with the greatest contributions were Germany, the United Kingdom, Italy, Brazil, and Chile, and these studies were related to developed countries and/or high energy demand and resource availability. The analysis of public policies on renewable energies and the integration of the CE started in 2015. The space assessments were directly linked to the environmental, economic, and availability-related analyses of renewable resources. The environmental analyses associated with space showed efficiency in terms of the use of renewable energy to reduce GHG emissions, in addition to being a viable alternative for complying with energy policies for the most developed countries. It was noted that the technological process represents the greatest exponent of pollutant emissions, with increasing effort in studies and in prospecting policies towards the implementation of circularity in the environment of industries and society.

A gap was observed concerning the performance of studies in countries that did not present research or presented little research on PPER in the CE and are advised to increase awareness of CE issues related to energy policies, minimizing dependence on raw materials, and greater public and private participation in raising awareness and achieving the objectives proposed in the studies.

The studies demonstrate the effective participation of private entities, such as investors and industries, seeking to regulate resources, reduce costs, expand sustainability, and promote development and disruptive design in the global economic model. This study presented some limitations that were mainly associated with the set of keywords, which might have led to the omission of some research relevant to the study area. Future studies may incorporate an analysis of references from the literature identified from the research data, thus significantly expanding the object of study and enabling the extraction of new information.

Based on cyclical natural resources, the energy matrix of countries, whether developed or not, has the potential to meet global concepts of sustainability. Despite the potential of the natural resources found in several countries and the discourse aligned with best

practices and good prospects for a predominantly green matrix, the barriers encountered for development are based on the lack of incentives for economic circularity.

However, the diffusion of circularity in the industrial sector propagates slowly, especially in developing countries. The applicability of the evidence extracted in this SLR can generate knowledge relevant to decision making regarding public and organizational managers and, consequently, to the economy and society. It is crucial to certify that the development of these nations is sustainable based on the formulation of public policies that propagate incentives and sustainable awareness, thereby mitigating the effects of a linear economy, which, despite being technological and practical, will have its costs overweighed by the degradation of the environment for future generations.

The limitations of the present study include its methodological choices, such as the use of only one database for the extraction of the articles, and the definition of the search strings, which could have led to the exclusion of studies relevant to the study. These limitations were minimized by choosing the largest database of academic studies in the world (WOS) and by making numerous adjustments to the search strings until finding the most relevant studies on the topic studied. Another limitation is related to the inclusion and exclusion criteria of each article used to form the final sample, which we sought to mitigate with the participation of four different researchers. Finally, as a suggestion for future studies, it is recommended to clarify search terms by referring to renewable sources individually, including solar, wind, geothermal, and, most importantly, biogas and biomass.

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