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SUMMARY DSO BRIEF

NO INVESTMENT, NO TRANSITION

THE FUTURE OF POWER DISTRIBUTION IN LATIN AMERICA

AUTHORS AND COLLABORATORS

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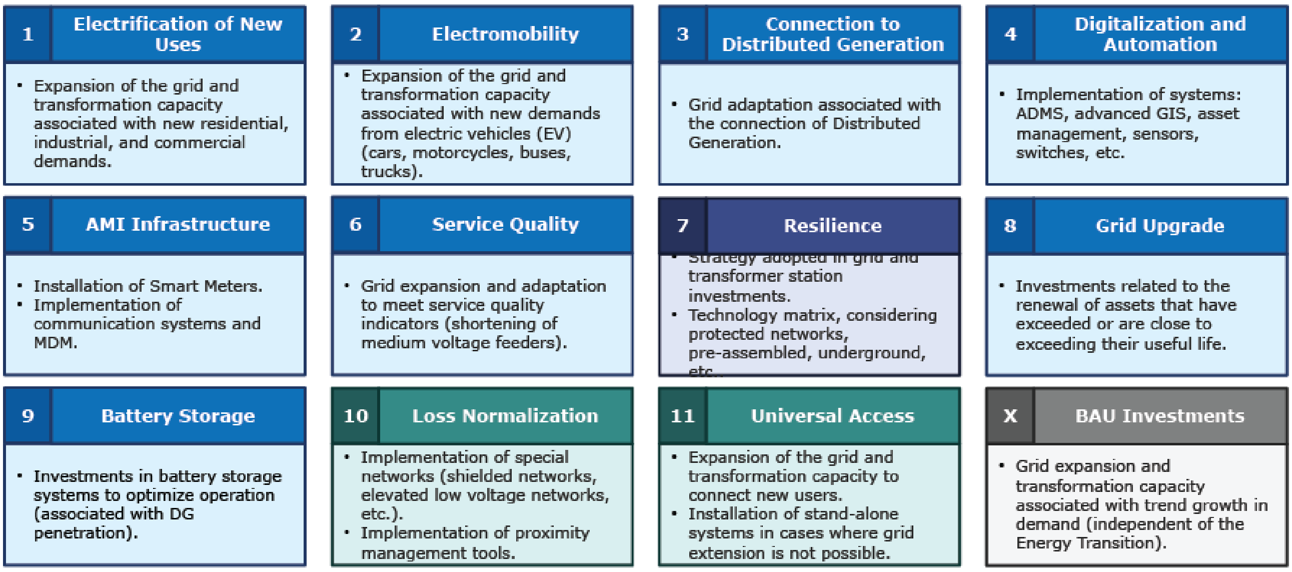
Historically, planning and investment in the electricity sector have focused on generation and transmission, with distribution networks considered the last link in the electricity supply chain. However, the energy transition is reversing this dynamic. The growing penetration of distributed generation, the demand for electrification in sectors such as transport and heating, and the need for greater resilience against extreme weather events have placed electricity distribution at the center of the stage. The transition to a cleaner and more efficient energy system cannot be achieved without significant investment in power distribution infrastructure.

This study's main objective is to offer a detailed view of the investment needs in the power distribution segment of seven key countries in the region: Argentina, Brazil, Chile, Colombia, Ecuador, Guatemala, and Peru. This analysis focuses on the implementation of eleven key vectors associated with the energy transition, which include everything from electrification of new uses to the universalization of electricity service:

Energy Transition Investment Vectors



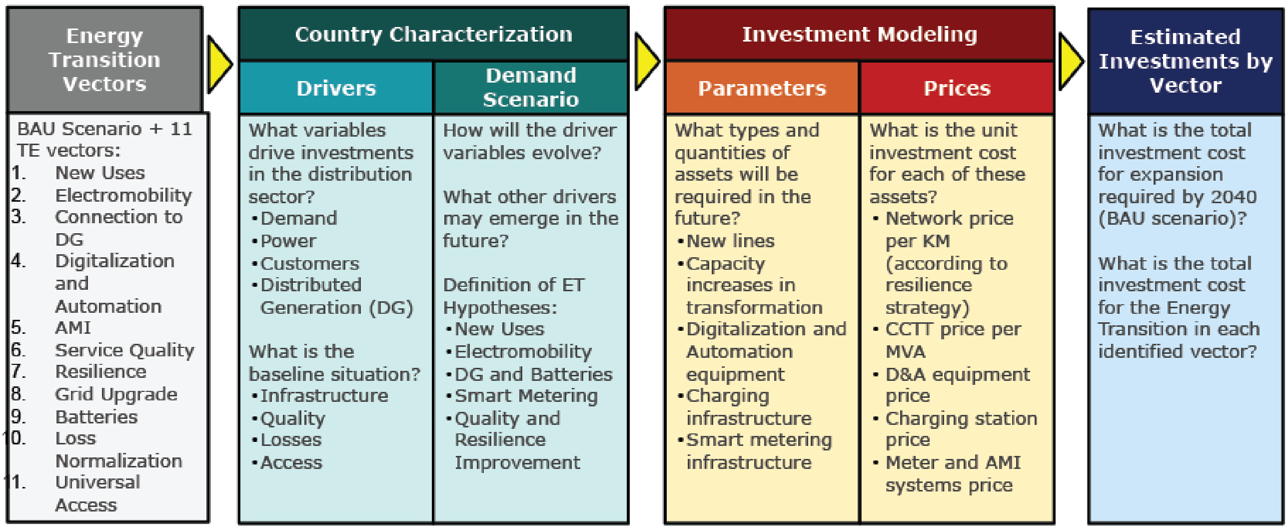
> "Investments are distributed with a special focus on those that have the greatest impact on modernization.

01 METHODOLOGY

The estimation of investment needs in the power distribution segment was carried out through a model that contemplates two theoretical energy transition scenarios for the year 2040. These scenarios were fed with data provided by distribution companies associated to ADELAT, a detailed characterization of the current situation in each country, and energy demand projections incorporating macroeconomic, demographic, and technological variables.

Technical parameters were established for each of the identified energy transition vectors, including, among others, the requirements for the expansion of new lines and transformation capacity to support increased demand and the integration of distributed generation. The investment needs in technology for grid digitization, including ADMS systems, sensors, and remote control devices, were also considered, along with the costs associated with installing charging stations and implementing smart meters and data management systems. Unit costs of the assets needed to implement the investments were estimated based on market prices and historical data. Costs per kilometer of grid, per megawatt of transformation capacity, and per unit of D&A and AMI equipment were among those considered.

Investment Model Structure



The model considers a baseline scenario of trend growth in DSO (Business As Usual or BAU) investments, which serves as a reference to compare the impact of investments in the energy transition scenarios. It estimates the evolution of electricity consumption until 2040 using an econometric projection approach. The projection is disaggregated by sectors, considering investments under two main categories: Mandatory Investments, necessary to meet demand growth and network expansion, and Discretionary Investments, planned and made based on internal company criteria.

Two scenarios were designed to capture the different paths countries could follow on their way to a more modern, efficient, and resilient electricity distribution network: Effective Transition, in which the seven countries achieve electrification levels similar to those proposed by the "Connecting the Dots" study for the European Union in 2030, and Partial Transition, where the network modernization advances more gradually, with slower adoption of advanced technologies and a focus on maintaining basic network operability. Below is a summary of the assumptions considered for each of the evaluated energy transition scenarios.

Effective and Partial Energy Transition Scenarios

Vector	Effective ET Scenario	Partial ET Scenario
Electrification of New Uses	Residential: Electrification of LPG and biomass. Industrial: Partial electrification (coal, biomass, gas, diesel, and fuel oil). Commercial & Public Sector: 100% electrified	Limited electrification scenario (50% of the Effective ET scenario)
Electromobility	Penetration of 20% of vehicle fleet	Penetration of 10% of vehicle fleet
Connection to DG	Distributed generation equivalent to 20% of total energy consumption	Distributed generation equivalent to 10% of total energy consumption
Digitalization and Automation	Fully digital and automated distribution. Implementation of ADMS, GIS, advanced systems, demand-side management, sensors, etc.	50% digitalization and automation. Implementation of SCADA and basic systems (GIS, etc.)
AMI	Full deployment of smart meters	Partial deployment of smart meters
Service Quality	Based on the characteristics of each country's grid. Decrease in frequency and duration of interruptions by -10%. Specific quality indicators like SAIDI/SAIFI (TTIK/FEC)	Based on the characteristics of each country's grid. Decrease by -5% in SAIDI/SAIFI (TTIK/FEC) indicators
Resilience	Active resilience regulation (90% Underground)	Active resilience regulation (10% Underground)
Battery Storage	Deployment of BESS as a backup for DG and storage at the system threshold	No deployment of BESS
Normalized Losses	Normalization of 100% of irregular customers	Normalization of 100% of irregular customers
Electrification of New Uses	Residential: Electrification of LPG and biomass. Industrial: Partial electrification (coal, biomass, gas, diesel, and fuel oil). Commercial & Public Sector: 100% electrified	Limited electrification scenario (50% of the Effective ET scenario)
Universal Access	Access to 100% guaranteed, with no space for stand-alone solutions	Access to 100% guaranteed, with no space for stand-alone solutions

The estimated investment amount for each scenario corresponds to those that would be made exclusively by DSOs, excluding other investments that may be developed by different actors, such as those related to distributed generation connection assets or electric vehicle charging infrastructure. Furthermore, the resulting investments are not considered to be restricted by the regulatory, financial, or operational contexts of each country. These are necessary investments regardless of current barriers, which underscores the importance of a policy and regulatory framework that facilitates their implementation.

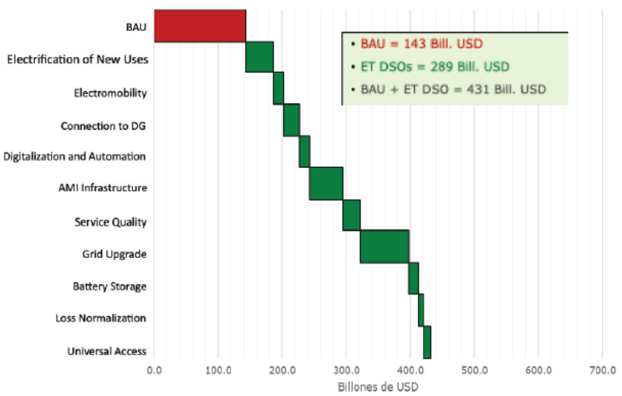
02

INVESTMENT MODEL RESULTS

EFFECTIVE TRANSITION SCENARIO

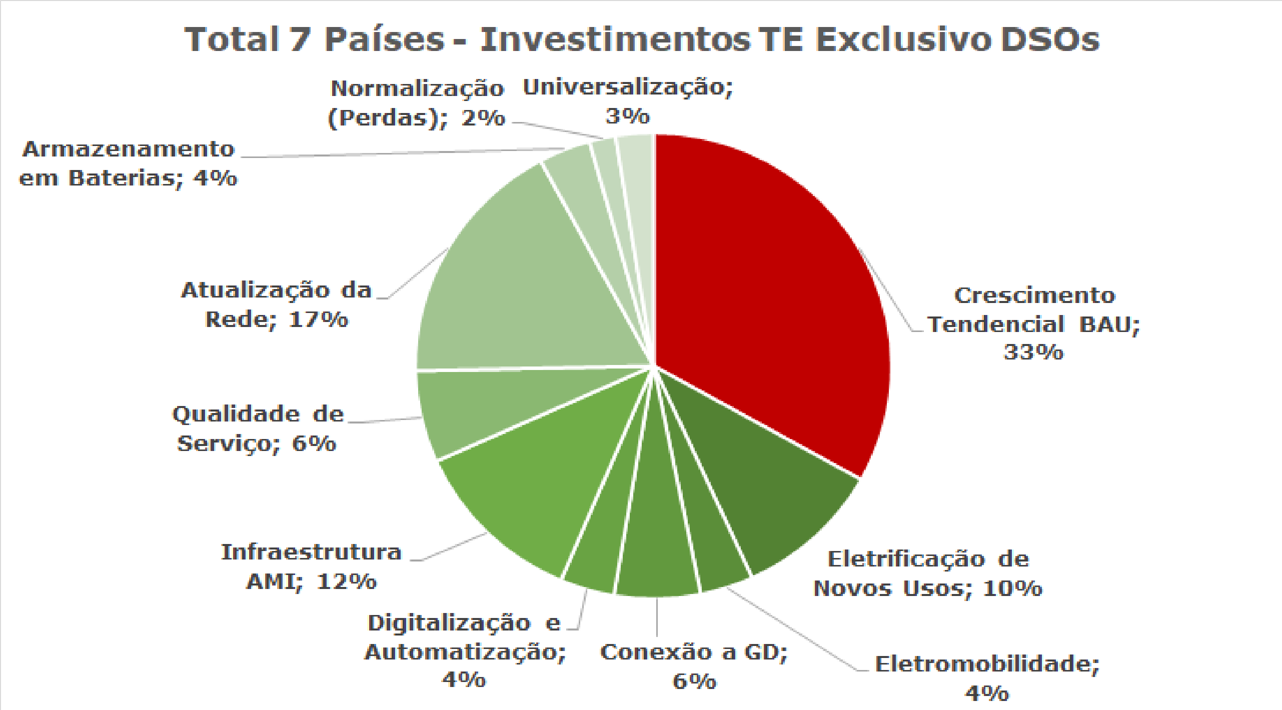
For the seven countries considered, the model estimates a total of USD 431 billion in accumulated investments needed by 2040 by power distribution system operators (DSOs), excluding those in distributed generation connection assets (GD), which would be made by other agents. **This value is 201% higher than the investments that would be made in the BAU growth scenario (USD 143 billion).**

Results of the Effective Transition Scenario (7 Countries Total)



Investments are distributed among different vectors of the energy transition, with a particular focus on those with the greatest impact on grid modernization and efficiency. The most significant vectors in this scenario are BAU Growth, representing 33% of the total investment. Regarding the energy transition, the most significant vectors are Grid Update (17%), AMI Infrastructure (12%), and Electrification of New Uses (10%).

Distribution of Investment Vectors in the Effective Transition Scenario (7 Countries Total)



The annualized investments would represent between 0.19% and 0.50% of the GDP of the evaluated countries and between USD 75.4 and USD 97.4 per customer (based on the total number of connected customers). Finally, the projected investments per distributed energy are between USD 6.0 and USD 16.1 per MWh. Below is a summary of the estimated average annual investments for each country in the Effective Transition scenario.

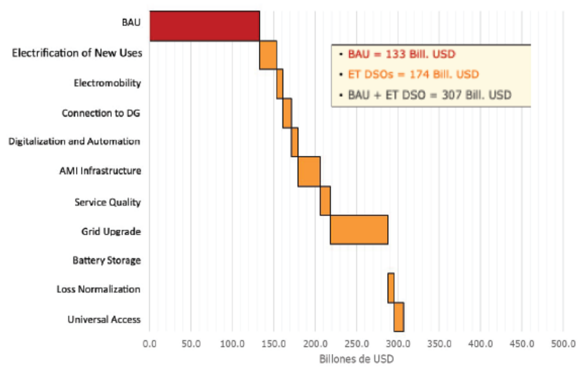
Average Annual Investments in the Effective Transition Scenario

Effective ET Investments by 2040: 11 Vectors + BAU (USD Billions/Year)							
Item	Argentina	Brazil	Chile	Colombia	Ecuador	Guatemala	Peru
BAU	0.8	5.6	0.2	0.9	0.4	0.2	0.3
11 ET Vectors	1.6	10.7	0.7	2.1	0.7	0.5	0.8

PARTIAL TRANSITION SCENARIO

In the Partial Transition scenario, the required investments are lower than in the Effective Transition scenario, reflecting a slower adoption of advanced technologies and less integration of renewable energies and electrification of new uses. **The model estimates a total of USD 307 billion in accumulated investments needed by 2040 for the seven countries considered,** corresponding to DSOs and excluding those in distributed generation connection assets made by other agents. **This value is 131% higher than the investments that would be made in the trend growth scenario (USD 143 billion).**

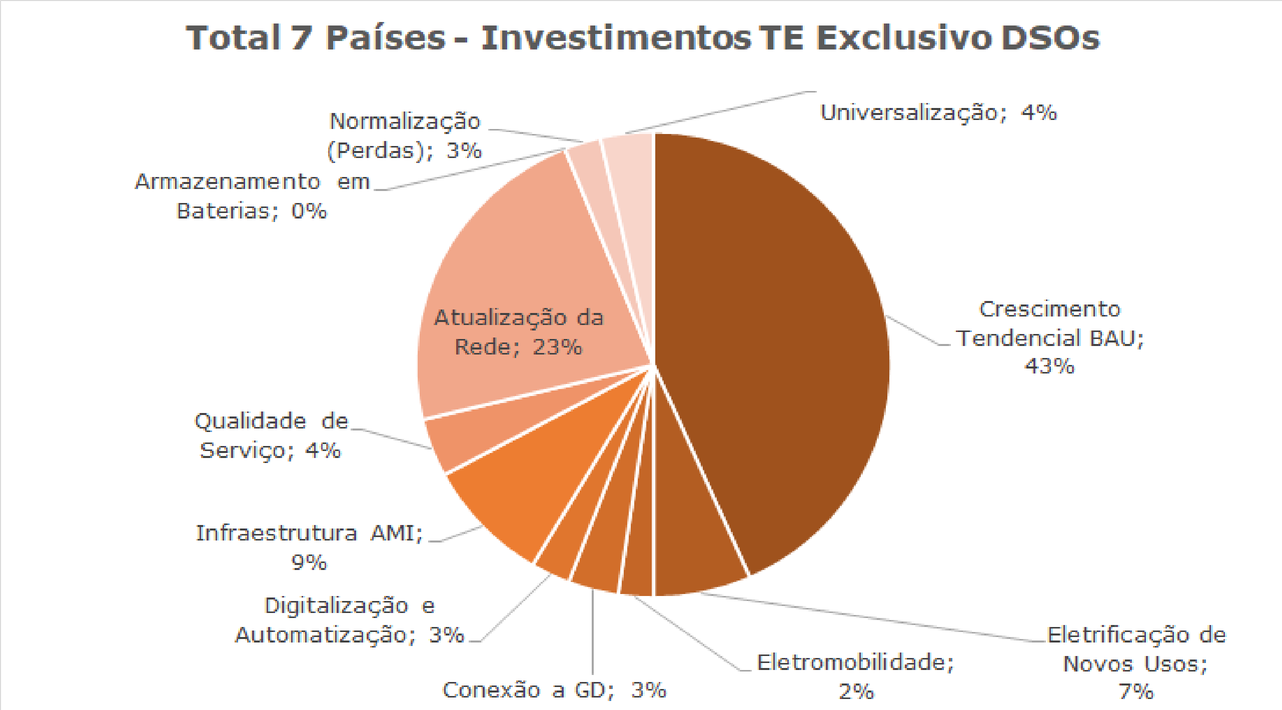
Partial Transition Scenario Results (7 Countries Total)



The investments in the Partial ET scenario are distributed differently compared to the Effective ET scenario, with a greater concentration on network expansion under the trend growth (BAU) scenario, which represents 43% of the investments. The other investment vectors with the highest percentage share in this scenario are: Grid Update (23%), AMI Infrastructure (9%), and Electrification of New Uses (7%).

> O sucesso da transição energética na América Latina não depende apenas da identificação das necessidades de investimento.

Distribution of Investment Vectors in the Partial Transition Scenario (7 Countries Total)



Below is a summary of the estimated average annual investments for each country in the Partial Transition scenario.

Average Annual Investments in the Partial Transition Scenario

Partial ET Investments by 2040: 11 Vectors + BAU (USD Billions/Year)							
Item	Argentina	Brazil	Chile	Colombia	Ecuador	Guatemala	Peru
BAU	0.6	5.5	0.2	0.8	0.3	0.1	0.3
11 ET Vectors	0.8	6.6	0.4	1.2	0.4	0.3	0.5

03

ENABLING CONDITIONS FOR INVESTMENTS

The success of the energy transition in Latin America will depend not only on identifying investment needs but also on creating a favorable environment to attract and sustain those investments. In this regard, remuneration schemes play a crucial role. In a price cap regulation scheme, regulators set a maximum limit on the tariffs that DSOs can charge, incentivizing companies to improve efficiency to increase their profits. This model can encourage cost containment, but if price caps are set too low, it can disincentivize the necessary investments.

In a revenue cap regulation scheme, DSOs are guaranteed a predefined level of income, so if demand decreases, tariffs can be adjusted. This mitigates demand risk, but companies may have less incentive to invest in efficiency-enhancing technologies, such as those associated with the energy transition, as their income is guaranteed.

In a cost-plus regulation scheme, DSOs are compensated for their operational costs plus a guaranteed rate of return. This scheme also provides limited incentives for investments in more efficient technologies, as DSOs have no motivation to reduce their costs.

On the contrary, an incentive-based regulation scheme offers additional incentives for DSOs to improve service quality, operational efficiency, and technological innovation. Incentive-based remuneration schemes can include specific mechanisms to promote investment in digitalization, resilience, and loss reduction.

In the context of the energy transition, some countries have begun developing specific regulatory schemes that offer additional incentives for investments in key areas such as the electrification of new uses, electric mobility, digitization, and grid resilience. These schemes may include bonuses for achieving decarbonization targets, connecting distributed generation, or improving energy efficiency.

Similarly, benchmarking remuneration mechanisms that set remuneration ex-ante based on the costs of an ideal company promote cost savings but also limit incentives to invest in infrastructure modernization. The state-of-the-art and modern regulations show that a good remuneration scheme considers both the recognition of actual costs and efficiency incentive schemes.

To enable investments in the energy transition, remuneration schemes must adapt to the transition objectives by incorporating clear incentives for DSOs to invest in priority areas such as grid resilience, distributed generation integration, and electrification of new uses. Additionally, return rates must reflect the inherent risks of investments and be attractive enough to draw capital, especially in countries with high-risk levels. Finally, regulatory frameworks must be stable and predictable, allowing DSOs and investors to plan with greater certainty, reduce financing costs, and incorporate schemes that reward the adoption of new technologies and innovative practices that improve operational efficiency and service quality.

04

BENEFITS OF ENERGY TRANSITION INVESTMENTS

Investments in the energy transition in Latin America are not only necessary to meet decarbonization and modernization goals for the electricity sector but also generate a series of operational, economic, social, and environmental benefits. ADELAT will develop a second phase of the study that will include a quantitative approximation of the impact of these benefits.

On the operational level, investments in the energy transition improve infrastructure efficiency, enhancing the financial sustainability of DSOs. These benefits include lower costs for inspection tasks, less need for interventions due to interruptions, optimization and flexibility of operations, reduction of labor risks, reduced need for commercial management tasks, and increased digital engagement.

Energy transition investments also generate significant economic benefits for DSOs, consumers, and the industry in general. These benefits include the development of new businesses, improved industrial competitiveness, reductions in consumer bills, reduced need for contingency investments, and reduced energy imports.

Socially, the benefits are evident in various aspects, from improving living conditions, promoting regional and circular economies, reducing gender gaps, and fostering productive activities, to generating skilled employment, improving public safety, and better identification and targeting of vulnerable users.

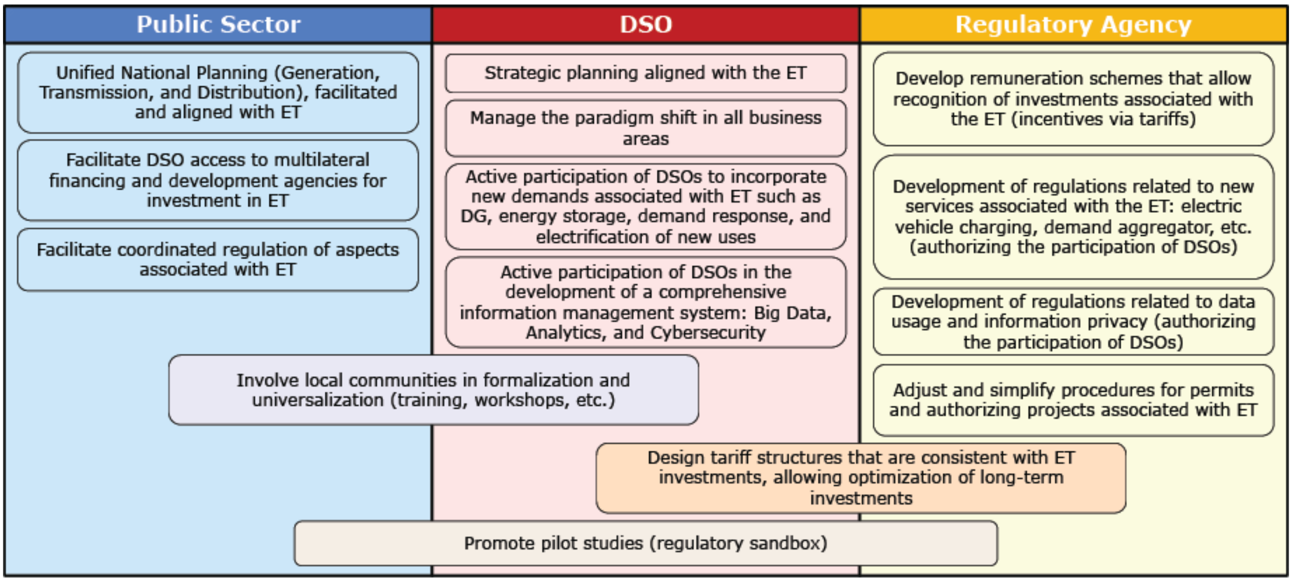
Finally, the energy transition generates significant environmental benefits through reduced energy consumption and greenhouse gas emissions (GHG), either through the substitution of conventional sources by incorporating distributed renewable resources, optimizing grid operations, and reducing energy losses.

05

CONCLUSIONS AND RECOMMENDATIONS

The results of the investment model show that the magnitude of the investments needed for an effective energy transition is significant, and the Latin American countries will need to mobilize considerable resources to modernize their electrical infrastructures. This requires overcoming challenges derived from financial limitations, regulatory uncertainty, resistance to change from some actors, and the need to develop technical and operational capacities in DSOs. Overcoming these challenges will require a coordinated and strategic approach, as well as continuous support from public policies favorable to the transition. The following are recommendations for addressing these challenges.

Recommendations for the Public Sector, DSOs, and Regulatory Agencies



Unified National Planning that integrates generation, transmission, and distribution policies and strategies, ensuring that all areas are aligned with energy transition goals. This approach should promote synergy between different sectors and be flexible to adapt to rapid technological innovations and changes in energy demand.

Access to Financing: It is essential for governments to facilitate DSOs' access to financing sources such as multilateral banks and development agencies, with favorable financial conditions, including low-interest rates and extended grace periods. This will allow DSOs to make the necessary investments without jeopardizing their financial stability.

Regional Coordination: This includes harmonizing regulations and technical standards, creating integrated regional electricity markets, and cooperating on infrastructure projects.

Aligned Strategic Planning: DSOs must continually develop and update their strategic plans to align them with the goals of the energy transition. This involves anticipating future investment needs, identifying new market opportunities, and adapting to changes in energy demand.

Change Management: Implement change management programs that include continuous training of the workforce in new technologies and processes, adopting a culture of innovation and adaptability, and organizational restructuring when necessary to improve operational efficiency and responsiveness to market demands.

Participation in New Markets: DSOs can capture new markets and services associated with the energy transition, such as demand management, electric vehicle charging infrastructure, and participation in aggregation and demand response markets. Additionally, they can explore opportunities in areas such as cybersecurity and data management.

Remuneration Schemes: Design remuneration schemes that allow DSOs to recover energy transition investments in advance. These schemes should be transparent, fair, and able to adapt to market and technology changes.

Regulation for New Services: Introduce regulations that facilitate the provision of new services associated with the energy transition, such as vehicle charging and demand aggregation.

Data Protection: Implement clear regulations on the use of data and privacy protection to benefit both consumers and the overall system while ensuring protection against the misuse of information.

Simplification of Procedures: Reduce bureaucracy and approval times for projects to attract investments and accelerate the development of necessary infrastructure.

Engagement with Local Communities: Develop training programs aimed at communities to explain the benefits of the energy transition and how they can participate in the process. This is especially important in rural areas where energy access can significantly transform living conditions.

Efficient Tariff Structures: Design tariff structures that not only cover investment costs but also incentivize consumers to adopt more efficient energy practices and actively participate in the energy transition.

Promote Pilot Studies: Support pilot studies that test and adjust new technologies, business models, and regulatory strategies. These can include the implementation of regulatory sandboxes, which allow safe and regulated experimentation before large-scale implementation.

The energy transition in Latin America is an ambitious challenge, but also a unique opportunity to build a more sustainable, equitable, and prosperous future. Investments in modernizing the electrical system are the cornerstone of this transformation, and their benefits extend far beyond the energy sector, positively impacting the economy, society, and the environment. The success of the energy transition in the region will depend on the countries' ability to overcome barriers and fully commit to transforming their electrical systems. The decisions made in the coming years will be crucial in defining the path towards a more sustainable, resilient, and just energy future for all.

> Energy transition scenarios consider a more ambitious evolution of the energy system.

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