

Executive Summary

RENEWABLE ENERGY MARKET ANALYSIS

LATIN AMERICA



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ABOUT IRENA

The International Renewable Energy Agency (IRENA) is an intergovernmental organisation that supports countries in their transition to a sustainable energy future, and serves as the principal platform for international co-operation, a centre of excellence, and a repository of policy, technology, resource and financial knowledge on renewable energy. IRENA promotes the widespread adoption and sustainable use of all forms of renewable energy, including bioenergy, geothermal, hydropower, ocean, solar and wind energy, in the pursuit of sustainable development, energy access, energy security and low-carbon economic growth and prosperity.

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Latin America hosts some of the world's most dynamic renewable energy markets, building on the historical role of hydropower – the cornerstone of the region's power sector development – and liquid biofuels, driven by Brazil's early determination to diversify its transport fuel mix.

Since 2004, renewable energy investment in the region (excluding large hydropower) has grown 11-fold, in comparison with a 6-fold increase worldwide. Investment trends attest to the rapid evolution of the region's energy mix towards a more diversified set of technologies and countries. For the first time in 2015, in addition to Brazil, both Mexico and Chile joined the list of the top 10 largest renewable energy markets globally.

In recent years, energy security has been a key driver for energy diversification to limit adverse macroeconomic effects due to the high reliance on fossil fuels and to reduce vulnerability to recurring climate events impacting hydropower generation. The imperative to decarbonise, together with national energy security concerns, in the context of rapidly falling costs of non-hydropower renewables, provides a compelling case for broader renewable energy development in Latin America.

Enabling policies have played a decisive role in the region's uptake of renewables. Policy instruments, from renewable power auctions, to solar thermal requirements, to biofuels blending mandates, have helped drive crucial cost reductions. Latin America boasts highly competitive development costs, notably for onshore wind and more recently, solar photovoltaic. In addition, policy makers increasingly recognise renewables as a catalyst for job creation, GDP growth, development of local industries, and energy access. For countries with high shares of hydropower, investment in non-hydropower renewables promises valuable complementarities – climatic, technical and economic – and greater power system reliability.

Renewable Energy Market Analysis: Latin America aims to capture the region's wealth of knowledge and draw key lessons from the region's experience. Building on earlier IRENA work, this ambitious report identifies emerging renewable energy trends and explores key themes at the intersection of public policy and market development.

Among those themes is the evolving investment landscape. While investment depends on country conditions, common factors – chiefly, access to funding and the cost of finance – underlie successful experiences across the region. The ability to leverage local capital, including from Latin America's strong national development banks, and to allocate risks between the public and private sectors, will be crucial to raise finance for renewables.

Energy security, environmental sustainability and economic competitiveness are all at stake in the region's delicate balancing act. With low technology costs, rapid policy learning curves and some of the world's best resources, rising energy demand presents an opportunity for the region to move to a more sustainable energy system based on higher shares of renewables.

Latin America's policies and achievements, furthermore, bring valuable insights for other renewable energy markets. IRENA's series of regional market analyses consolidates the growing knowledge on policies, finance, costs, benefits, resource potential, technologies and other dimensions into a coherent narrative. This report provides a strong basis to disseminate best practices for renewable energy development, both among countries in the region and in other regions that see comparable challenges and opportunities.



Adnan Z. Amin
Director-General
IRENA



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EXECUTIVE SUMMARY

TOWARDS A MORE DIVERSIFIED MIX OF TECHNOLOGIES AND COUNTRIES

Latin America¹ has seen significant investment in renewable energy in recent years, exceeding USD 80 billion over the period 2010-2015 (excluding large hydropower²). In 2015, total renewable energy investment in the region amounted to USD 16.4 billion, representing about 6% of the global total. The composition of these investments attests to the rapid evolution of the region's energy mix towards a more diversified portfolio of renewable energy sources (figure ES. 1).

Between 2005 and 2009, Brazil accounted for over 70% of renewable energy investment, but since 2010 the gap between the top investment market and the rest of the region has been progressively narrowing. In 2015, investment in Brazil represented a little over 40% of the region's total, equivalent to USD 7.1 billion (Bloomberg New Energy Finance, 2016).

The second highest destination was Mexico, where renewable energy investment doubled between 2014 and 2015 to reach USD 4 billion. Chile ranked

third with USD 3.4 billion invested, a 150% growth from 2014. For the first time, in 2015, both Mexico and Chile joined Brazil on the list of the top 10 renewable energy markets globally. Uruguay comes fourth with investment of around USD 1.1 billion. After a record year in Central America in 2014, activity slowed down in 2015, with the notable exception of Honduras, the region's highest investment destination for renewables as a share of GDP. In addition, IRENA estimates total regional investment in large hydropower at USD 9 billion in 2015.

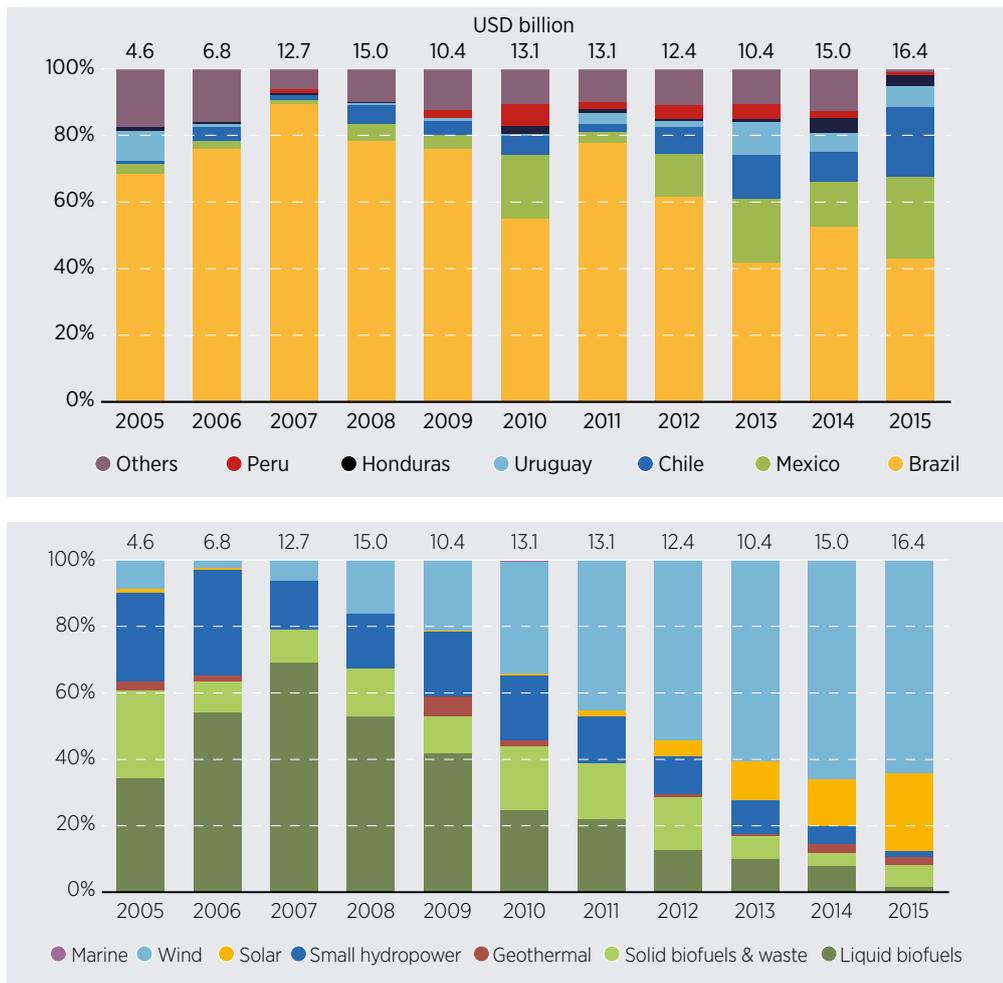
By technology, the trend over recent years reflects a decrease in investment in liquid biofuels, compensated by remarkable growth in wind investment and, more recently, solar. Lower investment in liquid biofuels in Brazil since 2008 is one of the reasons for the decline in aggregate investment between 2009 and 2013. In the past three years, surging investment in wind represented about two-thirds of renewable energy investment, excluding large hydropower, mostly led by Brazil, Uruguay and more recently Mexico. Since 2012, the region has seen the emergence of solar photovoltaic (PV) as a significant focus of investment, mainly in Chile, Brazil and Mexico.

1. The five main sub-regions used in this report to highlight key trends are the following: Mexico; Central America (Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama); Andean States (Plurinational State of Bolivia, Colombia, Ecuador, Peru and Bolivarian Republic of Venezuela); Brazil; and Southern Cone (Argentina, Chile, Paraguay, and Uruguay).

2. Bloomberg New Energy Finance considers as large hydropower those plants larger than 50MW.



Figure ES.1 Investment in renewable energy, 2010-2015: by country (top) and by technology (bottom)



Source:
Bloomberg New
Energy Finance, 2016

LATIN AMERICA'S CHANGING ENERGY SUPPLY AND DEMAND PROFILE

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Rapid growth in energy demand amid energy security concerns and increasing climate impacts present Latin American countries with an opportunity to rethink their energy mix. The region is endowed with vast energy resources, both fossil and renewables. The prominence of oil and gas in the region's energy mix largely derives from Latin America's role as a key oil and gas producer with some of the world's top 10 oil exporters. Oil, accounting for 46% of the region's primary energy supply (TPES) in 2013 (figure ES. 2), holds a much higher share than the world average of 31%. Oil is used mainly in transport, while its use in other sectors has decreased. In the power sector, it has been substituted mainly by natural gas which makes up 23% of TPES.



At the same time, Latin America has one of the largest shares of renewables, deriving from the historical development of hydropower and bioenergy. Bioenergy is mainly used in the industrial and transport sectors, and its share in TPES has decreased since 1990, due to the declining use of solid biofuels in the residential sector. It accounted for 16% of TPES in 2013. The share of hydropower has been slowly but steadily declining since 1990, representing 8% of TPES in 2013 (figure ES. 2).

Transport and industry dominate regional energy consumption. Transport represents a larger share than in other major regions of the world, due mainly to a less efficient vehicle fleet and differing modal composition. A higher energy use in industry partly reflects the economic structure of Latin America and the important role of energy-intensive industries, in particular extractive industries. The relatively small residential consumption is partly due to the lower use of space heating appliances due to mild weather. However, the use of cooling in some sub-regions is rapidly increasing.

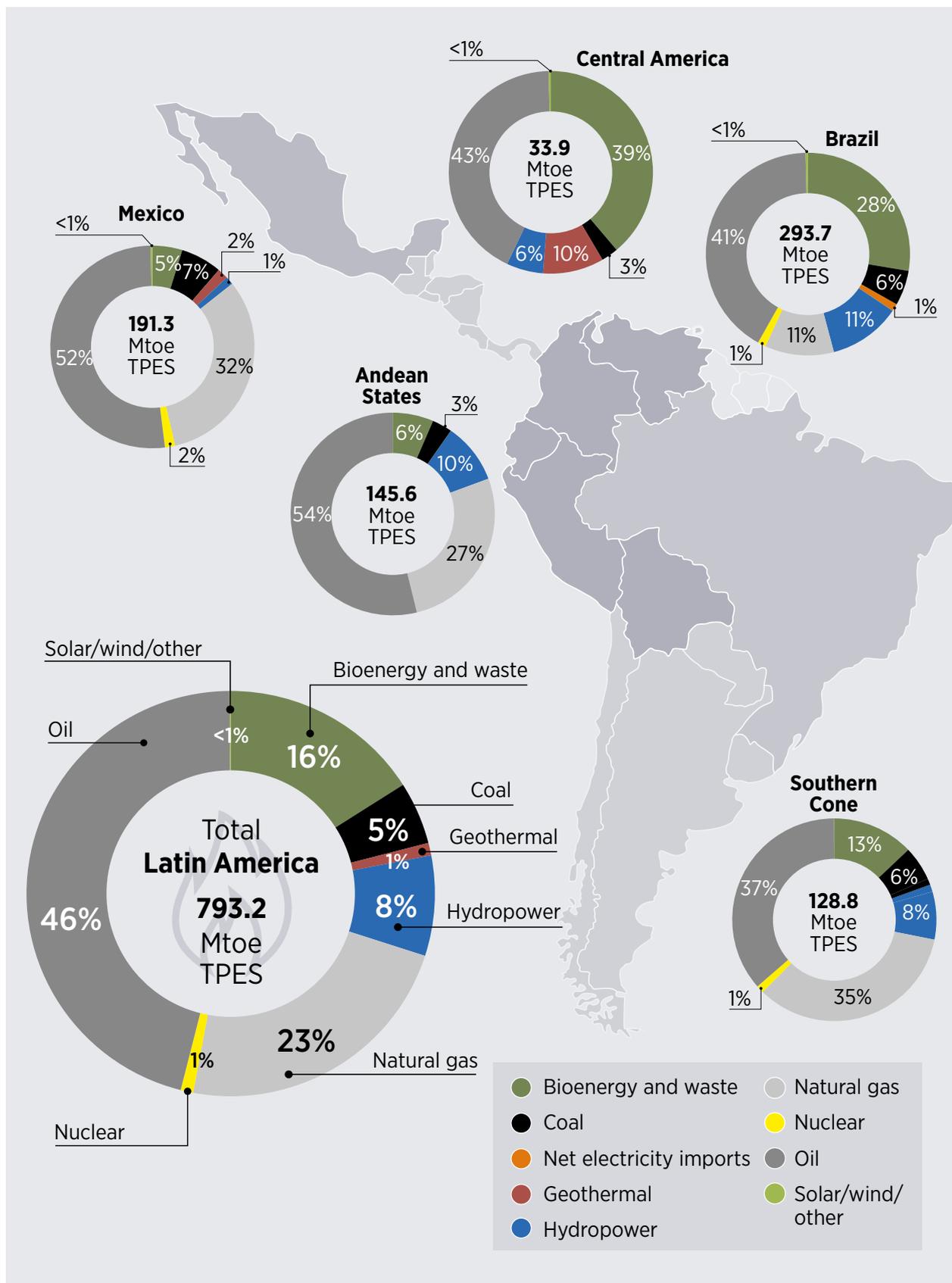
Power generation in Latin America has been expanding at a steady pace, and more than quadrupled between 1980 and 2013, increasing its contribution to total final energy consumption more than any other source. Electricity demand growth has been driven largely by economic growth, urbanisation, higher living standards and the successful expansion of electricity access, which currently reaches close to 95% of the population. While hydropower remains the main electricity generation source, natural gas and non-hydropower renewables are the fastest growing.

THE RISE OF NON-HYDROPOWER RENEWABLES

A distinctive feature of Latin America's power generation mix is the predominance of hydropower, due largely to the high share in Brazil, which generates 40% of total regional electricity – almost twice as much as Mexico. However, the relative share of hydropower in total renewable capacity has been steadily declining, from 95% in 2000 to 83% in 2015, due to slower capacity additions and the concerns created by major droughts across the region. As a result, recent years have seen impressive growth in non-hydropower renewables, whose installed capacity has more than tripled between 2006 and 2015, from 10 GW to 36 GW (IRENA, 2016a; figure ES. 3).

Bioenergy for power and onshore wind are the two technologies whose capacity has grown the most in absolute terms since 2000. The main bioenergy generation source is bagasse (sugarcane residue), primarily found in Brazil. Wind power is growing the most in Brazil, where a record capacity of 2.7 GW

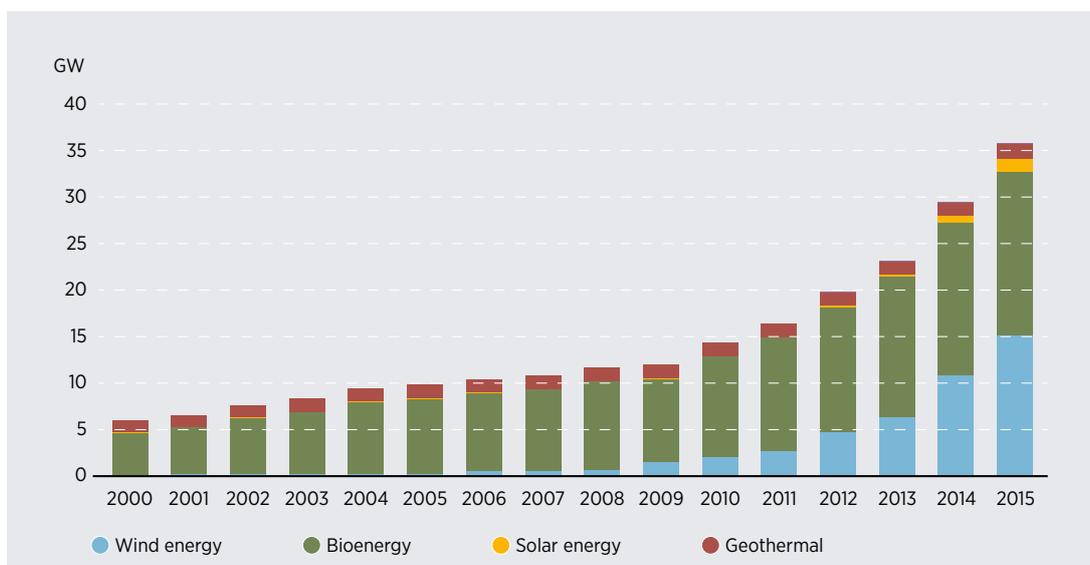
Figure ES.2 Total primary energy supply by sub-region in 2013



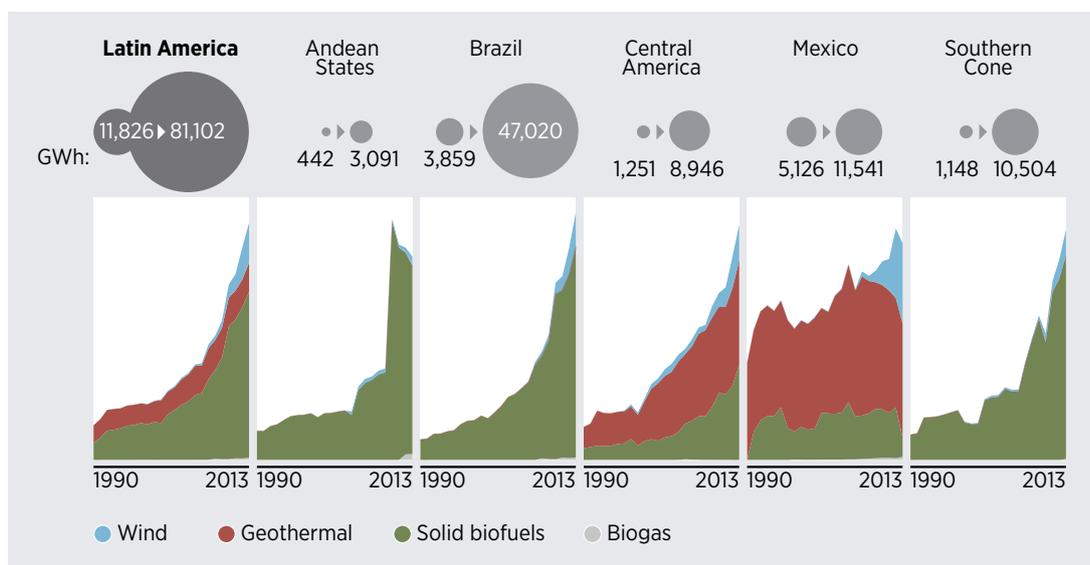
Source: IEA, 2015

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Figure ES.3 Renewable power capacity (top) and generation (bottom), excluding large hydropower



Source: IRENA, 2016a



Source: IEA, 2015

was commissioned in 2015 – almost three times the level installed in 2013. Mexico added 700 MW of wind power in 2015, doubling 2013 additions. Uruguay and Panama also significantly increased their wind capacity in 2015, with additions of 300 MW and 230 MW, respectively.

The share of geothermal power in the region has remained stable in Mexico, Costa Rica, El Salvador and Nicaragua, with capacity growing at the same pace as overall renewable power capacity. Installed capacity of solar power (mainly PV) remains relatively small, but has grown significantly in recent years in Chile, Mexico, Peru and Uruguay.

The diversification towards non-hydropower renewables is also reflected at the sub-regional level (figure ES.3). All Latin American sub-regions show exponential growth for non-hydropower renewable electricity, despite significant local differences. These developments have created opportunities to benefit from complementarities between large hydropower and other renewable energy technologies.

COMPLEMENTARITY BETWEEN HYDROPOWER AND OTHER RENEWABLES AS A LEVERAGING FACTOR

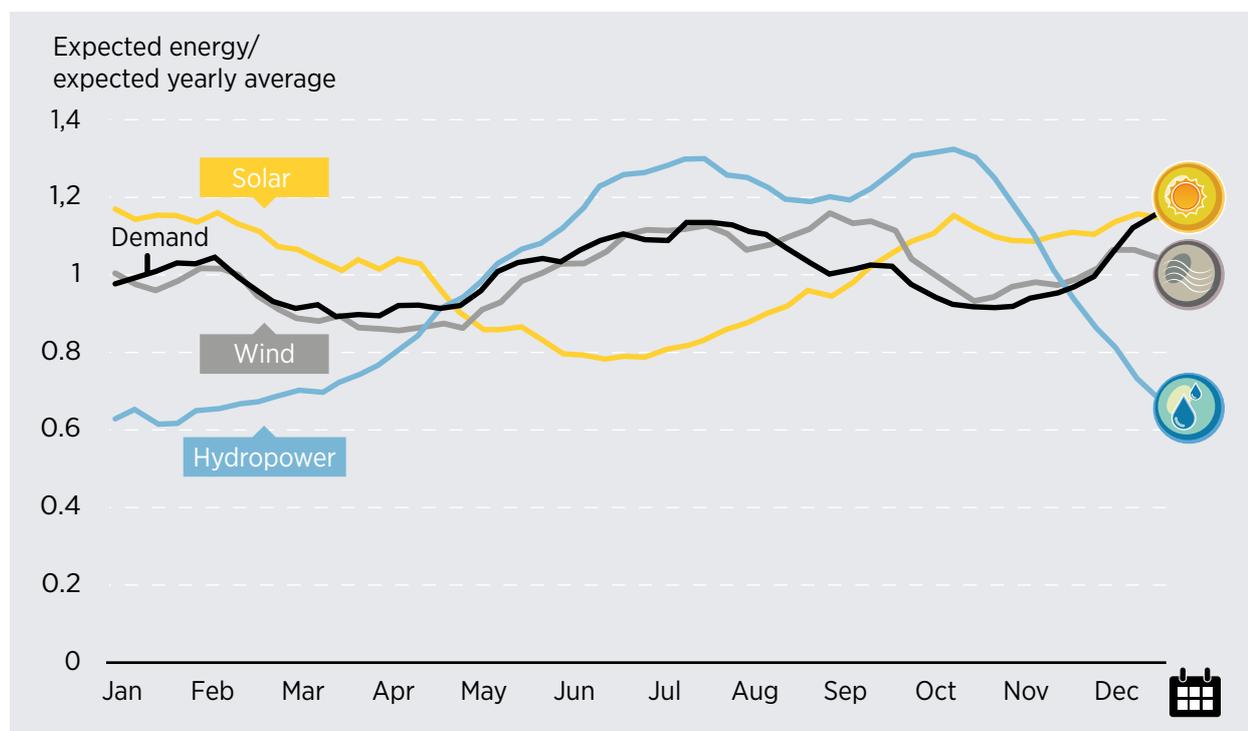
The high share of hydropower in the electricity mix of some Latin American countries (from 100% in Paraguay to 9% in Mexico, and averaging 50% for the whole region) creates opportunities for scaling up other renewable energy technologies, particularly by harnessing a range of complementarities. Chief among these are climate synergies (figure ES. 4) (non-hydropower renewables can compensate reduced hydropower supply in dry seasons, recently exacerbated by climate variability); improved economic performance and reliability of power systems (hydropower with reservoirs can counteract the short-term variability, or store the excess production, of other renewables more cost-efficiently than alternatives like natural gas generation); and market entry opportunities for new, smaller players (through modular wind and solar generation).

While many synergies relate to hydropower and variable renewables (solar and wind), others apply to

bioenergy and geothermal power, due to different generation patterns and technological characteristics. A well-developed electricity grid, connecting distant locations and ensuring enough transmission capacity, is key to harnessing these synergies. In addition, cross-border interconnections allow neighbouring countries (including those with lower hydropower shares) to benefit from complementarities. Importantly, exploiting the synergies in a sustainable manner requires paying close attention to the social and environmental impacts of large transmission and generation projects.

Several countries in the region possess valuable experience in exploiting some of the capabilities of hydropower with reservoirs, such as the provision of flexibility and storage capacity to the system. In the past, these flexible assets allowed to conveniently deal with many of the requirements of power sector management. Now, the increased recurrence of climate events, concerns about security of supply, rapid demand growth and the rising penetration of variable renewables call for a more robust, comprehensive approach to power sector management.

Figure ES.4 Yearly complementarity between renewable energy sources and demand in Uruguay



Source: Chaer et al., 2014

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Such an approach would internalise, in a systematic way, the value that the complementarities between hydropower and other renewables can bring by improving the system's reliability and economic efficiency. An understanding of the full range of complementarities can help identify those most relevant for each country with a view to improving policy and regulatory conditions.

RENEWABLES AT THE CROSSROADS OF MULTIPLE DRIVERS

Since the late 2000s, Latin America has seen a rapid and more diversified development of renewable energy sources, favoured by the convergence of overall drivers at the crossroads of energy security, economic competitiveness, and social and environmental sustainability.

Fundamental among those is energy security, which takes on two main forms for the region's energy importers (i.e., the majority of countries): the need to reduce the adverse economic effects of price volatility and the risk of supply disruptions. These risks are exacerbated by the expanded role of natural gas since the late 1990s. The prominent role of hydropower (half of regional generation) creates further energy security concerns, given the changes in hydrological

cycles (such as those occurring in El Niño years). Taking advantage of existing complementarities with non-hydropower renewables, and technology cost reductions through the use of market-based policy instruments, energy diversification through renewables has been contributing to energy security while also ensuring more stable electricity prices.

Renewable energy sources also contribute to energy sector decarbonisation. Although low by global standards, Latin America's greenhouse gas emissions are growing steadily. The reduced local health and environmental impacts of renewable energy sources compared with fossil fuels, highly relevant to reduce urban pollution, are also an important benefit. In addition, because of their modular nature and more limited social and environmental impacts, wind and solar PV generally have a significant advantage in terms of operational feasibility and social acceptability. The region faces growing popular resistance to large hydropower plants, resulting in delays of new projects.

More recently, the socio-economic benefits of renewables have become an important consideration for policy makers. These benefits include employment creation, the development of local value chains and access to modern energy. To bring about effective renewable deployment, these drivers need to translate into renewable energy targets, supporting policies and a broad enabling framework.



ENABLING POLICIES CENTRAL TO DEPLOYMENT

The analysis of regional and sub-regional dynamics clearly demonstrates the crucial role of renewable energy policies at the centre of deployment. Highly dynamic, particularly in the current context of accelerated deployment and rapid cost declines, the renewable energy policy landscape is marked by increasing political commitment, diversity and sophistication. With more than 300 policies identified, support for renewable energy is found in virtually all countries in the region (IRENA, 2015a).

Fiscal incentives, regulatory instruments and financial mechanisms are widespread policies to promote renewable energy sources (figure ES.5), identified in most countries in the region, and across sectors. The most common power sector policies in the region include auctions, with over 54 renewable energy auctions identified in 12 countries, and grid access policies, identified in 13 countries. In the transport sector, biofuel blending mandates, identified in 10 countries, are the main policy instrument. For heating purposes, a small, but growing number of countries are adopting solar thermal mandates. Furthermore, renewable

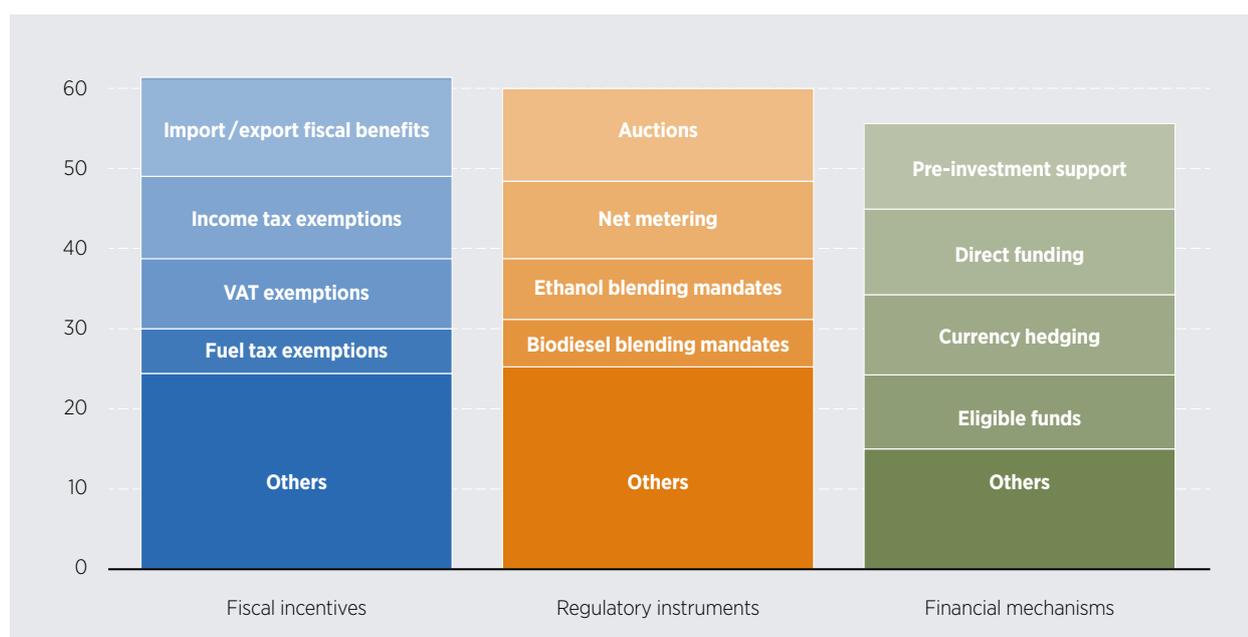
energy use in industry is growing, notably thanks to suitable contractual arrangements, the removal of price distortions and green labelling, which can open new market opportunities.

Enabling policies have played a decisive role in renewables investment. Some of the countries that attracted the highest investment levels in recent years – such as Brazil, Chile, Mexico and Uruguay – have received consistently high evaluations of their legal, institutional and administrative framework in investment surveys. This illustrates the variety of institutional, economic and regulatory conditions conducive to renewable energy investment in the region.

Countries with different degrees of power sector liberalisation, such as Chile or Brazil, ranked among the top destinations of renewable energy investments. Yet, top performers also include Uruguay and Costa Rica, which have vertically-integrated utilities and where private participation in the power sector follows the model of independent power producers.

Therefore, the region demonstrates that there is no one-size-fits-all policy mix, and that regulatory stability and transparency are essential to enable the further development of market-based financing schemes for renewables. One of the main challenges

Figure ES.5 Selected renewable energy policies in Latin America
(number of countries having adopted each policy)



Source: IRENA, 2015a

for renewable energy deployment in Latin America is to meet the increasing demand for capital at an affordable cost.

ES KEY ROLE OF PUBLIC FINANCING INSTITUTIONS IN LATIN AMERICA

A notable characteristic of Latin America's renewables sector is the key role played by national public financing institutions to promote investment in renewable energy. In 2015, they accounted for over one-third of new clean energy project finance in Latin America. Among these, national development banks have been leaders in the provision of loans for the large-scale deployment of renewable energy in some Latin American countries, offering particularly attractive conditions and covering a large share of the demand for debt by project developers. As such, they have been instrumental in advancing public policy goals such as the development of domestic markets (Chile, Honduras, Nicaragua, Mexico) or the creation of local value chains (Brazil, Uruguay), notably by conditioning loans to the use of domestic workforce and locally manufactured equipment.

Public financing institutions play a crucial role to catalyse financing for renewable energy projects, notably by providing financial products targeted specifically at renewable energy such as dedicated credit lines, currency hedging, and guarantees. At least 14 Latin American countries have established renewable energy public funds, while 10 countries have currency hedging mechanisms and 6 have guarantees to mitigate investment risks. In addition, several national public finance institutions foster renewable energy technological advance in the region through grants and subsidised loans for research, development and demonstration projects.

In many Latin American countries without domestic public financing institutions, or with limited financing capability, foreign public financing institutions have been important sources of capital for investment in renewable energy. Among these, multilateral development banks and overseas development agencies have been influential in kick starting deployment of some renewable technologies by combining risk mitigation funds, dedicated investment credit lines with long-term tenors, and technical

assistance (e.g. the Geothermal Development Facility). Multilateral development banks have also supported nascent off-grid markets (e.g. Nicaragua, Bolivia, and Argentina) and built related capacity, including for regulators, financial institutions and developers across the region. Looking ahead, climate finance can support the accelerated deployment of renewables in Latin America by increasing the volume of capital and offering specialised expertise.

RECENT EMERGENCE OF PRIVATE INVESTORS IN RENEWABLES

Private financing institutions (both domestic and foreign) have lately shown significant activity in the renewable energy sector in Latin America. These have been mostly concentrated in the more mature renewable energy technologies and markets in the region, including Brazil, Chile and Mexico, with increasing participation in countries considered stable economies with sound renewable energy policy mechanisms.

Private finance for renewable energy has a special role in certain niche segments such as short-term and bridge loans; refinancing; financing the acquisition of already operational assets; and mezzanine financing. Equity is a key component in the capital mix of renewable energy projects in Latin America, where the perceived financial risks require a higher share of equity. Latin American countries with more experience with renewables are currently witnessing an increased interest from infrastructure and pension funds, generally considered a sign of market maturity.



CATALYSING PRIVATE FINANCE TO SCALE UP INVESTMENT

Public finance has limitations, in particular regarding the long-term sustainability of development policies and the potential impact on public accounts. An important means to address this gap is to use the available public capital as a catalyst for private finance.

When the enabling framework is in place, public financing institutions can leverage the participation of private institutions in the capital mix of renewable energy investments through a range of financial instruments, including dedicated credit lines and guarantees to mitigate lending risks, particularly in countries where there is already some interest from private investors in the sector. One such example is the credit line offered by Chile's Economic Development Agency to partially hedge risks of venture capital funds investing in renewable energy technologies. Another approach is through structured arrangements between public institutions and private commercial banks, in the form of syndicated loans (e.g. in Mexico), which help to decrease banks' exposure to risk and leverage national development banks' resources.

Although more risk mitigation and financial facilitation measures are needed, specific mitigation instruments should be used carefully and selectively to address well-defined market failures. Public sector financiers should give priority to risk mitigation aimed at mobilising private finance, but be selective when deciding to de-risk private sector investment in renewable energy (IRENA, 2016b).

Project planning is an important part of the renewable energy project cycle (IRENA, 2015b). However, this stage is often overlooked when designing policies, and more emphasis usually is given to the financing and operational phase of the enabling environment, assuming that attractive projects will be developed anyway. This is a critical bottleneck in Latin America as in other regions, and technical assistance and project development funding schemes therefore have an important role to play in ensuring bankable project pipelines.

Looking forward, access to capital markets will be decisive, as non-bank financing plays a crucial role in scaling up renewable energy investment to the level

required to meet global climate goals. One promising approach to leverage institutional investor finance in Latin America would be to further develop the "financial value chain" so that developers, independent power producers, utilities and banks would have larger roles in construction stage financing, allowing them to then refinance operative assets after reaching the operational stage.

Lower financing costs and larger investment volumes combined with technological improvements and supply chain development are among key factors driving cost reductions.

DECLINING COSTS AND GROWING BENEFITS BOOST THE CASE FOR RENEWABLES

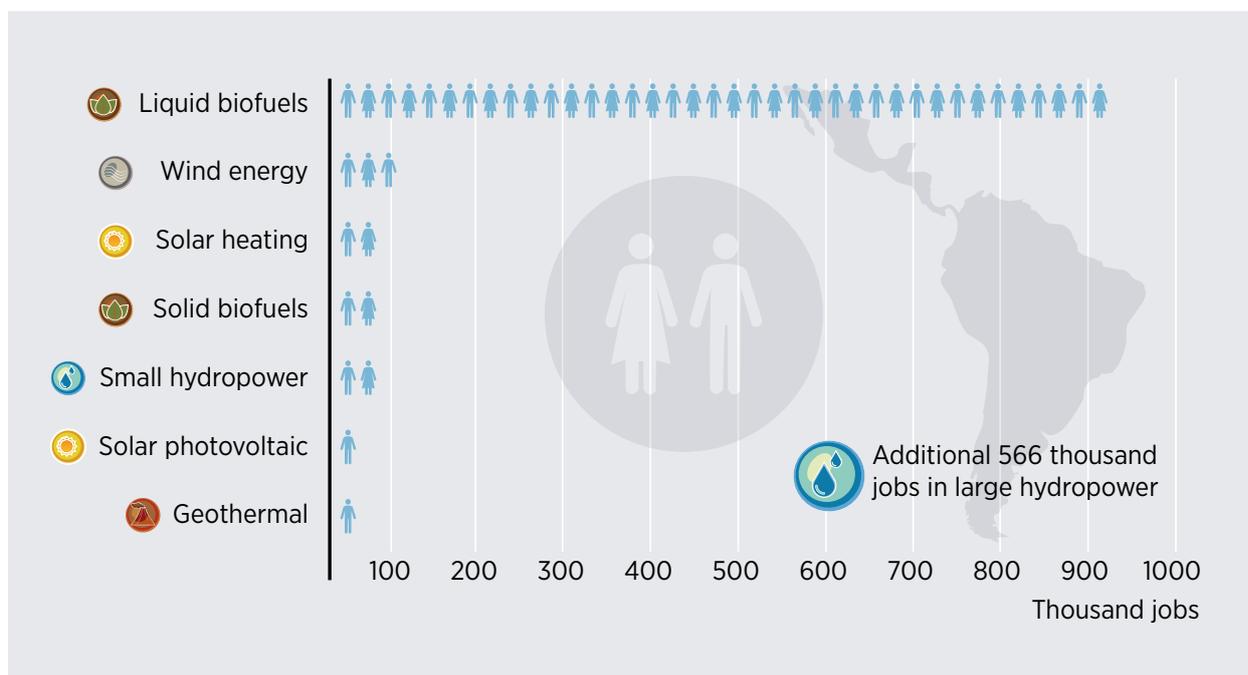
Renewables in Latin America are making strides in terms of cost reductions and are increasingly competitive with fossil fuels (IRENA, 2016c). In Latin America, the levelised cost of electricity has decreased by over 50% for solar PV since 2012, and by around 20% for hydropower and onshore wind since 2010, ranking among the lowest globally. Hydropower has historically been, and still is, one of the most cost-efficient technologies in the region. The competitiveness of solar PV is contributing to achieving record-low prices, such as in the recent PV auctions in Mexico and Peru, with prices of 36 USD/MWh and 48 USD/MWh respectively for the lowest bids. These reductions are underpinned by technological progress, local supply chain development, resource quality, reduced financing costs and growing sector maturity.

In parallel with cost reductions, the socio-economic benefits of renewable energy technologies are gaining prominence in the region, as they are globally. Renewables create jobs, support local industrial development, and have the potential to boost the region's economies. According to IRENA analysis, ramping up renewables in line with REmap 2030 could lift the GDP of Brazil and Mexico by more than 1% in 2030. Such economic improvement would also lead to net job creation (IRENA, 2016d).

As of today, close to two million people already work in renewables in the region (figure ES.6). Liquid bio-fuels is the main employer, accounting for nearly

Figure ES.6 Renewable energy jobs per technology in Latin America (direct and indirect)

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Source: IRENA, 2016e

1 million jobs, mostly in Brazil, Colombia and Argentina. The next employer is large hydropower with more than half a million jobs, and wind at 64,000 jobs (IRENA, 2016e).

Renewables are also supporting the creation of local industries, especially if synergistic activities already exist, as the case of the Brazilian wind sector shows. This is an attractive proposition for a region with a relatively low contribution of manufacturing to GDP. Several countries such as Brazil, Ecuador, Honduras, Panama and Uruguay have combined deployment policies with local content requirements in order to maximise local value creation from renewables.

The potential for local value creation from renewable energy is not limited to large industries. In the rural context, off-grid renewables can encourage small-scale economic activity and entrepreneurship. Latin America is close to achieving universal energy access, yet 15 million people live without electricity and over 56 million people rely on traditional uses of solid biofuels for cooking and heating. Recognising the importance of renewable energy technologies for energy access, at least 18 countries in the region have included them in energy access policies and at

least nine countries have renewable energy funds for access.

The interlinkage between the water, energy and food supply systems is beginning to emerge as a major consideration in the region's sustainable development strategies, given the high shares of hydropower and bioenergy. Some renewables can play a key role in decoupling the energy sector from water availability and use. Several countries in the region are ensuring that biofuels production does not compete with food supply and are increasingly taking into account the trade-offs between different water and land-uses (IRENA, 2015c).

This report finds that rapid cost reductions, maturing renewable energy technologies and the consolidation of renewable energy policies in a region endowed with some of the world's best renewable resources offer an unprecedented opportunity to accelerate the uptake of renewables across all sectors. At stake is a balancing act between energy security, environmental sustainability and economic competitiveness.



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