Global Energy Alliance
for People and Planet
GEAPP

POWERING THE LAST MILE

Achieving Universal Energy Access
in Latin America and the Caribbean

Contents

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Executive Summary

Latin America and the Caribbean (LAC) has made remarkable progress in electrification over the past few decades.

The region has achieved an impressive 97.6% access rate—a testament to successful national electrification programs that have connected millions of households to reliable power. Yet behind this success lies a stark reality: approximately 16 million people still live without electricity, primarily in remote rural areas and indigenous communities.

Recognizing that business-as-usual approaches have reached their limit, global and regional organizations with a keen interest in energy access have formed the Universal Access Coalition (UAC) to focus global efforts, mobilize resources, and break down barriers to universal electricity access. This white paper explores the lessons learned from past efforts and the new approaches needed to reach universal access in LAC. Referencing extensive research, data collection, interviews with relevant stakeholders, and input from UAC members, this paper compiles original analysis and critical insights into the challenges of electrification in LAC. It draws on eight in-depth country studies and presents a roadmap for achieving universal access by 2030, highlighting both the barriers that must be overcome and the innovative solutions that can transform energy access for the region's last-mile communities.

LAC's power sector is experiencing a classic "innovator's dilemma." Incumbent electricity utilities and other actors have developed deep expertise in grid expansion and operation, but last-mile electrification demands fundamentally different technologies and business models. By continuing to rely on traditional approaches to solve the last-mile challenge, governments are expecting organizations to change their methods and potentially disrupt their own business models. History has repeatedly shown this to be difficult, though not impossible.

The very success of traditional approaches makes disrupting them difficult. Utilities and government agencies have optimized their systems, expertise, and incentives around grid extension. Their planning methodologies, financing approaches, and technical standards were designed for a different set of challenges than those posed by remote, dispersed, and often low-income communities. Examples from countries like Suriname and Belize show that committed utilities with strong social policy mandates and dedicated rural electrification units can successfully adapt to these new challenges, especially in contexts with smaller access gaps.

Overall, this dilemma manifests in multiple specific barriers:

- **Regulatory frameworks often fail to accommodate innovative off-grid solutions or create incentives for serving remote areas**
- **Financial models and tariff structures that work in urban areas prove inadequate in remote regions with different economic realities**
- **Technical capacity focused on traditional infrastructure does not always translate to newer distributed technologies**
- **Community needs and the unique cultural and economic contexts of last-mile populations are very different from those in more urban communities**

The UAC was created specifically to help overcome this innovator's dilemma in LAC's power sector. Rather than expecting established institutions to fundamentally transform their operating models, the Coalition provides a platform for innovation. By bringing together global and regional organizations, the UAC can drive the disruptive approaches needed to finally achieve universal access.

The Coalition's work is organized around five interconnected outcomes:

1. **Enhanced knowledge creation and sharing through a dedicated Knowledge Hub that consolidates crucial data, best practices, and tools**
2. **Strengthened policy and regulatory environments that enable innovative solutions at national and regional levels**
3. **Increased technical capacity among key stakeholders to plan, implement, and operate new approaches**
4. **Improved livelihoods through energy access linked to productive uses and income generation**
5. **Mobilized human and financial resources to catalyze transformative change**

Central to this effort is the LAC Energy Access Facility, a mechanism to implement the Coalition's vision. The Facility will provide catalytic capital, technical assistance, and knowledge resources to drive innovation in last-mile electrification. It offers a pathway to overcome the innovator's dilemma and finally close the access gap.

The technological solutions and business models needed to achieve universal access already exist. Distributed renewable energy technologies— notably mini-grids and standalone solar systems—have proven to be cost-effective alternatives to traditional grid extension in remote areas. These technologies, which have seen widespread success in other regions, offer the potential to both compliment and leapfrog conventional infrastructure and provide clean, reliable power even in the most challenging contexts.

Other promising innovations include:

- **Community-centered approaches that align with local cultural contexts and build genuine ownership**
- **Integration of productive uses of energy that boost livelihoods and strengthen the financial viability of energy investments**
- **New business and financing models that overcome affordability constraints while ensuring operational sustainability**
- **Regional knowledge sharing that accelerates learning and replication of successful approaches**

This white paper showcases examples from across the region to illustrate the potential of these innovations. In Peru, the EMujer program has demonstrated how thoughtfully designed ownership models can create community buy-in. In Suriname, the integration of productive uses in mini-grid projects has improved both economic outcomes and project sustainability. In Panama, local capacity building through the Campeonas Solares program has empowered women while ensuring local maintenance capacity.

The impact of electricity access extends far beyond convenience—it fundamentally transforms lives. In healthcare facilities, reliable power enables vaccine refrigeration, medical equipment operation, and nighttime emergency services. For students, lighting allows extended study hours, while digital connectivity opens new educational possibilities. For businesses, power enables productivity enhancements, extends operating hours, and creates new economic opportunities.

The examples are numerous and powerful. In Bolivia's Cerro San Simon community, a mini-grid now powers both local health centers and small businesses, improving healthcare and economic outcomes simultaneously. In Suriname, cold storage powered by mini-grids has reduced food waste and increased agricultural productivity. In Haiti, solar power is enabling critical healthcare services in remote areas previously reliant on unreliable diesel generators.

These transformations represent not just technical achievements but fundamental improvements in human dignity, opportunity, and development. Access to electricity is both a moral imperative—ensuring that all communities can participate in modern society—and a practical necessity for achieving broader development goals.

Addressing this issue requires urgent action from all stakeholders:

- **Governments** must prioritize universal access through clear targets, enabling regulatory frameworks, and dedicated resources. By establishing universal access as state policy, governments can provide the stability needed for long-term investment and innovation.
- **Development and philanthropic partners** must embrace innovative solutions to deliver access to power for the last mile. Concessional financing and grants should target pilot projects that demonstrate scalable solutions, particularly those involving distributed renewable energy technologies.
- **Public and private electricity providers** must be incentivized to develop and deploy solutions tailored to LAC's unique challenges. By creating sustainable business models that work in remote contexts and building robust local supply chains, providers can drive rapid expansion of access.
- **Investors** must recognize the significant market opportunity in serving last-mile communities. Patient capital, innovative financing mechanisms, and a willingness to support early-stage initiatives are essential to unlocking the potential of this market. Experience in other regions demonstrates that distributed renewable energy solutions can be 'bankable' for commercially minded impact investors when risks are properly apportioned and concessional capital is mobilized.
- **Local communities** must be engaged as active partners rather than passive recipients. Their participation in project design, implementation, and maintenance creates the foundation for sustainable impact.
- **Regional organizations** must facilitate cross-border knowledge sharing, policy harmonization, and resource pooling to efficiently scale successful electrification models throughout the region, ensuring innovations in one country benefit all of LAC.
- **Academic and research institutions** must provide governments with evidence-based analysis of electrification options, using diverse data collection methods to evaluate conditions and design cost-effective roadmaps that support both energy access and broader development goals.

The path forward is clear. The technological solutions exist. The business models are proven. What remains is to mobilize the political will, financial resources, and collaborative spirit to implement them in LAC at scale. The Universal Access Coalition stands ready to support this vision and coordinate all stakeholders.

The time to act is now. Together, we can ensure that no one in Latin America and the Caribbean is left in the dark.

Introduction

Latin America and Caribbean (LAC) countries have made remarkable progress in connecting their citizens to electricity over the last few decades. Most are now within a few percentage points of universal access, but progress is stalling.

The business-as-usual approaches that successfully connected 97% of LAC are not sufficient to get to 100%. This white paper explores the lessons learned from past efforts and the new approaches needed to reach universal access in LAC.

In today's interconnected and technology-driven world, access to electricity is essential for full participation in the global community. Energy transforms lives by spurring economic growth, improving healthcare, enabling education and unlocking access to other basic services. Access to power should be viewed as a human right, and it is a deep injustice that roughly 16 million residents of the LAC region still do not have it. This persistent energy inequality demands urgent action.

All LAC countries have committed to achieving Sustainable Development Goal 7 (SDG 7), which calls for universal access to affordable, reliable, sustainable, and modern energy by 2030. Despite these commitments, progress has stalled. Some LAC countries have the needed resources but lack the methods, expertise, or needed urgency.

The challenge is uniquely complex. LAC's unelectrified "last-mile" communities are often low-income and marginalized groups, living in geographically isolated areas that lack transportation infrastructure and are expensive to connect to the grid. These vulnerabilities compound the lack of opportunity faced by last-mile communities and contribute to a self-reinforcing cycle of poverty. Furthermore, the electrification system in LAC is caught in an "innovator's dilemma," optimized for solutions that cannot solve the problem and struggling to adopt new approaches that would disrupt incumbent electricity providers.

In many cases, governments, energy providers, and other key actors lack needed resources, incentives, and expertise to deliver electricity access to the remaining last-mile communities. Business-as-usual approaches have reached their limit, with the cost of extending the grid to remaining last-mile households reaching as high as $20,000 per new connection. Recognizing the need for new approaches to solve these persistent challenges, global and regional organizations with a keen interest in energy access have come together to form the LAC Universal Access Coalition (UAC)[1]. This Coalition exists to focus global efforts, mobilize resources, and break down barriers to make SDG7 a reality, seizing the opportunity to bridge the persistent electricity access gap and achieve universal access in the LAC region.

This paper is the product of an unprecedented collective effort to understand and address this complex challenge. Referencing extensive research, data collection, and interviews with relevant stakeholders[2], this white paper compiles original analysis and critical insights into the challenges of electrification in LAC. Much of this research is available to the public in eight deep-dive research reports[3] on the electricity access challenges and opportunities for select LAC countries: Bolivia, Brazil, Colombia, Haiti, Honduras, Panama, Peru, and Suriname (**Figure 1**)[4]. Based on these country deep dives and supporting research, this paper discusses findings and recommends new approaches to achieving universal electricity access in LAC by 2030.

FIGURE 1: DEEP DIVE COUNTRIES

1 Current Coalition members have joined on a fully voluntary and flexible basis. They include: acciona.org, Commision de Integración Energética Regional (CIER), Centro Regional de Estudios de Energía (CREE), Global Energy Alliance for People and Planet (GEAPP), Inter-American Development Bank (IDB), International Renewable Energy Agen-cy (IRENA), Mesa de Acceso Universal a la Energía (MAUE), National Renewable Energy Lab (NREL), Organización Latino-americana de Energía (OLADE), PSR Energy Consulting, Regulatory Assistance Project (RAP), Sistema de la Integración Centroamericana (SICA), Trama TecnoAmbiental (TTA), United Nations Development Programme (UNDP), United Nations Industrial Development Organization (UNIDO), Waya Energy, and the World Bank (WB). The Coalition is also supported by the International Energy Agency (IEA)

2 Interviewees for this effort included staff at UAC organizations, government officials, utility personnel, energy sector researchers, and other stakeholders

3 Annexed at the end of this report

4 Deep-dive countries were selected based on the sizes of their energy access deficits and the strategic priorities of Coalition members

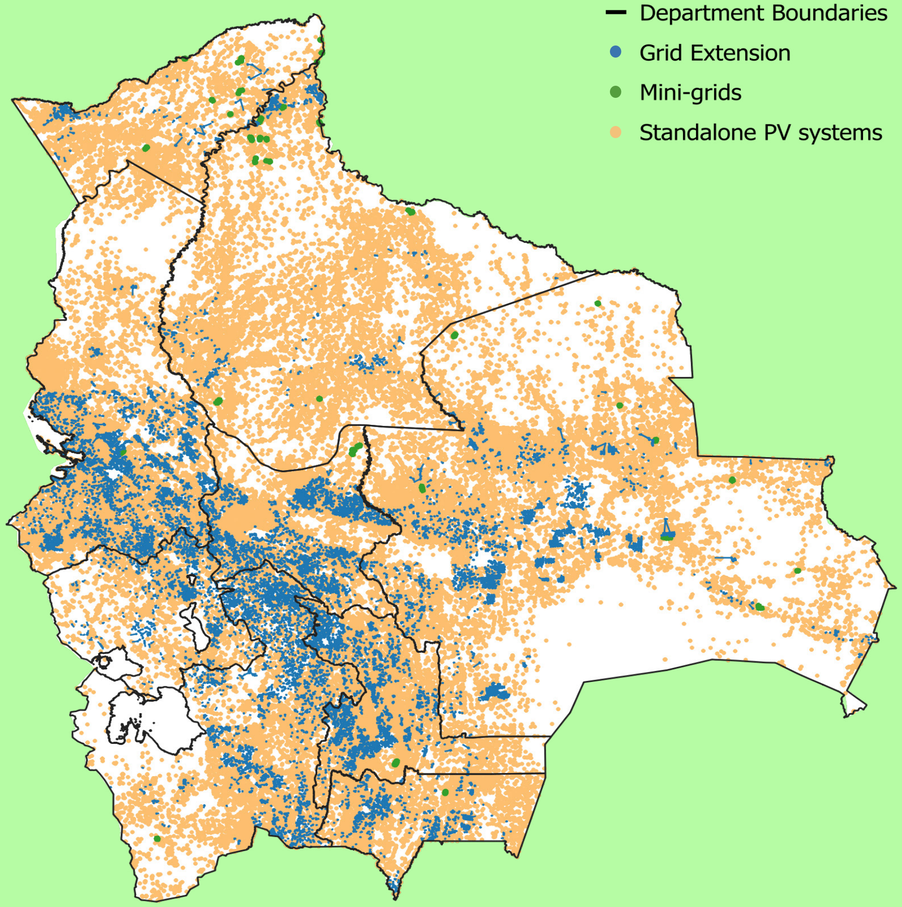
Through a collaborative process that gained significant momentum during an in-person convening in October 2024, the Coalition has identified five key strategic priorities as a preliminary roadmap to achieve universal electrification in LAC:

1. **Enhanced knowledge creation and sharing, peer learning, and collaboration across the region**
2. **Strengthened policy and regulatory environments at sub-national, national and regional levels**
3. **Increased technical capacity to plan, develop, and operate energy access projects**
4. **Improved livelihoods through energy access and productive uses of energy for households, businesses, and public facilities**
5. **Mobilized human and financial resources to catalyze transformative change**

The Coalition aims to address one of the most morally and economically important challenges currently facing the LAC region. Given the complexity of the challenge, the Coalition cannot hope to succeed alone. The paper below will further outline how global, national, and sub-national stakeholders can help build systemic solutions and catalyze real impact.

BOX 1: COUNTRY DEEP DIVES: ZOOMING IN ON ENERGY ACCESS

Example of Geospatial Analysis for Bolivia



The country deep-dives, published in parallel to this white paper, provide an overview of the history, status, and prospects of energy access in each country.

They include:

- **Energy sector statistics**
- **Demographic and geographic trends in energy access**
- **Summaries of selected electrification programs and policies**
- **Summaries of key players in the electrification space**
- **Geospatial analysis on least-cost electrification solutions for target communities**
- **Key challenges and recommendations for achieving last-mile electricity access**

PART 1

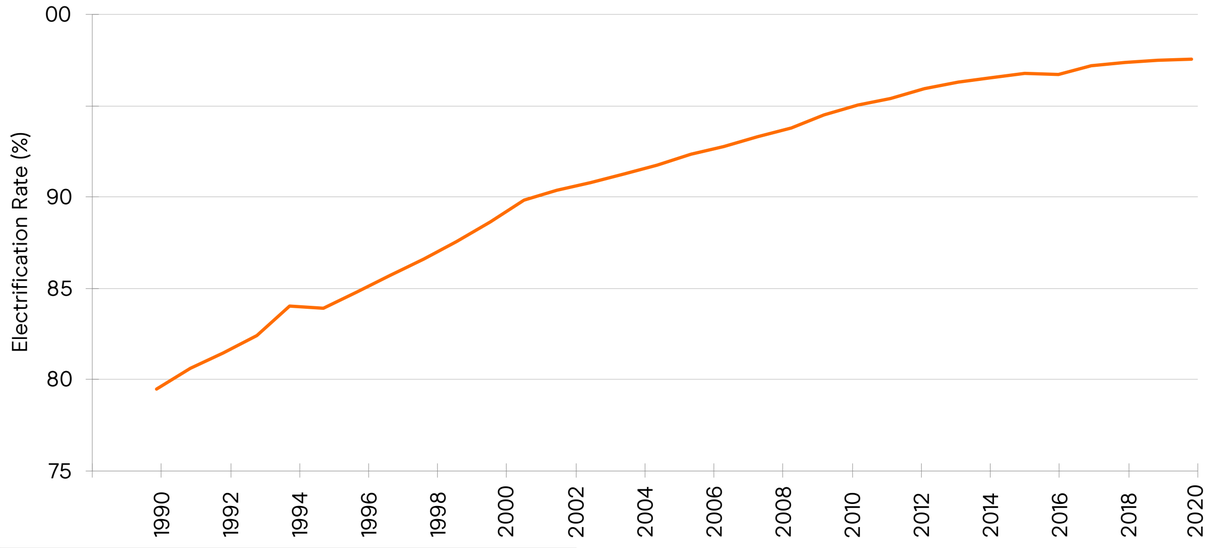
Context

PART 1: Context

Progress in the LAC region is clear, as seen in Figure 2 below. As of 2021, the regional average access rate was estimated at an impressive 97.6%.

This represents a major improvement from much lower levels just a few decades ago - in 1990, the region had an estimated energy access rate of just under 80%.[5][6]. This progress in expanding electricity access can largely be attributed to national institutions' ability to build out their electric grids and generation assets. While these institutions have successfully extended grids to reach the large majority of their populations, connecting the remaining unelectrified "last-mile" communities will require substantial new technical capacities, business models, enabling regulations, and resources. The unique challenge of reaching these communities is largely responsible for the plateau in progress since the mid-2010s **(Figure 2).** While the precise number of unelectrified people in LAC is difficult to determine due to data gaps (in some isolated regions and informal settlements) and differing definitions of "electrification" (see **Figure 5** on the Multi-Tier Framework), that number lies somewhere between 11 and 16 million as of 2021.[7]

FIGURE 2: ELECTRIFICATION RATE OVER TIME IN LAC



5 IDB, Energy Hub, 2021

6 Note that these estimates are based on the data available from the agencies responsible for energy statistics in each country. Thus, they may not be exact.

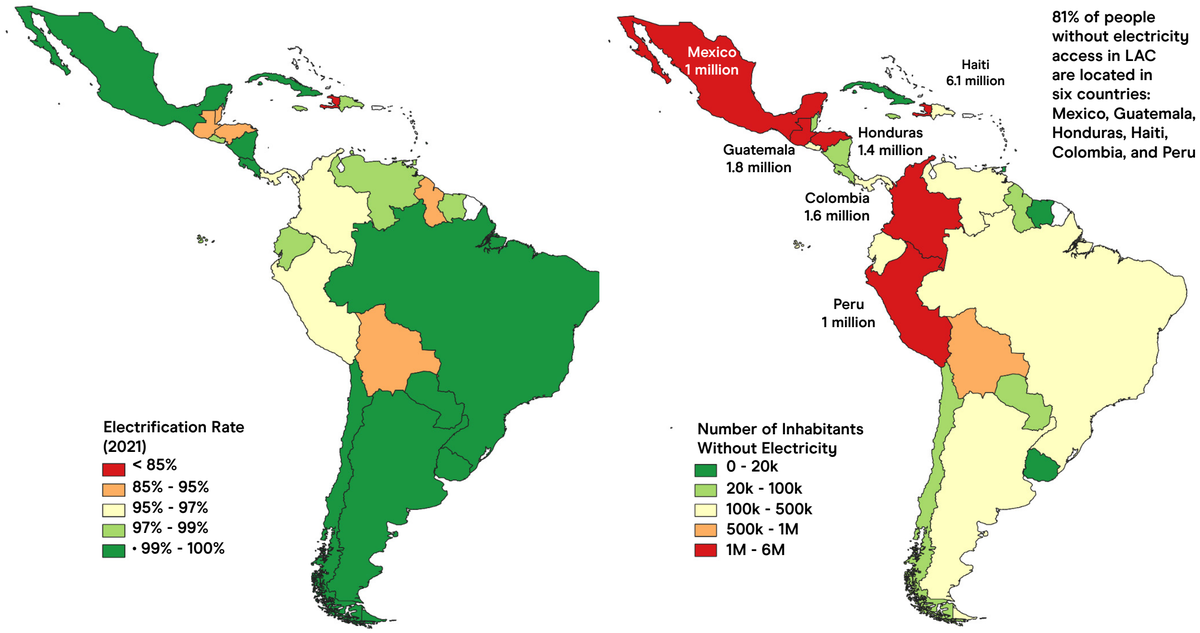
7 ESMAP reported about 11.4 million unelectrified in LAC in 2021, while IDB estimated 16 million.

Where are LAC's unelectrified?

Haiti, Honduras, and Guatemala have the lowest electrification rates in the LAC region, as shown in Figure 3 below.

Despite high national electrification rates in many countries across LAC, energy poverty persists in isolated pockets throughout the region. Even countries with the highest access levels, including Mexico and Brazil, still have significant unelectrified populations concentrated in remote or challenging-to-reach areas.

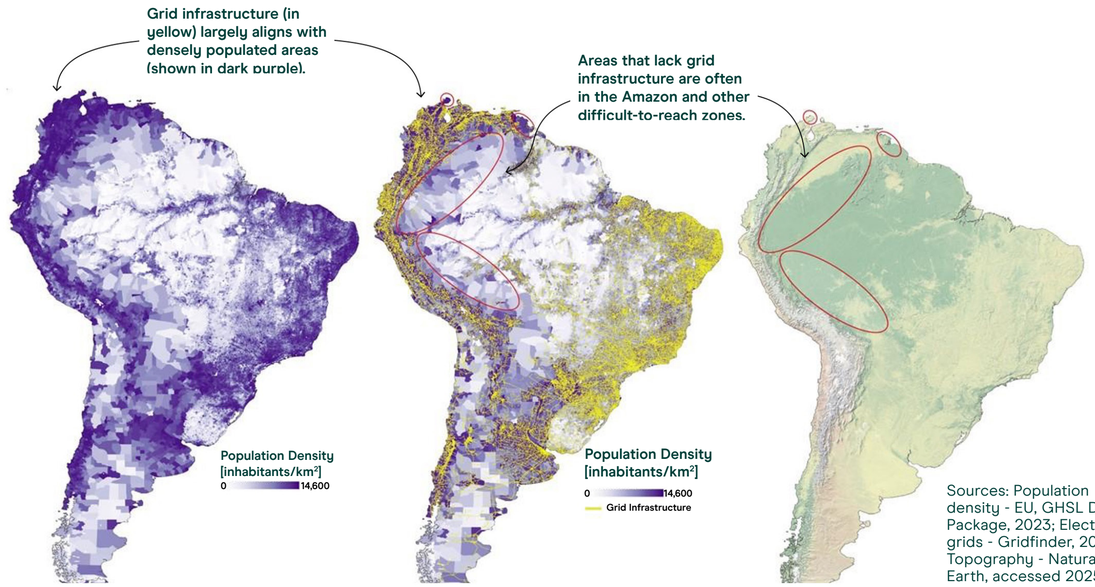
FIGURE 3: ELECTRIFICATION RATES AND SIZES OF UNELECTRIFIED POPULATIONS IN LAC COUNTRIES



Source: IDB, Energy Hub, 2021[8]

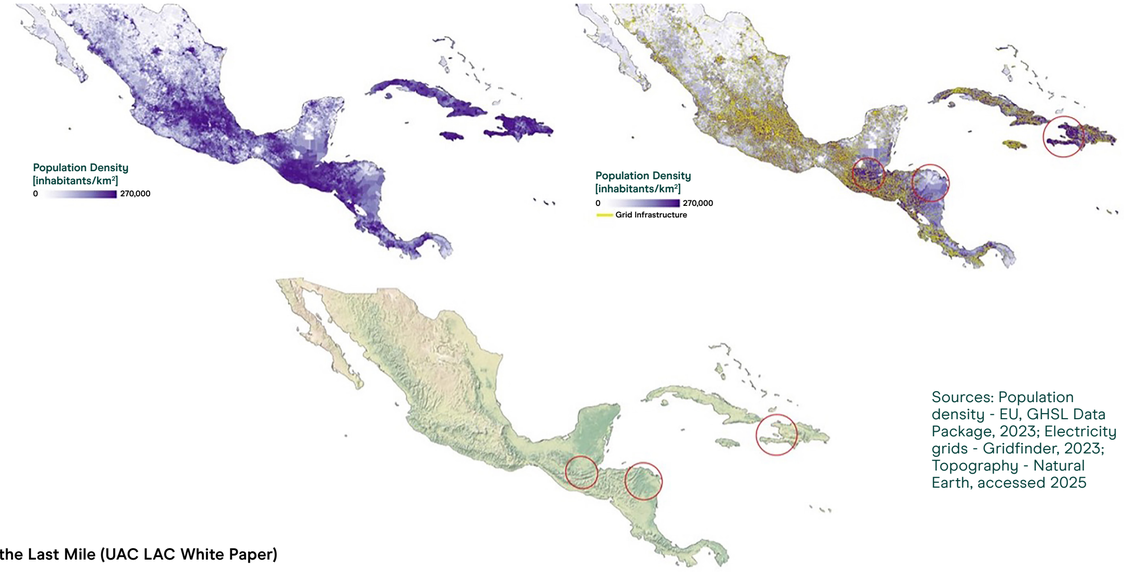
8 There are discrepancies between data sources regarding the number of inhabitants without electricity due to the differences in definitions of who are considered unelectrified. The Brazilian government, for example, considers users that don't have a reliable electricity connection as unelectrified. For data consistency, this figure depicts 2021 data as reported in IDB's Energy Hub database.

FIGURE 4: POPULATION DENSITY AND GRID INFRASTRUCTURE ACROSS SOUTH AMERICA



Sources: Population density - EU, GHSL Data Package, 2023; Electricity grids - Gridfinder, 2023; Topography - Natural Earth, accessed 2025

FIGURE 5: POPULATION DENSITY AND GRID INFRASTRUCTURE ACROSS CENTRAL AMERICA AND THE CARIBBEAN



Sources: Population density - EU, GHSL Data Package, 2023; Electricity grids - Gridfinder, 2023; Topography - Natural Earth, accessed 2025

While the grid covers most of densely populated South America, significant pockets of unserved communities remain **(Figures 4 & 5)**. Colombia's northern La Guajira peninsula, despite its high population density, suffers from underdeveloped grid infrastructure. Haiti stands out in the Caribbean with extensive high-density areas lacking grid access. In Brazil, although the grid reaches some moderately populated communities along the Amazon River, the vast Amazon region remains largely unconnected. In fact, at least 95% of Brazil's unelectrified[9] population lives in the Amazon, where both geographical and ecological factors create formidable challenges.[10] More broadly, the remaining unelectrified residents of LAC primarily inhabit remote rural areas where grid extension faces severe obstacles.

Topographical barriers—mountains, dense forests, and rivers—combined with dispersed, low-density settlements make traditional grid extension either prohibitively expensive or completely infeasible, necessitating innovative alternative solutions[11]

Some urban or peri-urban communities also face electrification gaps, often due to rapid population growth and the persistence of "informal" settlements that are underserved by governments and utilities. Although all LAC countries except for Haiti, Guyana, Honduras, Dominican Republic, and Suriname had urban access rates of at least 99% by 2021[12], the total unserved urban population is estimated to exceed 2 million.[13] [14]

9 The Brazilian government's definition of "unelectrified" includes people with access to diesel generators only.

10 Luz Para Todos universal access plan, 2023

11 IEMA, According to IEAM, about 1 million people don't have electricity in the Amazon, 2022.

12 IDB, Energy Hub, 2021

13 World Bank, Tracking SDG7: The Energy Progress Report, 2024

14 This estimate is marked by uncertainty due to inconsistency in data collection and reporting practices across countries

Who are LAC's unelectrified?

The unelectrified are typically rural households in remote areas or "under the grid"[15] urban households.

Whether rural or urban, electrification is a strong proxy for poverty, with unelectrified households consistently also being the poorest.[16] Many last-mile communities consist predominantly of indigenous peoples and other ethnic minority populations. For example, in Colombia, the non-interconnected zone (ZNI)[17] is home to nearly all of the country's indigenous communities.[18] In Bolivia, the departments with the lowest rural electrification rates - Beni, Pando, and Potosí - have higher concentrations of indigenous populations and significantly lower economic development, compared to the rest of the country.[19]

More broadly, LAC's unelectrified residents tend to experience multiple, intersecting vulnerabilities. Compared to national averages, they typically have higher poverty rates and often lack access to other basic services like clean water, healthcare, telecommunications, and education. In Peru, the districts where more than half of households lack electricity access had poverty rates of 48.6% in 2018 - more than double the national average.[20] In Haiti, some of the most densely populated and poorest communities are located far from existing grid infrastructure, making interconnection both technically challenging and costly.[21] Limited electricity demand and ability to pay among these populations further constrains the economics of electrification. These overlapping challenges - remoteness, poverty, lack of infrastructure, high costs, and limited resources - create a complex web of barriers that must be overcome to achieve universal access. Success often requires subsidies and accommodations for the unique contexts and constraints of LAC's last-mile communities.

15 "Under the grid" refers to households that are located within regions that have grid coverage but remain unconnected to the grid.

16 Interlinkages Between Multidimensional Poverty and Electricity

17 The non-interconnected zone, or ZNI, is the region of Colombia that is not connected to the grid.

18 Geographic and demographic trends, Colombia deep-dive

19 Geographic and demographic trends, Bolivia deep-dive

20 Geographic and demographic trends, Peru deep-dive

21 Geographic and demographic trends, Haiti deep-dive

Barriers to Electrification

Compared to other regions of the world, off-grid electricity solutions - particularly mini-grids and standalone systems - have seen limited adoption in LAC.

This is at least partially attributable to LAC's early start in last-mile electrification efforts, which began before today's most successful distributed and renewable energy technologies had matured. In contrast, Africa has some 43 million residents relying on solar home systems (SHS) for electricity, with over 2 million new households connected per year since 2022. These systems now provide power to 4% of all African households and 8% of electrified households[22], demonstrating the potential of this cost-effective approach.

In LAC, however, many SHS projects have failed and reliable data on SHS penetration remains scarce. Our research has shown that despite LAC's early start in this area, deployment of off-grid systems has not always been systematically tracked by countries in the region. Although there is some variation by country, the off-grid electricity industry in LAC has not kept up with rapid innovation in other regions, and grid-based power is so dominant that household surveys on electricity access may only refer to access from the grid.[23] These data gaps likely result from off-grid technology's smaller role in electricity access compared to Sub-Saharan Africa. Unlike Africa, where associations like GOGLA[24] track sales of quality-verified products, LAC's off-grid market is dominated by smaller companies selling a variety component-based systems that make data collection more difficult. Moreover, many off-grid power systems in LAC rely on expensive diesel fuel rather than renewable sources. This is visible in Colombia, where diesel accounts for 84% of off-grid electricity generation,[25] and Suriname, where 11.5% of the population depends exclusively on diesel generators for electricity access.[26] Underinvestment in off-grid power generation reflects broader systemic challenges: markets, business models, and supply chains needed to support off-grid renewable electricity solutions remain underdeveloped across the region, constrained by gaps in technical, institutional, and financial capacity.

22 Geographic and demographic trends, Peru deep-dive

23 National Institute of Statistics and Informatics (INEI), Government of Peru, Population and Housing Statistics (2013-2023)

24 GOGLA (Global Off-Grid Lighting Association) is the global association for the off-grid solar energy industry.

25 Institute for Planning and Promotion of Energy Solutions (IPSE), Government of Colombia, Monitoring of Infrastruc-ture and Energy Characterization of Non-Interconnected Areas https://ipse.gov.co/cnm/caracterizacion-de-las-zni/

26 TTA 8 Waya Energy, Least cost rural electrification plan: Formulation of the Rural Electrification Plan for Suriname to support the country's efforts to achieve universal energy access by 2030, 2024.

These constraints are further explored in the next section of this paper and are categorized as follows:

- **Policy and Regulation**: Existing regulatory frameworks in LAC are often inadequate to meet the needs of last-mile electrification, with weak incentives, flawed tariff and subsidy schemes, rules not designed for off-grid solutions, and bureaucratic permitting and concession processes. Roles and responsibilities for last-mile electrification are often unclear or unassigned.
- **Planning**: Electrification planning has often overlooked the last mile and lacked accurate, granular data on unelectrified populations. Plans have focused too much on grid-extension and have not adequately incorporated new technologies and business models that have proven successful in other regions. Planning processes have not consistently involved consultations with unelectrified communities to understand their needs and capacities.
- **Technology and Business Models**: Innovative off-grid technology solutions and business models are not yet widespread in LAC. Utilities often lack incentives and capabilities to deploy, operate, and maintain them. Dedicated off-grid service providers have not yet reached scale and also lack the incentives needed to accelerate progress.
- **Financing and Financial Viability**: The economics of electrifying the last mile are often unworkable, with very high costs to build and maintain infrastructure in remote areas that have small populations, difficult terrain, limited access to financing, limited ability to pay, and low availability of powered appliances. Dedicated funding for last-mile electrification remains constrained, with limited inclusion of productive uses of energy (PUE) in off-grid projects further undermining financial sustainability. Under energy-as-a-service models, maintenance costs for systems in remote communities are a major challenge. Concerted efforts to mobilize public, private, and concessional funding and structure workable financing solutions are still needed.
- **End-User Considerations**: Unelectrified households and communities in LAC are impacted by limited ability to pay, low familiarity with new technologies, business models that do not align with local cultures, and inadequate investment in capacity-building. These communities often require more engagement, with greater cultural sensitivity, to make electrification initiatives effective.

PART 2

Learning From Experience

PART 2: Learning From Experience

Drawing on examples from LAC and other regions, this section examines why, despite significant resources and decades of effort, universal access remains elusive in LAC.

The barriers preventing full electrification are complex and interconnected and should not be viewed in isolation. Finally closing the last-mile electrification gap will require solutions that integrate lessons from all of these areas.

POLICY AND REGULATION

Governments in LAC have a responsibility to promote universal energy access and enable a modern standard of living for all constituents.

The region needs well-designed policies that incentivize service providers to reach last-mile communities and regulations that support the new technologies and innovative business models specifically suited to LAC's remote unelectrified communities.

Political Prioritization and Accountability

While most LAC countries have plans and policies for their energy sectors that include universal access and/or rural electri cation in alignment with SDG7, the clarity, speci city, and feasibility of these plans vary.

Universal access initiatives in LAC also frequently suffer from inconsistent political support and weak accountability. The lack of targeted, actionable, and fully-resourced universal access policies leaves last-mile electrification efforts vulnerable to changing political priorities. In Peru, for example, having six different presidents between 2016 and 2021 led to repeated shifts in strategic policy and funding priorities for rural electrification.[27] [28]

This inconsistency is compounded by limited political accountability for achieving universal access goals. Remote and indigenous communities in LAC often lack effective political voice, making it easier for their needs to be overlooked. Ecuador, which has the highest proportion of indigenous political representation in Latin America, still faces a 27% gap between indigenous parliamentary seats and their share of total population, which stands at 7%. In contrast, Mexico has the largest representation gap at approximately 81%, despite indigenous people making up 15% of the population. Only Bolivia, Venezuela and Colombia have af rmative action policies for indigenous people, by which some seats in congress are reserved for indigenous legislators, yet there is little evidence of significant impact of the programs.[29] As one stakeholder in Suriname observed: “The interior consists of indigenous and Maroon communities, and the indigenous people don’t really have a political party.” Government funding decisions often do not fully represent the needs of all citizens.[30]

Moreover, because electricity access rarely emerges as a decisive election issue compared to more immediate concerns like economic growth and social programs, LAC’s political leaders often face few consequences for failing to prioritize electrification or deliver on access commitments. Without clear universal access targets and plans, and mechanisms to hold leaders accountable for progress, last-mile electrification efforts are constantly at risk of being sidelined by other competing priorities.

27 Feron & Cordero, Is Peru Prepared for Large-Scale Sustainable Rural Electrification?, Sustainability, 2018

28 Authors’ interviews with UAC members

29 Mercedes Hoffay & Sofía Rivas, The indigenous in Latin America: 45 million with little voice, 2016

Governance Structures and Institutional Coordination

The effectiveness of universal access programs in LAC is often undermined by weak institutional frameworks and poor interagency coordination.

In many countries, institutions specifically tasked with expanding electricity access lack adequate resources, do not coordinate with other relevant agencies, or do not exist. Haiti illustrates this challenge, as it operates without a dedicated energy sector institution such as a ministry, commission, or secretariat. Instead, Haiti houses its Energy Cell within the Ministry of Public Works, Transport, and Communication (MTPTC), an agency with an extremely broad mandate. This organizational structure diffuses focus and resources, leaving energy access as just one of many competing priorities and signi cantly hindering Haiti’s progress toward expanding electricity access.

Where institutions do exist, overlapping responsibilities, unclear mandates, and insufficient resources often create confusion and inefficiency. Interviews with key stakeholders in Colombia revealed that institutional teams working on energy access lack capacity and are often too overwhelmed with administrative work to focus on impact-driven activities. Meanwhile, in Suriname, lack of effective coordination between the Ministry of Natural Resources, the national utility EBS, and international donors, sometimes complicates the development and maintenance of standalone solar installations. More broadly, these coordination challenges undermine the development of a coherent regulatory framework for off-grid energy systems.

30 Authors’ interviews with UAC members

Regulating and Incentivizing Utilities

Electric utilities are central to achieving universal access in LAC, but current regulatory frameworks need significant improvement.

In some countries, such as Colombia, there are vast territories with no responsible actor mandated to carry out electrification. Many utilities hold exclusive rights for electricity distribution in their concession areas but lack either the mandate or incentives to deploy and maintain off-grid solutions in remote communities. In some cases, regulatory signals actually discourage utilities from serving last-mile communities. In Peru, for example, utilities have been guided to deprioritize electrification in zones where less than 40% of the physical area is covered by urban infrastructure, such as housing, buildings, and streets. When this regulatory guidance was suspended for the Light for All program in 2008, Peru's rural electrification rate roughly doubled over the following five years.[31]

Brazil stands out as the only country in LAC where every geographic area falls within a utility concession territory and private utilities, rather than the government, bear primary responsibility for implementing universal access. Utilities develop access investment plans, which must be approved by government authorities. Once approved, utilities become eligible for a partial government subsidy that helps finance these investments. This regulatory clarity has helped drive significant progress in expanding access, though challenges remain in reaching the most remote communities.

The regulatory challenge is particularly acute for mini-grid development. In Haiti, mini-grid projects suffer from lengthy and time-consuming processes to award concessions, secure land, and receive regulatory approvals. In Peru, mini-grid projects require separate concessions for generation and distribution, creating bureaucratic hurdles that can delay implementation. Past rural mini-grid and SHS electricity concessions in Peru also did not guarantee exclusivity of supply or otherwise protect operators from losses when the main grid was extended to their service areas. Meanwhile, well-performing utilities often lack incentives to participate in last-mile electrification projects, where financial returns may be limited and uncertain.

31 Peru's electrification efforts to date, Peru deep-dive

Knowledge and Capacity Constraints

Last-mile electrification efforts in LAC often require more targeted institutional capacity. Governance structures and institutional coordination are discussed above, and their shortfalls are worsened by high staff turnover in some government agencies.

For example, Bolivia, Haiti, Honduras, and Suriname have struggled with government staff retention and loss of institutional knowledge due to wage stagnation, emigration, and political instability.[32] [33]

Many of the relevant institutions in LAC also need more detailed understanding of last-mile communities' needs and circumstances. This knowledge gap stems from multiple factors, including:

- **Outdated or incomplete census and survey data**
- **Limited resources for field research in remote areas**
- **Inadequate community engagement practices**
- **Insufficient partnerships with NGOs and other organizations that have deep local knowledge**

The consequences of this knowledge deficit and lack of institutional capacity are evident in regulatory decisions. Without understanding of the energy consumption patterns and economic realities of remote communities, government policies and technical standards sometimes inadvertently undermine electricity access. In Panama, for example, minimum system size requirements to qualify for government electricity subsidies were found to exclude the smaller, more affordable solutions that match the needs of underserved communities (Box 2). Such smaller options, including plug-and-play solar home systems, could provide critical entry-level electricity access, especially for populations that cannot currently afford appliances.

Enabling local governments to manage energy projects is essential for their long-term sustainability in last-mile communities. Currently, local authorities often lack the technical capacity and financial resources to operate and manage these projects. Many countries in LAC lack the capacity to decentralize government management, adding to the logistical and operational burdens of developing and overseeing remote and dispersed projects.[34] [35]

National governments should provide funding, training, and capacity-building to enable local governments and utilities to contribute more effectively.

BOX 2: FINDING THE BALANCE: INVESTING THE RIGHT AMOUNT IN PANAMA

While underinvestment in electricity access can trap communities with inadequate service indefinitely, over-investment (in the wrong places) can also impede progress. In Panama, government planners sometimes overly favored solar home systems (SHS) capable of powering refrigerators, air conditioners, and other major appliances to enable eligibility for incentives like subsidies. While this level of access to electricity is desirable, pushing for too much, too soon can actually impede progress when:

- **High costs make systems unaffordable for families who need electricity now**
- **Complex logistics slow down deployment and complicate management**
- **Oversized systems result in underutilized capacity (field studies show last-mile households in Panama typically use only 50% of even small SHS systems of 50Wp)**

A study by key stakeholders evaluated changes in electricity demand in Panamanian last-mile communities. In communities that benefited from solar electrification, the next 5 years saw community priorities evolve from low-power lighting and phone charging to much higher energy demand. Electrified communities' priorities evolved toward productive uses, like refrigeration. In contrast, unelectrified communities continued to prioritize much less energy-intensive lighting & phone charging. This demonstrates the value of planning phased approaches that start with small, low cost (potentially modular) energy investments that can start a positive feedback loop of development, electricity demand, and further investment. This approach has been reflected in Panama's most recent National Rural Electrification Plan, published in 2024.

32 Future plans and considerations for electrification, Suriname deep-dive
33 Future plans and considerations for electrification, Bolivia deep-dive
34 Risks and Challenges for electrification in Haiti, Haiti deep-dive
35 Future plans and considerations for electrification, Bolivia deep-dive

Toward More Effective Regulatory Frameworks

Regulatory frameworks in LAC are often poorly suited to the unique requirements of last-mile electrification.

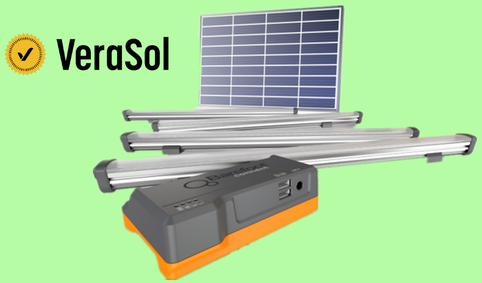
These frameworks must balance the need for sustainable business models with affordability for low-income households, potentially through targeted subsidies and other support mechanisms. **Key considerations include:**

- Financial incentives often don't reflect the true costs of rural electrification, hindering profitability for providers and compromising the quality of operations and maintenance (O&M) services. Tariffs may be based on grid-based infrastructure or operating models that do not align with last-mile realities, leaving providers without sufficient capital for off-grid O&M. Incentives should be tailored to specific sub-regions of the country, considering remoteness, terrain, seasonality, and level of access to payment systems, as each can have a significant impact on logistical and operational costs. These incentives should also support the development and retention of local operations and maintenance (O&M) staff who can handle basic troubleshooting and maintenance.
- There is a lack of clear, straightforward regulatory frameworks for standalone solar and mini-grid development in many countries, leaving off-grid providers without legal recognition or regulatory clarity. This challenge both deters investment and limits the ability to scale operations. In the case of a lack of legal recognition, it puts providers at risk of losing access to subsidies and financial incentives. Furthermore, the absence of clear policies on main grid arrival magnifies financial risk for off-grid providers whose upfront investments may be undermined without compensation.
- Long-term concession frameworks have proven effective at mobilizing private investment in urban areas but must be adapted for last-mile contexts. Governments should consider either expanding existing utility concessions to include off-grid service obligations or creating separate concessions specifically for mini-grid and standalone system deployment. Well-structured concessions with guaranteed revenue requirements, clear performance metrics, and appropriate duration can provide the certainty needed for private investment.
- Specialized expertise for off-grid solutions should be recognized in concession design. While incumbent utilities bring valuable experience in grid management, they often lack expertise in distributed renewable technologies. Concessions for last-mile electrification may be more effective when awarded to entities with demonstrated capabilities in deploying and maintaining off-grid systems, potentially through competitive auctions that attract specialized service providers or through partnerships of large incumbent utilities with smaller off-grid providers.
- Inefficient and complex permitting processes delay project implementation and discourage new market entrants. Regulatory frameworks should recognize the significant differences in size, methodology, and impact of off-grid system deployment relative to traditional grid infrastructure and reduce compliance burdens accordingly.
- Many countries lack clear and up-to-date technical standards for components like solar panels, batteries, and inverters, leading to variability in product quality and greater challenges around repair and replacement. Mini-grid developers often lack guidance on system design, compromising project sustainability.

BOX 3: VERASOL

Verasol is a globally-recognized quality assurance program for standalone systems with PV modules totaling under 350Wp. It builds upon the strong foundation of the World Bank's Lighting Global Quality Assurance program and is accredited under IEC TS 62257-9-8.* Verasol upholds rigorous testing standards to ensure that all approved products meet high benchmarks for quality, durability, and truth in advertising.

Managed by CLASP in partnership with the Schatz Energy Research Center, Verasol provides independent verification for solar home systems, appliances, and productive-use equipment. Currently, over 205 solar systems are quality-verified, including 34 systems providing Tier 2 levels of service. Verasol gives last-mile distribution companies and policymakers an opportunity to provide households and small businesses with only the most reliable, long-lasting standalone solar systems.



*The technical standard TS 62257-9-8 from the International Electrotechnical Commission (IEC) provides guidelines on the design, installation, and operation of off-grid photovoltaic systems.

PLANNING

The complexity of electricity access calls for significant investment in planning.

Past experience shows that careful and inclusive planning processes are needed to ensure that access will be universal, sustainable, and achieved efficiently. Below are some of the most pressing considerations for electrification planning.

Redefining Electricity Access

Governments define electricity access in varying ways, which significantly affects how they plan for and measure progress.

Traditional binary definitions of access (connected vs. not connected) often obscure critical nuances. A more precise definition and carefully considered targets ultimately enable better planning and decision-making.

For a decade, the Multi-Tier Framework (MTF) has offered a nuanced approach to measuring electricity access across attributes such as capacity, availability, reliability, quality, affordability, legality, and safety. The framework categorizes access into five Tiers, from Tier 1, representing basic access for lighting and phone charging, to Tier 5, which is sufficient to meet the needs of all but the wealthiest households in developing contexts. Tier 0 is reserved for those without even basic electricity service.[36]

A key debate today revolves around the level of electricity service that access projects should target. While moving households from Tier 0 to Tier 1 can significantly improve quality of life, it does not enable productive electricity uses, such as those that drive income generation. Advocates like the Energy for Growth Hub have proposed new thresholds, such as the Modern Energy Minimum (MEM), which calls for at least 1,000 kWh per capita annually—300 kWh for residential use and 700 kWh for non-residential, productive use. This roughly corresponds to Tier 4 under the MTF.

FIGURE 6: MULTI-TIER FRAMEWORK (MTF)

ATTRIBUTES		TIER 0	TIER 1	TIER 2	TIER 3[b]	TIER 4	TIER 5
Capacity	Power capacity ratings (W or daily Wh)	Less than 3 W	At least 3 W	At least 50 W	At least 200 W	At least 800 W	At least 2 kW
		Less than 2 Wh	At least 12 Wh	At least 200 Wh	At least 1 kWh	At least 3.4 kWh	At least 8.2 kWh
	Services		Lighting of 1,000 lmhr per day	Electrical lighting. air circulation, television, and phone charging are possible			
Availability[a]	Daily Availability	Less than 4 hours	At least 4 hours		At least 8 hours	At least 16 hours	At least 23 hours
	Evening Availability	Less than 1 hour	At least 1 hour	At least 2 hours	At least 3 hours	At least 4 hours	
Reliability		More than 14 disruptions per week			At most 14 disruptions per week or At most 3 disruptions per week with total duration of more than 2 hours"	(> 3 to 14 disruptions / week) or ≤ 3 disruptions / week with > 2 hours of outage	At most 3 disruptions per week with total duration of less than 2 hours
Quality		Household experiences voltage problems that damage appliances				Voltage problems do not affect the use of desired appliances	
Affordability		Cost of a standard consumption package of 365 kWh per year is more than 5% of household income			Cost of a standard consumption package of 365 kWh per year is less than 5% of household income		
Formality		No bill payments made for the use of electricity				Bill is paid to the utility, prepaid card seller, or authorized representative	
Health and Safety		Serious or fatal accidents due to electricity connection				Absence of past accidents	

Source: ESMAP, 2015

While delivering higher levels of service is desirable, it involves significant upfront costs, and government budgets are typically constrained. Moreover, many last-mile households have limited disposable income to purchase appliances or pay associated power bills. As demonstrated by the example from Panama discussed above (Box 2), program designers increasingly emphasize "right-sizing" investments and adopting modular systems that can scale with the growing demand of local households.

In cases where households cannot afford financing for individual appliances and/or the electricity bills for mid-tier power, governments should prioritize strategies that meet households' immediate, basic needs while enabling community-level access to higher tiers, supporting uses like refrigeration, water pumping, and milling or grinding. Over time, investments in scalable energy infrastructure will yield greater returns by facilitating upward movement along the energy ladder, ultimately achieving and surpassing the MEM threshold.

Governments must also develop the financial and logistical capacity to maintain systems and uphold service standards over time. In countries like Haiti and Honduras – where combined technical and non-technical grid power losses reach 65% and 38%, respectively[37] [38] – poor or aging infrastructure often undermines reliability, leaving users with electricity access that corresponds to lower tiers of service.

36 Energy for Growth Hub, 2018

37 Current status of electrification and energy access in Haiti, Haiti deep-dive

38 Risks and Challenges for Electrification in Honduras, Honduras deep-dive

Data-Driven Planning

Sound planning depends on accurate and comprehensive data, but across LAC, governments often do not have a clear picture of the locations and key attributes of unelectrified households.[39] [40] [41]

This data gap has real consequences. In Peru's massive SFV[42] (solar) program, poor census information led to overestimating system needs and inefficient deployment, including installation of systems in areas that already had power.[43] Brazil's Mais Luz para a Amazônia/Luz Para Todos program has been hampered by incomplete reporting on installations from distribution companies.[44]

Multiple data types and sources must be integrated to bridge the data gap and enable effective planning, including: satellite imagery, household surveys, market analysis, local government records; and private sector, local NGO, and community-sourced data. However, the dynamic nature of last-mile populations makes data collection an ongoing challenge. Some countries in the LAC region also experience significant internal migration due to limited economic opportunities and conflict.[45] [46] This means governments need systematic processes for continuously gathering and maintaining accurate household-level electricity access data.

Two promising approaches can help address these challenges cost-effectively:

1. **Integration with existing development data collection**. Many agencies already conduct regular household surveys for healthcare, education, and agriculture. Incorporating electricity access questions into these existing efforts allows for synergies and reduces costs.
2. **Geospatial data and analysis**. While some governments in LAC have developed their own methodologies for electrification planning, many rely on outdated information and lack access to the latest data on the costs and capabilities of distributed renewable energy (DRE) technologies. As a result, they often underestimate these solutions' potential to close energy access gaps quickly and affordably. Several Coalition members, including Waya Energy, MIT-Comillas, TTA, MAUE, and IDB, have compiled detailed geospatial datasets and cost-optimization models that enable sophisticated techno-economic analysis and planning in specific LAC countries. These efforts contributed significantly to the UAC's deep-dive research by identifying which technology solutions offer the best path to universal access by 2030 in each target community. They also have the potential to strengthen government planning capacity by enabling the development of data-driven roadmaps.

Success requires political will, technical ability, innovation, and resources. Governments must prioritize and fund systematic data collection, incentivize private companies to share their data, and embrace cross-sector collaboration in data gathering. Only with reliable, current information can planners make sound decisions about technology choices, business models, and resource allocation.

39 Risks and Challenges for electrification in Colombia, Colombia deep-dive
40 Future plans and considerations for electrification, Peru deep-dive
41 Future plans and considerations for electrification, Brazil deep-dive
42 SFV stands for "sistema fotovoltaico," or "photovoltaic system" in English
43 Future plans and considerations for electrification, Peru deep-dive
44 Future plans and considerations for electrification, Brazil deep-dive
45 Risks and Challenges for electrification in Colombia, Colombia deep-dive
46 Future plans and considerations for electrification, Suriname deep-dive

Community Engagement

The failure to meaningfully engage local communities has undermined many past electrification efforts in LAC.[47] [48]

Experience shows that successful last-mile electrification requires deep understanding of local contexts, practices, and needs - knowledge that can only come through sustained community engagement.

Past projects illustrate the high costs of insufficient engagement. In Peru and Brazil, inadequate community consultation led to oversized and unnecessarily expensive standalone solar systems. For example, some projects assumed that alternating current systems would offer greater flexibility, but in reality, consumers only needed basic lighting, which a simpler, safer, and more affordable direct current standalone system could have provided. In Peru, delayed communication created widespread misunderstandings about payment expectations for SHS. In Suriname, failure to account for communal cultural values resulted in ill-suited individual ownership models (further discussed in the Business Models section below). Indigenous communities have been particularly overlooked, despite facing some of the greatest energy access challenges. Readers who are interested in more detailed exploration of the unique contexts and challenges experienced across the LAC region can find this information in the country deep-dive reports annexed below.

47 Oliver Griffin, Lucinda Elliott & Fabio Teixeira, Latin America gears up for clean hydrogen boom but the road is not smooth, 2024
48 OLADE, Estrategia para una América Latina y el Caribe más renovable, 2023

The physical realities of last-mile communities in LAC make local knowledge indispensable. Many communities can only be reached by boat or by crossing difficult mountainous or densely forested terrain. In Suriname, and across the Amazon, both droughts and flooding can interfere with boat navigation and make communities inaccessible. Poorly understood environmental risks can also threaten projects. For example, two mini-grid installations in Suriname were damaged by floods, causing financial losses that could have been avoided if local communities had been properly consulted on project siting.

Understanding local economic patterns is crucial for project sustainability, as detailed in the Financing section below. The seasonal nature of agricultural income, which many last-mile households depend on, creates unique challenges for regular electricity payments. This challenge is compounded when community members temporarily relocate to secondary dwellings near their crops for months at a time, affecting their electricity needs, income, and willingness to invest in electricity generation systems in their primary households. Cultural attitudes toward payment also vary widely - in Colombia, for example, a history of accessing electricity through informal or illegal connections has created resistance to formal payment systems in some rural communities.

The key lesson from LAC experience is clear: community engagement is not just about gathering information - it is about building a foundation for sustainable development through understanding, trust, collaboration, and alignment between project goals and community needs. By systematically engaging communities from the start, projects can choose better technical solutions and payment models as well as build local support.

BOX 4: MEETING COMMUNITIES WHERE THEY ARE: LESSONS FROM PANAMA

acciona.org experience with deploying solar home systems (SHS) in Panama illustrates a critical lesson in electricity access planning: how to align government, project implementers, and communities around a common goal.

acciona.org experience with deploying solar home systems (SHS) in Panama illustrates a critical lesson in electricity access planning: how to align government, project implementers, and communities around a common goal.

acciona.org's successful approach centers on deep community engagement and presence. Their playbook has key lessons for ongoing energy access projects in the region:

- **They begin by working closely with local authorities to explain the project and build trust**
- **Communities select electrification committees serve as liaisons between residents and acciona.org**
- **Rather than simply train and depart, acciona.org maintains a permanent local technical and management team to handle maintenance, collect fees, operate service centers, and provide ongoing support**

Communities can also provide vital insights about opportunities to link electricity access with income-generating activities. Through engagement, project developers can identify local businesses and services that could benefit from reliable power, understand cultural preferences that affect electricity consumption patterns, and map existing informal electricity arrangements.

Training on the use of PV systems in the Guayabal de Pena Blanca Community, Ngabe Bugle (Source: acciona.org)

Integrated Planning Across Sectors and Geographies

Fragmented planning approaches in last-mile electrification efforts often miss opportunities for economies of scale and synergies with other development initiatives.

When communities' electrification needs are addressed in isolation - both within and across countries - projects become more expensive and less viable. By contrast, integrating these separate efforts into comprehensive regional plans could significantly reduce costs and improve project sustainability.

The same principle extends to cross-sector integration. While electrification enables progress across multiple development priorities - energy transition planning, agriculture, healthcare, education, telecommunications, and water access - these sectors typically plan and operate independently. Many programs are already funded but do not factor unelectrified communities into their planning. Better integration across sectors could unlock new sources of financing (e.g. results-based financing related to health or clean water outcomes) and amplify development impacts throughout the LAC region.

Effective integrated planning requires a comprehensive framework that encompasses all of the insights addressed by this white paper. A sustainable financial plan must outline viable business models with affordable user fees, appropriate subsidies, concessional financing, and private capital to fund both initial investments and long-term operations. A clear action plan must assign specific responsibilities for project development, including technical studies, permitting processes, and impact assessments. Regulatory mechanisms must create incentives that mobilize both public and private actors to implement the plan efficiently. Finally, all of these elements must be coordinated in a strategy that recognizes the unique characteristics of each community. This holistic approach ensures that electrification efforts are technically sound, financially sustainable, and socially equitable.

Recent projects demonstrate the potential of integrated approaches. In Haiti, the Renewable Energy for All Project connects energy access directly to healthcare centers by providing 1 MW of solar PV systems and 0.9 MWh of storage across five priority hospitals. Bolivia offers two examples: More Light for the Amazon links energy provision with education, healthcare, and water/sanitation infrastructure, while the Cerro San Simon mini-grid project delivers power to both local health centers and small businesses. Suriname's Bio-SWEET program represents an ambitious integrated planning model, aiming to provide 25 Maroon and Indigenous Communities with electricity,potable water, and telecommunications, while empowering bioeconomies.

There is great potential for improved last-mile electrification efforts by weaving together multiple elements: geographic coordination, cross-sector integration (energy, food, water, health, education, telecommunications), population growth projections, productive energy uses, and environmental priorities. While this integration presents challenges, electrification serves as a fundamental enabler that amplifies the impact of all development initiatives.

BOX 5: HEALTHCARE AND ENERGY ACCESS: A CRITICAL CONNECTION

The importance of integrated planning across sectors is powerfully illustrated by the healthcare sector. While LAC has made significant progress in electrifying healthcare facilities compared to other regions, approximately 8% still lack access to electricity. The challenge is particularly acute for rural facilities:

- **Rural healthcare posts often have significantly lower electrification rates than urban facilities**
- **Lower-tiered facilities that serve remote populations are most likely to lack power**
- **Without reliable electricity, facilities cannot provide essential services like vaccine refrigeration, medical equipment operation, or nighttime emergency care**

While global initiatives like the Health and Energy Platform of Action have helped bridge the health and energy sectors, there remains a pressing need for coordination at the country level. By integrating healthcare facility needs into energy access planning, countries can improve critical service provision and efficiency at the same time.

Tambo Hospital, Cauca Department, Colombia (Source: WHO, 2018)

BUSINESS MODELS AND TECHNOLOGY

Adopting the right business models and technologies will be crucial for closing the last-mile gap in LAC. The technologies and business models that worked well for grid extension are often poorly suited to the unique challenges of serving remote, low-income populations.

Success in last-mile electri cation requires carefully matched technologies and business models with an eye toward economic sustainability and disrupting the status quo. This section explores key technology options and business models, drawing lessons from electri cation efforts across LAC and globally.

Technology Overview

Three primary technological approaches are available for last-mile energy access, each with distinct advantages and limitations.

Each can supply power to last-mile residents independently, or they can be combined and interconnected with each other:

Grid Extension and Densification

Grid extension involves expanding existing centralized or regional power grids into new geographic zones to connect more households or businesses. While extension requires significant infrastructure investment in transmission and distribution lines, densification focuses on connecting households already living "under the grid" – near existing infrastructure.

One of the key advantages of grid extension is its high power capacity, which enables productive uses of energy. Additionally, it allows for cost-effective utilization of existing power infrastructure, teams, and resources. However, the approach has limitations, particularly in remote locations where the costs can be prohibitively high. Reliability of service from grid extension is dependent on the stability of existing systems, and development timelines can be prolonged due to the need for extensive planning, permitting, and impact assessments.

Mini-Grids

Mini-grids are small-scale distributed power networks serving specific communities or clusters of customers. Modern mini-grids typically combine renewable energy sources like solar PV with battery storage and sometimes diesel backup generators. They offer several advantages, including sufficient capacity to meet both household and small business needs, the potential for greater reliability compared to national grids, and the flexibility to scale generation and storage to match growing demand. Mini-grids are particularly suitable for remote communities where grid extension is not feasible. However, they also present challenges, such as high upfront costs for both generation and distribution infrastructure, difficulties in correctly sizing systems, and the complexity of operating and maintaining them in remote locations.

Standalone Solar Systems

Standalone solar systems are individual off-grid systems comprising solar panels, a charge controller, battery storage, and (in some cases) an inverter, providing power directly to households or small businesses. They are quick and easy to deploy, require no additional infrastructure, and offer modular designs that enable customization based on energy needs. Competitive markets for high-quality components contribute to their reliability, and their relatively low upfront costs make them more affordable than mini-grids or grid extension. However, their energy capacity is limited, with only the largest systems capable of supporting productive use equipment. For many last-mile households, even the lower initial investment remains a financial challenge.

Other Technological Developments

Recent technological innovations have dramatically improved the economics of mini-grids and standalone systems in particular. Table 1 below shows how a selection of new technologies is improving the viability of these three approaches to last-mile electrification:

TABLE 1: INNOVATIVE TECHNOLOGIES THAT ENABLE AND REDUCE THE COST OF LAST-MILE ELECTRIFICATION

*MG = mini-grid; SS= Standalone solar systems

TECHNOLOGY / INNOVATION	DETAILS	Which benefits?		
		Grid	MG*	SS*
Low-cost solar PV[49]	Solar PV module costs have dropped over 90% since 2010, while efficiency has significantly improved, making solar power more affordable and accessible.		✓	✓
Low-cost, reliable li-ion batteries[50]	Lithium-ion battery prices have fallen by over 90% since 2010, with advancements in reliability, safety, and energy density.		✓	✓
Efficient appliances[51]	Global initiatives have led to the development of affordable, energy-efficient appliances such as LEDs, fans, TVs, and productive-use technologies (e.g., refrigeration, milling, pumping).		✓	✓
Modular systems	Modular designs enable lower initial CAPEX investments and allow for incremental upgrades to meet growing energy demands.		✓	✓
Low-cost smart meters[52]	Low-cost prepaid smart meters help ensure customers pay for the electricity they consume, while also providing valuable usage data to system operators.	✓	✓	
Plug-and-play technology[53]	Simplifies the installation of standalone solar systems, making it safe and achievable by technicians with basic training.			✓
Lockout tech	Extends the functionality of smart meters to standalone systems, enabling service providers to disable power for non-payment and incentivize timely payments.			✓
Mesh grid technology[54]	Connects small systems in a network, allowing energy sharing and balancing demand while reducing costs and improving scalability.		✓	✓
Mobile money[55]	Eliminates the need for risky face-to-face cash collections by enabling secure, remote payments, significantly improving payment collection efficiency.	✓	✓	✓
Remote monitoring systems[56]	Enables operators to remotely diagnose and address issues, reducing operation and maintenance costs while improving reliability.	✓	✓	✓

49 US Department of Energy, Solar Photovoltaic System Cost Benchmarks, 2024
50 BloombergNEF, Lithium-Ion Battery Pack Prices See Largest Drop Since 2017Falling to $115 per Kilowatt-Hour 2024
51 IEA, Achievements of Energy Efficiency Appliance and Equipment Standards and Labelling Programmes, 2021
52 P. Ezhilarasi, L. Ramesh, P. Sanjeevikumar & Baseem Khan, A cost-effective smart metering approach towards affordable deployment strategy, 2023
53 Aishwarya S. Mundada, Emily W Prehoda, Joshua M. Pearce, U.S. market for solar photovoltaic plug-and-play systems, 2017
54 GEAPP, Rural Electrification: Are Mesh Grids a Game Changer?accessed 2025
55 Mamadou Saliou Barry, Anna Creti, "Does Financial Inclusion Facilitate Solar Panels' Adoption? Evidence from Tanzania, 2023
56 US Department of Energy, Monitoring Platforms for Solar Photovoltaic Systems, accessed 2025

Mini-grids and standalone solar systems have seen dramatic improvements in cost-effectiveness and adaptability thanks to advances in solar PV, batteries, and modular system design. Mini-grids now offer scalable, reliable solutions for communities with higher demand, while standalone solar systems provide a practical, affordable option for dispersed households with lower energy needs. Together, these developments position mini-grids and standalone solar as the most viable approaches to closing the last-mile gap in remote LAC communities, with grid extension limited to densely populated areas.

Energy storage solutions are another key area of technological innovation with the power to accelerate last-mile electrification. Numerous programs in LAC have used lead-acid batteries for energy storage, including the Massive SFV (SHS) program in Peru and Mais Luz para Amazonia/Luz Para Todos in Brazil. Past last-mile electrification programs that used lead acid batteries in LAC suffered significant financial losses as a result of frequent battery replacements. In contrast, newer lithium-ion batteries can sustain vastly more cycles and a greater discharge depth, enabling longer lifetimes. However, lithium-ion batteries still have their own challenges, such as lack of recognition in tariff models, premature battery failure due to lack of quality control for PV components,[57] and unclear or poorly enforced regulations on the disposal of lithium-ion batteries, raising environmental concerns about their usage in the Amazon. When used carefully, lithium-ion storage technology offers massive improvements in system reliability and program sustainability when compared to lead-acid technology.

To ensure the integration of cutting-edge solutions into electrification planning, governments must actively engage with the private sector to stay informed about emerging technologies. They must simultaneously update regulatory frameworks to accommodate these innovations, as existing regulations often narrowly target specific technology types or generations (such as second versus third-generation PV systems). Stronger collaboration between public and private sectors would enable last-mile communities to benefit from the current technologies described in this section as well as future technological advances.

BOX 6: MESH GRIDS

Mesh grids connect multiple standalone household energy systems into a small network, providing the resilience and reliability of a grid system at a lower cost than a traditional mini-grid.

By enabling energy sharing across households, they can better balance supply and demand within a community while supporting more energy-intensive productive uses than standalone systems. As an intermediate solution between standalone solutions and mini-grids, mesh grids can provide a cost-effective means to deliver off-grid power to remote communities and foster economic development. They employ modular designs that enable new households to be added incrementally, supporting long-term sustainability for the community.

Matching business models with the right technologies is key to creating successful innovation in this space. For example, new mesh grid technologies could further enable community-based approaches by allowing households to share energy resources across connected homes. This lower cost alternative to traditional mini-grids can improve the economics of last-mile electrification by enabling productive uses of energy with much less up-front investment required. Although it may not be representative of the entire LAC region, a study of Okra Solar's mesh grid clients in Haiti showed that customers with low energy consumption (<150 Wh per day) make up 73% of the total customers but only 30% of total energy revenue. In contrast, larger consumers (>800 Wh per day) make up just 4% of clients but account for 52% of revenues. This demonstrates both the immediate impact of enabling productive uses, even for a small subset of customers, and the potential for outsized impact on project economics.

57 Zavala, Consulting services for the analysis and systematization of rural electrification business models with home photovoltaic systems in the public and private sector, 2018

Business Models

LAC was an early adopter of off-grid solar systems, with early programs led by public institutions. However, the region has not kept up with technology or business model innovations that have transformed the sector elsewhere.

Today, the LAC off-grid power industry employs different business models from those that are now prevalent in Africa and South Asia. This divergence began around 2010, when Bangladesh's Infrastructure Development Company Limited (IDCOL) pioneered an innovative approach that combined microfinance for users, performance-based incentives for providers, and a decentralized network of local distributors and technicians to create a scalable and sustainable off-grid solar model. Soon after, Sub-Saharan Africa saw rapid adoption of technology-enabled pay-as-you-go (PAYGo) solutions, which enabled private sector companies to deliver decentralized energy access through flexible repayment structures, even in countries where governments lacked budget for large rural electrification programs. While these regions have evolved and scaled their commercial approaches, LAC has maintained its earlier models, missing opportunities to leverage these proven innovations.

Notably, the choice between utility-led or private sector-driven business models depends heavily on country context. Both approaches can be effective with the right conditions and support. In countries like Suriname and Belize, national utilities (EBS and BEL, respectively) have demonstrated success in expanding access to remote communities.

Their achievements highlight several key factors that enable utility-led approaches to succeed:

- **Strong utilities**: All things equal, utilities with mandates for energy access and strong records of developing electrical infrastructure have shown the potential to develop last-mile electrification projects.
- **Dedicated rural electrification units**: Utilities that establish specialized departments focused specifically on off-grid and last-mile solutions can develop the distinct capabilities and expertise needed for these unique challenges. These specialized units can operate with different metrics, technologies, and approaches than traditional grid operations while still benefiting from the utility's institutional knowledge and resources.
- **Strong social policy records**: Countries with histories and cultures that favor universal policies and equal opportunity agendas have had more success with utility-led models.
- **Small access gap**: Counties with fewer unelectrified communities have smaller markets for commercial enterprise. This creates greater reliance on government and utilities that is sometimes met with greater capacity for innovation within those organizations.

In cases where utilities demonstrate the capacity and commitment to reach last-mile communities, directing resources toward expanding these existing capabilities may provide a more straightforward and cost-effective path to universal access compared to developing a nascent private sector from scratch. This is particularly true in smaller countries where the absolute number of unconnected households is manageable, and the utility already has significant reach into rural areas.

While the choice between public and private sector leadership will always depend on context, business models for last-mile electricity access generally fall under two broad categories: service and ownership.

Service Models

Most early programs in LAC adopted "service models," analogous to traditional utility arrangements where customers pay either consumption-based fees or fixed monthly tariffs for electricity service. Under this approach, a service provider (often a utility or specialized energy service company) owns and maintains the systems while customers pay for the electricity provided. When executed well, this model ensures professional system maintenance and operation, provides clear accountability for service quality, and enables cross-subsidization between customer segments. However, it requires a strong regulator significant institutional capacity and long-term commitment. Service models have struggled in last-mile contexts, particularly in cases when O&M costs are high and regulatory incentives are not aligned. This can be particularly challenging when O&M responsibilities and payment collection are assigned to different parties. If operators do not have local service outposts or sufficient O&M budgets, they may not be able to successfully maintain system reliability.

While service models dominated early off-grid electrification efforts in LAC, ownership models have gained prominence globally, particularly in Africa and South Asia. These different approaches reflect varying institutional contexts and market conditions. In regions with strong microfinance sectors and established solar distribution networks, ownership models have proven highly successful at rapidly scaling access.

Ownership Models

In ownership models, customers purchase systems outright, either through upfront payment or financing arrangements. This approach is primarily applicable to standalone solar systems and has dominated markets in Africa and South Asia.

Financing for these purchases can come through two main channels:

- **Solar distributors partner with microfinance institutions to provide customer financing (most prevalent in South Asia)**
- **Solar companies provide financing directly through "pay-as-you-go" (PAYGo) arrangements (most prevalent in Africa)**

The success of ownership models depends heavily on their alignment with local community needs and values. In Peru, the EMujer pilot program explored how thoughtfully designed ownership models can create community buy-in. This program provided communities with access to appropriately-priced equipment and created financial mechanisms that enabled local ownership through bank partnerships and micro-finance. By combining accessible pricing, financial partnerships, and community engagement, EMujer generated excitement and community participation that enabled its success.

(see Box 12: Innovative Financing in Peru for further detail). Depending on the technology, this

BOX 7: THE OWNERSHIP CHALLENGE: COLOMBIA'S ENERGY COMMUNITIES

Colombia's recent Energy Communities initiative illustrates both the potential and challenges of community ownership models. With over 20,000 community applications received by the government, there is clearly strong interest in local ownership and control of energy resources. However, the initiative also reveals that successful community ownership requires carefully designed support structures including:

- **Clear and proven community governance structures**
- **Clear regulatory frameworks that enable community generation and distribution**
- **Sustainable business models that balance costs and benefits**
- **Access to technical capacity and maintenance support**
- **Strong institutional backing, especially in remote areas**
- **Well-designed financing mechanisms that blend public and private capital**

While this initiative has generated high expectations within last-mile communities, implementation has lagged. Uncertainty around capex responsibilities and lack of access to capital are major challenges that could be at least partially addressed through clarified business models and ownership structures.

Rural Colombian community (Source: La Republica, 2023)

(see Box 12: Innovative Financing in Peru for further detail). Depending on the technology, this approach may require the provision of training in basic maintenance, as well as sufficient access to replacement parts, which can be a challenge in last-mile contexts.

Economic Sustainability Through Productive Use of Energy

The economics of last-mile electrification present unique challenges for creating truly sustainable business models.

One problem centers on the difficulty of implementing accountability mechanisms.Traditional approaches to managing non-payment, such as system repossession, become impractical in remote areas where retrieval costs may exceed the value of unpaid bills, as was demonstrated in Peru's SFV program. This fundamental challenge demands innovative approaches to ensure economic sustainability.

To attract investment capital and cover operational expenses, electrification projects need to produce financial returns. One of the most promising solutions is linking electricity access to productive use of energy

(PUE) - using electrical power to enable income-generating activities. Extensive interviews show that energy access project planners in LAC increasingly recognize the importance of including PUE, but they have not yet implemented this insight at scale.

When designed well, PUE programs create a virtuous cycle: reliable electricity enables economic activity which in turn supports system maintenance and expansion through consistent cashflow. Evidence from successful electrification programs shows that projects that incorporate PUE are more likely to achieve sustainability. Meanwhile, insufficient incorporation of PUE has been a common critique of unsuccessful last-mile projects in LAC. Given the high poverty levels in last-mile communities, it is doubly important that electricity access programs include funding to support PUE investments.

It is critical to consider that not all productive activities provide the consistent income needed for sustainability. For example, seasonal activities like cassava processing or oil production may not generate sufficient year-round revenue to cover regular electricity payments. Research from sub-Saharan Africa suggests which PUE technologies tend to be most economically viable. It showed that out of 47 different PUE equipment types analyzed, just six technologies - water pumps, solar dryers, freezers, milling machines, and oil presses - account for 88% of the total market opportunity.[58] This concentration suggests that these proven technologies may offer more reliable paths to economic sustainability and highlights the importance of carefully selecting which activities to promote.

Successful integration of PUE requires attention to several key factors:

- **Selection of locally-appropriate productive activities that can generate consistent income**
- **Investment in proven PUE technologies with**

58 DNA Economics, Capital required to maximise the productive use of energy in rural Sub-Saharan Africa, 2021

BOX 8: SPOTLIGHT ON ONGOING PUE PROGRAMS IN LAC

Several recent programs in LAC are demonstrating the potential of PUE. One example is the E-Coop program, launched in Colombia in 2024, which aims to improve rural producer associations' access to clean technology through the Energy Communities model (see Box 7). By leveraging local networks and financial mechanisms, the program seeks to drive the adoption of sustainable energy solutions that support rural livelihoods.

At the core of the E-Coop program is the support for local Savings and Loans Cooperatives (SLCs) in designing and implementing green credit lines to facilitate access to clean technology. In parallel, the program will pilot a community-based clean energy model for productive uses such as food processing, crop irrigation, refrigeration, and water pumping, ensuring that rural businesses benefit from reliable and affordable energy.

In 2025, the program will expand to Brazil, Honduras, and Peru. Overall, the initiative aims to enable 1.67 MW of installed community clean energy capacity across 46 rural producer associations, directly benefiting 2,300 low-income producers and reaching 8,800 indirect beneficiaries.

While E-Coop focuses on integrating clean energy into rural businesses, the Bio-SWEET program, launched in Suriname in 2024, takes a broader approach by combining renewable energy, clean water, and telecommunications to support both economic and social development. Through a mix of mini-grids and standalone systems, Bio-SWEET will provide reliable access to essential resources for 10 rural Amazon villages.

A key objective of Bio-SWEET is to foster a sustainable bio-economy with a strong gender and diversity perspective. The program will create economic opportunities for local farmers, small business owners, women, indigenous communities, and Afro-descendant populations in sectors such as stingless beekeeping, cosmetic oil production, herbal tea cultivation, ecotourism, and handicrafts. Additionally, it will generate 18 jobs in water system operations and maintenance (O&M) and 30 jobs in energy system O&M. The program's impact will extend to approximately 2,000 households, 25 health clinics, 30 schools, and 50 businesses, strengthening both economic and social infrastructure in the region.

demonstrated market success

- **Customer education about payment obligations and the impact of nonpayment**
- **Support systems to help users maximize the productive potential of their electricity access**

The success of any business model ultimately depends on finding sustainable ways to deliver reliable electricity while keeping costs affordable for last-mile communities. This requires careful attention to local conditions and needs, innovative technological solutions, and flexible approaches to ownership and payment collection. As the sector continues to evolve, new hybrid models incorporating elements of both community ownership and productive uses of energy may offer promising paths forward for expanding energy access across LAC.

Operational Challenges and Solutions

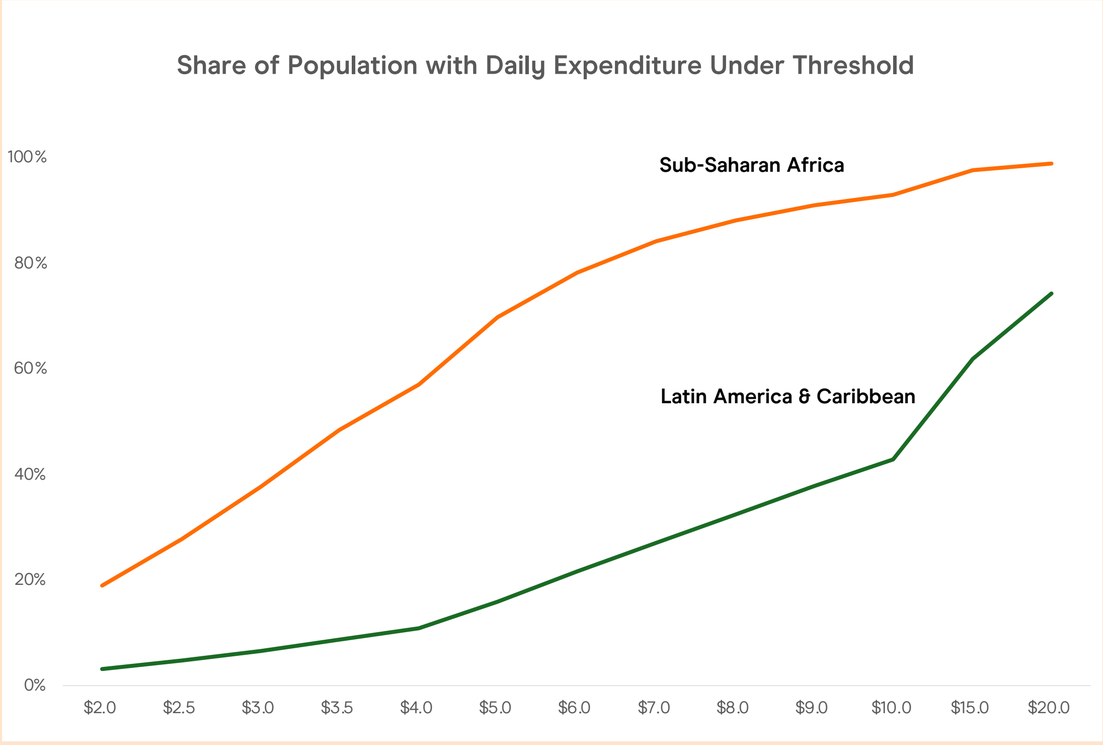
As discussed throughout this paper, last-mile energy providers in LAC face significant operational barriers that traditional business models struggle to overcome.

Remote locations drive up installation and maintenance costs while making regular payment collection difficult. Poorer community members have low ability to pay market rates for services, especially when these high costs of O&M and payment collection are included. For these reasons, many traditional system vendors and installers show limited interest in working in such challenging areas (as seen in Colombia's non-interconnected zones) or choose to absorb delinquency costs as less expensive than visiting homes to decommission systems (as seen in Peru).

Supply chain constraints further complicate last-mile electrification efforts. Rural households frequently struggle to find compatible replacement parts for their solar home systems, particularly lighting and appliances

In LAC, consumer expenditures—and consequently, the ability to pay for products and services—are significantly higher than in Sub-Saharan Africa, where PAYGo solar sales have played a significant role in rural electrification efforts. In fact, only the richest quintile of Africans has higher expenditures than the poorest quintile in LAC.

This does not mean that affordability challenges are absent in LAC, particularly among the most marginalized and remote populations. However, it suggests that most consumers, except for the very poorest, can likely afford to make regular payments for systems, even if subsidized. Such payments have been shown to enhance a sense of product ownership and contribute to the long-term sustainability of programs.



Data is based on 2024 poverty headcounts reported by the World Bank.

Several technological innovations are helping to address these operational challenges:

1. **PAYGo systems that help manage payment collection are little-used in LAC but have demonstrated enormous potential in projects throughout Africa, where some 40% of new off-grid solar systems are being sold with embedded PAYGo technology[59]**
2. **Remote monitoring systems allow providers to track system performance and usage patterns, diagnose problems remotely, and avoid expensive site visits**
3. **Efficient appliances like LED lights and DC fans and refrigerators can be bundled with SHS systems to ensure compatibility and optimize household energy consumption**
4. **Modular, plug-and-play systems reduce installation complexity and maintenance requirements while enabling scalability and easy integration of efficient appliances (Box 3)**
5. **More robust energy storage technologies, such as lithium-ion batteries, which replace lead-acid battery technology, can improve system lifetimes and reduce maintenance costs**

With 72% of LAC now possessing mobile phones[60], PAYGo could help overcome traditional barriers to system ownership in remote areas. The model has proven transformative in other regions, though it remains relatively less common in LAC.

59 https://gogla.org/reports/semi-annual-solar-market-report/global-off-grid-solar-market-data-jan-june-2023/ 2

60 GSMA, The Mobile Economy in Latin America 2024, 2024

BOX 10: THE POWER OF PAY-AS-YOU-GO

Pay-as-you-go (also called PAYGo or PAYG) technology is transforming access to clean energy. PAYGo enables households to acquire solar home systems (SHS) through an innovative financing model - users pay for their systems in small, flexible installments.

Under the hood, PAYGo systems use a "lock-unlock" feature to help manage financial risks. This integrated lockout technology can use manual inputs or automatic data-connected chipsets to deactivate systems if customers do not pay and remotely reactivate them when accounts are settled.

The beauty of PAYGo is its accessibility. By lowering upfront costs and aligning payments with income streams, it opens the door to solar for customers who may lack access to traditional credit. Most PAYGo models reward completion of payment plans with full system ownership, transforming energy access into an empowering investment.

This technology can also be applied in service models, and has successfully been deployed in Mexico Peru and Panama. Thus, in combination with the right business models and other technologies, PAYGo systems were sold across sub-Saharan Africa.

Quality of service remains a persistent challenge in last-mile electrification efforts. Many business models lack effective mechanisms for two-way accountability between service providers and customers. Service providers may fail to deliver promised maintenance while still charging customers or may set billing rates too low to support adequate O&M services. Conversely, providers need ways to ensure payment compliance from customers.

Remote monitoring technology can help address these accountability gaps by providing transparent data on system performance and usage. The Cerro San Simon mini-grid in Bolivia demonstrates how smart grid technology can enhance service quality and accountability. As the first fully integrated smart grid in Bolivia, backed by the country's largest lithium-ion battery system of its kind, the project showcases several key success factors:

- **Strong collaboration between multiple stakeholders including the government, development banks, utilities and technology providers**
- **Implementation of lifeline tariffs and tiered pricing structures supported by prepaid meters**
- **Provision of power to critical community services like health centers and small enterprises**
- **Investment in training users and local technicians to operate and maintain the system.**

acciona.org experience in Panama demonstrates that a long-term local presence dramatically improves service quality and system longevity. By establishing service centers in locations already frequented by community members, like markets and medical facilities, acciona.org has been able to respond rapidly to maintenance needs. Their local technical teams can quickly diagnose and repair issues, rather than waiting for technicians to arrive from far away urban centers. This model recognizes that while basic training is valuable, complex energy infrastructure benefits from maintenance support that is both professional and accessible (**Box 4**).

FINANCING AND FINANCIAL VIABILITY

Historically, early-stage energy access projects in LAC have been funded primarily through public sector resources, with multilateral development banks playing a supporting role.

While it has worked well for grid extension into more densely populated areas, this traditional financing model is failing to adapt to innovative technologies and business models. The high costs and unique challenges of serving remote populations require new approaches to financing. One possible solution might be to redirect funding from extractive industries located in these regions to help nance off-grid electri cation. Better, more targeted incentives, a clear understanding of financing models that have been successful in other regions, the adoption of new risk management strategies, and other nancial innovations are urgently needed.

Impact investment in LAC's last-mile electri cation remains far below its potential, with current levels reaching only a fraction of comparable investment in Africa. The development of portfolios of bankable projects and regional investment approaches would help bring in capital at scale. As discussed above, lack of data, studies, regulatory certainty, coordination, and proper inclusion of PUE all combine to reduce the appearance of financial viability and thus continue to constrain investment flows.

Private investment has been limited by real and perceived risks. While the economic case for renewable energy in last-mile contexts is often strong - particularly compared to diesel alternatives - regulatory structures, market conditions, and institutional capacity are not where they need to be in order to unlock the needed investment and ensure successful implementation. This creates a complex web of interrelated challenges that span cost structures, regulatory gaps, revenue models, market development, and resource mobilization.

As of 2021, the IDB estimated that achieving universal electricity access in LAC by 2030 would require $25.4 billion in new infrastructure investments. This equates to a relatively modest $2.82 billion per year, highlighting the potential for targeted, strategic investments to drive signi cant impact. Separate analyses—led primarily by Waya Energy, MIT-Comillas, MAUE, and TTA.—estimate that closing the access gaps in the UAC's eight deep-dive countries will require approximately $7 billion in investment by 2030 (see cost breakdown in Table 2).

TABLE 2: ESTIMATED INVESTMENT REQUIRED FOR THE 8 DEEP-DIVE COUNTRIES TO ACHIEVE UNIVERSAL ACCESS TO A MINIMUM OF TIER 2 ELECTRICITY SERVICE BY 2030 (MILLION USD)[61]

	Grid densification and extension	Mini-grids	Standalone solar	Total
Haiti (low grid reliability, LGR)[62]	-	320	1,270	1,590
Peru	1,081	142	309	1,532
Haiti (high grid reliability, HGR)[63]	210	830	320	1,360
Brazil	621	198	522	1,341
Panama	194	340	245	779
Bolivia	605	17	95	717
Honduras[64]	148	547		695
Colombia	108	128	78	314
Suriname	1	92	8	101
Total (Haiti LGR)	***2,758***	***1,784***	***2,527***	***7,069***
Total (Haiti HGR)	***2,968***	***2,294***	***1,577***	***6,839***

61 The data for all countries except Honduras is based on geospatial analysis performed by Waya Energy, MIT-Comillas, MAUE, and TTA. The investment amounts include provision of both new and improved service to achieve a minimum of Tier 2 62 This scenario assumes that Haiti's current 30% grid reliability persists.

63 This scenario assumes that Haiti achieves grid reliability of 75%.

64 The analysis for Honduras, developed jointly by Sigla and Asinelsa S.A., does not distinguish between different modalities of off-grid technology. It also does not specify the tier(s) of electricity service being proposed.

Cost Structure Issues

The fundamental economics of last-mile electri cation are shaped by remote locations, dif cult terrain, and dispersed populations.

With high logistical costs for project implementation and limited economies of scale, the need for technological and business model innovation is clear. As discussed in the section above, many key innovations have already proven in other markets that they offer new least-cost alternatives in project design. Proactively seeking out these models, which are now mainstream in much of the world, promises to reduce costs, improve service to end-users, and finally make last-mile electri cation financially viable.

The logistical challenges of LAC last-mile projects are magni ed by risk-driven cost increases. Interviews uncovered that financial institutions, perceiving high risks in last-mile projects, impose substantial risk premiums that elevate the cost of capital far above levels seen in traditional energy infrastructure projects. This dynamic can create a negative feedback loop where high financing costs make projects unviable and fewer viable projects contribute to higher costs to plan, develop, operate, and finance projects.

The lack of standardized cost benchmarks and limited financial modeling expertise for off-grid solutions further distorts the investment landscape. The global average cost to install solar systems in the 5-250 Wp range is $80-550[56], but in Colombia, systems under 500 Wp cost almost $6,000 - approximately five times more on a per-watt basis[66]. Similarly, the average cost for systems installed through Brazil's Luz Para Todos program reached $7,000 in 2023[67]. These dramatic disparities suggest that suppliers may be inflating costs. Without standardized benchmarks, regulators lack the tools to effectively evaluate project economics, leaving them unable to identify and address potential inflation.

Operational costs pose another often overlooked challenge. While much attention focuses on upfront capital expenditure, long-term operational expenses often determine project sustainability. Structural issues, like payment collection in remote areas and separation of payment collection from O&M responsibilities, can be prohibitively expensive. Additional incentives and capacity building centered on local workforce development could help drive down costs and improve sustainability over time.

65 UPME (2019), Plan Indicativo de Expansión de Cobertura de Energía Eléctrica PIEC 2019-2023, Planning unit of the Ministry of Mines and Energy - Unidad de Planeación Minero Energética, Bogota

66 Wood Mackenzie (2019), Strategic investments in off-grid energy access, Wood Mackenzie Power and Renewables

67 Estimate provided by Brazil energy sector stakeholders

BOX 11: PERU'S SFV (SHS) AUCTION: MISALIGNED INCENTIVES IN PROGRAM DESIGN

Peru's Massive Solar Home System Auction program illustrates how structural misalignments can undermine financial sustainability. The program created a complex web of split accountabilities between the technology provider (Ergon) and local utilities that produced critical issues:

- **Misaligned installation and collection incentives:** The program tasked Ergon Peru with system installation and maintenance, while making local utilities responsible for payment collection. This divided responsibility created challenges for both parties. Ergon's guaranteed payments reduced their urgency to bring systems online quickly. Meanwhile, utilities faced prohibitively high costs to collect payments from remote households, often exceeding potential revenues. The result was delays of up to 6 months in registering installed systems, leading to customer perceptions that systems were free and delinquency rates exceeding 90%.
- **Challenging economics for utilities:** The costs of reaching remote households for payment collection, combined with the utilities' focus on their core grid business, made the economics dif cult. With collection costs often exceeding potential revenues and disconnection costs being prohibitively high in remote areas, utilities struggled to make the model work financially.
- **Inadequate planning and communication:** Launching the program without proper census data led to installations in non-priority areas and locations with existing power systems. Insufficient community engagement produced widespread misunderstandings about system costs, benefits, and payment expectations. These issues further undermined customers' willingness to pay.

Peru's experience with the SFV (SHS) Auction program demonstrates the importance of carefully designing incentive structures, clearly allocating responsibilities, and properly engaging communities. Future programs must thoughtfully consider the practical realities and economics of serving remote populations to ensure long-term sustainability.

Revenue Model Limitations

The electricity sector in LAC faces a classic innovator's dilemma:[68] traditional (grid-extension) service models and technologies dominate the overall market but struggle to address last-mile challenges cost-effectively.

Experience shows that alternative models involving distributed renewable energy may be more suitable for many remote communities. While some forward-thinking utilities have built capacity to deploy these solutions, other incumbent companies struggle to embrace innovation."

This resistance to innovation manifests in multiple ways. Traditional tariff structures create an impossible choice between financial sustainability and universal access. “Lifeline” tariffs, which are designed to ensure affordability for low-income households, require significant public subsidies to be effective. Without adequate government support, these tariffs often fail to cover basic service costs while still being too expensive for the poorest households. Meanwhile, utility revenue models that work well in cities prove completely inadequate in remote areas where customer density is low, and service costs are high.

Cross-subsidy schemes represent a powerful yet underutilized solution for last-mile communities. Analysis from Panama, Peru, and Paraguay demonstrates that comprehensive electrification plans could be financed sustainably by increasing tariffs for high-income households and industrial consumers by just 2% over ten years—a mere 0.2% annually. This approach is remarkably cost-effective: the nancial burden is approximately twenty times smaller than the costs already expected to be absorbed by ratepayers or national budgets for the broader energy transition. This makes cross-subsidization not only equitable—ensuring last-mile communities receive the same nancial support as grid-connected populations—but also economically viable.

The lack of productive use of energy (PUE) integration is another factor undermining financial viability. Without commercial demand to strengthen revenue streams, projects struggle to attract investment. This creates a vicious cycle: limited investment in PUE stems from inadequate policy support, which in turn constrains the revenue potential needed to attract future investment.

Mini-grid operators in Colombia grapple with complex tariff schemes that fail to account for widely varying ability-to-pay across last-mile communities. The situation is further complicated in parts of Colombia, Peru, and other LAC countries where historical precedent has led communities to expect electricity as a free public service. Breaking free of these entrenched patterns will require embracing new technologies, business models, and ways of thinking about energy access.

Risk Sharing and Market Development

The development of viable markets for last-mile electrification requires a more sophisticated approach to risk sharing between public and private actors.

Current models in LAC often place disproportionate risk on either private utilities, which may lack incentives to serve remote areas, or on end users who have limited ability to pay. While utilities and nanciers may perceive high technology risks, many of these technologies - from solar home systems to mini-grids - have been thoroughly proven at scale in Africa and Asia. Further impeding progress are misaligned incentives created by fossil fuel subsidies, particularly for diesel generation. Phasing out these subsidies represents a signi cant opportunity - in Brazil, Peru, and Bolivia alone, redirecting these resources could potentially unlock sufficient funding to achieve universal access while simultaneously creating more balanced market incentives for renewable solutions. Such policy shifts would not only level the playing field between fossil fuels and renewables but would also free up substantial public resources that could be strategically deployed to support last-mile electrification efforts.

The real challenge lies in business model innovation: LAC must develop service models that better balance risks and rewards across stakeholders, moving beyond traditional utility approaches to embrace new ways of delivering and paying for electricity access. Government guarantees and risk-pooling mechanisms can help address these imbalances, but they must be paired with business models that create sustainable incentives for all parties.

The barriers to market development are surmountable, but they require coordinated action. Standardized benchmarks for project costs can help prevent in ation of prices by service providers. Development of local currency nancing options can reduce foreign exchange risks. Project preparation grants that help build a pipeline of bankable projects and strategic grouping of projects and communities can help achieve economies of scale that make investment more attractive. However, these solutions must be accompanied by capacity building in financial institutions and government agencies to properly assess and manage risks in last-mile projects.

68 The Persistence of the Innovator’s Dilemma, https://hbr.org/2011/11/why-does-the-innovators-dilemm

BOX 12: INNOVATIVE FINANCING IN PERU

Peru's EMujer pilot program offers a powerful example of linking nance and community engagement. The program trained indigenous women to install and maintain solar systems while also connecting them with nancial institutions. This enabled the women to offer micro- nancing options within their communities, creating a sustainable local nancing ecosystem that made solar energy more accessible.

Key Success Factors:

- **Reduced maintenance costs by eliminating need for technicians to travel to remote areas**
- **Enabled community-based financing through bank partnerships**
- **Created local economic opportunities through training and business development**
- **Built trust and understanding of solar technology through local leadership**

The program shows how combining technical training, access to finance, and community engagement can create financially sustainable models for last-mile energy access.

Successful pilot projects have taken place in Cajamarca, Cusco, Loreto, and Puno (Source: UNDP, 2021)

The Innovator's Dilemma in LAC Electrification

Governments across LAC are investing substantial resources in their electricity sectors, with annual investments in the tens of billions of dollars. Most is directed toward expansion and maintenance of existing national grids.

While this investment approach has enabled the region to reach a 97% electri cation rate, it cannot bridge the final gap to universal access. The remaining unelectrified populations are precisely those that traditional grid infrastructure struggles to serve - remote communities, difficult terrain, and dispersed households. Off-grid solutions are the least-cost solution for 73% of unelectrified (or inadequately electrified[69]) households in Colombia, and they're the least-cost solution for 86% and 98% of households in Panama and Suriname, respectively.[70]

This creates a classic "innovator's dilemma" for the region's electricity sector. Traditional utilities and energy agencies have developed deep expertise in grid expansion and operation, but last-mile electri cation demands fundamentally different technologies and business models, discussed in the section above. By continuing to rely on utilities to solve the last-mile challenge using traditional approaches alone, governments are effectively asking incumbent organizations to disrupt their own businesses - a notoriously dif cult thing to do. Even though renewable and distributed energy systems have emerged as often the most cost-effective solution for last-mile electri cation, successfully deploying these technologies requires new capabilities, novel business models, and comfort with higher levels of risk and innovation than traditional utilities typically possess. However, utilities should still be part of the solution - just in new ways. Forward-thinking utilities in countries like Suriname and Belize are creating specialized rural electri cation units focused speci cally on distributed renewable energy solutions. This approach, as well as partnering with experienced organizations, allows utilities to leverage their existing strengths while building the new capabilities needed for last-mile innovation.

Breaking free of this status quo requires redirecting funding and support toward organizations specifically focused on last-mile innovation. While some projects and new approaches will inevitably fail, these "successful failures" can and must generate critical lessons that inform the next solution. Rather than doubling down on grid extension, which has failed to economically reach the last-mile, the LAC electrification sector must embrace and fund disruption. This shift in both mindset and resource allocation - from avoiding failure to learning from it, from incumbent solutions to innovative approaches - is key. The Universal Access Coalition is uniquely positioned to capture and share these critical lessons across the region, helping to accelerate learning and ensure that innovative approaches that work in one context can be adapted and scaled in others.

69 Having electricity service below Tier 2

70 Calculated based on the geospatial analysis for these countries.

FOCUS ON END USERS

The success of energy access initiatives in LAC hinges on truly understanding and addressing the needs of unelectrified populations.

A persistent challenge across the region is limited direct contact with last-mile communities. Many governments lack basic data about where these communities are located and how many people live there. Furthermore, failure to understand the economic and cultural preferences of these communities makes it difficult to develop appropriate solutions.

While trust in institutions is low across LAC[71], it is even lower in last-mile communities. These communities may harbor signicant distrust of institutions due to poor experiences with extractive industries, unfulfilled promises from previous development initiatives, and business models designed for very different economic, social, and cultural contexts. They have distinct primary economic activities, lifestyles, experiential knowledge, and income patterns that call for context-aware programs. New service provision models, technologies, payment structures, and community engagement efforts are needed to meet last-mile communities where they are.

Latin America has a rich history of community-centered development and empowerment that is rooted in indigenous traditions. LAC was at the forefront of grassroots empowerment in the post-colonial era, with a particular emphasis on land reform, health and education. Tapping into these traditions, alongside ongoing efforts to spur community inclusion and ownership of development activities, will certainly strengthen efforts to deliver access to the last mile in LAC.

71 UNDP, In whom do we trust? Less in institutions and more in communities in LAC, 2024

Cultural Alignment

The effectiveness of energy access initiatives is easily undermined by misalignment between programs and local cultural expectations.

As mentioned earlier in the Revenue Model Limitations section, Colombia's Non-Interconnected Zones (ZNI) have faced challenges where communities accustomed to heavily subsidized energy resist paying for standalone systems. Similarly, Peru's Massive SFV program (also discussed previously) struggled in the face of poor communication programs regarding the payment mechanism, leading to the false impression among end users that photovoltaic systems were being distributed for free.

BOX 13: CULTURAL ALIGNMENT IN OWNERSHIP MODELS: LESSONS FROM SURINAME

In Suriname, some indigenous and rural communities have a strong cultural preference for communal ownership and shared resources that challenges conventional individual ownership models. When solar home systems were introduced using individual household ownership structures, this created friction with community values that prioritize collective wellbeing.

The experience highlights a crucial lesson: ownership models must align with local cultural realities. In communities with strong communal traditions, collective ownership approaches like mini-grids or community-managed systems may be more appropriate and sustainable than individual household systems. The successful Pokigron mini-grid project demonstrated the benefits of adapting ownership structures to local preferences.

Local Capacity Building

Energy access projects can be significantly more successful when local communities are meaningfully engaged while avoiding the pitfall of placing too much responsibility on communities alone.

Past experiences in LAC have shown that projects often failed when they handed over complete ownership and maintenance responsibilities to communities without providing ongoing support. While many modern solar PV systems require minimal maintenance, having trained local points of contact helps ensure timely identification and remedy of technical issues. However, these local resources must be properly supported by qualified service providers and institutions.

In Colombia's La Guajira region, NREL demonstrates how targeted capacity building can empower indigenous communities while addressing electricity access challenges. NREL has implemented several complementary initiatives, including a youth training program in partnership with the National Training Service (SENA) that equips participants with practical skills in solar PV installation and maintenance. Building on this foundation, NREL's collaboration with USAID has developed specialized technical training materials for indigenous communities, integrating renewable energy education into existing programs. The Guajira Young Professionals Program represents a particularly successful intervention, having trained 37 young Wayuu community members on energy transition topics, creating pathways to employment and entrepreneurship that leverage traditional knowledge while building crucial technical skills for the region's renewable energy future.

Successful projects must establish governance mechanisms that enable local community members to coordinate with quali ed service providers while ensuring communities are not overburdened. The wide variation in organizational capacity across LAC's last-mile communities means that support models must be carefully tailored to local contexts. Rather than leaving communities to manage complex systems on their own after initial installation, projects need sustained engagement from utilities, government agencies, or private operators who can provide technical expertise and maintenance support. By leveraging and investing in the skills of local community members while maintaining professional support systems, projects can reduce costs, improve reliability, and support local economic development. This balanced approach increases community buy-in and the odds of long-term success.

Fostering Women's Engagement and Leadership

Past experience with electri cation and other LAC development initiatives has consistently demonstrated the critical role of women in ensuring the success and sustainability of projects.

Women are not only direct beneficiaries of energy access, but also key drivers of change, influencing adoption, community buy-in, and long-term viability. Ignoring gender considerations in electri cation efforts risks worsening inequities and overlooking powerful catalysts for progress.

Project planners must recognize that women may face systemic barriers – economic, educational, and socio-cultural – that limit their participation in energy access initiatives. In Peru, for example, gender gaps in education have limited women's participation in technical training. These barriers are not necessarily consistent across the region, with economic participation varying widely among women in different communities.

However, even in cases where a gender-gap in education may limit women's participation in technical aspects of an electrification project, experience shows that women have tremendous influence within their communities. Women have proven to excel at building community buy-in, leading change, and raising funds. Given that women can be among the most effective communicators and disseminators of information in a community, leveraging their social influence can help improve community participation and sustainability.

The EMujer pilot program in Peru led by UNDP and the Ministry of Energy and Mines (Box 12) demonstrated the multiple benefits of empowering women in energy access initiatives. This program highlighted that women can be effective and in uential promoters of clean energy technologies in their communities while also creating new financial opportunities for women.

Another example is Suriname's fist solar mini-grid project in Pokigron (Box 13). In this case, female community leaders successfully negotiated with other community members and a nearby logging company and persuaded all to share in the construction costs for this valuable electri cation project. Their ability to build consensus and engage various stakeholders helped make the project financially viable. As one stakeholder in Suriname observed, "The men will leave the village and be away for long periods, while the women stick around. You have to focus on the women for project execution, strengthen the women in the villages, and build capacity for women to maintain the system."

Panama's Campeonas Solares program also shows the value of empowering women through renewable energy. Led by the National Energy Secretariat (SNE), this program aims to bridge the gender gap in the energy transition by equipping women with skills to install and maintain standalone solar systems. Beyond technical training, participants gain knowledge in gender empowerment, personal finance, and entrepreneurship. Since its inception, the program has graduated three cohorts, with the most recent in 2024 comprising 85 women. Some graduates have gone on to become employed within the initiative itself, serving as assistant instructors for new cohorts. Equipped with specialized skills, these women are now playing a vital role in sustaining solar energy solutions within their communities.

These experiences show that integrating women into electrification programs - as technicians, educators, community liaisons, and business leaders - can enhance both the implementation and sustainability of energy access initiatives. However, programs must integrate gender considerations across their design and implementation (such as providing childcare during training sessions) to enable women's full participation.

Powering the Last Mile (UAC LAC White Paper)

Integrated Development Approach

As discussed in the Planning section above, energy access initiatives are most effective when integrated into broader development efforts.

By linking energy provision with healthcare, education, water and sanitation, telecommunications, and productive use opportunities, all of these development goals can be better addressed. Understanding and planning for the power needs of other basic services makes electrification projects and other services more financially viable and more likely to succeed. For example, electrifying a school enables better education, while powering a health clinic enables transformative services like vaccine refrigeration. Displacing diesel generators benefits both household budgets and the environment.

This integrated approach also helps support communities in maximizing the developmental impact of their electricity access. In Peru, the Ministry of Energy and Mines (MINEM) implemented several solar-powered mini-grids in remote villages in the Loreto region of the Amazon. These mini-grids provided electricity not just to households, but also to schools and health centers. This significantly improved quality of life by enabling access to clean and reliable energy for education and healthcare needs. At the same time, it reduced reliance on expensive, polluting diesel generators.

Mini-grids, as opposed to standalone solar home systems, are particularly valuable for integrated development plans. By aggregating demand and enabling productive uses of energy, mini-grids create a virtuous cycle of economic development and energy sustainability. This potential can be realized through various approaches, including modular or “anchor” development strategies. Under this model, mini-grids are initially deployed to serve critical community infrastructure like healthcare facilities, telecommunications towers, or agricultural processing centers. These anchor installations prove operational viability while serving essential community needs, creating a foundation for future expansion to serve more households and businesses. This staged approach reduces upfront risk for developers, lowers initial project costs and complexity, and can attract different types of funders or financing instruments compared to traditional all-at-once deployment.

Suriname’s first solar mini-grid electrification program in Pokigron exemplifies the potential of integrated mini-grid development. The mini-grid has catalyzed economic development with community members now using cold storage to reduce food waste/spoilage and increase agricultural productivity and processing.

Thoughtful planning to maximize productive use of energy amplifies the development impact of electricity access. Integrating energy with agriculture, health, education, and water unlocks the full potential of each, advancing multiple SDGs simultaneously. While it requires greater coordination, this approach more effectively and sustainably improves lives. Governments, development organizations, and energy access practitioners must recognize that siloed interventions are missed opportunities to achieve better outcomes.

PART 3

Disrupting Business-As-Usual: The Universal Access Coalition

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WHY THE UAC EXISTS

The Universal Access Coalition (UAC) exists to address the urgent moral imperative of universal electrification.[72] The status quo that got LAC this far will not get the region to 100% access. The Coalition is here to mobilize political will, catalyze innovative approaches, coordinate resources, and finally address the urgent need for electricity access of all LAC residents.

To achieve SDG7 by 2030, LAC's access challenge must be elevated on the international stage. Stakeholders must break down the institutional, financial, technological, and geographic barriers that have historically hindered progress. They must collaborate, rather than continuing to work in siloed isolation. The Coalition will focus global attention on LAC's energy access challenges, mobilize resources, and create the other enabling conditions needed to finally disrupt business-as-usual and make energy access universal.

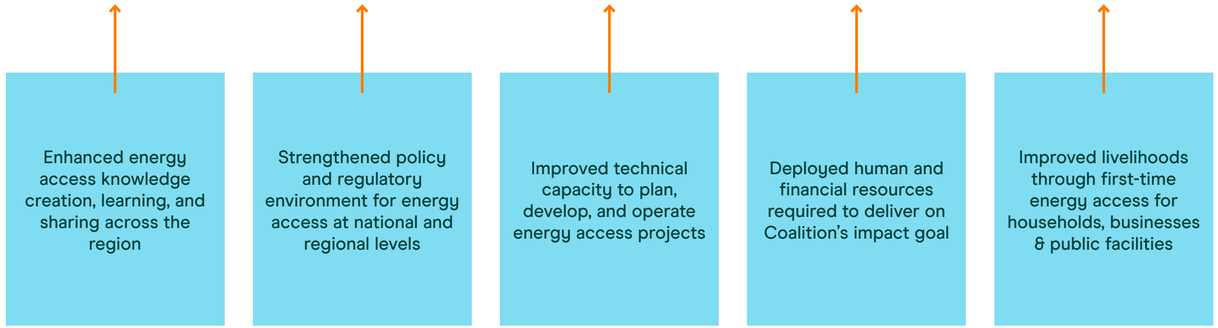
72 Current Coalition members have joined on a fully voluntary and flexible basis. They include: acciona.org, Commision de Integración Energética Regional (CIER), Centro Regional de Estudios de Energía (CREE), Global Energy Alliance for People and Planet (GEAPP), Inter-American Development Bank (IDB), International Renewable Energy Agency (IRENA), Mesa de Acceso Universal a la Energía (MAUE), National Renewable Energy Lab (NREL), Organización Latinoamericana de Energía (OLADE), PSR Energy Consulting, Regulatory Assistance Project (RAP), Sistema de la Integración Centroamericana (SICA), Trama TecnoAmbiental (TTA), United Nations Development Programme (UNDP), United Nations Industrial Development Organization (UNIDO), Waya Energy, and the World Bank (WB). The Coalition is also supported by the International Energy Agency (IEA).

THE COALITION'S MISSION AND GOALS

The UAC has established an ambitious but essential target: achieving universal access to modern, affordable, reliable, and abundant energy in Latin America and the Caribbean by 2030.

This overarching goal is supported by five interconnected outcomes that together create a roadmap for transformative change in the region.

IMPACT: By 2030, achieve universal access to modern, affordable, reliable, and abundant electricity in Latin America and the Caribbean.



Mobilizing Resources to Disrupt Business-As-Usual

Achieving universal access in the Latin America and Caribbean region requires a fundamental shift in how energy access initiatives are designed, resourced, and delivered.

While grid extension and densification can and will deliver first time access to a meaningful portion of the currently unelectrified, the grid simply cannot reach everyone. Distributed renewable technologies and business models - most notably mini-grids and standalone solar systems - are the most appropriate and least-cost solution. This paper also demonstrates that these modalities have struggled to gain traction in LAC, even as they have succeeded in other parts of the world. It is time for LAC to accelerate its distributed renewable energy transformation.

In order for this to happen, human and financial resources must be mobilized. Stakeholders must gather and share existing knowledge, develop new tools and capacities, develop a bankable pipeline of access activities, and marshal the financial capital necessary for these projects to be realized at scale. **For this reason, key partners in the Coalition are establishing a LAC Energy Access Facility.**

Creating, curating, and convening around energy access knowledge will be critical. This will enable practitioners and policymakers to learn from one another and from global experience. The Facility will establish a publicly available **Knowledge Hub** that will bring together and disseminate data and insights around the business models, technologies, case studies, and key lessons that will empower LAC's DRE transition. The Hub will also host a help desk function, able to mobilize expertise and technical assistance (or other forms of support) to tackle access challenges at regional, national, and sub-national levels.

Success at the last mile depends on establishing clear rules and incentives for all stakeholders. As this paper shows, current policies and regulations often fail to effectively address distributed renewable technologies, creating uncertainty that slows innovation and investment. To address this gap, the Facility will work through its Knowledge Hub to identify, document, and **promote proven policy and regulatory frameworks** for distributed renewables. The Facility will leverage the Coalition's convening power to engage key decision-makers at both national and regional levels. Working closely with OLADE, it will advocate for policy reforms that drive innovation and impact in last-mile communities while ensuring energy access remains a priority in regional energy planning and dialogue.

A third critical building block centers around the planning and development of energy access interventions on the ground. The country deep-dives underpinning this report powerfully illustrate the necessity and utility of rigorous least-cost geospatial plans. Not only do plans need to be deployed across LAC, resources need to be mobilized for government agencies to effectively put those plans into action, including establishing specialized implementation units.

Grid extension and densification identified in these least-cost plans can likely proceed without external support, given utilities' proven capacity to expand their networks. However, distributed renewable energy solutions - particularly mini-grids and standalone systems - require disruptive change to succeed in LAC. This preparation involves multiple critical

elements: defining clear roles and responsibilities across the project lifecycle (from design through operations); allocating risk appropriately among stakeholders; selecting suitable business models and technologies; developing detailed cost estimates; and identifying potential policy or regulatory barriers that could hinder implementation. The Facility will dedicate specific resources to this essential preparatory work, ensuring DRE projects are properly structured for successful deployment.

Significant financing will be needed to make universal access a reality for LAC residents. While many governments have resources that could finance a portion of these investments, **catalytic capital is essential to complement public funding and unlock broader investment. The Facility will play a critical role in mobilizing this capital through multiple channels.** It will finance innovative pilot projects to demonstrate feasibility before scaling, while providing catalytic capital such as subordinated debt or junior equity to unlock external financing for specific projects. The Facility will also support the structuring of guarantees and other de-risking mechanisms to attract private sector participation and additional funding sources. To ensure solutions remain affordable, the Facility will help unlock end-user financing through rebates and subsidies for first-time electricity users. Beyond basic access, the Facility will support novel approaches that link electricity access to income generation, fostering micro-entrepreneurship by ensuring reliable power access and sustainable business models. This comprehensive financing strategy will enable the private sector to enter markets with innovative business models and technologies, while ensuring solutions remain affordable for end users.

Learning and Sharing Key Lessons

It will be impossible to achieve universal access in LAC if stakeholders do not share and leverage their collective knowledge and data.

This paper has uncovered a variety of technical methodologies, case studies, data, tools, regulatory strategies, community engagement approaches, and other lessons learned that can boost multi-stakeholder collaboration on energy access in LAC.

Rather than continuously recreating the wheel, key actors in the region, alongside their development partners, must apply the lessons learned from past successes and failures in LAC and around the world. Addressing the challenge of siloed knowledge and efforts is a strategic imperative.

Central to this effort is the creation of a regional **Knowledge Hub** that will serve as the nexus for critical data, knowledge exchange, and capacity building. The Hub will operate through three main pillars:

1. **Capacity building and knowledge sharing**: Development of a knowledge repository, containing relevant materials such as case studies, toolkits, technology guides, and training resources to support stakeholders across the region. The starting foundation of the knowledge repository will be existing materials from organizations like OLADE and IDB. Knowledge sharing will be facilitated by the Hub, potentially following a model similar to that of the Renewable Energy in Latin America and the Caribbean (RELAC) Initiative.[73]
2. **Centralized deep data repository**: Creation of a centralized deep data repository on energy access, collected from open access sources, national and international stakeholders, enhanced AI data analytics, and geospatial data tools. Data will be made available to all relevant public, private, and civil society stakeholders, to include:
   - **Customer data on location, electrification status, demand forecasts, and affordability**
   - **Infrastructure mapping of transmission and distribution networks, mini-grids, and standalone systems**
   - **Contextual data on climate, socio-economic factors, costs, and energy resources**
   - **Deep-dive research reports on electrification issues and projects, organized by country**
3. **Value-added tools**: Development of decision-support tools (many of which are open source), that leverage the Hub's data resources to assist stakeholders with planning, project design, investment assessment, regional access monitoring, program implementation, and more

The Hub represents more than just a repository of information - it will serve as an active platform for collaboration and learning. Through facilitated events, peer exchanges, and targeted knowledge products, the Hub will help break down silos between stakeholders and accelerate the spread of effective approaches to last-mile electrification. Easy access to relevant data and replicable examples will aid electrification efforts and help address key challenges illustrated in Part 2 of this paper.

73 Renewables in Latin America and the Caribbean (RELAC) is a regional initiative across LAC created in 2019 within the framework of the United Nations Climate Action Summit, with the objective of reaching at least 70% of renewable en-ergy installed capacity and 80% of the region's total electricity generation from renewables by 2030. It includes knowl-edge exchange via peer-learning and sharing of best practices in renewable energy integration to the electrical grid.

Strengthening Policy and Regulation

Policy and regulation are powerful tools that LAC governments are not effectively leveraging.

Too often, shortcomings in policy and regulation are smothering innovation instead of catalyzing it.

We must tailor the regulatory environment to support decentralized electrification solutions, ensure that stakeholders understand the rules of the game, and create the necessary incentives for investors to commit their capital.

The needed fundamental changes to electricity access policies and regulations are discussed extensively in Part 2 of this paper. Clear and complementary roles and responsibilities must be established for public, private, and civic stakeholders to ensure effective collaboration. Enhancing planning processes, meaningful community engagement, equitable and sustainable tariffs, and better structured markets are all needed in order to finally deliver inclusive energy access.

The UAC will take a multifaceted approach to policy and regulatory reform. With the support of regional partners like OLADE, the Coalition will work with LAC governments to understand the policy and regulatory needs of the energy access challenge; elevate universal access on policy agendas; leverage existing expertise, data, and analysis; and continue to develop clear and robust regulatory frameworks that encourage both public and private sector participation, particularly in standalone solar and mini-grid solutions. This includes advocating for the establishment of dedicated bodies mandated to provide last-mile access in markets where such institutions are lacking. Through collaboration with existing regional bodies such as OLADE, the UAC can foster discussion among governments of different LAC countries regarding policy and regulatory needs. Such intergovernmental discussions can drive solutions and encourage key commitments.

A key priority is supporting LAC governments in establishing clear definitions for "access" that ensure end users receive an appropriate minimum level of service. The Coalition will also work with regulators to develop affordable and sustainable tariff structures for first-time electricity access, coupled with consumer protections, and standards for quality of service, operations, and maintenance

The regulatory frameworks promoted by the Coalition aim to strike a careful balance - staying flexible enough to drive disruptive innovation in business models and technologies while also providing sufficient oversight to ensure quality service for all.

Technical Capacity

Universal access in LAC requires new technical capacities to disrupt business-as-usual.

Where the grid cannot (cost effectively) go, DRE solutions offer a proven least-cost solution. Part 2 of this paper documents some important successes in building local capacity. Key stakeholders can and must continue to develop the needed technical capabilities to effectively plan, implement, and operate DRE projects.

The Coalition's capacity building work will follow a systematic three-phase approach:

- **Phase 1** focuses on comprehensive assessment of existing initiatives and identification of critical gaps. This includes reviewing current programs, mapping key stakeholders across the project development cycle, and determining specific areas where capacity building is most needed.
- **Phase 2** centers on organizing and structuring the capacity building response. The Coalition will establish systems for data collection and coordination, leveraging information from multiple sources, including: existing open data resources; Coalition member knowledge and expertise; and input from governments, utilities, regulators, practitioners, and communities. This phase also includes assessing information gaps, determining roles for different Coalition members and partners, and designing specific capacity building activities.
- **Phase 3** implements activities designed to address the previously identified gaps. Key activities include: developing standardized curricula and certification programs for different stakeholder groups; fostering communities of practice and working groups to enable peer learning; and conducting regular regional workshops on priority topics.

Improved Livelihoods

For the residents of LAC, sustainable livelihoods are the key to living healthy, productive, dignified lives.

This is the heart of the Coalition's mission, and it greatly depends on electricity access. This is explored in Part 2's discussions of PUE, including an important case study from Haiti, as well as exploration of the importance of integrating energy access with other development priorities such as health, education, and water. The Coalition is working to develop a pipeline of bankable access projects that go beyond basic access to spur holistic and sustainable development through productive uses of power, value-add opportunities, and enhanced quality of life for households, businesses, and communities.

The Coalition strives to take a community- rst approach, working closely with target bene ciaries to build a deep understanding of community contexts. Factoring in the cultural and economic realities of communities will help deliver real last-mile electri cation results and positive returns on investment.

To achieve this, the Coalition is working to understand what has and has not worked in PUE programs across LAC. This involves mapping existing activities, identifying knowledge gaps, and compiling lessons learned and successes from past initiatives. Based on this foundation, the Coalition will develop guiding principles for effective PUE program design that consider both technical and community engagement aspects.

These principles will be tested and re ned through direct engagement with Coalition member projects. By providing real-time feedback on 2-3 pilot initiatives, the Coalition will validate approaches and identify practical implementation challenges. This hands-on learning will feed into broader guidelines for project bankability that consider both supply and demand factors, including innovative approaches to financing productive use appliances.

Not all PUE opportunities have equal impact. That is why the Coalition is developing frameworks to prioritize projects based on their potential for sustainably improving livelihoods. This will be coupled with robust monitoring and evaluation strategies to track and demonstrate how electricity access translates into tangible benefits for communities.

The five outcomes described above are deeply interconnected. Success in knowledge sharing supports better policy development. Improved policies enable increased technical capacity. Enhanced capacity leads to more impactful projects. And mobilized resources make it all possible. Together, these outcomes create a comprehensive framework for achieving the Coalition's ambitious but essential goal of universal access by 2030.

PART 4

Conclusion and Call to Action

PART 4: Conclusion and Call to Action

To achieve universal electricity access by 2030 in Latin America and the Caribbean, stakeholders must recognize that traditional approaches alone will not bridge the final gap.

The path forward demands innovation, collaboration, and commitment from all parties.

The experiences highlighted throughout this paper reveal crucial insights for success. Cross-institutional collaboration stands as a cornerstone for effective implementation. By bringing together governments, utilities, private companies, development partners, and communities, the UAC can leverage diverse expertise and resources to overcome the complex challenges of last-mile electrification. Equally important is building genuine trust and engagement with local communities. When projects are developed with—rather than for—communities, they gain the acceptance, ownership, and cultural alignment necessary for long-term sustainability.

The inclusion of historically marginalized groups, particularly indigenous communities and women, has repeatedly proven to strengthen project outcomes. In Panama's Campeonas Solares program, women are leading deployment and maintenance of solar systems, while in Suriname, female community leaders successfully brokered critical partnerships to finance mini-grid projects. These examples show how inclusive approaches not only address historic inequities but also improve project effectiveness and longevity.

Securing long-term commitments from diverse stakeholders ensures that electrification efforts extend beyond initial installation to encompass ongoing maintenance, community support, and eventual system expansion. The promising integration of productive uses of energy—from cold storage in Suriname to agricultural processing in Haiti—demonstrates how electricity access can catalyze broader economic development and create self-reinforcing cycles of growth.

Perhaps most critically, creating innovative and flexible business and financing models opens doors for new participants and attracts much-needed capital. Successful approaches like EMujer in Peru show how thoughtfully designed ownership models paired with accessible financing can generate genuine community enthusiasm and participation. Meanwhile, experiences in Colombia and Brazil highlight the importance of adapting business models to local cultural expectations and economic realities.

The path forward requires each stakeholder group to embrace specific responsibilities:

- **National and Subnational Governments** must prioritize universal access with clear targets, updated regulatory frameworks, and funding. Governments must systematically map unelectrified communities, identify appropriate electrification solutions, and provide cost estimates that guide targeted investment. Policymakers have the power to create environments that enable private investment, establish cross-sector integration, and mobilize public resources efficiently. By establishing universal access as state policy, governments can provide the stability needed for long-term investment and innovation.

- **Development and Philanthropic Partners** must evolve beyond traditional funding models. By providing concessional financing and grants that target innovative approaches, these institutions can catalyze change while supporting vital knowledge sharing and capacity building. Their resources should prioritize funding for pilot projects that demonstrate scalable solutions, particularly those involving distributed renewable energy technologies that have proven successful elsewhere. They can also provide critical technical assistance to support governments in capacity-building and program implementation.

- **Public and Private Electricity Providers** hold the key to technological and business model innovation. By developing and deploying solutions tailored to LAC's unique challenges, creating sustainable business models that work in remote contexts, and building robust local supply chains and business ecosystems, the private sector can drive rapid expansion of access. Strategic partnerships between incumbent utilities and specialized DRE developers offer a powerful pathway forward—combining established infrastructure and regulatory expertise with innovative last-mile technologies and business models. Utilities and grid operators must leverage their technical expertise while remaining open to disruptive approaches that complement traditional infrastructure.

- **Investors** must recognize the significant market opportunity in serving last-mile communities. Experience in other regions demonstrates that distributed renewable energy solutions can be 'bankable' for commercially minded impact investors when risks are properly apportioned and concessional capital is mobilized to mitigate those risks. By catalyzing investment in scalable projects, developing diverse portfolios for risk management, and supporting innovative payment models, investors can unlock the financing needed to achieve universal access. Working collaboratively with governments to develop enabling regulatory frameworks will further reduce risks and attract commercial impact capital at scale.

- **Local Communities and Implementation Partners** are essential to success on the ground. Active participation in project design and development, engagement in productive uses of energy, and contribution to system maintenance creates the foundation for sustainability. Municipalities can facilitate community engagement while NGOs provide implementation support and capacity building. Research institutions strengthen these efforts through rigorous data collection and analysis.

- **Regional Partnerships** offer powerful mechanisms for accelerating progress across borders. By facilitating knowledge sharing, harmonizing policies, pooling resources, and replicating successful models, regional actors can help overcome common challenges more efficiently. Organizations like OLADE are uniquely positioned to foster these collaborations and ensure that innovations in one country benefit the entire region.

- **Academic and Research Institutions** play a vital role in helping governments assess how technical, financial, and socioeconomic factors impact the cost and feasibility of different electrification approaches for last-mile communities. To provide meaningful insights, these institutions must engage directly with local populations and employ diverse data collection methods, such as satellite imagery and surveys, to evaluate existing conditions and analyze potential solutions. By leveraging these insights, they can support governments in designing least-cost electri cation roadmaps that expand energy access while driving broader development outcomes.

The Universal Access Coalition stands ready to support these efforts through its comprehensive approach centered on enhanced knowledge creation and sharing, strengthened policy environments, increased technical capacity, improved livelihoods through energy access, and mobilized human and nancial resources. The LAC Energy Access Facility will provide a concrete mechanism for stakeholders to engage with this vision, offering both financial resources and technical expertise to catalyze transformative change.

The time for incremental progress has passed. We must embrace innovative approaches to finally reach the 17 million people in LAC who still lack access to electricity. The technological solutions and business models needed to achieve universal access by 2030, even in the most remote and challenging contexts, already exist. What remains is to mobilize the political will, financial resources, and collaborative spirit to implement them at scale.

Universal electricity access in Latin America and the Caribbean is both a moral imperative and an achievable goal. By working together, governments, private sector entities, communities, development partners, and philanthropists can ensure that no one is left in the dark. The path forward is clear.
THE TIME TO ACT IS NOW.

Thank You

Global Energy Alliance
for People and Planet
GEAPP