Renewable Energies in Ecuador: Opportunities and Challenges in Diversifying the Energy Matrix

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Abstract

Based on an analysis of the opportunities and challenges Ecuador faces in diversifying its energy mix, the country presents high potential for generating solar, wind, and biomass energy, although its current mix is dominated by hydropower and petroleum derivatives. The methodology used for this study was qualitative and exploratory, including a bibliographic review of scientific studies and government plans. Despite this potential, several challenges were identified, such as a lack of strategic planning, a deficient regulatory framework, and limited public and private investment. The study concludes that, to achieve an efficient energy transition, it is crucial to strengthen institutions, establish clear public policies, and promote incentives for the development of clean technologies. These actions are necessary to improve the country's energy sustainability and resilience in the face of climate change and energy supply volatility. Although hydropower is the main source of electricity in Ecuador, covering 80% of the supply, this dependence makes the country vulnerable to climatic phenomena such as droughts, which has led to energy crises and rationing. Diversification is seen as a necessity to ensure energy security and reduce dependence on fossil fuels.

Keywords:
Renewable energy; energy matrix; hydroelectric power; wind power.

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Energías Renovables en Ecuador: Oportunidades y desafíos en la diversificación de la matriz energética

Resumen

A partir de un análisis de las oportunidades y desafíos que enfrenta Ecuador en la diversificación de su matriz energética, el país presenta un alto potencial para generar energía solar, eólica y de biomasa, aunque su matriz actual está dominada por la hidroenergía y los derivados del petróleo. La metodología utilizada para este estudio fue de tipo cualitativa y exploratoria, e incluyó una revisión bibliográfica de estudios científicos y planes gubernamentales. A pesar del potencial, se han identificado varios desafíos, como la falta de planificación estratégica, un marco regulatorio deficiente y una escasa inversión tanto pública como privada. El estudio concluye que, para lograr una transición energética eficiente, es crucial fortalecer las instituciones, establecer políticas públicas claras e impulsar incentivos para el desarrollo de tecnologías limpias. Estas acciones son necesarias para mejorar la sostenibilidad y la resiliencia energética del país frente al cambio climático y la volatilidad en el suministro de energía. Si bien la energía hidroeléctrica es la principal fuente de electricidad en Ecuador, cubriendo el 80% del suministro, esta dependencia hace al país vulnerable a fenómenos climáticos como las sequías, lo que ha llevado a crisis energéticas y racionamientos. La diversificación es vista como una necesidad para garantizar la seguridad energética y reducir la dependencia de los combustibles fósiles.

Palabras clave: Energías renovables; matriz energética; hidroeléctricas; energía eólica.

Energias renováveis no Equador: Oportunidades e desafios na diversificação da matriz energética

Resumo

Com base em uma análise das oportunidades e desafios que o Equador enfrenta na diversificação de sua matriz energética, o país apresenta alto potencial para geração de energia solar, eólica e de biomassa, embora sua matriz atual seja dominada por energia hidrelétrica e derivados de petróleo. A metodologia utilizada neste estudo foi qualitativa e exploratória, incluindo uma revisão bibliográfica de estudos científicos e planos governamentais. Apesar desse potencial, vários desafios foram identificados, como a falta de planejamento estratégico, um marco regulatório deficiente e investimentos públicos e privados limitados. O estudo conclui que, para alcançar uma transição energética eficiente, é crucial fortalecer as instituições, estabelecer políticas públicas claras e promover incentivos para o desenvolvimento de tecnologias limpas. Essas ações são necessárias para melhorar a sustentabilidade e a resiliência energética do país diante das mudanças climáticas e da volatilidade do fornecimento de energia. Embora a energia hidrelétrica seja a principal fonte de eletricidade no Equador, cobrindo 80% do fornecimento, essa dependência torna o país vulnerável a fenômenos climáticos como secas, o que levou a crises energéticas e racionamento. A diversificação é vista como uma necessidade para garantir a segurança energética e reduzir a dependência de combustíveis fósseis.

Palavras-chave: Energia renovável; matriz energética; energia hidrelétrica; energia eólica.

Introduction

Renewable energy sources, such as solar, wind, and hydropower, are classified as inexhaustible resources that have been fundamental to human development throughout history (Correa et al., 2016). In contrast to the prevailing dependence on fossil fuels, the utilization of these sources is crucial for combating climate change and fostering sustainability.

In the case of Ecuador, the discovery of oil fields fostered a profound dependence on this resource, establishing it as the nation's primary source of non-renewable energy. Thus, the development of alternative renewable energies, which could serve as substitutes, has been limited. Although the Ecuadorian energy matrix comprises various sources—including hydroelectric, wind, solar, and biomass—it maintains a low level of diversification. As noted by Chamorro and Mera (2025), electricity generation relies predominantly on hydroelectric plants, rendering the system vulnerable to climatic phenomena such as El Niño and subsequent periods of drought. This dependency has led to energy rationing and significant economic impacts, highlighting the structural fragility of the system.

Given this context, the transition toward renewable energy emerges as a key solution to guarantee energy security and national resilience. Nevertheless, investment in projects aimed at diversifying the energy matrix has been remarkably scarce (Guamán, 2017), illustrating a deficiency in clean alternatives.

It is important to emphasize that, while energy derived from natural sources aligns with environmental conservation—being essential to address issues such as global warming and greenhouse gas emissions (Barrón et al., 2021)—its contribution within the country remains marginal. Lack of investment, technological limitations, and insufficient energy policies hinder further development. Consequently, strengthening renewable energy would not only reduce reliance on hydroelectricity but also facilitate the construction of a more stable, diversified, and resilient system in the face of the current crisis.

The following sections present the fundamental and technical concepts regarding different renewable energies, their operation, limitations, and public policies, thereby providing a more comprehensive overview of the proposed topic.

Renewable Energy Sources with Energetic Potential

Renewable energy refers to power obtained from natural sources that are replenished over time. This concept is considered inexhaustible due to its high regenerative capacity, harnessed through various technologies and resources to produce "green energy" on an industrial scale (Hidrovo, 2019).

The widespread use of resources such as hydroelectric, solar, and wind power has allowed nations to develop their own energy production systems. Consequently, a broad and diversified renewable energy installation capacity is a fundamental pillar for achieving energy self-sufficiency (Ortega et al., 2022).

Hydraulic energy is obtained from the potential and kinetic energy of water masses transported by rivers or glacial melt (Galbán et al., 2023). Represented by generators or dams, hydropower is primarily used for electricity production due to its remarkably high efficiency compared to other energy sources.

In fact, hydroelectricity is the primary source of electricity generation in Ecuador. According to Llanes and Guastay (2020), the country ranks fifth globally in terms of renewable energy generation, with hydropower being the most significant contributor. Between 2009 and 2017, Ecuador increased its hydroelectric capacity by 20%, consolidating a system that accounts for 71% of the nation's electricity production. This growth is part of a government strategy to transform the energy matrix, aiming to reduce fossil fuel consumption and its environmental impact. Furthermore, research indicates that hydroelectric power saves 200 ml of fossil fuel for every kWh generated, contributing significantly to environmental sustainability.

Another renewable source with significant potential is solar energy, based on the photovoltaic effect. This effect allows certain semiconductor materials to generate an electric current when exposed to sunlight. Solar cells release electrons upon exposure to light, converting solar energy directly into electricity as a clean and renewable source. In regions with high solar radiation, such as tropical areas, the installation of photovoltaic systems is particularly effective for meeting energy needs sustainably (Rodríguez et al., 2020).

In Ecuador, the high solar radiation in the tropics offers immense potential for this technology. According to Renewable Energies in Ecuador: Current Situation, Trends, and Perspectives (Peláez & Espinoza, 2015), solar energy is a vital resource due to consistent radiation levels throughout the year. However, the development of this source is hindered by a lack of economic incentives and the need for a more robust regulatory framework to encourage adoption.

Following this line of reasoning, wind energy—which generates electricity through wind turbines—warrants mention (Párraga et al., 2019). In Ecuador, regions such as Loja and Manabí have been identified as having great potential for such projects. A notable example is the Villonaco Wind Farm, which benefits from the region's favorable wind conditions.

The Villonaco wind power plant, with a capacity of 16.5 MW, is located in the province of Loja. This project was one of the first of its kind in continental Ecuador; its construction began in 2011 and it entered commercial operation on January 2, 2013. By 2022, the plant had contributed 676.20 GWh (gigawatt-hours) to the national system. Villonaco features 11 wind turbines of 1.5 MW each, spanning approximately 2 km along the summit of the hill of the same name (Ministerio de Energía y Minas del Ecuador [MINEM], 2022).

Despite the potential, Ecuador faces several challenges in harnessing wind energy, such as the requirement for significant initial investment and adequate infrastructure to connect wind farms to the national grid. Nevertheless, studies confirm that wind conditions in Loja and Manabí are highly suitable, making this resource a viable option for enhancing energy security and promoting sustainable development (Uvidia & Masaquiza, 2023).

Finally, biomass consists of non-fossilized organic material with multiple applications. Its primary use is food-based, while its secondary use serves as raw material for industries such as pharmaceuticals, cosmetics, and textiles. Biomass possesses physicochemical characteristics that make it highly useful for energy recovery (López et al., 2024).

In neighboring contexts, such as Colombia, residual biomass from agriculture, livestock, and forestry represents a significant renewable source. A study by Pérez et al. (2023) analyzed the energetic potential of various biomass types, including residues from sugarcane, coffee, and rice crops. The results suggest that biomass gasification could satisfy a significant portion of electricity needs, facilitating the transition toward sustainable sources and reducing fossil fuel dependency.

To acknowledge the contribution of these energy types to Ecuadorian electricity production, reference is made to Figure 1. As illustrated, hydropower accounted for 82% of electricity generation in 2024, confirming a significant national reliance on this energy source. Following at a considerable distance are other energy types; biomass (9%) and wind energy (7%) rank second and third, respectively. As their generation shares indicate, these sources do not constitute a substantial contribution to the power grid. Furthermore, biogas (1%) and photovoltaic energy (1%) provide a negligible contribution, reflecting the country's limited energy diversification.

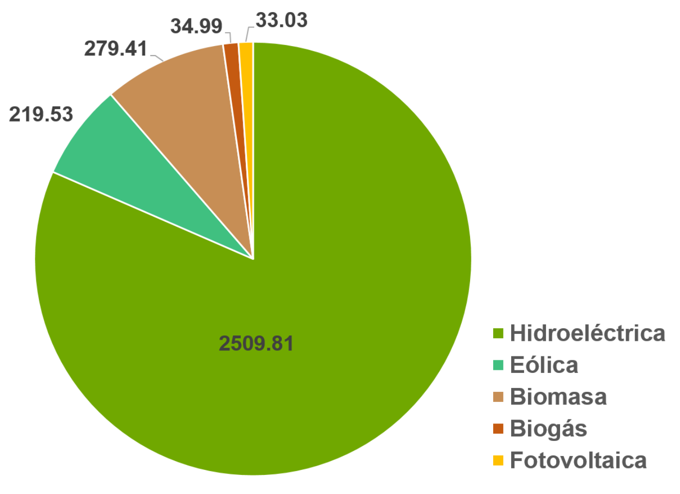


Figure 1.
Gross energy production by generation type, 2024 (GWh).

Note: National Electricity Operator – CENACE (2025).

Policies and Challenges of the Energy Matrix in Ecuador

Several factors drive the promotion of investment and efficient energy use. These include the advancement of long-term energy efficiency policies, which are pivotal for national economic competitiveness, environmental preservation, and the mitigation of global warming (Pazmiño, 2020).

The energy crisis in Ecuador, as identified by Sáenz (2024), is attributed to an excessive reliance on fossil fuels. To address this, the current research proposes an action framework focused on institutional strengthening, the establishment of clear public policies, and the creation of incentives for clean technology development, particularly by bolstering potential resources such as solar and wind energy.

According to Vélez et al. (2024), Ecuador has implemented various political strategies to enhance energy efficiency and increase investment in renewable sources. Notable among these is the development of a robust legal and regulatory framework aligned with the Sustainable Development Goals (SDGs)—specifically SDG 7, which aims to ensure access to affordable, reliable, sustainable, and modern energy for all. The 2008 Constitution, along with various legislative instruments such as the Organic Law on Energy Efficiency and the National Energy Efficiency Plan, are cornerstone elements of this transition. Furthermore, the country has updated its Electricity Master Plan to stimulate investment in non-conventional renewable energy (NCRE), totaling approximately USD 2.2 billion.

The regulatory framework has integrated initiatives to ensure compliance with the energy efficiency standards established by the Ecuadorian Construction Code (NEC). One such proposal involves implementing monitoring and oversight mechanisms to promote the sustained application and progressive improvement of guidelines regarding HVAC (heating, ventilation, and air conditioning), renewable energy, and energy efficiency (Pazmiño, 2020).

Consequently, building permit processes are expected to include detailed technical documentation, encompassing energy consumption calculations, material performance analysis, and thermal transmittance values of building components. This measure aims to ensure that projects adhere to rigorous technical criteria from their inception. Additionally, it has fostered stricter regulation of non-conventional renewables, enhanced investment project execution and mitigating the risk of economic losses due to deficient implementations.

Energy sources are paramount for national development and growth, powering sectors such as transportation and lighting. However, this massive demand is a primary driver of large-scale pollution through carbon dioxide emissions.

The integration of diverse non-conventional generation technologies faces persistent limitations, including inadequate planning, lack of financing, and a deficiency in public policies that incentivize investment. Overcoming these barriers requires addressing the lack of institutional capacity and the limited legal certainty currently hindering these processes (Arias et al., 2022).

According to Pérez and Schweickardt (2021), electrical losses arise from the inefficient distribution of power systems and are classified into two categories:

- **Technical Losses:** These are strictly dependent on the physical infrastructure, including transformers, secondary grids, and lighting systems. They are determined by the specific characteristics and configurations of the distribution networks.
- **Non-Technical Losses:** These are characterized by deficiencies in commercial management, such as inaccurate billing and administrative inefficiencies. This category includes energy measurement equipment that is either faulty or tampered with, as well as illegal connections made by users (National Electricity Council [CONELEC], 2023).

As previously discussed, although the country possesses vast potential for developing diverse renewable energy sources, their contribution and the support for such projects remain marginal. This is due to technological constraints, a lack of investment, and insufficient energy policies. Strengthening these sources would not only reduce the current over-reliance on hydroelectric power but also foster a more stable, diversified, and resilient system in the face of contemporary crises.

In light of the above, the present study seeks to analyze the opportunities and challenges Ecuador faces in diversifying its energy matrix, evaluating the potential of non-conventional renewable energies and the policy frameworks necessary for their effective implementation.

Methodology

The research adopted a qualitative approach which, according to Piña (2023), is appropriate when the objective is to examine the properties or the state of the art of a phenomenon without testing hypotheses through statistical analysis. Instead, the problem is addressed based on the previous contributions of various authors.

The study was developed at a descriptive level using a documentary typology. As noted by Guevara et al. (2020), this type of research facilitates a detailed analysis of the characteristics of the subject of study, contributing to a clearer understanding of its structure. This approach was particularly useful for characterizing the current state of renewable energy in Ecuador, as well as identifying both the opportunities and obstacles for its incorporation into the national energy matrix.

The analytical-synthetic method was utilized, which, according to Rodríguez and Pérez (2017), involves decomposing the object of study into distinct components for individual analysis and subsequently integrating them through a process of synthesis, thereby allowing for conclusions to be drawn from their interrelationships. This methodological strategy made it possible to break down the different types of energy sources and examine their integration within the country's energy system.

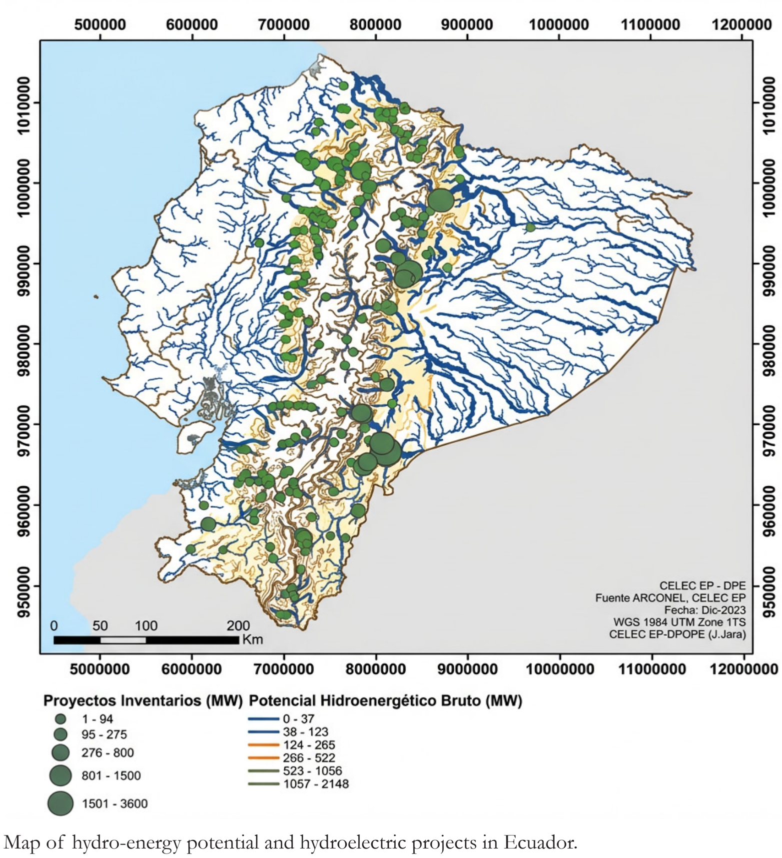
The primary technique employed was documentary analysis, which allowed for the identification, evaluation, and synthesis of relevant research concerning the Ecuadorian energy matrix. Guevara (2019) highlights that this technique favors a comprehensive and contextualized understanding of the existing literature surrounding a specific problem.

For the development of the results, the "Electricity Master Plan 2023–2032" (MINEM, 2023) was used as the principal reference, which establishes the roadmap for energy planning in Ecuador over the next decade. This official instrument also provides detailed information regarding the geographic location and the implementation status of renewable energy projects in the country.

Concluding the methodological section, the design was framed as non-experimental, as it was limited to collecting, systematizing, and interpreting pre-existing information without alterations to suit the proposed object of study, thereby ensuring the integrity and objectivity of the analyzed data (Bernal, 2016).

Results

In opening this section, it is essential to highlight that the Ecuadorian nation possesses a vast potential of resources for hydroelectric power generation that remains untapped. According to MINEM (2023), based on studies conducted by CELEC EP in 2020, the country has an estimated capacity of 24,896 MW for the implementation of hydroelectric plants with outputs exceeding 5 MW. However, the development of these projects has been hindered by insufficient public investment and difficulties in attracting private capital. Projects of significant energetic relevance, such as Cardenillo and Santiago, have experienced delays or suspensions due to a lack of financing, as well as social and environmental conflicts.



Map of hydro-energy potential and hydroelectric projects in Ecuador.

Note: MINEM (2023).**Figure 2.**

Ecuador possesses a network of 21 meteorological stations distributed throughout the territory, which have contributed to identifying new areas suitable for wind energy development (Figure 3). These projects are considered viable in the long term from technical, economic, and social perspectives. Nevertheless, despite an identified potential exceeding 1,600 MW, their execution has been sparse and has faced considerable delays. This slow progress is attributed to insufficient investment, corruption issues, and environmental disputes. For instance, although the country already has operational wind farms such as Villonaco I, initiatives like Villonaco III and Pimo are progressing behind schedule and require the strengthening of public-private partnerships for their reactivation.

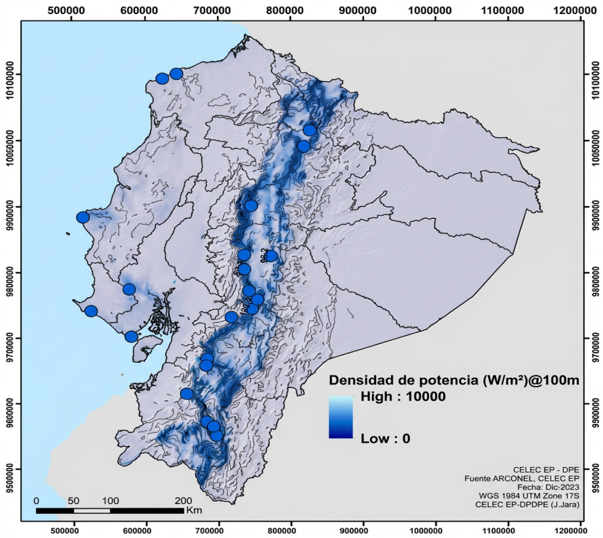


Figure 3.
Map of potential wind energy projects in Ecuador.

Note: MINEM (2023).

Existing Renewable Energy Power Plants

Table 1.
Electricity generation plants in Ecuador.

POWER PLANT TYPE	NOMINAL CAPACITY NW	EFFECTIVE CAPACITY NW
Hydraulic	5.186,24	5.146,52
Thermal	2.061,87	1.796,81
Biomass	144,3	136,4
Wind	66,448	66,48
Solar	24,46	23,57
Biogas	8,32	7,2
TOTAL	7.491,67	7.176,98

Note: MINEM (2023).

Based on the government planning outlined in the 2023–2032 Master Plan, it is anticipated that through adequate policies and consistent financing, Ecuador could achieve a predominantly renewable electricity matrix by 2030. This projection is supported by the high potential of untapped resources, such as hydroelectricity (over 24,000 MW) and wind power (over 1,600 MW), which have been identified as technically, economically, and socially viable. Consequently, this assertion is not a mere assumption but a target grounded in existing resource potential and official state planning. The following section lists the primary power generation plants incorporated in recent years.

Table 2.
Hydroelectric Power Plants

DATE	LOCATION	GENERATION
January 2019	Pusuno, Napo	38,25 MW
April 2019	Río Verde Chico, Tungurahua	10,20 MW
July 2020	San José de Minas, Pichincha	5,95 MW
Novembre 2020	El Laurel, Carchi	1 MW
April 2021	Chalpi, Napo	8,10 MW
December 2022	Sabanilla, Zamora Chinchipe	30,60 MW
March 2023	Central Sarapullo, Toachi-Pilatón	48,45 MW
April 2023	Ulba, Tungurahua	1 MW
December 2023	Huayquichuma	6,5 MW (in operational testing)

Note: MINEM (2023).

Table 3.
Solar and wind power plants.

FECHA	TIPO / UBICACIÓN	GENERACIÓN
January 2022	Solar Plant San Cristóbal, Galápagos	1 MW
March 2023	Eolic Minas de Huascachaca, Loja	49,98 MW

Note: MINEM (2023).

Efficiency and Generation within the Electricity Sector

The implementation of public policies is fundamental for optimizing the utilization of natural resources and meeting the country's energy generation requirements. However, although the law emphasizes these improvements, their application faces significant challenges. A lack of sustained public investment and limited private sector participation, compounded by bureaucratic barriers and corruption, have prevented these resources from being fully exploited. Consequently, the transition toward a more diversified matrix remains a slow and complex process that has yet to achieve the expected progress, leaving the country vulnerable to fluctuations in its primary energy sources. Therefore, the strategies to be implemented across the various proposed projects regarding the appropriate use of renewable energies are as follows:

- Harness available primary renewable energy sources for electricity generation.
- Advance toward the universalization of access to reliable, modern, and affordable energy.
- Promote energy efficiency through the responsible use of energy and process optimization.
- Reduce atmospheric pollutant emissions and support the conservation of ecosystems.
- Maintain and strengthen a fair regulatory framework that is technologically inclusive and establishes guidelines for the incorporation of emerging technologies.

Table 4.
Generación de Energía eléctrica 2023 - 2032 (GWh)

STAGE	HYDROELECTRIC WIND	WIND	PHOTOVOLTAIC
2023	25.749,1	179,2	41,4
2024	26.360,8	206,5	41,4
2025	28.108,8	496,5	336,2
2026	29.363,3	841,8	900,2
2027	30.662,4	934,3	1.033,2
2028	31.503,4	1.471,1	1.462,2
2029	32.582,0	2.718,7	1.821,7
2030	34.439,8	2.718,7	1.821,7
2031	38.799,5	2.718,7	1.821,7
2032	42.822,9	2.718,7	1.821,7

Note: MINEM (2023).

In Ecuador's electricity master plan, it was estimated that between 2023 and 2032, renewable energy generation would increase significantly over a 10-year period. As we can see from hydroelectric power plants, energy is expected to increase from 25,794.1 to 42,822.9 GWh respectively during that period, representing a significant increase. Similarly, wind energy generation is expected to increase from 179.2 to 2,718.7 GWh during the same period, and photovoltaic energy generation is expected to increase from 41.4 to 1,821.7 GWh.

In 2024, the Agency for the Regulation and Control of Energy and Non-Renewable Natural Resources (ARCERNNR) reported that the total energy delivered to the public service amounted to 29,267.37 GWh, of which 21,539.63 GWh (73.60%) corresponded to renewable sources. Furthermore, the composition of renewable energy for that year was distributed as follows:

- Hydropower: 22,614.43 GWh (96.75%)
- Biomass: 460.91 GWh (1.97%)
- Wind: 223.54 GWh (0.96%)

These figures evidence a pronounced dependence on hydraulic sources, which accounted for nearly the entirety of renewable generation. In contrast, other sources, such as biomass and wind, maintained a marginal share. This imbalance highlights one of the sector's primary challenges: limited diversification. Despite possessing extensive renewable resources, the national energy matrix continues to rely almost exclusively on a single source, thereby increasing vulnerability to adverse climatic phenomena. In this regard, promoting non-conventional renewable energies—such as biomass, wind, and photovoltaics—is crucial to reducing this exposure and ensuring a stable and resilient electricity supply in the future.

Discussion

This study has found that Ecuador's reliance on hydroelectric power, which accounts for 70% of electricity generation, exposes the country to high vulnerability regarding climatic phenomena such as droughts. This finding aligns with the research by Salas et al. (2025). Indeed, despite the country's high potential for solar and wind energy, these sources represent a minority contribution, providing only 3% of total electricity generation. This is reflected in the data from the Electricity Master Plan 2023–2032 (MINEM, 2023), which indicates that non-conventional renewable energies only have a 2% participation rate at the national level. This lack of diversification suggests that, although government plans exist, they lack sufficient projects to meet current energy needs and reduce the country's vulnerability.

Complementarily, Bautista (2024) argues there is a lack of strategic continuity toward solar and wind energy, which is reinforced by Cambindo et al. (2024), who point out significant technological challenges for diversification. For this reason, an increase in investment in Research and Development (R&D) is considered necessary to achieve an effective energy transition. Although geographical conditions are favorable in areas such as Loja and Manabí, the expansion of these energies is restricted by a lack of economic and technological incentives.

Currently, progress has been concentrated in isolated projects such as the Minas de Huascachaca wind farm and the San Cristóbal solar park, which, while positive steps, do not represent a significant transformation of the national energy system. In this sense, the study by Millingalli et al. (2025) revealed excellent conditions for the development of photovoltaic systems in the country, highlighting that these would allow for a reduction in technical grid losses of between 8% and 15%, demonstrating untapped potential.

Furthermore, Vargas and Pinos (2023) note that, although Ecuador has received funds for the development of renewable energy, these have not been managed efficiently due to the lack of solid regulatory frameworks. This finding coincides with the deficiency in comprehensive public policies identified in this work, indicating that an effective energy transition requires not only infrastructure but also strengthened regulations and institutions to obtain concrete results. Along the same lines, Arias et al. (2022) mention that the integration of non-conventional energy technologies is constantly limited by a lack of planning, financing, and public policies that incentivize investment.

The aforementioned barriers prevent overcoming the lack of institutional capacity and the limited legal certainty necessary for these processes. This is supported by the report from Soria et al. (2024), who emphasize that public energy policy must focus on integrated long-term planning to prevent Ecuador from becoming a destination for obsolete technologies. In fact, Macas et al. (2024) stress the need for a flexible regulatory framework to foster innovation, in addition to consolidating regional energy interconnection to strengthen international security and cooperation.

Conclusions

- The study confirms that Ecuador's energy matrix depends almost entirely on hydroelectric power; while this has functioned in the past, it renders the system extremely vulnerable to extreme climatic phenomena, such as droughts. This represents a significant risk to the country's energy security and electricity supply, underscoring the urgent need for diversification.
- Furthermore, it has been demonstrated that despite Ecuador's vast potential to harness non-conventional renewable sources—including solar, wind, biomass, and geothermal energy—their development is hindered by a lack of integrated strategic planning, sustainable investment, and continuous political will. The literature review corroborated that the current regulatory framework is insufficient, and effective fiscal incentives and financing mechanisms remain scarce.
- Although the government has implemented frameworks such as the Electricity Master Plan 2023–2032, the proportion of non-hydroelectric renewable energy in the country remains low, indicating inadequate and slow policy implementation. This particular finding addresses the stated objective of evaluating the effectiveness of current energy policies.
- To achieve a just, sustainable, and efficient energy transition, Ecuador must commit more firmly to diversification. This entails creating a conducive environment for private investment, strengthening institutions, and prioritizing clean, decentralized technologies that not only meet energy demands but also contribute to environmental goals. Only through a comprehensive, long-term approach can a resilient and inclusive energy matrix be constructed in alignment with global sustainable development commitments.

- As this study was based on a qualitative literature review, the analysis is limited to information available in scientific articles and government documents; therefore, primary quantitative data and interviews with key sectoral stakeholders were not included. Future research is recommended to address these limitations through:
  - Quantitative Analysis: Conducting empirical studies that include primary data analysis regarding installation costs, project efficiency, and the return on investment (ROI) of non-conventional renewable energies.
  - Case Studies of Success: Studying successful energy transition cases in countries with geographic and economic characteristics similar to Ecuador to identify replicable policies and strategies.
  - Expert Interviews: Engaging with decision-makers, investors, and energy sector experts to obtain a deeper perspective on the obstacles and opportunities not fully captured in public literature.

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