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ENERGY TRANSITION, CLIMATE CHANGE, AND CAPACITY BUILDING IN THE AMERICAS: A SYSTEMATIC REVIEW FOR CAPACITY BUILDING

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Abstract

Developing countries, especially Latin America and Venezuela, face the challenge of implementing a low-emission development model (United Nations Framework Convention on Climate Change, and subsequently signed multilateral agreements: the Kyoto Protocol and the Paris Agreement). In this context, this systematic review was proposed with the aim of describing the studies that develop training in Energy Transition and Climate Change (ET&CC) in countries in the Americas and the Caribbean, in order to draw conclusions that provide

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input to professionals in this field, as an effort in climate action and sustainable development. The research followed the approach and protocol of Campbell and Cochrane Collaboration for systematic reviews, which are descriptive in nature, assuming rapid review approaches. Qualitative studies and quantitative evidence on training were systematically collected and synthesized from academic and scientific journals, and relevant official institutions were reviewed to determine official positions in the Americas and the Caribbean between 2015 and 2022. Finally, the topic was researched in Germany to establish a comparative benchmark. The research highlighted the different levels of progress made by countries with regard to training in TEyCC, highlighting achievements in Mexico, Colombia, and Argentina, but demonstrating the incipient progress in all others; how climate action, based on environmental education, characterizes training on the subject in the selected countries and the emphasis of the academic offerings researched on climate change, public policy and regulation, technologies, energy transition, and unconventional energies.

Keywords: Energy Transition. Climate Change. Training. Systematic Review.

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Introduction

What do Climate Change and Energy Transition mean for Venezuela and Latin America?

Climate Change (CC) is a global issue with great significance for the region and for Venezuela in particular. Specifically, and for the purposes of this research, CC creates an urgent need to adapt to the negative effects of global warming and forces us to devise and implement new low-emission development models. In this sense, the energy transition is, first and foremost, a response to the recognition of the negative effects on the region's energy models, which forces us to adapt to various gradual changes taking place around the world, from public policy to natural conditions in order to generate sufficient energy for development. Secondly, it is a response to the need to generate changes that help diversify the energy matrix, incorporating new ways of generating energy with new technologies that comply with the commitments agreed upon and set forth in the Paris Agreement and, of course, the UNFCCC.

While it is true that climate change is beginning to be a "high-tension" issue around the world, instead of reducing emissions, more are being emitted: In fact, in statements made by the Secretary-General of the World Meteorological Organization, Prof. Petteri Taalas, he warned that GHG concentrations are the highest they have been in the last 800,000 years (World Meteorological Organization, 2023) . Therefore, we believe that an agreement between the countries of Latin America and the Caribbean is necessary. It is a global and regional challenge to consider development within the framework of the Kyoto Protocol and the Paris Agreement . To this end, it is urgent to develop a theoretical construct that allows for a consensus-building debate on technologies, public policies, and best practices.

In this context, we propose this review, at the request of the consulting firm Venergy Global, which set out to describe the studies that address the issue of training in energy transition and climate change in countries in the Americas and the Caribbean, in order to draw conclusions that contribute to the professional field, such as efforts in climate action and sustainable development. Consequently, the following research questions were proposed: What is the status of training in energy transition and climate change in the selected countries? What characterizes training in energy transition and climate change in the selected countries? How is training on energy transition and climate change included in the NDCs of the selected

countries? And what stands out in the publication of the topic in the selected countries when compared to the German case, as a European reference?

The research revealed the different levels of progress made by countries with regard to training in ET&CC, highlighting achievements in Mexico, Colombia, and Argentina, but demonstrating incipient progress in all others, such as climate action, supported by environmental education, which characterizes training on the subject in the selected countries and the emphasis of the academic offerings researched on climate change, public policy and regulation, technologies, energy transition, and unconventional energies.

Methodological Approach

The research followed the approach and protocol of Campbell and Cochrane Collaboration for systematic reviews, of a descriptive nature, assuming approaches typical of a rapid review (Gannan, Ciliska, & Thomas, 2010) by not excluding studies based on quality or risk of bias.

Qualitative studies and quantitative evidence on training were systematically collected and synthesized from academic and scientific journals to answer the questions. Subsequently, relevant official institutions were reviewed to determine official positions in the Americas and the Caribbean. Finally, the topic was researched in Germany to establish a comparative benchmark.

The case studies were located in countries in the Americas and the Caribbean. The period studied in this review covers the years 2015 to 2022, in order to take the Paris Agreement as a starting point.

Criteria for inclusion and exclusion of studies

Studies were accepted or excluded according to the following criteria:

- Inclusion: Case studies in the Americas and the Caribbean; with explicit results; published in peer-reviewed journals; research conducted with data from the selected years (inclusive).

- Exclusion: Studies in countries not covered; studies that do not provide clear indications regarding training, energy transition, and climate change; studies that do not present the full text; studies were reviewed for the appropriateness of the analysis and presentation of data; and the ethical implications of the intervention they evaluate (Jadad cited in Petticrew & Roberts, 2006) .

Search Strategy

The search strategy for identifying relevant studies began with the identification of the databases to be used: Redalyc, Dialnet, LA Referencia, World Wide Science, and Google Scholar. From there, a scoping search was conducted to identify relevant sources and develop strategies, followed by a first round of separate reviews for each database, using database-specific subject headings and keywords, discarding duplicate studies. This resulted in the first matrix of general and specialized databases (analysis matrix in Excel). Subsequently, a second round was carried out: selection search by title and abstract, abstract review of studies based on inclusion/exclusion criteria, analysis supported by the Atlas Ti 7 program, refinement of the analysis matrix, and final selection, which consisted of a complete review of the studies included based on the inclusion/exclusion criteria, and discretionary evaluation of publications, drawing on the researchers' experience with the topic and selecting those that could provide the greatest initial contributions to offer an overview of the topic in the countries under study. Cross-reference analysis was not considered.

The studies were classified according to their research design: qualitative, quantitative, or qualitative-quantitative, and the countries according to their World Bank income level (World Bank, 2023) .

Discussion

The search protocol yielded the following results:

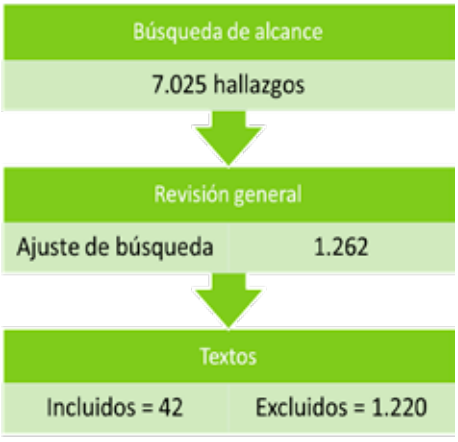

Figure 1 Findings from the search protocol

Figure 2 shows the countries identified in the studies:

Figure1 Countries identified in the studies

Highlighting Venezuela's low participation in publications on the subject, the countries studied in the publications were categorized according to the World Bank's gross national income classification: upper-middle income: Brazil, Cuba, Argentina, Colombia, Mexico; high income: Chile; and unclassified: Venezuela. Thus, the publications mainly correspond to upper-middle income countries.

On the other hand, Figure 3 shows the distribution of publications by year, noting the clear association with the dates of the Conferences of the Parties to the United Nations Framework Convention on Climate Change.

Figure 3 Publications by year

Results of the second round and results matrix.

For the second round, a matrix of findings was developed that systematized the title, first author, year of publication, name of the journal, number of pages, whether it was carried out at a research center, its source of funding, the country where the study was conducted, as well as those analyzed and the most salient methodological characteristics. The selection was refined and, based on this, a matrix was developed reflecting the main results of the studies reviewed, as shown in the following table (5), in which, for reasons of space, the rejected articles have been omitted.

Title	First author	Main results	N°
1) Scielo			**1**
10 questions about zero-energy buildings: review of the state of the art	Dámanzo	The study concludes that ZEBs are holistically integrated into the transformation towards a renewable and sustainable future in terms of energy solutions and, in turn, have the potential to be implemented in different geographical and climatic locations.	1.1
The promotion of renewable energies in the fight against climate change through environmental certificates in the Mexican electricity sector	Ibarra	In Mexico, the energy reform regulates CELs to promote not only renewables but also less polluting energies, based on the criterion that they generate fewer emissions or waste, somewhat neglecting the great potential we have in renewable energies and their significant contribution to the efficient reduction of GHG emissions. Therefore, it would be beneficial to adjust the regulatory framework by reviewing concepts and criteria in order to implement a sustainable energy transition in line with international climate provisions, which necessarily involves reducing dependence on fossil fuels.	1.2
Energy and climate change: socio-environmental impacts of hydroelectric power plants and diversification of the Brazilian energy matrix	Galbiatti Silveira	The article's findings consider the Brazilian energy matrix to be unsustainable and that decision-makers and society need to make an energy transition to alternative renewable sources and also implement public policies to reduce consumption. There should be no choice for a single source, but rather environmental studies to determine the impacts of renewables and an assessment of their benefits and harms.	1.3
Evaluation of indicators for vehicle penetration routes in the Brazilian transport sector	Baptista	It was found that a purely battery-powered electric fleet would require the least amount of energy in 2050. There is also the problem of job losses in the sugar and alcohol sector, which can be reduced in this scenario of a battery-powered electric vehicle fleet. The opportunities for maintaining ethanol production as an energy vector in the transport sector are evident.	1.4
Generation in transition. Bioenergy from livestock waste in Argentina	Chomicki	Preliminary results show that producing bioenergy from livestock waste: i) transforms waste/pollution/problems into bioenergy, ii) diversifies income, iii) generates biofertilizers, and iv) creates multifunctional rural spaces.	1.5

The King is naked	Meza	This work is the perfect invitation for readers to observe the fierce and often covert ideological and economic struggles that arise when attempting to respond to the climatic, energy, and economic challenges facing humanity.	1.6
Transition from firewood to liquefied petroleum gas (LPG) in southern Mexico: an opportunity for climate change mitigation in the least developed region of the country.	Lagunes-Díaz	An approach is presented to estimate the CO2 emissions savings achievable by transitioning to liquefied petroleum gas (LPG), which could reach 3.14 Mt CO2e, 26% less than the baseline scenario. It concludes with a discussion of the transition to modern fuels, the barriers that prevent it, and the successes and failures of the distribution of wood-saving stoves, the main government initiative to alleviate wood consumption in the country.	1.7
2) REDALYC			**2**
Experts by experience in climate change education: emotions, actions, and strategies from the perspective of participants in three Chilean school programs	Prosser Bravo	Finally, we conclude that it is important to introduce the notion of experts by experience in the management of these educational interventions, in order to actively include the opinions and perspectives of participants in climate change education.	2.1
Photovoltaic development in San Juan: an approach to the framework of public strategies for energy transition	Kazimierski, Martín	It is necessary to rethink the role of public enterprises and the ownership of energy sources, transform primary production networks to move up the green value chain, and establish mechanisms for expanding distributed generation based on plans that consider the case of Caucete within a broader public-social transition project-social project that advocates an alternative to the monopolistic conditions in centers with higher population density and energy consumption	2.2
Energy reform in the face of falling oil prices: an opportunity for renewable energy in Mexico?	Muñoz	It concludes that it is necessary to continue diversifying the national energy matrix through the use of renewable energies.	2.3
Climate change governance in Mexico: expectations for reforms in the sub-national context	Ricardo V	In the context of decentralization, there is recognition of the need for states and municipalities to take on a relevant role in the national strategy against CC; the federal government must address this challenge.	2.4
Experiences of the free climate change lecture series in promoting adaptation capacities within the framework of the United Nations Convention on Climate Change	Ferrara de Giner	The CLCC has not yet been able to evaluate the effects of its activities, but this is a global problem, as pointed out by the Doha Work Program. This limitation has not prevented the Chair from continuing to develop activities that are within its scope and possibilities.	2.5

Study on the social perception of the concept of climate change and its dissemination in the media in the Santander region of Colombia.	Moreno Cano	It is necessary to encourage proactivity and not wait for others to decide to act, ensuring that these issues are present in the media, with the rigor and frequency necessary to bring about the appropriate cultural changes.	2.6
Public policies for regional development in relation to climate change towards 2020 in contexts of marginalization and international migration.	Gundlach	It was concluded that the parts of the territory studied with the highest levels of international migration and average levels of marginalization will be those most severely impacted by climate change.	2.7
Dialogue between academia and politics for sustainable and equitable development	Díaz Pérez	It is necessary to continue promoting a culture of dialogue, participation, and collaboration that contributes to consolidating the articulation between academia, politics, and citizenship.	2.8
Environmental education as a strategy for tackling climate change	Cavilanes Capelo	Guidelines were established to contribute to a change in the strategies, approaches, and methodologies currently used in environmental education, with the aim of ensuring that it is addressed in a cross-cutting and holistic manner within the curriculum of the educational centers included in the study.	2.9
Education for sustainable development: towards a socio-pedagogical vision	Núñez	The dialectical and holistic approach based on the requirements of ESD and its expression in the educational model and curriculum requires an organized, institutional, and inter-institutional effort, with a cascading effect, down to the grassroots level, to the most remote schools, both for the training of educators, with the same characteristics and competencies required for the educational work that has been characterized, and to establish a system for evaluating the quality of teaching and teachers, and institutions, which guarantees (as does the evaluation of student learning) that these characteristics are learned in the rigorous exercise of their functions.	2.11
From environmental education to sustainable development: challenges and tensions in times of climate change	Canazza-Choque	It is advisable to provide epistemological support from schools, not only in terms of raising awareness of EA and SD, but also in terms of directing academic efforts towards harsher realities and truths, such as the aspirations of EJ. However, implementation in the curriculum does not fully guarantee that the circumstances of the moment will change. It is therefore time to leave the classrooms and desks behind and go further, taking books and texts into reality, confronting the outside world and its complexities, and, from spaces of local and geoglobal recognition, embarking on paths that defend and provide tools and devices that ensure the survival on the planet of marginalized, vulnerable, and disadvantaged groups affected by the consequences of climate change.	2.12

Energy Dynamics of Tourist Accommodations in the Province of Buenos Aires (Argentina)	Flensborg	The results show the existence of political, economic, sociocultural, technical, and environmental factors that act as drivers and barriers to the implementation of measures related to efficient energy use, consumption, and production.	2.13
Green energy and public control: environmental and ethical concerns of companies	Antúnez-Sánchez	In the Cuban legal system, with the enactment of Decree Law No. 345 of 2017, the promotion of green energy use by individuals and the state sector as a provider of this public service is a way of responding to the adverse effects of the economic blockade that prevents the purchase of oil for electricity generation. It establishes that the Ministry of Energy and Mines is responsible for overseeing the electricity service and recognizes individuals in energy generation, liberalizing this activity. The challenge is how to contextualize its acquisition in the foreign and domestic markets within the strategies of national public policy for mitigating the energy crisis in the environment-development relationship.	2.14
Education for climate change mitigation and adaptation in Latin America	Cruz Castaño	The results indicate that in Latin America, education on climate change has been addressed mainly through studies of perception and social representations and, in some cases, through educational proposals targeting young people. There is evidence of misconceptions about climate change and confusion between this phenomenon and other environmental issues.	2.15
Index of the use of renewable energy sources associated with appropriate technologies on family farms in Cuba	Casimiro-Rodríguez	The analysis of the Index of Use of Renewable Energy Sources on the Medio Farm showed that, through the use of appropriate technologies, 83.7% of energy demand is met by renewable energy sources.	2.16
Analysis of opportunities and challenges for solar power in Baja California Sur, economic impacts	Escalante Terán	Considering the growth in electricity demand estimated by the Federal Electricity Commission for the coming years, as well as the high costs of electricity generation in the state, it is highly relevant to consider a rethinking of the energy matrix, preferably towards cleaner renewable alternatives to fossil fuels.	2.17
Environmental education and communication on climate change. A perspective from discourse analysis	Rosales Romero	The findings reveal how a purely informative connotation prevails in the education and communication actions carried out by the program, which leads to weak social participation, inhibiting citizen empowerment and limiting dialogue, discussion, and decision-making. In its conclusion, it offers some lines of analysis and discussion that seek to broaden the debate on the issue and reframe the discourse, as well as specific criteria and proposals for the design of environmental education and communication activities aimed at prevention, mitigation, and adaptation to climate change in our context.	2.18

The link between climate change and renewable energy in Mercosur. A comparative analysis of the legislation of Argentina and Brazil	Freier	The results suggest the possibility of achieving a gradual regulatory and political rapprochement for future sustainable energy cooperation. In this regard, the main elements that point to the gradual emergence of common sustainable energy standards include the creation of public funding for the development of the renewable energy sector, the implementation of bidding processes to maximize the efficiency of green energy production, the stimulation of domestic industry by giving priority access to financing to companies with a greater domestic component, and the implementation of capacity-building programs in renewable energy production.	2.19
New Argentine energy? Lithium policy, science, and industry	Fornillo	He concludes that it will be very difficult for Argentina to have a lithium battery without a very detailed strategy involving all of the current and potential stakeholders in order to develop a gradual progression in the value chain that will allow it to overcome the many challenges that will arise, with a view to the future in South American terms.	2.21
New Strategies for an Efficient Electricity Use Plan	Hernández	A set of strategies is proposed for a new plan for the rational and efficient use of electrical energy, applicable to any country and based on the coexistence of new forms of energy generation (alternative generation, cogeneration, distributed generation) with traditional forms of generation, as well as the incorporation of cutting-edge techniques and methodologies, such as Smart Grid, DR (Dynamic Response), etc. Likewise, the proposed plan defines a comprehensive holistic solution to address the rational use of electrical energy by promoting a change in the behavior of service users. The plan establishes specific objectives, strategies, and lines of action in fourteen areas of opportunity.	2.22
The green university: perceptions of the university community in the process of transformation towards sustainability	Lopera	The results showed the community's perception of the institution's transformation process and the degree of interest in participating in these processes. The study concluded that efforts to promote sustainability and care for the environment have an impact on the community and could contribute to the construction of sustainable cities.	2.23
Analysis of urban and educational infrastructure in marginalized areas marginalized areas of the tourist beach city, with the implementation of photovoltaic energy; case study Puerto Vallarta, Mexico	Reyez-González	The beach resort city in Mexico requires a comprehensive analysis of its urban infrastructure in order to generate comprehensive proposals that not only verify energy supply but also propose scenarios for energy self-sufficiency. The implementation of photovoltaic technology in a public institution, specifically in educational facilities, faces not only the technical challenge of installation but also the general process of technology management and familiarization of decision-makers.	2.24

3) Dialnet			**3**
Social and environmental potential of the wind industry for an energy transition in Latin America	Zepeda Cancino	Four advantages of wind energy were identified (low carbon footprint, reduced production costs, job creation, and income from land rental) and five disadvantages (loss of forest cover, impact on birds and water sources, pollution from oil spills and waste, and health effects).	3.1
Climate change and sustainable energy development in Latin America and the Caribbean under the Paris Agreement and the 2030 Agenda	Rivera Albarracin	The energy transition is seen as an opportunity to improve production, service, and transportation systems, making them more efficient and sustainable. It is necessary to anticipate and plan for the transition with a cross-sectoral vision, including policies to support social welfare, the development of renewable energy and energy efficiency, R&D&I, as well as adaptation for companies undergoing transformation and their workers.	3.2
Principles for sustainable urban transport in Ibero-America towards the energy transition	Ramírez-Pisco	Three (3) groups of principles are prioritized that will enable the development of sustainable urban transport towards the desired energy transition.	3.3
Economics of Energy Poverty Why and how to ensure universal and equitable access to energy?	Billi	Consider the growing emphasis in the specialized literature on moving from limited definitions of energy poverty—associated with a lack of economic or technological opportunities for access to energy—to more comprehensive and multidimensional understandings of the phenomenon. The latter understand energy poverty in terms of the effective capacity of every person and household to access adequate energy services to meet their needs, which implies placing emphasis on equalizing the benefits that energy actually provides to its users, rather than merely equalizing the opportunity to access the energy services offered by the market.	3.4
4) World Wide Science			**4**
Environmental and Circular Economy Implications of Solar Energy in a Decarbonized U.S. Grid	Heath	Recommends research and development (R&D) activities that could help clarify challenges and identify solutions. Because photovoltaic deployment is expected to be much greater than CSP deployment, we provide a more detailed analysis of issues related to photovoltaic energy.	4.1

5) The Reference			**5**
Education and Energy Transition: Recommendations for Sustainable Development and Climate Change Mitigation	Lagunes	The paper urges decision-makers to consider the transition to modern fuels and education more ambitiously in their agendas and to design a roadmap for the transition, given that many characteristics of development can be mitigated by overcoming energy poverty and that education is a tool that helps achieve rational energy consumption.	5.1
6) Google Scholar			**6**
Energy Transition in Colombia: Not Necessarily a Reality Based on Climate Change	Di Terlizzi	While it is true that FNCERs have been promoted within the political agenda, an analysis of the incentives created so far through Law 1715 of 2014 shows that they have high transaction costs and there is still some way to go to ensure their effectiveness. The importance of Colombia focusing on developing FNCERs such as solar, wind, or green hydrogen does not lie primarily in environmental commitments such as high CO2 emissions, but rather in diversifying its energy matrix, achieving NZE, and finding other sources of international competitiveness besides oil. One of the proposals to further diversify Colombia's energy matrix is the exploration of new sources or technologies that have been developed around the world and are now beginning to be introduced into the Colombian political agenda: green hydrogen.: green hydrogen. This is undoubtedly a viable option with good results internationally and, as has happened with FNCERs, investment costs will tend to decrease over time, giving them a greater share in the energy matrix.	6.1
Public Policies on Energy Transition and Climate Change	Gundlach	This chapter focuses on public policies designed to mitigate and adapt to climate change, and on those that promote the transition from fossil fuels to other, more efficient alternative energy sources with low emission levels. It describes the categories into which the different legal and regulatory approaches that countries have adopted in response to climate change and energy transition can be grouped, illustrating them with carefully chosen examples from various jurisdictions. This chapter also examines the regulations and public policies that address the issue of climate change and energy transition, the role of the main international agreements on the subject, and other factors important for the efficiency and transferability of public policies. The discussion covers the scope and structure of laws governing climate change and energy transition, public policies at the national, subnational, and local levels, the role of the executive and legislative branches, litigation surrounding public policies on climate change, and substantive provisions relevant to energy efficiency and electrification, renewable energies, and nuclear energy.	6.2

The challenges of climate change and energy transition in Uruguay	Vázquez	Since 1972, the so-called "Earth Summits" have been held, an expression used to refer to the United Nations conferences on the environment and development. These are international meetings between heads of state, which seek to reach agreements on the environment, development, climate change, biodiversity, and other related issues. The first of these summits took place in Stockholm (Sweden) between June 5 and 16, 1972. Twenty years later, the second summit was held in Rio de Janeiro (Brazil) between June 2 and 13, 1992. Subsequently, summits were held in Johannesburg, South Africa, between August 23 and September 5, 2002, and in Rio de Janeiro, Brazil, in June 2012 (under the name Rio+20 Conference on Sustainable Development).	6.3
Global perspectives for Mexico's energy transition in Mexico	Gibran	The authors address different aspects of Mexico's energy transition from an interdisciplinary perspective. The publication begins by discussing the co-benefits and challenges for a sustainable energy transition in the context of the Sustainable Development Goals. Throughout the chapters, the authors discuss: 1) The challenges of energy development in Latin America 2) Human rights and corporate responsibility in the energy sector 3) Challenges for sustainable economic growth in Mexico and the paradox of abundance 4) Energy and carbon in Mexican household consumption 5) Expanding the concept of energy poverty from a fundamental human needs perspective 6) Regulatory evolution of the energy sector in Mexico, and 7) Prior consultation in Mexico and global governance of development.	6.4

Table 5 Results matrix

Source: own elaboration

Using the ATLAS Ti 7 program, the selected texts were coded, with a high frequency of the codes *Adaptation* and *Mitigation*, immediately after *Climate Change* and *Energy Transition* (those sought thematically), telling us of a narrative focused mainly on climate action, mostly towards adaptation. Other codes such as *SDGs, Decarbonization*, and *Unconventional Renewable Energies* reflect the alignment of the discourse with the 2030 Agenda and Sustainable Development. The appearance of the code *Environmental Education* expresses the fundamental pedagogical model used in the processes of awareness-raising and training on the subject. Finally, the code *Green Hydrogen* appears with interesting frequency, showing a relevant appearance in the published discourse.

On the other hand, in the co-occurrence of codes, *Adaptation, Mitigation, and Energy Efficiency* stood out as the strongest, while the weakest were *Anthropocene, Biofuels, Zero Carbon, Electrical Energy, Green Hydrogen, Climate Justice, Energy Resources, and Zero Energy Building*.

This co-occurrence confirms that the strongest narrative (trend), i.e., the theme, is mainly addressed from the perspective of climate action, primarily adaptation.

Search for academic offerings

The search for academic offerings in the field of TEyCC revealed the main trend in America. Twenty-six proposals were selected, and the research was halted due to information saturation. In practice, this search was carried out in parallel with the scope search, which was used to select the most relevant terms for the research, which became the codes for analysis.

For 57 selected citations, 133 occurrences were found. Excluding *climate change* and *energy transition*, the highest number of occurrences were concentrated in *public policy and regulation*, *technologies*, *energy efficiency*, and *unconventional renewable energies*, followed by *adaptation and mitigation* and *energy resources*, as shown in Figure 4.

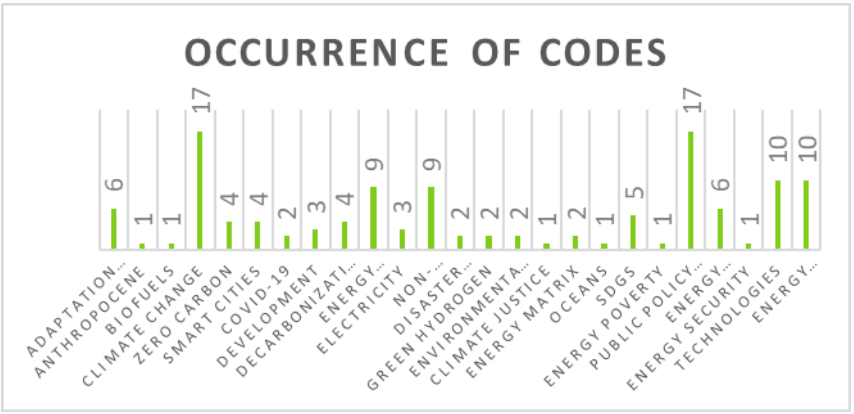

Figure 4 Academic offering search - data occurrences

German Case Review

In this section, a review was carried out based on two different sources: initially, the academic offerings between 2015 and 2022. However, the search revealed that the description of the instructional designs and content available online focused on current courses, which made it impossible to construct a historical record, as access to past offerings was not available. Therefore, the search was supplemented with information from official sources that disclose training activities within a German institutional framework. The highlights are presented below.

Training, Climate Change, and Energy Transition in Germany

A review of the main official source reveals the German government's interest in addressing the energy transition, largely based on its concern about climate change. The Deutsche Energie-Agentur (DENA) is the German energy agency and functions as the body that centralizes "technical knowledge in the fields of energy efficiency, renewable energies, and smart energy systems." (Deutsche Energie-Agentur GmbH (Deutsche Energie-Agentur GmbH (DENA), 2018) The organization itself states that it functions as an "applied energy transition agency." Therefore, actions by the public and private sectors aimed at training in climate change and energy transition issues are subject to consideration by this body.

Thus, DENA runs the Renewable Energy Solutions (RES) program, which is sponsored by the Federal Ministry for Economic Affairs and Climate Protection. The program provides support to the private sector in the field of renewable energies seeking to penetrate new markets: "...

it involves the implementation of reference and demonstration projects in collaboration with renowned institutions. The implementation is carried out in conjunction with PR, marketing, and training programs." (Deutsche Energie-Agentur GmbH (DENA), 2018). In many cases, the training programs involve an engineering technology component, but in others, they focus on energy business management and its relationship to climate change, either in terms of adaptation or mitigation. The other approach on which DENA places great emphasis is technology transfer with the "Made in Germany" seal through international cooperation.

Judging by the evidence reviewed, it can be said that in the case of German training for addressing climate change and the energy transition, there are large areas of work: implementation of clean technologies and energy business management, in both cases going through a phase of conceptualization and awareness-raising on climate change, its causes and consequences in relation to energy consumption and the economy. The existing concept in this regard is that proposed by the German Federal Environmental Foundation (DBU), which recognizes that the energy transition requires in-depth knowledge and awareness of energy sources, energy efficiency, and renewable technologies, including an understanding of the challenges and opportunities associated with the transformation of the energy system (IRENA, 2022) . On the other hand, the dissemination of knowledge about energy transition is proposed in strategies such as: degree-leading training programs and non-degree training programs for professionals, specialized audiences, public officials, and local communities, as well as outreach activities in seminars, especially web seminars, and talks for the general public.

Narrative synthesis

In this section, evidence found in the systematic review was qualitatively synthesized, focusing on the main trends found.

- Regarding adaptation, based on the evidence, it is highlighted that, in general, the narrative on the concept is the strongest among the evidence found, such as climate action, which revolves around linking the measure to other policies, decisions, and the legal framework.

- For the link between adaptation and training with regard to climate change education, the proposal focuses mainly on environmental education, considering the need for a different approach to the traditional one, assuming that the focus on climate change in education involves a different conception of the teaching-learning process.

- In the adaptation/mitigation association, although the frequency of the *Mitigation* code is lower than *Adaptation*, the high co-occurrence of both codes shows that the narrative discourse on climate action is mostly generalized, placing adaptation and mitigation as complementary strategies to reduce and manage climate change risks in accordance with the IPCC. Unlike the Kyoto Protocol, the Agreement includes

commitments from both developed and developing countries, so the coverage is broader, which addresses the application of the Principle of Solidarity, given the urgent need for a global mitigation and adaptation effort in the interest of all States. In short, responses are usually presented jointly.

- With regard to the energy transition, the main topic of this review, there is a robust selection of citations on which to build a theoretical construct, highlighting some specific aspects, beginning with the characterization of the energy transition itself from the discourse in Latin America, which proposes the energy transition as a problem beyond technological change, involving alternative forms of production of goods and services or lower consumption of energy resources based on fossil fuels. The concept of a just transition is strongly linked to this, whereby the energy transition must avoid reproducing the social and environmental inequalities of the current model and must become a real alternative e for development and the fight against climate change (Newell and Mulvaney, 2013, cited in Rivera Albarracín, 2019).

- With regard to innovation, it is pointed out how it can trigger and accelerate the energy transition, but at the same time, warnings are issued about unforeseen consequences.

- With regard to training, using the Colombian case as a reference, the importance of tax incentives, anticipated by academia and the global context, to promote the energy transition is highlighted.

- Regarding the benefits of the energy transition, it is evident that "The energy transition is seen as an opportunity to improve production, service, and transportation systems, making them more efficient and sustainable." (Rivera Albarracín, 2019, p. 39) and at the same time, aligning it with the 2030 Agenda "An energy transition that meets the sustainable development goal promises numerous social, infrastructure, and environmental benefits to boost the country's human and economic capital." (Garza, et al., 2019, p. 8)

- The evidence on the challenges of the energy transition in Latin America, possibly one of the most striking aspects of the review, reinforces the criteria seen in the findings on adaptation and mitigation, mainly based on experiences in Mexico, Argentina, and Colombia. In principle, it highlights the contradictions between the different interests involved, which are expressed in contradictions between climate change policies and energy transition policies, resulting, among other things, from the region's high dependence on raw material exports, which requires a systemic and intersectoral approach.

- It also highlights the "carbon curse" or the "natural resource curse," stating that "An energy transition on a human scale must promote strategies that provide efficient social benefits and minimize defensive expenditures." (Garza, et al., 2019) Finally, two observations: "The biggest driver of the energy transition is cost, as this allows one energy source to be replaced by another. The energy transition is slow and is usually delayed by regulatory issues, the influence of current governments, and uncertainty about technology." (Di Terlizzi, Gama, & Jaramillo Quintero, 2021, p. 107)

Conclusions

Historically, increased energy consumption and its positive effects on development have advanced hand in hand in a symbiotic relationship to the point that they have become virtually indistinguishable from one another. Therefore, to the extent that their co-dependence presents itself as a formula for the achievement of complex, technified, and globalized societies, it also brings with it profound environmental problems and imbalances.

In this context, the concept of energy transition arises, since energy consumption and production are at the heart of the problems posed by development. At the same time, energy transition ideally represents the consolidation of a model of sustainable energy use and production in response to the crisis caused by humans in their quest for greater well-being. In other words, the energy transition does not merely imply a change in technology; it requires a profound reflection on the development model in the context of the multidimensional problems that arise in current contexts and, above all, in less developed countries, where priorities often reflect basic needs.

In relation to the purpose of the review, it fulfills the requirements, providing elements to develop the justification and context of a training program, clarifying narrative trends, and offering an initial approach to the program's agenda.

With regard to the questions raised in the review, the different levels of progress made by countries in terms of training in energy transition and climate change are evident, highlighting the achievements in Mexico, Colombia, and Argentina, but demonstrating the incipient progress in all others. Similarly, climate action, based on the environmental education model, characterizes training in energy transition and climate change in the selected countries. When comparing the publications with the academic offerings researched, it is notable that the latter emphasizes climate change, public policy and regulation, technologies, energy transition, and unconventional energies as a priority from a perspective that tends first toward general understanding and comprehensive management, without necessarily implying a vision of the energy business.

No evidence was found on how training in energy transition and climate change is included in the NDCs of the selected countries. When comparing the publications with the German case, as a European reference, it is evident that the approach is particularly focused on the implementation of clean technologies and energy business management.

Documentary References

Deutsche Energie-Agentur GmbH (DENA). (2018). Energy Solutions "Made In Germany" Innovative, intelligent, and sustainable energy technologies around the world. Berlin, Germany: Federal Ministry for Economic Affairs and Energy. Retrieved August 2022, from https://www.dena.de/fileadmin/dena/Publikationen/PDFs/2019/dena_RES-Broschuere_Energy_Solutions_-_Made_in_Germany_spanisch.pdf

Di Terlizzi, S., Gama, I., & Jaramillo Quintero, T. (July-December 2021). Energy Transition in Colombia: Not Necessarily a Reality Based on Climate Change. *Verba Iuris*, 105-128.

Gannan, R., Ciliska, D., & Thomas, H. (2010). Expediting systematic reviews: methods and implications of rapid reviews. *Implementations Science 2010*.

Garza, V., Gibran, R., Hernández Paz, A., Berlanga Ramírez, J., Cantú Rivera, H., Pérez Guzmán, K., . . . Duthoy Figueroa, A. (2019). *Global Perspectives for Mexico's Energy Transition: Governance and Sustainability Challenges.* Mexico City. Retrieved from https://ssrn.com/abstract=3497822

IRENA. (2022). *Global Energy Transitions Outlook 2022: 1.5°C Pathway.* Abu Dhabi: International Renewable Energy Agency. Retrieved from www.irena.org/publications

World Meteorological Organization. (May 24, 2023). *World Meteorological Congress approves Global Greenhouse Gas Monitoring*. Retrieved August 21, 2023, from World Meteorological Organization: https://public.wmo.int/es/media/comunicados-de-prensa/el-congreso-meteorol%C3%B3gico-mundial-aprueba-la-vigilancia-mundial-de-los

Petticrew, M., & Roberts, H. (2006). *Systematic reviews in the social sciences: a practical guide.* Oxford, UK: Blackwell Publishing Ltd.

Rivera Albarracín, L. (2019). Climate change and sustainable energy development in Latin America and the Caribbean under the Paris Agreement and the 2030 Agenda. *Working papers (Carolina Foundation)* (15). Retrieved from https://dialnet.unirioja.es/servlet/articulo?codigo=7097499

World Bank. (2023). *World Bank Country and Lending Groups*. Retrieved November 2023, from World Bank: https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups