


## **A Study of China-Latin America Cooperation in Green Energy Industry: Status, Obstacles, and the Policy Suggestions**



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### **ABSTRACT**

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In the global context of tackling climate change and promoting energy transition, cooperation between China and Latin America in the green energy industry is gaining prominence. This study employs literature analysis, case studies, and data statistics to systematically examine the development status, cooperation dynamics, and key challenges faced by both regions. It proposes tailored strategies to overcome these obstacles. The research reveals China has accumulated strong technological strength in the fields of renewable energy and nuclear power, while Latin America has abundant renewable energy resources. At the same time, there are still many challenges in the cooperation between the two regions, such as policy barriers, technological disparities, and financial constraints. Nonetheless, collaboration in areas like wind power, solar energy, and hydropower holds immense potential for mutual economic and environmental gains. To enhance collaboration, the study recommends strengthening policy alignment, facilitating technology transfer, diversifying financing options, and attaching importance to the evaluation of geopolitical risks. Future efforts should focus on fostering policy dialogue, promoting market integration, and ensuring sustainable development in the green energy sector. This research contributes to academic discourse and offers practical insights for governments, businesses, and international entities seeking to advance cooperation in green energy between China and Latin America.

## **1. INTRODUCTION**

### **1.1 Research background and significance**

At present, a new wave of the global energy and technological revolution is deeply evolving and thriving. Actively developing renewable energy has become a pivotal strategic direction for global energy transformation and combating climate change. The 2015 Paris United Nations Climate Change Conference highlighted that by doubling the share of renewable energy by 2030, it could account for 36% of total energy consumption, aiding in the control of climate change and the achievement of sustainable development goals. In 2020, China made a solemn pledge to the world to strive for a peak in carbon emissions before 2030 and achieve carbon neutrality before 2060. The proposal of China's "dual carbon" goals marks a significant phase in China's "energy revolution." Given its vast geographical expanse and rich natural resources, Latin America has the potential to become a major player in this field.

In fact, both China and Latin America have consistently been active participants and collaborators in global climate governance. In 2021, the renewable energy generation capacity in Latin America reached nearly 292 gigawatts, marking an increase of nearly 68% compared to a decade ago. As a responsible major developing country, China engages in

green development cooperation with other developing nations, including Latin American countries, through South-South cooperation, the Belt and Road Initiative (BRI), and its enterprises going global, among other methods, to collectively pursue a green development path. In this framework, energy cooperation stands as a highlight of the new era of China-Latin America cooperation, establishing a robust foundation for extending BRI to Latin America. Concurrently, the collaborative construction of the Belt and Road continuously brings new vigor to deepening China-Latin America energy cooperation.

This research conducts a thorough exploration from multiple angles, including the green energy industry capabilities, current status of cooperation, challenges encountered, and strategies for mitigation between China and Latin America, bearing significant theoretical and practical implications. Theoretically, it examines not only the technological strengths and cooperation models of both regions within the global green energy sector but also provides practical case studies and strategic recommendations by pinpointing the obstacles and countermeasures within the cooperation, thus enriching the theory of international collaboration. Practically, the findings aid policymakers in optimizing cooperation policies, facilitate technology and knowledge transfer, and bolster sustainable development cooperation between the two regions, particularly in balancing

economic growth with environmental protection. It offers pragmatic guidance for achieving carbon reduction targets and enhancing energy security. Overall, this study delivers profound insights and guides specific cooperation strategies and policy adjustments for China-Latin America green energy cooperation, demonstrating significant academic value and practical prospects.

## 1.2 Literature review

### 1.2.1 Overview of the current study

China and Latin America's collaboration in green energy is undertaken within the context of global responses to climate change and the transition towards renewable energy sources. With the increasing global demand for renewable energy, both China and Latin America have acknowledged the critical need and urgency for collaborative efforts in this field. Current research focuses on several aspects:

Firstly, Sino-Latin American energy cooperation is a key focus. He [1] and Zhang's [2] researches emphasize Brazilian or Latin American energy market reforms and Sino-Brazilian or Sino-Latin American energy cooperation, illustrating how China has become both a beneficiary and an active participant in these processes. Zheng and Guo [3] discuss the foundations and industrial characteristics of Latin American mineral and energy resources, highlighting the opportunities and challenges in Sino-Latin resource cooperation and emphasizing the complementarity of resources. Research from the Chinese Ministry of Commerce's International Trade and Economic Cooperation Research Institute and Brazil's Institute of Applied Economic Research suggests that China and Brazil have broad prospects for cooperation in renewable energy, advocating for the optimization of energy structures by leveraging each other's strengths. Alves Teixeira et al. [4] analyze the evolution of international cooperation in green energy under a global carbon neutrality vision, proposing an agenda for sustainable development.

Secondly, the theme of green energy and climate change response is significant. Wu [5] highlights China's status as the world's largest producer and user of renewable energy and the importance of promoting international green energy cooperation. Mao [6] discusses the need for new mechanisms of international energy industry cooperation to address global climate change challenges. Xing [7], from the perspective of righteousness and profit, explores the progress, challenges, and importance of high-quality green cooperation between China and Latin America. Melanie Müller [8] and others discussed that in the regions of Africa and Latin America, although rich in essential minerals like copper, lithium, and cobalt, they face the dual challenge of transforming both their energy and mining sectors, potentially unlocking significant opportunities for development and economic growth amidst global geopolitical shifts. They [9] also discussed the development potential of green hydrogen energy in Latin America, with a special emphasis on Chile's leading position in this field. In Gaafar Muhammed and Neyre Tekbiyik-Ersoy's article [10], they explore China's advancements in sustainable energy, focusing particularly on a comparative study of renewable energy policies between China, the United States, and Brazil, providing an overview of renewable energy initiatives in these three countries and performs a comparative analysis of how renewable energy support policies are implemented across them. Silvia R. Santos da Silva and others [11] center on the impact of climate change on renewable

energy resources in Latin America and the Caribbean, as well as the profound implications of these impacts for investments in the electricity sector.

Thirdly, international law and cooperation barriers are examined. Xiao and Chen [12] use a dynamic evolutionary game model to analyze the interactions between developed and developing countries in green energy cooperation, exploring strategies to enhance cooperation. Liu and Zhang [13] discuss the main challenges faced by green energy investments under the "Belt and Road" initiative, such as unstable investment environments and a lack of professional talent.

Fourthly, the role of China in Latin American energy transformation and the impact of BRI on energy cooperation are addressed. Ugarteche and León [14] analyze China's role in transforming Latin America's energy landscape, especially in the fields of solar energy and electric vehicles, suggesting that China is leading a global energy reshaping. ECLAC's [15] report notes that BRI brings new opportunities and spaces for Sino-Latin energy cooperation, especially in infrastructure investment and green energy development. Fu Jingjun [16] emphasizes the importance of advancing Belt and Road energy cooperation towards a new round of high-quality development, providing specific suggestions for fostering cooperation. Tatiana Gélvez Rubio and her colleagues [17] explore China's investments and financing in the renewable energy sector in Argentina and Brazil, particularly focusing on how these investments aid the energy transition and sustainable development goals of these two countries. Their article outlines China's foreign direct investment and lending activities in Latin America, analyzing how these endeavors align with the renewable energy policies and energy transition objectives of Argentina and Brazil. Prof. Douglas de Castro [18] emphasizes the significance of China-Latin America cooperation in advancing sustainable development and explores how this cooperation helps Latin American countries respect nature and promote sustainable growth while avoiding the repetition of past colonialism. The article highlights that China-Latin America cooperation is not just a part of international relations but a crucial force in the realm of sustainable development. Particularly in the Global South, this cooperation is vital as it provides a development model that both fosters economic growth and supports environmental sustainability. Benedicte Bull [19], Adrian H. Hearn [20] respectively discussed China's role in the context of new geopolitics of climate multilateralism and in the social engagement programs in Latin America.

These studies not only reflect the key role of Sino-Latin energy cooperation in promoting regional economic development, deepening international relations, and addressing global climate change, but also highlight that successful cooperation depends on the complementarity of economies and resources, overcoming legal and policy obstacles, and establishing effective international cooperation mechanisms. Furthermore, these studies underscore the strategic significance of Sino-Latin cooperation in global energy politics, reshaping international energy security and climate response frameworks through traditional and green energy cooperation.

### 1.2.2 Deficiencies in existing research

The existing literature extensively covers the fields of economics, policy, and international cooperation but exhibits several clear deficiencies. Firstly, the literature generally lacks

in-depth analysis of specific projects or policies, particularly concerning their local economic, environmental, and social impacts. Secondly, despite emphasizing the importance of international cooperation, detailed mechanisms for technological collaboration, the practical operations of technology transfer, and assessments of their effects are seldom discussed; moreover, there is a lack of strategies and examples for enhancing technological autonomy in Latin American countries. Additionally, although the general framework of China-Latin America cooperation is discussed, there is often a neglect of detailed analysis of specific countries or regions, including differences in political stability, economic development levels, and energy policies. The analysis of legal and policy frameworks is also insufficient, lacking deep discussions on the practicality of laws, reform recommendations, and policy implementation. Lastly, research tends to focus on macroeconomic and policy levels, with little consideration of the roles and interests of diverse stakeholders such as local governments, indigenous communities, and private enterprises.

### 1.2.3 Innovations of this study

This study utilizes a combination of literature analysis, case studies, and data statistics to broaden the analytical perspective and deepen the understanding of the complexities of cooperation, aiming to comprehensively reveal the dynamics and details of existing green energy cooperation. It conducts an in-depth analysis of the existing policy, technological, and financing challenges and proposes practical strategies, emphasizing the need to consider the specific conditions of different Latin American countries, reflecting a deep understanding and respect for the target region. Additionally, the research advocates for promoting policy dialogue and market integration, envisioning a sustainable development path for cooperation, providing valuable decision-making references for policymakers and practitioners. This enriches the theoretical research on China-Latin America green energy cooperation and enhances the feasibility of strategic planning for cooperation.

### 1.3 Research objectives and organization

This study is dedicated to conducting an in-depth analysis of the current state of cooperation between China and Latin America in the green energy sector, focusing on the challenges encountered and the potential economic and environmental benefits that could be realized. The primary objectives are to systematically assess the technological strengths and resource richness of both regions in renewable energy and nuclear power, with particular attention to areas such as wind, solar, and hydropower. Additionally, the research aims to identify and analyze the main obstacles that hinder this cooperation, including policy barriers, technological disparities, and financial constraints, and subsequently propose targeted strategies to address these challenges. These strategies involve strengthening policy alignment, facilitating technology transfer, diversifying financing options, improving risk evaluation, etc. Ultimately, the study seeks to bolster sustainable cooperation in the green energy sector between the two regions by enhancing policy dialogue and promoting market integration. Through this research, the paper aspires to provide practical strategies and recommendations for governments, businesses, and international organizations engaged in advancing Sino-Latin American green energy

cooperation, while emphasizing the importance of considering regional environmental variations and tailoring strategies to ensure that the proposed solutions are practical and effective.

The research is organized into five parts: The first part provides a brief introduction to the study. The second part presents an overview of the development of renewable and nuclear energy in China and Latin America, analyzing the policy support and technological capabilities of both regions. The third part delves into the current state of China-Latin America green energy cooperation and outlines the challenges related to policy regulations, technological gaps, and financing obstacles. The fourth part proposes strategies for strengthening policy coordination, promoting technology transfer and cooperation, expanding financing channels, etc. The final part concludes with a summary and a forward-looking perspective on future research directions. This structure is designed to offer decision-making references for governments and businesses in both regions for green energy cooperation and to elevate the level of green energy collaboration between China and Latin America within the context of the "Belt and Road" initiative and the global energy transition.

## 2. CURRENT STATUS OF GREEN ENERGY INDUSTRY IN CHINA AND LATIN AMERICA

### 2.1 Overview of green energy industry in China

As the world's largest producer and consumer of energy, China's characteristic of being "rich in coal, poor in oil, and lacking in gas" has shaped its long-standing energy system predominantly reliant on coal. The "Outlook for China's Energy Transition 2023" report indicates that although fossil fuels will still account for 40% of the energy structure by 2050, China is leveraging its scale and technological advantages in renewable energy to establish itself as a global leader in green energy. This report highlights strong policy support reflected in the rapid adoption of green technologies, positioning China as a leader in renewable energy investment, with renewable energy capacity expected to increase by over five times by 2050. Taking wind power as an example, in 2010, wind power accounted for only 1% of China's electricity generation. However, policies have injected strong momentum into the industry, and now wind power has become China's largest source of electricity after coal and hydropower. In 2023, wind power accounted for 9.4% of China's total electricity supply. By the middle of this century, China will become the world's largest wind power market.

Intense policy focus and technological innovation are transforming China into a green energy powerhouse. There are many admirable aspects of China's energy transition, with clear signs indicating efforts to decarbonize and develop clean technologies in renewable energy, energy storage, and transmission. China has the potential to further accelerate the reduction of its reliance on fossil fuels, advancing energy transition and moving closer to net-zero emissions before 2050. Projections suggest that China's share of global CO<sub>2</sub> emissions will decrease from one-third in 2023 to one-fifth by 2050. In absolute terms, China's emissions are expected to decrease by 70%, approaching its goal of carbon neutrality by 2060. Similarly, the proportion of solar energy in electricity generation was less than 1% in 2015, but in less than a decade, it has risen to 5% today. By 2050, solar and wind energy are projected to contribute 38% each to electricity generation.

### 2.1.1 Renewable energy

In recent years, China has made remarkable achievements in the development of renewable energy, particularly in wind and solar power. The country leads the world in installed capacity, with a steadily increasing share of electricity generation and rapidly decreasing costs. These advancements in energy structure adjustment and carbon reduction have laid a solid foundation for China to achieve its carbon peak and carbon neutrality goals on schedule. In 2022, China added 49.83 GW of wind power, bringing the total to 395.57 GW; 87.41 GW of solar power, bringing the total to 392.61 GW; 2.28 GW of nuclear power, bringing the total to 55.53 GW; and 3.34 GW of biomass energy, bringing the total to 41.32 GW.

Currently, China's wind and solar products are exported to over 200 countries and regions, with cumulative export values exceeding \$33.4 billion and \$245.3 billion, respectively. The 2023 International Renewable Energy Agency (IRENA) report noted that, over the past decade, the average levelized cost of electricity for global wind and solar projects has decreased by more than 60% and 80%, respectively, largely thanks to Chinese innovation, manufacturing, and engineering. While supporting global clean energy development, China also welcomes international businesses to invest and operate in China, continuously creating a friendly business environment that is market-oriented, law-based, and internationalized, thereby jointly promoting clean energy development and advancing the global energy transition.

China has become a leader in the renewable energy sector. In 2023, China's newly installed wind power capacity increased by 66% compared to the previous year, and the newly installed solar PV capacity in 2023 was equivalent to the global total for 2022. It is projected that by 2028, China will account for 60% of the world's new renewable energy generation capacity. The IRENA report states that China plays a crucial role in achieving the global goal of doubling renewable energy capacity.

Meanwhile, China's solar PV industry is developing rapidly and maintaining its international lead. Currently, nearly 90% of the world's solar PV capacity is in China, and seven of the top ten global solar module manufacturers are Chinese companies. While reducing costs and improving efficiency, Chinese companies are also increasing their R&D efforts to develop the next generation of solar cell technology.

China's wind power equipment exports are also growing rapidly. Statistics show that about 60% of the global wind power equipment market is supplied by China. Since 2015, the compound annual growth rate of China's wind power equipment export capacity has exceeded 50%. Recently, the first wind power project in the UAE, built by a Chinese company, officially began operation with a total installed capacity of 117.5 MW. Additionally, the first centralized wind power project in Bangladesh, also built and invested in by a Chinese company, was recently connected to the grid, providing 145 million kilowatt-hour of green electricity annually. While achieving its own green development, China is also supporting more countries in developing renewable energy, contributing to global climate goals and making significant contributions to the global new energy industry and climate change mitigation.

Overall, China has become an indispensable force in global clean energy development. In terms of investment, Chinese companies' overseas clean energy investments span major countries and regions, covering wind power, solar power, and

hydropower, thereby strongly supporting the green and low-carbon energy development of related countries based on mutual benefit and win-win outcomes. In terms of industry, China continuously promotes technological and product innovation, actively integrating into the global clean energy supply chain and consistently sharing high-quality clean energy products with the world.

### 2.1.2 Nuclear energy

In recent years, most major global economies have explicitly proposed the active development of nuclear energy. The European Parliament has officially included nuclear energy projects in its green investment classification. France has proposed a large-scale revitalization of its nuclear power plans, and the UK has made the vigorous development of nuclear energy an important part of its national energy strategy. A recent study by the U.S. Department of Energy indicates that at least an additional 200 gigawatts of nuclear power capacity will be needed by 2050 to support its carbon neutrality goals. China has also explicitly put forward the principle of "actively, safely, and orderly developing nuclear power," and the scale and pace of nuclear power development have entered into a new level.

According to the China Nuclear Energy Association and related institutions, it is estimated that by 2035, the share of nuclear power in China's electricity mix will reach around 10%, comparable to the current global average level, and will reduce carbon dioxide emissions by approximately 900 million tons. By 2060, the share of nuclear power generation needs to reach about 18%, comparable to the current average level of OECD countries. However, the proportion of nuclear power installed capacity in China's power system now is only 2%, and its power generation is just 5%, far below the levels of developed countries. In nuclear power strongholds like France and the United States, the proportions of nuclear power generation are as high as 70% and 20%, respectively. From 2012 to 2022, China's nuclear power penetration rate increased from 2% to only 5%, which is also below the levels of developed countries.

Currently, China has 55 operational nuclear power units and 36 units approved and under construction, making its total installed capacity the second largest in the world. Meanwhile, China has maintained the largest scale of nuclear power construction globally for many years. China has been continuously building nuclear power plants for nearly 40 years and has the capability to construct 40 nuclear power units simultaneously. As a major energy producer and consumer, China has significant potential for future nuclear energy development and will continue to be a key market for global nuclear energy development. Meanwhile, more emerging countries are planning to develop or expand their nuclear power capacity. Among the countries that have signed Belt and Road Initiative international cooperation documents with China, 75 emerging countries plan to develop or expand their nuclear power capacity, indicating that the global focus of nuclear power development will further shift towards emerging countries.

### 2.1.3 Policy support and technical capabilities

On January 1, 2006, the "Renewable Energy Law of the People's Republic of China" was officially implemented. Its first chapter and the first article clearly state: "In order to promote the development and utilization of renewable energy, increase energy supply, improve energy structure, ensure

energy security, protect the environment, and achieve sustainable economic and social development, this law is enacted." Chapter three specifically addresses industry guidance and technical support, stating that the state prioritizes scientific research and industrial development of renewable energy utilization, incorporating it into national plans for science and technology development and high-tech industry development. Funds are allocated to support scientific research, application demonstrations, and industrialization of renewable energy development, aiming to promote technological advancements, reduce production costs, and enhance product quality. Since the enactment of the renewable energy law, China's renewable energy industry has entered a period of rapid development.

The development of renewable energy is a systematic endeavor that requires not only legal safeguards and guidance but also a series of top-level designs and constructions in terms of planning, policies, funding, and technology. In 2007, China introduced the "National Medium and Long-Term Renewable Energy Development Plan," and since 2009, it has successively proposed targets for the proportion of non-fossil energy in primary energy consumption for 2015, 2020, 2030, and 2050, along with energy development strategies. In May 2019, the National Development and Reform Commission and the National Energy Administration officially issued the "Notice on Establishing and Improving the Mechanism for Guaranteeing the Consumption of Renewable Energy Electricity," establishing weighted targets for the responsibility of consuming renewable energy electricity and identifying market entities responsible for consumption in various provinces and cities.

With solid policy support in place, China's development model for renewable energy is shifting towards high-quality development. Renewable energy will gradually become the mainstream source, with profound changes in technology types and application modes, and economic benefits will further manifest. With the advent of the 5G era, the electrification of China's future is an inevitable trend. The energy consumption from sectors such as industry, construction, and transportation will continue to grow, making low-carbon development in the power industry a necessary path for China's carbon transition. China will continue to focus on enhancing the proportion of renewable energy, reducing the consumption of coal and other fossil fuels, and promoting deep decarbonization in the power industry through reforms in institutional mechanisms and technological innovations.

Currently, China ranks among the world's leaders in the scale of clean energy development and utilization, with significant advantages throughout the entire clean energy industry chain. The effects of energy transition are evident, and clean energy development is progressing rapidly. Driven by clean energy technologies, China maintains world-leading indicators in hydropower, wind power, solar power, and nuclear power under construction, contributing to the world's largest clean power generation system. Simultaneously, China emphasizes the export of clean energy technologies, focusing on countries and regions with relatively abundant renewable energy resources and relatively low levels of local technology development. For instance, in Southeast Asia, China primarily exports hydropower technologies, while in South Asia and Central Asia, wind power technologies are predominant. Given the diversity of renewable energy resources in Africa, China's clean energy technology exports encompass various technologies such as hydropower, wind power, solar power,

and geothermal energy.

In conclusion, the International Energy Agency (IEA) [21] believes that China possesses technological and cost advantages, coupled with a long-term stable policy environment, playing an important role in promoting global energy revolution, especially in reducing global solar power generation costs.

## 2.2 Overview of green energy industry in Latin America

Like other regions of the world, Latin America faces severe challenges due to climate change. Global warming, La Niña, and El Niño phenomena are occurring in succession, leading to extreme weather changes that trigger hurricanes, droughts, and floods. For example, climate warming has begun to accelerate the melting of large glaciers in Chile and Argentina. The region's long coastline and numerous low-lying islands make it particularly vulnerable to rising sea levels, which also increases the risk of severe flooding. Areas such as the Amazon rainforest, Brazil's Pantanal wetlands, and Colombia's páramos possess rich biodiversity. However, even slight disruptions to these fragile ecosystems can trigger exponentially larger chain reactions on a global scale, especially within the region. Therefore, increasing the use of renewable energy and reducing carbon emissions are crucial for Latin America. Currently, many Latin American countries have made energy transition a core component of their national sustainable development agendas and have introduced a series of comprehensive support policies.

### 2.2.1 Renewable energy resources

Latin America is often referred to as a region favored by the heavens, with abundant renewable energy resources. It boasts the world's richest solar and wind energy resources. With long hours of sunshine and intense solar radiation, as well as dense wind energy, the region also possesses abundant hydroelectric resources. The Amazon River, for instance, is the world's largest river by discharge volume, drainage area, and number of tributaries. More than half of the electricity supply in this region comes from hydroelectric power, with countries like Brazil, Paraguay, Panama, Uruguay, Venezuela, and Colombia relying on hydroelectric power for over 60% of their total electricity generation. According to Global Renewable Energy Outlook by IRENA, the investment demand for renewable energy in Latin America and the Caribbean is estimated to be \$45 billion annually by 2050, with each dollar invested yielding economic returns of \$3-8.

Due to its immense natural potential, Latin America has become one of the most promising regions for renewable energy generation globally. As of the end of 2022, Latin America ranked fourth in renewable energy generation capacity, following Asia, North America, and Europe. The region benefits from abundant natural resources such as the Sonora and Atacama deserts in Mexico and Chile, strong winds in the Patagonia region of Argentina, and vast coastlines in Brazil, making it a leader in non-traditional renewable energy potential worldwide. Additionally, thanks to its extensive water bodies, the region traditionally has strong hydroelectric power capabilities, with rivers like the Amazon, La Plata, and Orinoco providing ample resources for hydroelectricity in Brazil, Argentina, Uruguay, Paraguay, Colombia, and Venezuela.

In terms of renewable energy installed capacity, Brazil is indisputably the leader in Latin America, with a capacity of

175.3 gigawatts as of the end of 2022, more than five times that of the second-place Mexico with 31.7 gigawatts. While the non-traditional renewable energy (geothermal, biomass, nuclear, hydrogen, etc.) generation capacity of these Latin American countries has continued to grow steadily, hydroelectric power remains a major source of renewable energy generation and installed capacity. Chile is one of the fastest-growing markets for non-traditional renewable energy generation in Latin America, ranking third with an installed capacity of 17.9 gigawatts, followed by Venezuela and Argentina, mainly due to their strong hydroelectric resources. Colombia ranks sixth, with an installed capacity of 13.4 gigawatts as of the end of 2022.

The renewable energy industry in Latin America is developing rapidly, with many countries vigorously promoting clean energy, which is expected to become one of the engines driving the region's economic recovery. Several Latin American governments are also positioning clean energy development as a key driver for post-pandemic economic recovery, proposing relevant plans and initiatives for green recovery. A report by the energy research firm Rystad Energy forecasts that by 2025, clean energy installed capacity in Latin America is expected to skyrocket from the current 49 gigawatts to 123 gigawatts, representing a staggering 150% increase.

Major renewable energy-producing countries in Latin America have experienced rapid growth in capacity over the past decade, reflecting their significant development potential. As the largest economy in Latin America, Brazil leads the region in capacity for wind, solar, hydro, and biomass energy, with its capacity set to continue growing in the future. Additionally, Mexico, Argentina, and Chile, although trailing Brazil in wind, solar, and photovoltaic capacity, possess relatively competitive advantages in this area, making their capacity scale and growth trends noteworthy.

### 2.2.2 Nuclear energy

In Latin America, only three countries—Mexico, Argentina, and Brazil—have a total of seven nuclear power plants. These seven plants have an installed capacity of 5,069 megawatts, accounting for 1.29% of the global nuclear power installed capacity. Nuclear power's share of the total electricity generation in Latin America is relatively small, significantly lagging behind the global level. According to BP's 2020 data, nuclear energy currently accounts for only 6.03% of Argentina's total electricity generation, 2.58% for Brazil, and 3.09% for Mexico. However, all three countries using nuclear power in the region are seeking to expand its use and promote the adoption of next-generation and emerging nuclear technologies, aiming to significantly increase their nuclear power output.

In November 2019, Argentina's Ministry of Energy released the "Energy Vision 2030," which states that by 2030, nuclear power will account for 9.6% of its total electricity generation, continuing to advance its nuclear energy development plans. Brazil's President Bolsonaro, who took office in January 2019, promised to complete the Angra 3 nuclear power plant and explore the construction of new nuclear plants to boost nuclear energy's contribution to Brazil's electricity supply. In December 2020, Brazil's power company Eletrobras released the "Five-Year Business and Management Plan," stating that from 2021 to 2025, the company plans to invest about 41.1 billion Brazilian reais (approximately \$7.91 billion), with its nuclear power operating company receiving 47% of the

investment. In 2015, Mexico enacted the "Energy Transition Law," which set a goal for 35% of its electricity to come from clean energy sources, including nuclear, by 2024. In June 2018, Mexico's Ministry of Energy released the "2018-2032 National Electric System Development Program" (PRODESEN), which projected that over 15 years, the country's electricity demand would grow by an average annual rate of 2.8% to 3.6%, with plans to add three nuclear power units of 1,360 megawatts each in 2029, 2030, and 2031.

Currently, Latin America is undergoing an energy transition, making progress in developing renewable energy, enhancing energy efficiency, and other innovative technologies. However, these advancements are still insufficient to offset the region's growing electricity demand. Nuclear energy will play a crucial role in helping achieve its sustainable development goals and enhancing energy security.

### 2.2.3 Policies and measures

In recent years, Latin American countries have continued to introduce relevant policies and measures to accelerate the development of the green energy industry. In December 2019, under the framework of the United Nations Climate Action Summit, the Latin America and Caribbean Renewable Energy Initiative was officially launched, with the goal of having at least 70% of electricity come from renewable sources by 2030. Currently, countries in the region are striving to harness their resource advantages and potential, with many governments positioning clean energy development as a key driver for post-pandemic economic recovery and proposing related green recovery plans and initiatives.

The Brazilian Congress plans to introduce a bill to reduce tariffs on imported production equipment and parts for qualifying green energy companies. The Brazilian National Bank for Economic and Social Development has also pledged to provide these companies with the most favorable long-term low-interest loans available on the market. According to forecasts from Brazil's National Energy Agency, the total investment in the country's electricity industry will exceed \$30 billion by 2035, with 70% of this investment going to renewable energy technologies such as solar photovoltaics, wind power, biomass, and ocean energy. By 2035, Brazil is expected to have over 800,000 solar photovoltaic systems, with an installed capacity exceeding 2,000 megawatts.

Chile has passed the Energy Efficiency Law, which mandates that large enterprises establish corresponding energy management systems and regularly report their energy consumption to the Ministry of Energy. New residential buildings must have energy efficiency labels, allowing the public to clearly understand the energy efficiency of homes, providing a reference for home purchases. The law also encourages the adoption of electric vehicles. By 2030, Chile is projected to save \$15.2 billion and help reduce carbon dioxide emissions by 28.6 million tons.

The Colombian government has formulated a "Clean Growth" plan, aiming to increase the overall installed capacity of solar and wind energy from less than 50 megawatts in 2018 to 2,500 megawatts by 2022. The government has proposed 27 strategic renewable energy and transmission projects, including nine wind energy projects, five solar energy projects, three geothermal projects, one hydrogen project, and nine transmission lines, with a total investment exceeding 16 trillion pesos (approximately \$4.54 billion). These initiatives are expected to create over 55,000 jobs in Colombia. Additionally, with the growing demand for electric and natural

gas vehicles, the country aims to reduce the demand for liquid fuels, diesel, and gasoline by 20% by 2050.

In Peru, 50% of electricity is generated from hydropower, with solar and wind energy accounting for 5%. The Ministry of Energy and Mines in Peru has announced plans to invest more than \$3.3 billion to build 23 new power plants, with a total installed capacity of 2,045 megawatts. Of these, 22 are renewable energy projects, primarily hydropower, solar, and wind power plants, accounting for 99.1% of the total installed capacity. Only one is a traditional thermal power plant, making up just 0.9% of the total installed capacity.

Based on the policy environment and market demand in these key Latin American countries, international rating agency Fitch believes that the momentum for investment in the Latin American renewable energy industry will continue, with a promising outlook. "Latin American Economic Outlook 2022" report from OECD also indicates that the energy structure in Latin America is increasingly optimized, with a clear trend towards environmental sustainability: renewable energy accounts for 33% of the region's total energy supply, compared to 13% globally. The report highlights that the development of renewable energy in Latin America holds significant potential, and advancing the green energy transition will help alleviate regional development imbalances, promote the achievement of economic, social, and environmental sustainable development goals, and meanwhile enhance public well-being.

### **3. CURRENT STATUS AND OBSTACLES OF CHINA-LATIN AMERICA GREEN ENERGY COOPERATION**

#### **3.1 Cooperation status**

Trade cooperation between China and Latin America began in 1993, marking the commencement of energy cooperation between the two regions as well. Over the past three decades, China and Latin America have engaged in various businesses such as oil and gas import-export and investment development in oil and gas fields, with Latin America becoming an important region for China's oil imports. In recent years, facing the task of balancing economic development and environmental protection, both China and several Latin American countries have introduced a series of measures to promote the development of clean energy. Green energy cooperation has become a new highlight and driving force for economic and trade exchanges between the two regions. With the China-Latin America Community as a foundation, both sides have gradually established a relatively sophisticated mechanism for clean energy cooperation. The cooperation model continues to be optimized, and the scope of cooperation encompasses multiple fields including hydropower, wind power, solar power, biomass energy, and nuclear energy, resulting in fruitful cooperation projects and outcomes.

##### **3.1.1 Cooperation mechanism**

In January 2015, at the inaugural ministerial meeting of the China-Latin America Forum (China-CELAC Forum) held in Beijing, both sides jointly formulated the "Cooperation Plan between China and Latin American and Caribbean Countries (2015-2019)". The plan clearly stated the need to strengthen cooperation and investment between the two sides in the field of electricity, including power generation, high-voltage and ultra-high-voltage transmission, water resource planning and

development, as well as biomass, solar, geothermal, and wind energy. It also emphasized the importance of enhancing training programs for technical personnel and experts in the field of renewable energy management and development.

In 2018, the second ministerial meeting of the China-CELAC Forum adopted the "Joint Action Plan for Cooperation in Priority Areas between China and CELAC Member States (2019-2021)", which identified the environment as a priority area for cooperation between the two sides. In 2021, the third ministerial meeting of the China-CELAC Forum adopted the "Joint Action Plan for Cooperation in Key Areas between China and CELAC Member States (2022-2024)", which explicitly stated the need to promote cooperation in energy resources between the two sides, particularly the transition to cleaner and more inclusive energy systems, as well as the expansion of cooperation in emerging industries related to clean energy resources. In the same year, Chinese President Xi Jinping proposed the Global Development Initiative (GDI) at the 76th session of the United Nations General Assembly, aimed at promoting global sustainable development and achieving the United Nations' sustainable development goals by 2030. The initiative pledged China's strong support for the green and low-carbon development of developing countries, and the cessation of new overseas coal-fired power projects.

Under the framework of these mechanisms and close cooperation among China and Latin American countries, a series of clean energy projects have been implemented, becoming exemplary cases of exchange, technology transfer, and project cooperation in clean energy between the two regions.

##### **3.1.2 Cooperation model**

Energy cooperation is a complex endeavor that involves relevant policies as well as international rules and conventions. Given the specificity of cooperation in the energy sector, clean energy cooperation between China and Latin America is primarily driven by government-to-government and state-owned enterprise investments and loans, utilizing international cooperation mechanisms for bilateral negotiations. In recent years, with the improvement of the "Belt and Road" cooperation mechanism, Chinese private enterprises have also increased their overseas cooperation in the clean energy sector. Overall, clean energy cooperation between China and Latin America has evolved from a single engineering contracting model to an integrated model of "investment + construction + operation". Since the end of the 20th century, international engineering contracting has transitioned from a "separation of construction and financing" model to a "contracting with capital" model, supported by strong efforts from the Chinese government to transform overseas expansion of Chinese power companies towards the "construction-operation-transfer" (BOT) model and "contracting with capital" model. After the financial crisis of 2008, the investment and financing capabilities of Western countries declined, while Chinese enterprises and banks accelerated their pace of overseas investment layout. From 2009 to 2020, Chinese enterprises and policy banks invested and financed a total installed capacity of 24.3 gigawatts in the Latin American clean energy sector through acquisitions, greenfield investments, and loans.

Currently, the "investment + construction + operation" model, which combines investment and financing with engineering contracting and project operation, is gradually becoming the mainstream mode of clean energy cooperation

between the two sides. China's two global policy banks—China Development Bank (CDB) and China Export-Import Bank (CEXIM)—are gradually becoming the largest sources of energy financing for governments worldwide. In terms of installed capacity, the Latin American region has received substantial loans from these two banks for clean energy, with an estimated contribution of 2,827 megawatts from CEXIM and 1,507 megawatts from CDB for Latin American clean energy from 2000 to 2032.

In addition, trust funds related to clean energy investment are continuously emerging. In 2014, the China-Latin America Cooperation Fund was officially launched, primarily targeting private equity investment in Latin America, with a scale of \$10 billion, aimed at strengthening cooperation and upgrading between China and Latin America in clean energy, infrastructure, finance, and other areas. As of 2021, the fund has invested \$680 million in four countries including Brazil and Peru, implemented 11 projects, involving clean energy, electricity, and other industries. Despite multiple challenges such as the spread of the COVID-19 pandemic, exchange rate fluctuations, and political instability, it has achieved a good internal rate of return, becoming a stabilizer for clean energy cooperation between China and Latin America [22].

### 3.1.3 Cooperation areas and projects

Hydropower is a key area of cooperation between China and Latin America. China possesses mature technology and expertise in hydropower, accounting for over 70% of the global hydropower market share and has constructed numerous large and medium-sized hydropower projects overseas. Since 2015, China's hydropower investments in Latin America and around the world have risen rapidly, peaking in 2017, with Latin America accounting for 73% of China's hydropower investment installed capacity that year. From 2000 to 2032, China's projected installed capacity for overseas hydropower investment is estimated at 49,414 megawatts, with 20,567 megawatts invested in Latin America, accounting for 42% of China's overseas hydropower investment, making it the largest region for Chinese hydropower investment. In addition to direct investment and financing for hydropower stations, Chinese companies are also actively involved in local transmission and distribution construction in Latin America. A prime example is State Grid Corporation of China's investment, construction, and operation of the transmission project for the Belo Monte hydropower station in Brazil. This project is the world's longest  $\pm 800$  kV high-voltage direct current transmission project, creating an "electricity highway" for Brazil. Along the route, 22 million people benefit, accounting for approximately 10% of Brazil's total population. This project not only promotes the internationalization of Chinese enterprises and technologies but also effectively addresses the electricity supply difficulties in southern Brazil, improving local livelihoods there.

- In the field of wind power, according to data from the China Global Power Database, it is estimated that China's wind power investment installed capacity in Latin America from 2000 to 2032 will reach 4,170 megawatts, accounting for 34% of total foreign wind power investment, surpassing Europe to rank first. China's wind power investment is mainly concentrated in countries such as Brazil, Mexico, Argentina, and Chile. China National Electric Power Investment Corporation cooperated with Chile to invest in and construct the Punta

Sierra wind farm on the outskirts of Ovaey in northern Chile. With a total installed capacity of 82 megawatts and a total investment of nearly \$150 million, it was completed and put into operation on August 24, 2018. The annual average electricity generation is 282 gigawatt-hours, which not only meets the electricity needs of 130,000 Chilean households but also reduces carbon emissions by 157,000 tons per year. On November 25, 2021, the LDB wind power expansion project, a cooperation between China Guangdong Nuclear Power Group and the Brazilian energy company, was completed and put into operation. Located in Piauí State, Brazil, this project is the first greenfield wind power project independently developed and constructed by China Guangdong Nuclear Power Group. It not only alleviates Brazil's energy shortage but also marks the successful application of mature wind power technology from China in Latin America, paving the way for future self-sustaining development. On February 27, 2020, the Romang Blanca wind power project in Argentina, constructed by China Energy Engineering Group, was successfully connected to the grid and began supplying electricity to local residents. With an installed capacity of 354.6 megawatts, the project can help Argentina reduce the burning of 650,000 tons of coal and 1.8 million tons of carbon emissions annually.

- In the field of solar energy, it is estimated that China's solar energy investment installed capacity in Latin America from 2000 to 2032 will reach 2,250 megawatts, accounting for 30% of total foreign solar energy investment. China's solar energy investment in Latin America is mainly distributed in countries such as Mexico, Brazil, and Argentina. 2022 was a fruitful year for Sino-Latin American cooperation in the solar energy sector. On September 26, 2020, the Gaucho 300-megawatt photovoltaic power project, a cooperation between China and Argentina, obtained approval from the local electricity department and officially commenced operations. This project is Argentina's largest photovoltaic power project and can meet the electricity needs of at least 60,000 households. On November 17, 2022, the "Sol do Cerrado" solar park, a cooperation between China's JinkoSolar Holding Co., Ltd. and Brazil's Companhia Vale do Rio Doce, was launched and put into operation. The photovoltaic modules and components used in the park are all supplied by JinkoSolar. This project is one of the largest solar projects in Latin America, with 1.4 million solar panels and a maximum installed capacity of 766 megawatts, and can provide electricity consumption for 800,000 residents. As a result, Companhia Vale do Rio Doce will reduce annual carbon dioxide emissions by 134,000 tons.
- In the fields of biomass energy and nuclear energy, cooperation between China and Latin America has also strengthened. Nuclear cooperation between China and Latin America began in the early 1980s, with China selling nuclear fuel to Brazil and Argentina [23]. To date from the China Overseas Power Assets Database, Chinese enterprises have invested in biomass energy projects in Brazil, with an installed capacity of up to 768 megawatts. CPFL Nova Energia, a subsidiary of State Grid International Development Ltd., holds multiple projects. In 2018, Sinfeng Environmental Industry Group's subsidiary, Sinfeng Caranta, signed a contract to



supply equipment for an incinerator and waste heat boiler for a garbage power generation project in Barueri, Sao Paulo, Brazil, becoming one of the representative projects of Sino-Brazilian biomass energy cooperation. Argentina is a key country for Sino-Latin American nuclear energy cooperation. In February 2015, China and Argentina signed agreements on the construction of pressurized water reactor nuclear power plants and heavy water reactor nuclear power plants in Argentina, marking the formal export of Chinese nuclear power technology to Latin America. Currently, China's "Hualong One" technology has been successfully applied in the construction of nuclear power plants in Argentina (such as Atucha 3), opening a new chapter in Sino-Latin American nuclear energy technology cooperation.

Currently, China has become the country providing the most financing and conducting the most cooperation projects in Bolivia. Dozens of Chinese companies are operating in Bolivia, mainly in projects such as hydropower stations, wind power, and communication projects. These projects are fundamental industries for the economic and social development of Bolivia. The completion of these projects will strongly promote the economic and social development of Bolivia, which is also one of the main target countries for China's government-to-government economic cooperation projects in Latin America. China has implemented more than a dozen cooperation projects in Bolivia, including small hydropower stations and rural electrification, achieving good economic and social benefits.

### 3.2 Obstacles to cooperation

Latin America has abundant renewable energy resources, albeit with concentrated distribution. However, its infrastructure and technological capacities lag behind, compounded by fiscal constraints and susceptibility to U.S. influence. Consequently, while Sino-Latin American green energy collaboration has made significant strides and shows promising potential, there are still substantial barriers.

#### 3.2.1 Policy and regulatory obstacles

At present, China's foray into the global clean energy arena remains at a nascent stage, necessitating an ongoing exploration of institutional frameworks and industry standards. In terms of institutional development, the alignment between government policies and corporate strategies in Sino-Latin American clean energy collaborations requires refinement, with an evolving international paradigm emphasizing competitive enterprises guided by governmental directives. Concurrently, many clean energy projects are still in the exploratory phase, presenting Chinese firms with challenges throughout the bidding, project execution, and management transition processes. Consequently, there's a pressing need for Chinese clean energy enterprises to continually enhance their institutional capacities during their global expansion efforts. Concerning industry standards, divergences between Chinese entities and their Latin American counterparts pose communication barriers and complicate harmonization efforts. Overall, discrepancies and conflicts in green energy policies and regulations between the two regions, coupled with incomplete regulatory frameworks in certain Latin American nations, manifest in variations in technology standards, certification protocols, safety assessments, and other regulatory aspects. These differences

are consequently erect policy impediments for Chinese enterprises investing and operating in Latin America.

Furthermore, a notable absence of long-term strategic initiatives to overhaul energy structures prevails across most Latin American countries. From Mexico to Argentina, governments are poised to persist in the development of new oil and gas ventures for both domestic consumption and export purposes in the forthcoming decades. This trajectory not only poses challenges in realizing climate change mitigation objectives but also exposes the region to significant risks associated with stranded assets, spanning from pipelines to thermal power installations.

#### 3.2.2 Technological gap

Latin America is endowed with abundant clean energy resources such as hydropower, wind power, and solar energy. However, the inherent instability of clean energy generation poses significant challenges to power quality when integrated into the grid, compromising the security of power systems. Particularly, wind and solar power generation demand high stability and robust storage facilities, given their intermittent, random, and fluctuating nature influenced by weather conditions. Presently, Latin America's wind and photovoltaic infrastructure is insufficient to ensure the stable operation of power systems and cannot accommodate large-scale clean energy generation, representing a significant barrier to Chinese clean energy investments in the region. Additionally, the distribution of clean energy resources in Latin America is uneven, and the region lacks comprehensive transmission and distribution equipment and corresponding grid dispatching capabilities, adding complexity to the advancement of clean energy. Insufficient generation capacity, inadequate supporting grids, storage facilities, and grid dispatching capabilities exacerbate these challenges. For instance, in 2001, Brazil experienced a major crisis during a drought, losing 20% of its national power supply. Despite the Brazilian government's utmost efforts to maintain the power system's operation, power shortages persist during drought seasons. This issue extends beyond Brazil, as the entire Latin American region faces the critical bottleneck of developing comprehensive power and storage systems essential for the sustainable advancement of clean energy.

#### 3.2.3 Financial barriers

Energy financing is characterized by large amounts and long cycles. Policy banks such as CDB and CEXIM from China, supported by national credit and substantial national savings, have traditionally been the main sources of overseas financing for China's conventional energy projects. However, non-hydropower clean energy financing in China and Latin America is primarily provided by private enterprises. Data from the Chinese Overseas Power Assets Database indicates that between 2000 and 2020, the majority of China's policy bank financing for clean energy in Latin America was concentrated in hydropower, with limited funding allocated to non-hydropower clean energy sectors. Due to the smaller asset scale of private enterprises, they often face financial constraints, posing challenges to Sino-Latin American green energy cooperation. Additionally, the considerable distance between the two regions means that project financing frequently encounters financial risks such as exchange rate and interest rate fluctuations, and lacks comprehensive investment risk prevention and compensation mechanisms.

### 3.2.4 Political and social risks

In the aftermath of the COVID-19 pandemic, political transitions and social unrest in Latin American countries have intensified, heightening the risks associated with bilateral clean energy cooperation. The pandemic has significantly increased poverty rates, unemployment, and income inequality in the region. By the end of 2022, the poverty rate had reached 32.1%, and the extreme poverty rate had climbed to 13.1%, both higher than pre-pandemic levels. Approximately 201 million people lack sufficient income to meet basic needs, leading to a surge in social conflicts and a decline in the business environment. This increase in social risks has also contributed to political instability. Due to the failure of right-wing governments to address poverty and inequality during the pandemic, many citizens have sought change. Latin America has a history of populism, and the public's strong desire for change can lead to governmental instability, accelerating regime changes and political turnovers. This volatility can adversely affect the early stages of investment and project implementation under Sino-Latin American clean energy cooperation. Currently, there is a trend of "leftward movement" in Latin American politics, but leftist governments face unstable governing environments. From late 2022 to early 2023, countries such as Brazil, Peru, and Bolivia experienced right-wing backlash, strikes, and protests. Leftist administrations in Latin America are grappling with domestic political crises and deteriorating investment conditions due to interference from right-wing and Western powers. The foremost tasks for leftist leaders will be economic recovery and addressing domestic political and social divisions, which are also critical prerequisites for deepening Sino-Latin American clean energy cooperation.

From a social governance perspective, differences in labor laws and environmental regulations between China and Latin American countries pose obstacles to clean energy cooperation. For example, Argentina's Condor Cliff and La Barrancosa hydropower projects, initially financed by Chinese policy banks, were halted by the Argentine Supreme Court due to non-compliance with local environmental regulations. Over the past two decades, several Chinese energy projects in Latin America have faced complaints, strikes, and protests. Notably, five major projects have encountered large-scale demonstrations by local populations: Peru's Block 1AB/8 oil project, Ecuador's Block 17 oil project in Orellana Province, Venezuela's Anaco natural gas project, Honduras' Agua Zarca hydropower project, and Brazil's Libra deep-sea oil field project [24].

### 3.2.5 American influence

As climate change continues to worsen, investment and cooperation in clean energy have become crucial components of great power competition, with the United States viewing climate policy as one of its key national security strategies. During his campaign, the Biden administration proposed ambitious climate plans, aiming to achieve carbon-free power generation by 2035 and net-zero emissions by 2050 through sustainable infrastructure and clean energy investments. Following Biden's election as president, the U.S. shifted away from its previous "energy dominance" policy and embarked on a "clean energy revolution," vigorously supporting clean energy investment and development to curb China's investments and development in clean energy from multiple angles. This signifies a period of competition and cooperation between China and the U.S. in the realm of low-carbon

economy and technology. The Biden administration has increased investment in domestic and international clean energy, seeking to utilize climate diplomacy to squeeze China's overseas clean energy investments. On August 16, 2022, Biden signed the \$750 billion "Inflation Reduction Act of 2022" (IRA), allocating \$369 billion for energy security and climate change, earning it the moniker of the "climate bill." The bill provides subsidies for purchasing electric vehicles, but these vehicles must be assembled in North America, with battery materials and "critical minerals" sourced from the U.S. or countries under free trade agreements (FTA), attempting to disrupt China's position in the global clean energy supply chain and rebuild a U.S.-centered global supply chain, thereby increasing the difficulty of China's investments in overseas clean energy industries. In order to limit China's investments in clean energy in Latin America, Biden announced an expansion of funding and technological assistance for clean energy in developing countries, including those in Latin America, under the guise of addressing climate challenges, making multiple visits to the region.

Given Latin America's traditional position in U.S. geopolitical strategy, the rising influence of China in the region's clean energy sector is likely to provoke concerns and suspicions from the U.S., potentially exacerbating competition between China and the U.S. in the clean energy sector in Latin America, inevitably affecting the effectiveness of Sino-Latin American green energy cooperation [25].

In conclusion, significant disparities exist between China and Latin American countries regarding various aspects of green energy, encompassing legal and policy frameworks, extraction technologies and infrastructure, economic and financial landscapes, market competition, and political risks, as well as pressures for environmental conservation and requirements for sustainable development. Both regions require further enhancement of public awareness and acceptance of green energy initiatives, while effective communication and coordination mechanisms between Chinese and Latin American enterprises remain lacking. Moreover, the linguistic and cultural disparities between the two sides pose formidable challenges to collaboration within the green energy sector.

## 4. POLICY SUGGESTIONS

### 4.1 Strengthen the policy coordination and communication

In the context of the "dual carbon" initiative, the prospects for cooperation in clean energy between China and Latin American countries are extensive, with clean energy diplomacy emerging as a pivotal channel for contemporary Chinese foreign engagement. Initiatives such as the inauguration of the "China-LAC Forum" and the issuance of the "Policy Paper on China's Relations with Latin America and the Caribbean" have established the institutional framework for deepening the strategic partnership between the two regions. Looking ahead, China and Latin America can leverage platforms like BRI and the China-LAC Community to foster deeper collaboration in clean energy through avenues such as project development, financial assistance, loans, capacity-building, talent cultivation, and technology transfer.

Concurrently, there is a pressing need to enhance communication mechanisms between enterprises and governments. Presently, private enterprises, particularly in

China's internationalization efforts in clean energy, play a pivotal role. However, they encounter challenges such as insufficient funding and credibility deficits in their ventures abroad. It is imperative to establish robust mechanisms for regular dialogue between governments and private enterprises, with developmental finance remaining instrumental in facilitating Sino-Latin American clean energy cooperation. Additionally, strengthening information exchange between the two parties, enhancing the transparency and coherence of green energy policies, and nurturing a specialized workforce familiar with policies in both regions are indispensable steps forward.

#### **4.2 Promote the technical transfer and cooperation**

In the field of technological talent, Latin America exhibits insufficient capacity for technological innovation, positioning itself at a disadvantage in the global clean energy value chain with a low stock of innovation capital. China's innovative technologies and technological talents in clean energy can help compensate for the technological research and development capabilities, patent application abilities, and labor quality deficiencies in Latin American countries. Both parties can establish a Sino-Latin American Clean Energy Technology Cooperation Alliance and a Sino-Latin American Technology Assistance Platform to facilitate exchanges of technological talents and information in the clean energy sector. As a leader among BRICS countries, China should further integrate into the global clean energy partnership network, leveraging clean energy diplomacy to enhance its structural advantages internationally. For instance, joining institutions such as IRENA and the Renewable Energy and Energy Efficiency Partnership (REEEP) can elevate the strategic partnership status between China and Latin America through multilateral relationship networks.

Through the development of internet technology, financial technology, and the digital economy, empowering clean energy network platforms can achieve collaboration in "Internet + Clean Energy." This approach encompasses big data, cloud computing, the Internet of Things (IoT), and other internet information technologies, enabling the digital transformation and upgrading of the clean energy industry in production, transportation, consumption, and other fields. Leveraging internet technology to establish Sino-Latin American clean energy trading platforms, financial platforms, and information sharing platforms can shape a new form of cooperation and development in the clean energy industry between China and Latin America. In the 21st century, characterized by the rapid development of the internet and the digital economy, building a Sino-Latin American clean energy network information sharing platform and conducting timely data exchange are crucial for achieving connectivity under BRI and promoting regional economic development. Utilizing 5G technology to improve navigation and communication systems in Latin America, supplementing geographic data related to clean energy development, enhancing the detection efficiency of energy projects, reducing the "rent-seeking costs" required for traditional cooperation, and avoiding delays in bilateral clean energy cooperation due to issues such as information opacity and asymmetry. Key areas of cooperation between China and Latin America in energy technology include advanced nuclear power technology, clean energy technology, and other high-tech core technologies. With continuous technological research and development and

the accumulation of experience, deeper exchanges in the technological field between China and Latin America will create greater benefits for both parties.

#### **4.3 Expand the financial channels**

Currently, China's overseas investments are primarily undertaken by state-owned enterprises. It is essential to strictly enforce internal management systems within these enterprises, enhance the risk prediction and control capabilities of management, and establish a robust "firewall" for enterprise investments. Additionally, given the lengthy investment cycles of clean energy projects, it is crucial to remain vigilant to potential economic and political changes during the later stages of investment and adjust energy investment strategies promptly. When disputes arise, efforts should be made to strengthen Sino-Latin American roundtable negotiation mechanisms, engage in bilateral or multilateral cooperation with Latin American countries, seek support and solutions, and regularly report progress to local governments.

Meanwhile, Chinese policy banks and financial institutions should conduct thorough risk assessments and increase support for green energy projects in Latin America through loans. They can issue special green energy funds and green bonds as financing tools, adopt diversified cooperation models, strengthen financing efforts from multilateral development financial institutions and third-party financial support, and actively explore innovative financing models such as carbon trading and carbon taxes to enhance financing capacity.

#### **4.4 Emphasize the evaluation of geopolitical risks**

Due to the relatively short duration of energy cooperation between China and Latin America, the main forms of cooperation have been joint ventures or construction projects, resulting in relatively few protest events. However, as Venezuela and Ecuador increase their dependence on Chinese funds and domestic political instability persists in both countries, the political risks associated with China's cooperation are steadily increasing. For example, in Ecuador, when President Rafael Correa announced the suspension of the Yasuni National Park protection project in 2013 and began to develop its oil resources, non-governmental organizations and environmentalists pointed fingers at China, accusing the government of sacrificing conservation initiatives to meet China's oil demands. Corresponding opinion polls showed that 90% of the population wished to preserve the Yasuni National Park intact and opposed oil extraction. In this context, Chinese enterprises are easily targeted by protests. When further promoting energy cooperation between China and Latin America, prudent selection of investment projects and rigorous pre-investment risk assessments should be a priority for Chinese companies.

At the same time, emphasis should be placed on multidimensional risk monitoring and strengthening the risk monitoring and management mechanisms for clean energy projects in Latin America. The overall stability of the region is lower than the average level of OECD countries, and clean energy project investments are typically large-scale, time-consuming, and technologically demanding. Therefore, it is essential to establish risk assessment models for investment. Comprehensive assessments of economic (debt levels, financial stability, degree of economic openness), political

(party stability, governance, corruption, policy regulation), social (social conflicts, external social contradictions, indigenous wishes), resource (extraction difficulty, energy production), environmental (pollution, carbon emissions), and operational and legal (tax policies, labor policies) risks faced by clean energy investments are necessary, along with the establishment of comprehensive risk information databases and the timely formulation of risk management plans. Faced with the frequent occurrence of social, operational, and legal conflicts in Sino-Latin American economic and energy cooperation in recent years, efforts should be made to strengthen communication among legislative bodies, law enforcement agencies, government officials, and corporate leaders from both sides to promote further development and improvement of relevant policies and regulations in Latin American countries. The Chinese government can engage in discussions with host country governments regarding legal and financial issues related to projects and establish legal exchange platforms to provide a favorable environment for Chinese enterprises entering the Latin American market.

Furthermore, it is important to prioritize clean energy cooperation with Central American countries. Since the 1990s, Central American and Caribbean countries have made significant progress in electricity supply through initiatives such as "bilateral and multilateral power interconnections" and encouraging competition in public and private investment. However, millions of people in the region still lack access to electricity. Therefore, China can leverage its own advantages to help build the electricity systems of low-income countries in Central America and the Caribbean, such as establishing model projects to gain recognition from regional countries, and minimizing competition by emphasizing cooperation with regional and external development assistance agencies. At the same time, it is crucial to strengthen cooperation with developed countries in third-party markets. Developed countries in Europe and America have comparative advantages in industry standards, consulting, and operational management in international cooperation on clean energy, while China possesses technological and experiential advantages in international clean energy cooperation. Therefore, looking ahead, seizing opportunities for third-party market cooperation in the process of clean energy cooperation in Latin America can fully leverage each party's strengths and enhance cooperation efficiency.

## 5. CONCLUSION

The IEA stated in the "2023 Energy Technology Outlook" that countries around the world are taking action to expand the clean energy manufacturing industry, promote the transition to net-zero emissions, strengthen energy security, and secure a place in the new global energy economy competition. As the world's largest energy consumer, producer, importer of oil, and emitter of carbon dioxide, China is at a turning point in its transition to a low-carbon future. China's interests in energy security, economic development, and sustainable growth are increasingly aligned with global common interests. In the field of global energy governance, China is gradually transitioning from an outsider to an insider, from following to exerting influence, thus exerting a significant impact on both its own country and the world.

While achieving its own clean and low-carbon development, China is also contributing to global energy

transition and climate change mitigation with the "Chinese solution." Especially under BRI, China actively establishes cooperation mechanisms for green and low-carbon development with BRI partner countries and international organizations, jointly promoting green development and addressing climate change, which has become an inherent part of BRI construction. In the future, relying on technological innovation, a well-developed industrial chain and supply chain system, and vigorous market competition, China will achieve rapid development of the new energy industry. It will continue to engage in extensive international cooperation with a more open attitude, bringing green development opportunities to countries worldwide. As co-builders of BRI, many countries in Latin America engaging in green technology cooperation with China and sharing experiences in green development will effectively promote innovation and development in various fields such as green energy and green infrastructure in the region. They will strengthen policy dialogue and seize new opportunities for jointly promoting green development under BRI, deepen cooperation in various aspects of the green economy, and jointly enhance the level of sustainable development.

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