HOW NEW TECHNOLOGIES ARE TRANSFORMING ENERGY IN LATIN AMERICA AND THE CARIBBEAN

Energy

Digital economy

NTT DATA

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BACKGROUND

The Latin America and Caribbean (LAC) region is undergoing a digital revolution, and we are convinced that technological innovations have the potential to significantly accelerate and scale the region's development. These technologies are reshaping both traditional sectors and innovative industries. In this context, the main objective of this report is to address the disruptive technologies that are revolutionizing each of the industries in which IDB Invest operates in a structured manner. New emerging business models will be evaluated in the context of economic and social development, the foundation of the IDB Group. The selected models will prioritize inclusion, productivity, and innovation while addressing cross-cutting issues such as environmental sustainability, climate change, and gender equality.

Although new technologies have enormous potential to drive efficiency and open up new avenues of value creation, they also pose significant challenges in terms of governance, security, and equality. The rapid adoption of digital solutions has highlighted the importance of establishing a strong regulatory and investment framework that maximizes benefits while mitigating risks. As a result, the role of different economic agents and their ability to adapt and adopt these innovations becomes a critical aspect of catalyzing sustainable economic and social development.

As we examine the impact and potential of various key technologies in this report, it is important to understand that we are dealing with an interconnected ecosystem that is growing in complexity and scale. Advances in one area, such as Artificial Intelligence or Automation, are fed back and amplified in constructive collaboration with others, such as Big Data or the Internet of Things, resulting in a multiplier effect on value generation. This report aims to highlight how this technological interconnection is reshaping the economic and social context in LAC, providing an analysis that goes beyond the current situation to forecast how new technologies will continue to shape the region over the next decade.

CONTEXT

LAC is a region that has a great diversity of both traditional and renewable energy matrices, which creates major opportunities. Early 2023 activities are predominantly concentrated on hydropower plants, although most countries have the required conditions and are perceived globally as a potential source of renewable energies.

As concerns more traditional sources such as oil and gas, the region retains 20% and 5% of the world's reserves, respectively[1], which represents an important source of income for the countries that have them and one of the cornerstones of their economies.

As for renewable energies, they have grown steadily by around 70% over the last decade, and at the end of 2021, they accounted for more than 60% of the installed capacity for electricity generation in LAC[1]. This growth has not been level, with different countries showing marked contrasts in their advance.

In this sense, we highlight Brazil's work as a leader both at the level of installed capacity, since it represents 36% of the region's tally, and at the level of domestic consumption, where more than 50% comes from renewable sources. Secondly, in terms of installed capacity, but at a considerable distance is Mexico, where primary energy generation via renewables is less than 12%[2], mainly owing to the incumbent government's commitment to fossil fuels.

[1] Panorama energético de América Latina y Caribe 2022, OLADE
[2] Statista

INDUSTRY IMPORTANCE

From the IDB's perspective, the energy transition is one of the main strategic goals for the region, which is why it seeks to focus efforts on the furtherance of the adoption of renewable energies, seeking to turn LAC into a renewable energy hub, leading the development of new clean technologies such as green hydrogen.

In a broader sense, the energy industry is a strategic sector for countries since achieving energy independence allows them major savings for public coffers, especially for those countries in the region that do not have hydrocarbon reserves. What is more, the industry acts as a main driver of growth and development, exerting a significant impact on job creation and GDP.

In recent years, the industry has undergone a profound transformation that will continue over the next decade. The energy transition has been at the heart of the political, business, and social debate, while the whole of society is demanding to leave behind the dependence on fossil fuels to implement a model based on clean energy.

CHALLENGES AND OPPORTUNITIES

The region's governments have established very ambitious medium and long-term commitments in terms of energy transition, especially RELAC, an initiative devised in 2019 within the framework of the United Nations Climate Action Summit, with a view to achieving at least 70% share of renewables in the region's electricity matrix by 2030[3] and the Net Zero 2050 initiative, which aims to generate net emissions along the energy value chain: Generation, Storage, and Distribution.

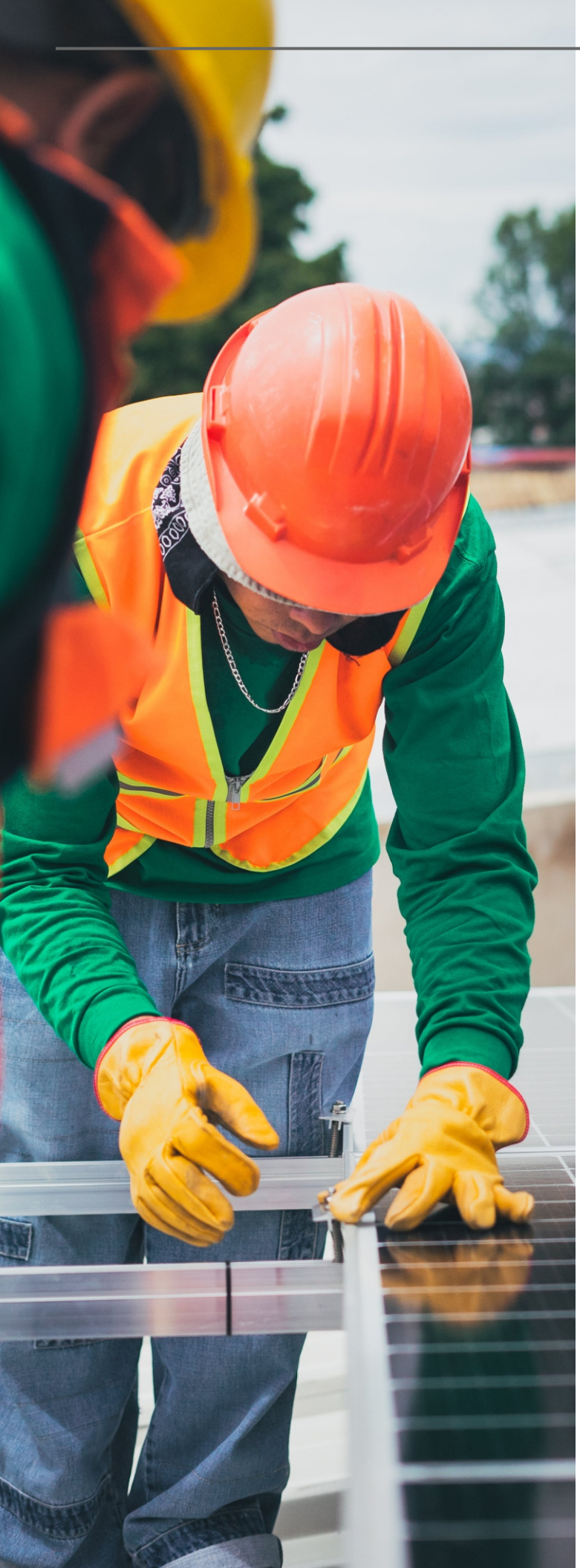
Complying with these agreements is a huge challenge that requires public-private collaboration to be achieved. In this regard, governments should establish regulatory frameworks that encourage and facilitate energy transition while companies and large corporations are expected to double down their commitment to these goals.

In a context of steady growth in energy demand, which is expected to triple by 2050[4], it is essential to accelerate the adoption of renewable sources to gradually replace fossil fuels in electricity and biomass generation.

Despite advances in energy transition technologies, challenges remain. On the one hand, established technologies such as solar and wind have achieved economies of scale and high adoption, although they are yet to address intermittency in generation. On the other hand, new sources such as hydrogen, which has all the conditions for its development in LAC, require improvements in efficiency and costs for its widespread use.

There are also significant challenges in terms of energy storage and distribution, especially when it comes to reducing the costs of batteries, increasing their useful life and reusability, as well as advances required to make them more accessible and encourage the adoption of smart grids, which demand a strong investment to streamline the outdated electricity grids that loom large in the region.

[3] RELAC
[4] Panorama energético de América Latina y Caribe 2022, OLADE



From the standpoint of opportunities, the energy transition and the need to meet ambitious sustainability and decarbonization commitments by 2050 will allow the creation of new jobs focused on clean energy, the so-called green jobs, which are estimated to reach 15 million net by 2030[5] (already accounting for the jobs pertaining to fossil fuels that would be lost).

DIGITALIZATION IN ENERGY INDUSTRY

The energy industry is a crucial issue, with the convergence of digitalization and technological advances playing a major role in driving significant transformation.

While technological advances provide tools and capabilities for power generation, storage, and distribution, digitalization implies converting processes and data into digital formats, enabling optimization and remote control. Together, these elements collaborate to improve efficiency and sustainability in the energy industry transition.

[5] IDB-ILO report: Jobs in a net-zero emissions future in Latin America and the Caribbean

Value Chain Decarbonization

By and large, we can divide the industry's value chain into 3 large blocks: Generation, Storage, and Distribution of energy. The industry's ambition is to achieve carbon neutrality at each of these stages:

a) Generation

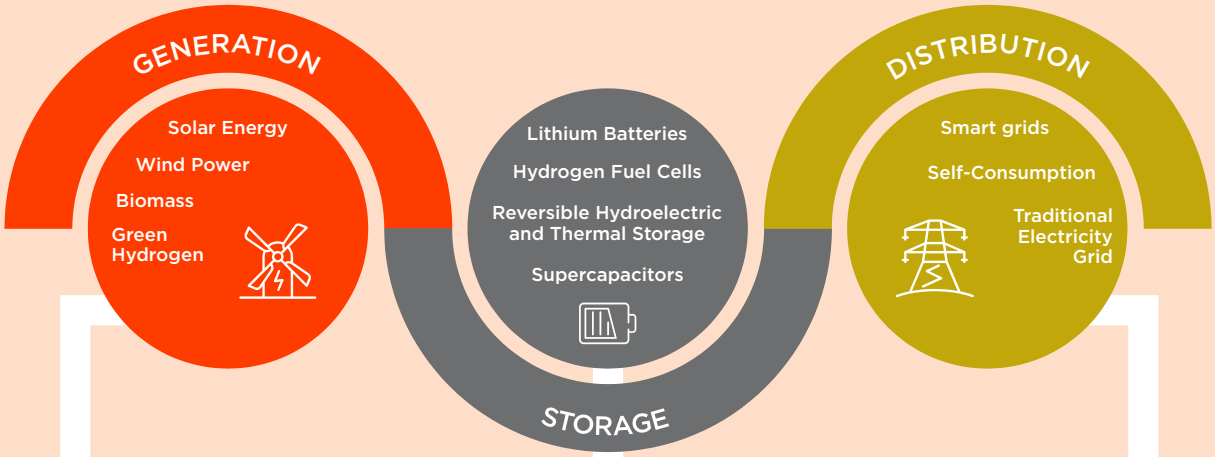
This stage covers the most mature and widely adopted technologies, such as hydro, solar, and wind power. Advances in these technologies are driving their adoption to reach 59%6 of the total electricity production in the region.

Going into detail on technological advances, greater efficiency in power generation has been spotted, resulting in greater reliability. Barriers that previously called for very particular geographical and climatic conditions are being overcome, allowing efficient operation in more ordinary situations. In addition, the economies of scale achieved in the production of machinery have made these technologies more affordable, further driving their adoption.

Regarding cross technologies, they are optimizing power generation, making it more efficient, safe, and cost-effective. The use of sensors that continuously monitor the infrastructure, coupled with the use of digital twins, allows maintenance to be more accurate and efficient, reducing its cost and the number of breakdowns.

Decarbonizing the Value Chain

Solutions through Digitalization



USE CASES

- Sensors to monitor the condition of solar panels and windmills
- Big Data to spot the best locations for infrastructure
- Big Data and AI to accurately predict the amount of energy
- Digital twins can generate for preventive maintenance and remote testing

- IoT devices and sensors to monitor and measure battery capacity
- Big Data to set when to charge or discharge batteries based on energy price, increasing battery life
- Big data to predict failures
- AI for predictive models that optimize the moments of charging and/or sending energy to the grid

- Big Data and AI to enable Smart grids
- IoT to bring together different decentralized and AI-coordinated power plants in a form of virtual power plants
- IoT and Big data to generate more accurate consumption predictions

Blockchain to ensure the "clean" origin of energy

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Through big data, the optimal installation sites can be located. This analysis can be complemented with AI to accurately predict the amount to be generated, broken down according to the relevant time horizon at any given time.

For the proper development of the region, it is essential to find a balance between meeting the decarbonization goals and the cost of power, which implies a slow and controlled transition that does not negatively impact the purchasing power of citizens or the competitiveness of companies.

b) Storage

In a context where most renewable energy sources are intermittent owing to uncontrollable external conditions, efficient energy storage becomes crucial to achieve a model based on these sources at 100%.

Although lithium batteries have experienced cost reduction and high adoption in everyday products, they are not ideal for long-term energy storage. Therefore, it is decisive to explore durable and affordable storage alternatives to avoid obstacles in the transition between renewable energy generation and distribution.

The IoT makes it possible to measure the capacity of batteries in real-time, and the data collected can be used both to predict when the battery may fail and to set the best times for charging or discharging them, optimizing their use and extending battery lives.

Likewise, AI can generate advanced predictive models that optimize charging and discharging moments based on the price of electricity, reducing costs since they would charge additional batteries when electricity is cheaper and discharge this energy when the price goes up.

c) Distribution

A more efficient distribution network can save costs and ensure electricity supply for both private and industrial consumption.

To achieve this, it is necessary to combine emerging technologies such as AI, Big Data, and IoT to implement smart grid systems that optimize the distribution network.

The digitalization of the network opens the door to "self-consumption" and, although in this aspect the region is very far from North America or Europe, it is necessary to invest in these technologies and streamline the networks to try to mitigate the price increases stemming from the transition to renewables. An interesting idea is to seek to subsidize this transition by liberalizing the market.

The challenge at this stage will be to ensure that access to clean energy is not exclusive to large urban centers but reaches rural districts that typically have poor infrastructures and socio-economic problems.

It is important to note that, depending on the evolution of electric cars in the region, charging networks will have to increase to cope with this new trend.

I.Technologies Catalyzing the Energy Transition

Availing of new technological advances is capital when migrating to renewable energy sources, as it will allow the connection of different energy matrices in the future, even with export possibilities to other markets, generating safer and more efficient networks with better distribution.

Technologies such as artificial intelligence, IoT, and Big Data are increasingly relevant within the industry and, over the next decade, will allow the development of highly digitalized energy systems capable of predicting demand and distributing energy in that direction at the right time and at a competitive price.

Traditional energy systems used to work in a single direction, while new technologies allow multidirectional operation, which provides greater control and allows demand to be managed more efficiently.

a) The Role of AI in Energy Transition

The rapid development of Artificial Intelligence and its growing use globally is also impacting the energy industry in LAC, although to a lesser extent than in other regions such as North America and Europe.

The potential of AI in the sector, especially as an enabler of the energy transition, is huge: Greater security, optimized integration of various energy matrices, intelligent decision-making in real-time, cost optimization, and demand management are just a few of the improvements that AI can enable.

New AI-based solutions are emerging along the value chain, such as the use of long-range drones to control air networks. However, for the industry to seize its full potential, it still has to solve its high cost and lack of talent with expertise in technology.

b) Smart grids

The development of intelligent electricity distribution networks is still a trend in the early stages of development, although it has the potential to revolutionize the energy industry, yielding significant improvements in terms of network management and control, which can be used both at the household and industrial levels.

One of the main innovations brought about by smart grids is that while traditional energy systems used to work in a single direction, this new technology allows multidirectional operation, which provides greater control and allows demand to be managed more efficiently.

The current electricity grid is one of the main problems for the distribution of power in the region since renewable energy generation units are usually located far from large urban centers, which implies the need to distribute energy long distances. On top of this challenge is the poor quality of the electrical infrastructure, which loses around 15% of the power it carries, making it one of the worst in the world.[6]

The growth of Smart grids in the region would be an important advance for the sector at a critical point such as electricity distribution, where we currently find old networks, obsolete technology, or nonexistent grids, so the need to modernize it is critical. To foster this transition, it is necessary to liberalize the energy market and set stable long-term energy policies that provide legal certainty and draw investment.

[6] IDB

c) Data Democratization

The nonstop increase of available data is closely linked to digitalization. In this context, the proliferation of sensors along the industry's value chain is generating huge volumes of information, which are expected to continue to increase over the next decade.

Emerging technologies such as AI need this data to learn and propose improvements; optimizing charge balancing, choosing the right times to provide or store power, and accurately predicting future demand are just a few of the processes where the implementation of AI can revolutionize the industry.

Energy Efficiency and Optimization

It consists of developing software solutions that make it possible to improve energy management, mainly in the industrial field. They are usually plug-and-play solutions enabled by new technologies that can be installed on traditional player systems, generating efficiencies at different stages of the value chain.

a) Artificial Intelligence

The sector is witnessing the widespread of AI solutions focused on generating efficiencies in the management, administration, and control of networks, all aligned with the energy sustainability commitments reached by the different governments in the region and with the main purpose of guaranteeing the energy transition.

AI can have a positive impact at each stage of the value chain, and, what is more interesting in the future, it can generate exponential value by being able to control the entire chain, receiving, analyzing, and sharing information from the different phases in real-time.

b) Cloud

Digitalization and the advances in connectivity that are transforming the sector generate a huge amount of information that needs to be stored, processed, and analyzed in real-time to take advantage of all its potential benefits. In this sense, migrating to cloud platforms becomes a competitive edge, taking the lead in the massive adoption of technologies such as AI, Big Data, or IoT in the medium run.

In the traditional model, energy companies stored information in different on-premise systems that are normally poorly connected to each other. In order to offer efficient and scalable solutions, it is necessary to let go of this type of infrastructure and implement cloud models that favor the flow and access to information.

c) IoT

The implementation of sensors capable of capturing, processing, and sharing information in real-time is a paradigm shift within the industry. The proliferation of this type of instrument goes hand in hand with the adoption of other technologies that need this information in real-time to seize its full potential.

In this category, we can highlight smart meters, digital electrical meters that collect and share information on energy consumption in real-time. In such a way, it is possible to predict demands more accurately, optimizing the distribution and generation of electricity and generating a benefit for both companies and end consumers.

BUSINESS MODELS STEMMING FROM DIGITALIZATION

The combination of technological progress with governmental and social commitments means a breath of new air for an industry historically reluctant to innovate. This convergence not only attracts new investments but also drives the development of new innovative business models aligned with sustainability goals.

In this scenario, collaboration between large corporations and energy startups emerges as a major building block. It is operationalized either through the injection of capital through CVCs (Corporate Venture Capital) or the venture client approach, where well-established companies stand as the main sales channel of these startups, mitigating risks and preventing shareholder dilution.

Among the most important advances, microgrids are gaining ground. These allow communities and companies to generate, store, and distribute renewable energy in local areas, furthering energy decentralization and strengthening communities, especially in remote or less developed areas. Concomitantly, Solar as a Service (SaaS) models are revolutionizing access to solar power; through monthly subscriptions, consumers benefit from clean energy solutions without the need for upfront contributions.

One area that deserves special mention is green hydrogen. Its rise represents a historic opportunity for the region to take a lead in this global trend. Initiatives ranging from production to distribution are already taking shape, drawing a greener and more sustainable energy future for the region.

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