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Electrification in Bolivia

Deep-Dive Analysis

31 January, 2024

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UAC country deep-dive reports are produced to serve as reference material to accelerate last-mile access. Reports consist of 3 components:

1. Overview of electrification in the country, including history, current status, geographic & demographic trends, and future plans.

Source: Various publicly available data sources; interviews with Coalition members & other partners

2. Summary of a geospatial plan, recommending electrification modalities for target communities in order to achieve 100% electricity access and improve quality of service

Source: Geospatial plans produced by groups comprising Waya Energy, the MIT-Comillas Universal Access Lab, and/or TTA (authorship varies by country), based on satellite imagery and data inputs from national agencies & other sources

3. Summary of challenges & considerations for operationalizing electrification plans, organized by theme

Source: Interviews with coalition members & other partners; publicly available reports; analysis by Catalyst

DISCLAIMERS

- The geospatial plans are not government-endorsed roadmaps. They are intended as reference material to support future electricity access planning and implementation. As such, they are presented for informational purposes only.
- Each plan is based on modeling that incorporates a specific set of assumptions (including a specific definition of "unelectrified"). Thus, the plans' conclusions may not be directly comparable to those of other electrification analyses for that country.
- Grid densification activities outlined in the geospatial plans are intended to represent business-as-usual operations for utilities, based on expected service improvements & demand growth in communities already electrified today.

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Acronyms and abbreviations

ABER	Agencia de Boliviana Energía Renovable
ENDE	National Electricity Company (Empresa Nacional de Electricidad)
GIZ	German Corporation for International Cooperation
IDA	International Development Association (of World Bank)
IDB	Inter-American Development Bank
INEI	National Institute of Statistics and Informatics
kWh	Kilowatt hour
LV	Low voltage
MHE	Ministry of Hydrocarbons and Energy
MOPSV	Ministry of Public Works, Services, and Housing
O&M	Operations and maintenance
OBA	Output-based aid
PER	Rural Electrification Program
PEVD	Electricity for Living with Dignity Program
PPP	Public-private partnership
PV	Photovoltaic
PUE	Productive use of energy
RE	Renewable energy
SHS	Solar Home System
UNDP	United Nations Development Program
USAID	United States Agency for International Development
USD	United States Dollar
VMEER	Vice Ministry of Electricity and Renewable Energy
WB	World Bank

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Current status of electrification and energy access in Bolivia

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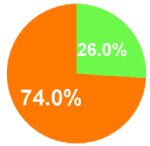
Despite a rapidly growing population, Bolivia has made significant progress in expanding electrification access

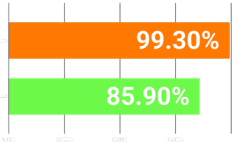
535 thousand people without access to electricity[1,2] in 2023

12.2 million
Total population[1], with an urban & rural split of:[3]



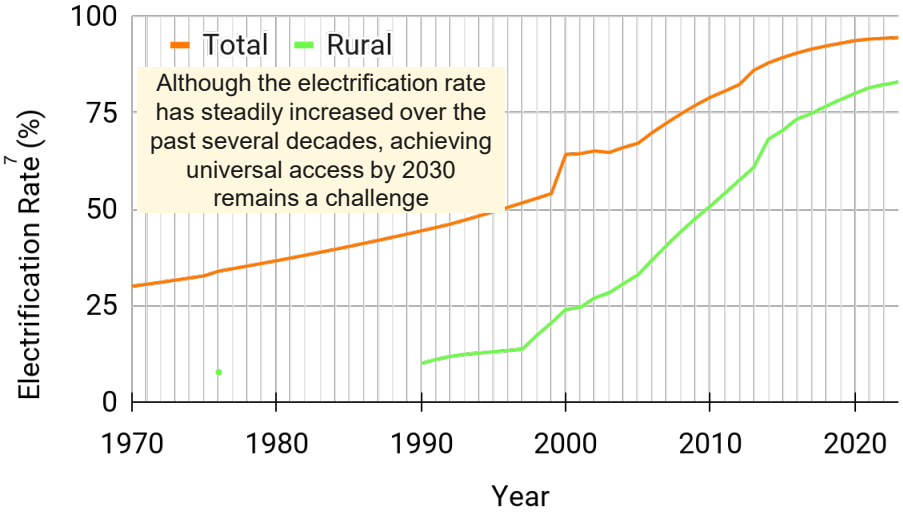
*There is a current population growth rate of 1.36%[4]

95.6%
Total electrification rate, corresponding to **152 thousand households** without electricity access.[1,5]



urban/rural electrification rate (%)[2]

368 kWh
Annual residential electricity demand per capita[6]



[1] Balance Energetico Nacional a Nivel Departamental, Ministerio de Hidrocarburos y Energias, 2023. [2] Balance Energetico Nacional, Ministerio de Hidrocarburos y Energias, 2023. [3] Population, LAC Energy Hub, IDB, 2021. [4] Calculated from World Population Prospects 2022 UNDESA, 2022. [5] Household size and composition, UNDESA, 2022. [6] Calculated based on IEA data, 2022. [7] Access to Electricity Database, IADB, 2021.

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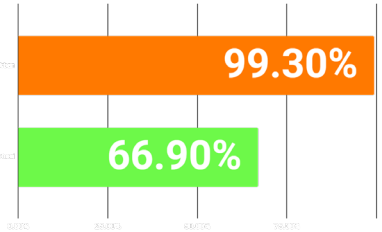
Natural gas dominates Bolivia's energy mix and will continue to play a key role due to its existing generation infrastructure; but, lack of permanent exploration processes can lead to rapid depletion of the resource.

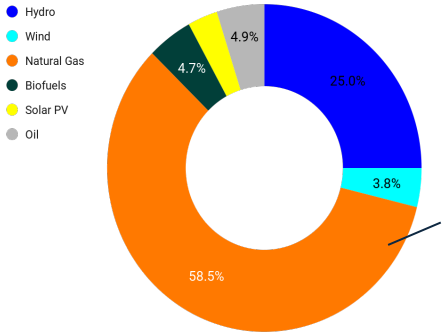
89%

Clean cooking access rate[1]:
380 thousand households without access to clean cooking in 2022[2]



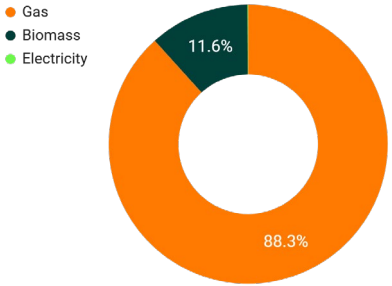
urban/rural clean cooking access rate (%)[1]

Electric grid mix in 2022[4]



Note: It is estimated that Bolivia will begin importing natural gas and LPG by 2028 due to well depletion.

Breakdown of primary cooking fuels in 2021[3]



Grid Reliability

Distribution losses (2024)[4]	**10.2%**
Duration of electricity interruptions (2020)[5]	**8** hours/year
Number of electricity interruptions (2020)[5]	**8.6** times/year

[1]WHO, 2022 Clean Cooking Access rate, 2024. [2]Calculated based on access rate, the population reported by UNDESA (World Population Prospects 2022), and the household size according to UNDESA for the latest year 2012. [3]WHO, Database: Cooking fuels and technologies (by specific fuel category), 2021. [4] Ministry of Hydrocarbons and Energy, direct communication, 2025 [5] Bolivia Economy Profile, World Bank Doing Business, 2020.

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Geographic and demographic trends

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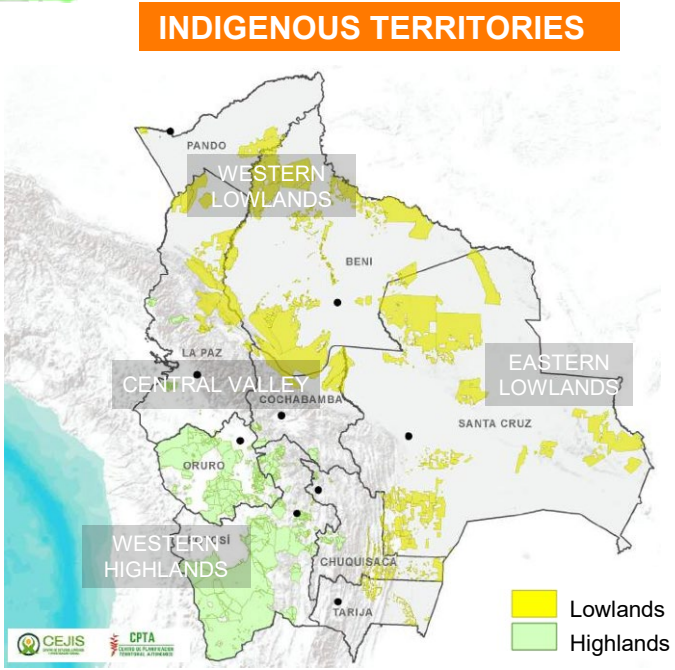
Bolivia's territory is divided into highland and lowland regions and is home to rich demographic diversity.



- Bolivia has the **highest proportion of Indigenous people** in South America, with 41% of the population identifying as Indigenous or of Afro-descendant heritage in 2022.
- The country **recognizes 36 Indigenous groups**, 34 of which live in the lowlands. The more populous Quechua and Aymara peoples, who reside in the highlands, identify as 16 distinct tribes.
- Although the Indigenous population has a **higher workforce participation** rate than the national average, approximately **66% live in poverty or extreme poverty**, compared to 43% of the overall population.

Sources: Censo de Poblacion y Vivienda en Bolivia 2022: La inclusion de lo plural e intercultural, CEJIS, 2022; Estado Plurinacional de Bolivia, FIDA & IWGIA, 2022.

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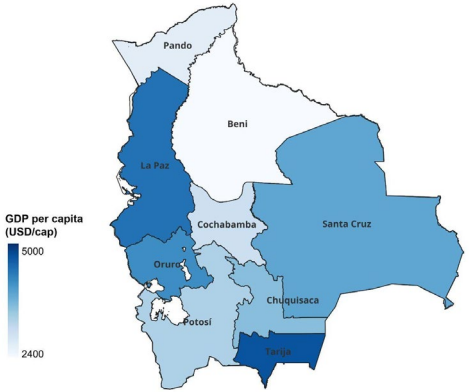
Over the past few decades, Bolivia has made great efforts to reduce poverty, but a development gap between departments still remains.

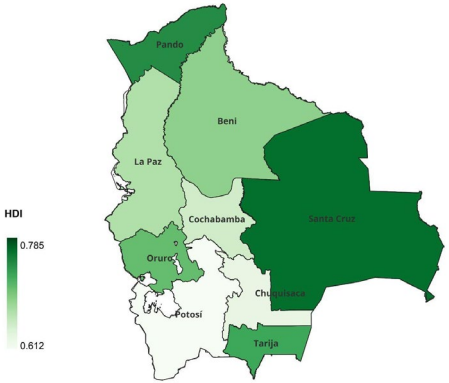
- Potosí, Beni and Pando have a higher share of **indigenous** population and display an overall **lower economic output and development**.
- Indigenous people are more likely to participate in **informal employment** in extractivist and agro-productive activities.
- Productive activities include cattle raising and agriculture for local consumption in **Beni** & **Pando** and mining in **Potosí**.

GDP PER CAPITA



Tarija has the highest GDP/capita thanks to increased government investment to bolster local production.

HUMAN DEVELOPMENT INDEX



Santa Cruz boasts the highest HDI thanks to its efforts to improve education, reaching a 96% literacy rate.

Sources: Balance Energetico Nacional a Nivel Departamental, Departamento de Hidrocarburos y Energías, 2022; La economía de los departamentos de Bolivia, TOP Comunidad Escolar, 2024.

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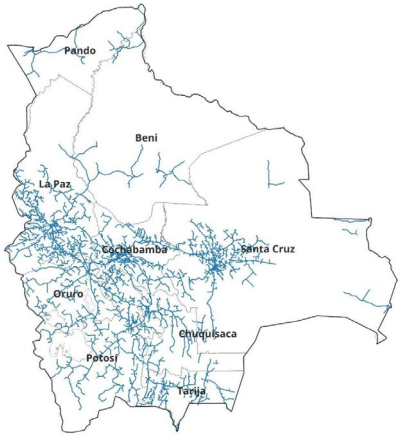
Bolivia's interconnected electricity grid primarily serves the more populated highland region.

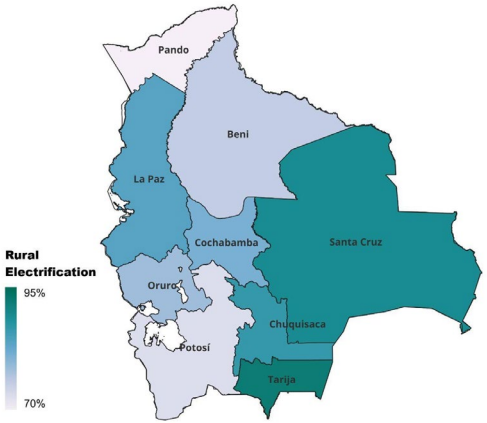
NIS GRID NETWORK



Grid infrastructure is operated primarily by the state-owned utility, **ENDE**, with several other private distribution companies providing independent services in specific regions.

Sources: Gridfinder, 2024; Balance Energetico Nacional a Nivel Departamental, Departamento de Hidrocarburos y Energías, 2022

RURAL ELECTRIFICATION



Beni, Pando, and **Potosí** have the lowest rural electrification rates, while **Santa Cruz** and **Tarija** have the highest rates.

Almost 80% of the population is connected to the NIS, while about 3% receives electricity from distributed generation. These mainly include gensets and solar PV.

Tarija, the department with the highest total

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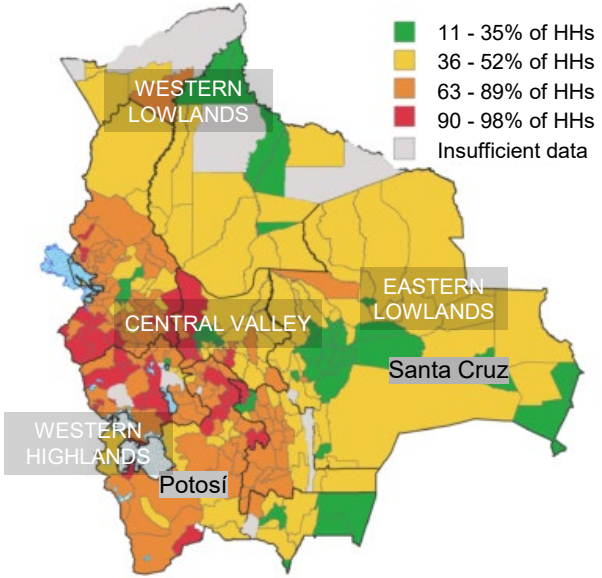
Energy poverty rates are higher in areas that have lower economic activity

ENERGY POVERTY LEVEL[1, 2]



- **Energy poverty**[1] is more prevalent in the Bolivian highlands where there is **lower economic output** than the western lowlands. Highland capital cities are “islands” with low energy poverty.
- **Energy poverty is unequally distributed** across the country; 74% of Potosi’s users were considered energy poor in 2019, while only 24% of Santa Cruz’s were.[3]
- **Clients who receive subsidies** (those who consume less than 70 kWh/month,) have been consistently **increasing**, reaching almost 1.3 million users in 2020 and costing Bolivia about US $10 million/year.[3]

(1) Energy poverty refers to households consuming less than a quarter of the limit for Bolivia’s Dignity Tariff; (2) Source: Midiendo la pobreza y la desigualdad energética a nivel municipal en Bolivia, SDSN Bolivia, 2019; (3) Source: La pobreza eléctrica de los bolivianos, Francesco Zaratti, 2022

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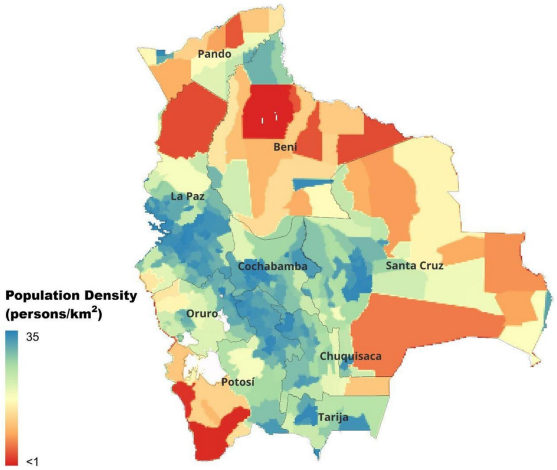
Low population density is one of Bolivia's electricity sector's biggest challenges.



The La Paz, Santa Cruz, and Cochabamba departments are home to over 70% of Bolivia's population.

- Bolivia has among the **lowest population densities** in South America with about 11 people/km^2. This contrasts with the regional average of 25 people/km^2.
- The more densely populated departments have rural electrification rates above 85%, reaching a peak of 95% in Tarija.
- Therefore, closing the electrification gap will require **significant investment** in grid extension and a higher share of distributed energy sources.

Dept	Rural Elec (%)	Pop Density (per/km^2)
Bolivia	**84.2**	**11.2**
Santa Cruz	88.7	61.6
Cochabamba	83.4	38.1
La Paz	85.4	22.8
Tarija	95.4	16

Dept	Rural Elec (%)	Pop Density (per/km^2)
Chuquisaca	87.8	12.8
Oruro	81.6	9.1
Potosi	76.0	7.2
Pando	70.6	2.6
Beni	79.8	2.5

Sources: National Census, INEI, 2022; Balance Energetico Nacional a Nivel Departamental, Departamento de Hidrocarburos y Energías, 2022

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Bolivia’s electrification efforts to date

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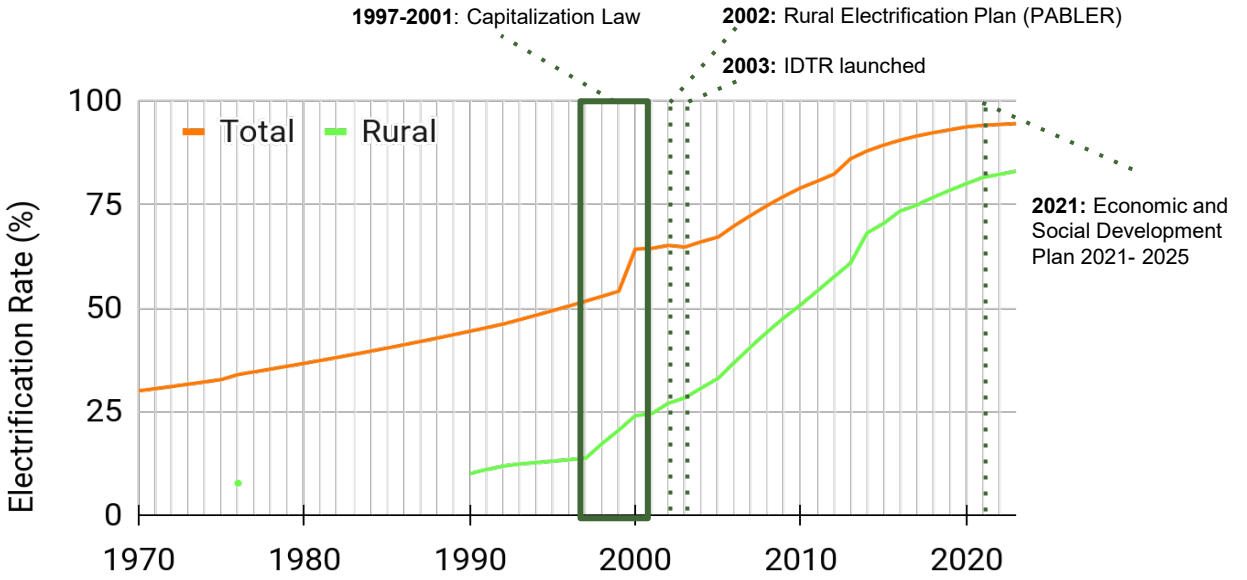
Bolivia has embraced various policy strategies in its continued efforts to achieve universal access

- The gap between urban and rural electrification has been narrowing in the past decades.
- Besides reaching universal access, the Bolivian electricity sector has the added challenge of embracing the energy transition and shifting to cleaner energy sources while meeting the growing demand.



- In 1994, the **Capitalization Law** fully restructured Bolivia's electricity sector by opening the doors to private investment, getting rid of the vertical integration, and introducing new, more structured regulations.
- In 2002, the GoB established **Bolivia's Rural Electrification Plan (PLABER)** with the goal of connecting 200,000 households by 2007. Political and economic crises of the time only allowed about 20,000 new connections.
- In 2003, the **Decentralized Infrastructure for Rural Transformation (IDTR)** was launched to increase electricity access in rural areas for improved living standards and economic opportunities
- In 2008 the **Electricity for Living with Dignity Program (PEVD)** was launched to achieve 100% electricity access by 2025, giving national priority to rural areas and fostering the use of RE in rural and urban areas.
- In 2009, Bolivia's Constitution defined electricity access as a citizen's fundamental **human right** and the sector began a shift towards nationalization.
- In 2021, the GoB launched the **Economic and Social Development Plan 2021-2025**, a broad, multi-sector development plan which, among other goals, aims to strengthen the electricity sector and improve electricity access at a pace that enables universal access by 2029. It replaced the previous Patriotic Agenda of the Bi-Century 2015-2025.

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Program spotlight: Decentralized Infrastructure for Rural Transformation (IDTR I and II)

Who	ESTADO PLURINACIONAL DE BOLIVIA MINISTERIO DE HIDROCARBUROS Y ENERGÍAS
What	Program focused on new rural connections, capacity building, and project sustainability
Where	**Phase I**: Underserved rural areas, incl. the highlands (Altiplano) and Amazon basin **Phase II**: Chuquisaca and Potosí
When	**Phase I**: 2003-2012 **Phase II**: 2014-2022
Funding	IDA credits from **World Bank**: **USD $20 million** in **Phase I**; USD $50 million (later reduced to **$11.13 million**) in Phase II
Technology	Grid extensions and off-grid solutions
Tariff / Subsidy Details	**OBA subsides**: USD $200-300 per HH for SHS systems >40 Wp **Pico-PV pilot subsidies**: USD $150/unit

Successful Outcomes

- Provided electricity access to **~40,000 households**
- Pioneered a model of decentralized electrification using **both on-grid and off-grid solutions**
- **Engaged local communities** to identify their needs and ensure project sustainability
- **Trained technicians** for the installation and maintenance of solar systems
- Applied **flexible payment schemes**, including cash purchases and credit options, to accommodate varying financial capacities of rural households.

Challenges

- Transporting equipment and materials to remote areas was **logistically complex and expensive**
- **Municipal governments often lacked the technical expertise** and experience to manage electrification projects effectively
- The decentralized model introduced **complexities in financial management and contract supervision**, necessitating robust institutional strengthening
- Project underwent restructuring in 2018, resulting in a **reduction in the IDA credit** from USD $50 million to $11.13 million. This led to **reduced project scope & coverage** in some areas, raising **concerns about social equity**
- **Infrastructure was sometimes oversized** for the actual demand, due to limited data on household usage patterns and economic activities

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Program spotlight: El Remanso (*executed under PEVD*)

Who	ESTADO PLURINACIONAL DE BOLIVIA MINISTERIO DE HIDROCARBUROS Y ENERGÍAS
What	Solar hybrid mini-grid electrifying ~175 households
Where	El Remanso community in La Paz
When	2018
Funding	USD $1.8 million from GoB, IDB, and the GEF
Technology	166.5 kWp solar mini-grid with 685 kWh battery backup; 250 kVA diesel generator
Tariff / Subsidy Details	"Tarifa dignidad": 25% discount for consumption ≤70 kWh/month Subsidies: Cross-subsidy from urban users

Successful Outcomes

- All households equipped with pre-paid smart meters
- **Lifeline tariff system** leverages government subsidies to make basic consumption affordable to low-income households
- Tariffs and other funding sources have **covered O&M costs**, contributing to the sustainability of the project
- **Local residents were trained** to operate and maintain the system
- Built a framework for the creation of a local electricity cooperative

Challenges

- **High initial capital costs** for solar panels, batteries, and infrastructure.
- **Geographic and logistical barriers** due to the remote location and access.
- **Financial sustainability** concerns, particularly in light of reliance on subsidies.

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Program spotlight:
Cerro San Simon (*executed under PEVD*)

Who	Estado Plurinacional de Bolivia – Ministerio de Hidrocarburos y Energías; tta Trama TecnoAmbiental; Servicios Integrales de Energía SIESA
What	Solar hybrid mini-grid electrifying >160 households
Where	Cerro San Simón, Department of La Paz, Bolivia (Altiplano region)
When	2022
Funding	USD $1.5 million from IDB
Technology	181 kWp solar mini-grid with 800 kWh Li-ion battery and diesel backup
Tariff / Subsidy Details	"Tarifa dignidad": 25% discount for consumption ≤70 kWh/month Subsidies: Cross-subsidy from urban users

Successful Outcomes

The Cerro San Simon mini-grid is the **first fully integrated smart grid in Bolivia**, and it is backed up by the **largest lithium-ion battery of its kind** in the country. Successful elements include:

- **Strong collaboration** between the GoB, IDB, ENDE, and the SIE-TTA-Mora Consortium (provider of EPC services), and various technology providers
- **Discounted tariffs, cross-subsidies, tiered pricing, and pre-paid meters** implemented
- Provided electricity to local health centers and small enterprises
- Users and local technicians were **trained** to operate, manage, and maintain the system

Challenges

- **Geographic and logistical difficulties** due to the remote location and harsh weather conditions in the Altiplano region.
- **High initial capital costs** for installation, even with government subsidies.
- **Technical challenges**, including the need for local capacity building and maintaining battery health over time.
- **Financial sustainability** issues, particularly balancing affordable tariffs with covering operating costs and system upkeep.

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Future plans and considerations for electrification

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Bolivia's electrification goals are anchored in the Bolivia Electric Plan 2020-2025 (Plan del Sector Eléctrico del Estado Plurinacional de Bolivia)

- *The Bolivia Electric Plan 2020-2025 was initially aligned with the Patriotic Agenda of the Bi-Century 2015-2025, which aimed to achieve 100% access to basic services, including electricity, by 2025.*
- *The Patriotic Agenda has since been replaced by the Economic and Social Development Plan 2021-2025, which puts the country on track for **universal access by 2029**.*

MODIFIED TARGETS (updated from 2025 to 2029)

Achieve universal access to electricity by 2029

Achieve 183 MW of renewable power generation by 2029, including biomass (10 MW), wind (53 MW), solar PV (20 MW), and geothermal (100 MW)

Cover at least 70% of the internal electricity demand with renewable sources by 2029

Upgrade transmission infrastructure and become a regional energy leader by exporting surplus energy to neighboring countries

This plan is supported by initiatives like the Rural Electrification Program III (PER III), launched in 2023, and the Electricity Program for Living with Dignity (PEVD), initiated in 2008.

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The Rural Electrification Program III (PER III) and the Project to Improve Sustainable Energy Access in Bolivia (IDTR III) are the most recent large-scale efforts by the GoB to achieve the goals of the Electric Plan

Program	**Rural Electrification Program III (PER III)** (Follow-up on PER I & II, which connected 32,000 households)	**Project to Improve Sustainable Energy Access in Bolivia (IDTR III)**
Targets	● Provide electricity to more than **50,000 new households** ● Enable and promote **PUE in rural areas** ● Enhance **institutional capacity**, including by training personnel and beneficiaries—particularly women—in system O&M.	● Provide new or improved electricity access to **over 141,000 people**, including **households**, **public services** (schools & health centers), and small-scale **productive units** in rural areas ● Integrate **renewable energy** sources into **rural electrification** efforts
Target areas	**Countrywide**, with a specific focus on **rural and remote** communities	**Countrywide** (to **begin with rural municipalities** of Beni, Pando, Potosí, Santa Cruz and Tarija)
Technological Approach	Grid extensions and off-grid systems	Grid extension, mini-grids, hybrid systems, and standalone solar
Leading Agency	MHE, ENDE	VMEEA, ENDE
Funding details	**USD $200 million loan** (incl. USD $100 million from the Korea Infrastructure Development Co-Financing Facility for LAC) and a **USD $2 million grant** (provided by GEAPP), **approved by IDB**	USD $125 million **approved by World Bank**
Approval date	2022	2023

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To support plans for operationalizing these targets, a research group recently developed a **least-cost geospatial plan (published in 2023)** to identify unelectrified areas and recommend appropriate technologies to electrify them.

THE OBJECTIVE

To develop a least-cost approach to achieve 100% electricity access in Bolivia by 2030, including definition of technology type and estimated investment by client.

THE USE CASE

To serve as a reference to support Ministerio de Energias and relevant partners to update the **Plan Nacional de Energía** and develop plans to achieve last-mile electrification by 2030.

Note that this plan references satellite images & other supporting data to run a model based on a specific set of assumptions (including a specific definition of "unelectrified"). As such, its conclusions may not be directly comparable to those of other electrification analyses. This plan is *not* a government-endorsed roadmap, and it was not originated for the context of UAC research. It is presented here for informational purposes only.

Least cost geospatial plan partners

Client

Ministerio de Energías

Contracting entity

IDB
Inter-American Development Bank

Financing support

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Technical partners

we waya energy

Universal Energy Access Lab
MIT and IIT-Comillas

tta Trama TecnoAmbiental

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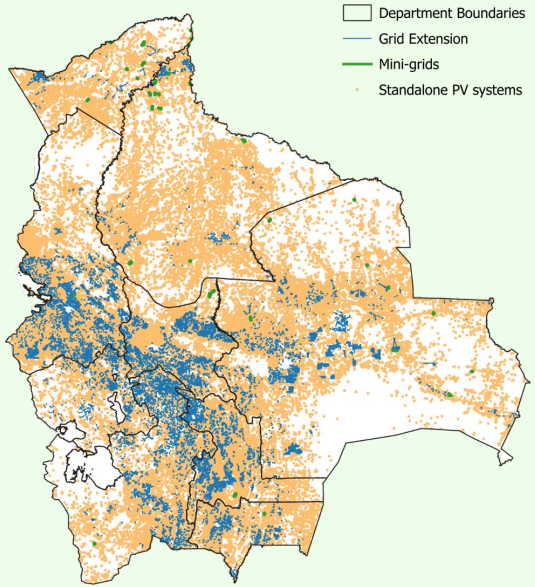
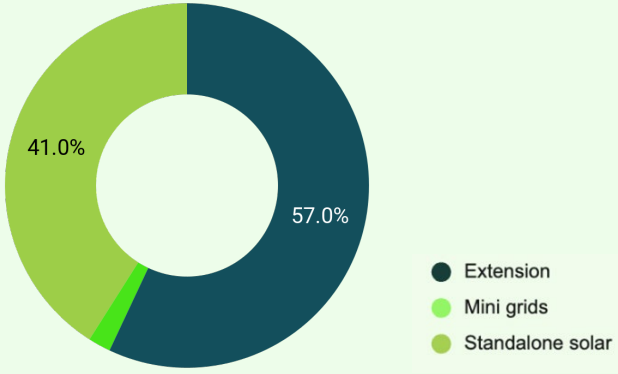
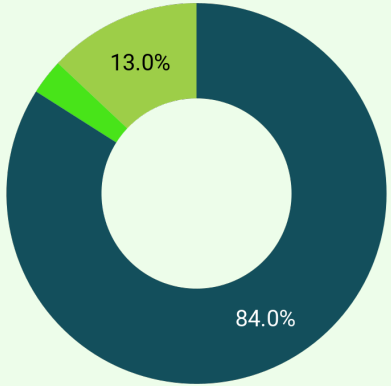
The least-cost plan considers 279,710 new & upgrade connections at an estimated investment of USD $717 million to achieve universal access by 2030.



Breakdown of Clients



Total Investment



- This includes 7,225 projects with 159,435 connections through grid extension, 5,594 connections through mini-grids, and 114,681 stand alone solar systems.

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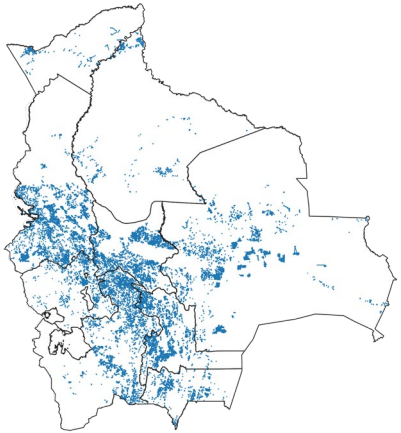
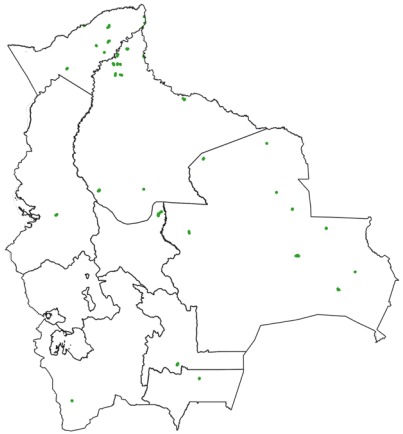
The least-cost plan illustrates which electrification technologies are the most optimal, choosing from grid extension, mini-grids, and standalone solutions

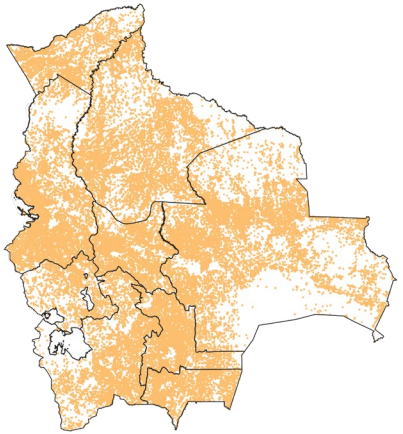
Areas where grid extension is the least-cost approach



Areas where mini-grids are the least-cost approach



Areas where standalone solar is the least-cost option



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Technology 1: Standalone Solar

The plan for dispersed, low-demand households far from the grid

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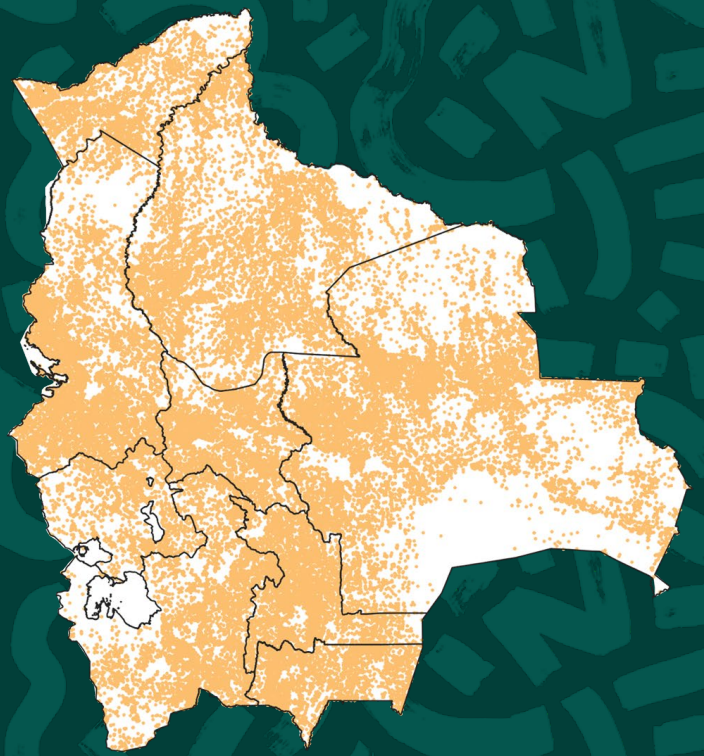
For standalone solar, the least cost plan shows…

That stand-alone solar systems are the most cost effective solution for electrifying **114,681** households. This represents 13% of required connections for universal access by 2030.

In the scenario presented in the geospatial plan, **USD $95 million in investment** will be required to reach this target.



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Key Players in Standalone Solar: Government Partners

Name	Description
	**Ministry of Hydrocarbons and Energy (Ministerio de Hidrocarburos y Energías)** is the central government body responsible for energy policy, regulation, and strategic development. It oversees national energy planning, including the expansion of renewable energy sources like **solar** for both on-grid and off-grid systems.
	Vice Ministry of Electricity and Renewable Energies (Viceministerio de Electricidad y Energías Renovables, VMEER), under the Ministry of Energy, is the agency responsible for rural electrification programs, including policy development and overseeing integration of standalone solar in remote areas. It leads efforts such as the Rural Electrification Plan III (**PER III**) and the Electricity for Living with Dignity Program (**PEVD**).
	**National Electricity Company (Empresa Nacional de Electricidad, ENDE)** primarily focuses on managing Bolivia's national grid and large-scale energy projects. However, it also plays a role in supporting **solar mini-grids** and off-grid systems, particularly in remote and isolated regions.
	The **Electricity and Nuclear Technology Regulatory Authority (Autoridad de Fiscalización de Electricidad y Tecnología Nuclear, AETN)** is the **electricity regulatory authority** in Bolivia. It establishes regulations and ensures that the provision of complies with national standards for quality, safety, and pricing. In July 2024, AETN introduced regulations and tariffs to allow users to **generate electricity in homes and buildings** with renewable energy systems up to 500 kW.
Regional and local governments	Departmental Governments (Gobernaciones) oversee regional energy policies, coordinate with national and local governments and allocate funding for rural electrification projects, often in partnership with international organizations. Municipal Governments (Gobiernos Municipales) implement solar energy projects at the community level, identify off-grid rural communities in need of electrification and facilitate land use, permits, and local infrastructure for solar installations.

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Key Players in Standalone Solar: Development Partners

Name	Description
IDB Inter-American Development Bank	The **Inter-American Development Bank (IDB)** has provided **loans and grants** to fund off-grid solar solutions and supported Bolivia in **policy development** for rural electrification and **solar energy integration**. IDB has provided financing for past programs like PEVD, and in 2023, they approved a $200 million loan and a $2 million grant to support GoB's Rural Electrification Program III.
THE WORLD BANK	The **World Bank** has been a significant player in financing Bolivia's rural electrification efforts, including the promotion of **solar energy** for off-grid communities. The **World Bank's International Development Association (IDA)** provided funding and technical assistance to several rural electrification programs in Bolivia, including **Decentralized Infrastructure for Rural Transformation** (IDTR I and II) in 2003 and 2014.
UNDP	UNDP has supported **solar home systems** and **community-based renewable energy projects** in rural Bolivian communities, through policy development and financing projects, ensuring that **solar energy** is accessible to the most remote populations.
gef global environment facility INVESTING IN OUR PLANET	The **Global Environment Facility (GEF)** is a key partner in supporting Bolivia's **stand-alone solar** projects. Through its funding, GEF has supported the installation of **standalone solar** in remote Bolivian communities, including for projects executed under PEVD.
BDP SAM Banco de Desarrollo Productivo	**Banco de Desarrollo Productivo (BDP)** is a Bolivian **development bank** that offers **microloans** and **financing programs** to promote **sustainable energy projects**, including solar home systems and **solar-powered equipment** for small businesses.

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Key Players in Standalone Solar: Execution

Name	Description
ENDE	ENDE is responsible for **implementing electrification projects**, including the installation of standalone solar systems and hybrid systems, in **rural areas** as part of **PER III** and other initiatives
giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH	GIZ has **implemented solar PV installations** in schools, health centers, and off-grid households through the **Energising Development (EnDev) program**, focusing on high-quality installation and capacity building for local technicians.
tta Trama TecnoAmbiental	TTA has provided significant support for both planning and execution of **rural electrification** in Bolivia, often partnering with major actors in the public and private sectors. It applies its technical expertise and on-ground knowledge to design and implement systems.
LUCES NUEVAS FUNDACIÓN	Luces Nuevas Internacional is a non-governmental organization (NGO) that originated in Bolivia. Its mission is to achieve universal access to energy, particularly focusing on providing basic electricity to rural communities in Bolivia. Luces Nuevas also promotes understanding of electrification plans at different administrative levels and acts as a facilitator for information sharing and consensus-building, especially at the community level.
ENERGÉTICA	Energética – Energía para el Desarrollo is a private, non-profit civil development institution based in Cochabamba, Bolivia. It promotes and implements standalone solar solutions in Bolivia, focusing on rural electrification to provide sustainable energy access for off-grid communities.
Private renewable energy companies (suppliers, local engineering firms, and installers)	Companies like Enersol SA, SIE, Jinko, SMA, Cegasa, and Camedino play a critical role in implementation, providing components and engineering & installation services for standalone solar solutions.

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Standalone systems: Key Challenges

Economic Sustainability

Challenges	Key considerations going forward
• The **upfront cost** of installing stand-alone solar systems can be **prohibitively high** for many households, particularly in low-income and rural areas.	• Consider **bulk procurement**: Leverage geospatial analysis to group small projects in order to leverage **economies of scale**, reduce logistics costs, and lower the price of individual solar kits. • Introduce **financial support mechanisms from the public sector** to reduce upfront costs and ongoing expenses. • Consider financing **pre-electrification programs** that leverage the current spending behavior of communities. In some communities, spending on candles, radio and torch batteries, cell phone charging, etc. over the course of 9 months is equivalent to the cost of a Tier 1 solar energy system (**PicoPV**). Providing such systems with a **payment installment plan** can improve reliability and modernity of services in the medium term while communities await higher tiers of electricity.
• Investments in off-grid areas are considered high-risk by first-tier financial entities. • O&M costs, including monitoring, repair and replacement, are high	• Pay as you go solar systems could allow for the coverage of Operations and Maintenance costs and reduce financial risk • Training local technicians in the Operations and Maintenance of systems could cut down on time and money required for routine maintenance and repair of system
• Stand-alone solar systems **may not be sufficient for energy-intensive activities** that could drive income generation. When usage is limited to lighting, charging, and small appliances, the **potential for ROI is limited**.	• **Promote productive uses** that stand-alone solar systems can support, such as powering basic loads for small businesses or running irrigation pumps.

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Standalone systems: Key Challenges

Logistical & Geographic

Challenges	Key considerations going forward
• Bolivia's **rugged geography**, with its **mountainous regions**, **high-altitude plateaus**, and **dense forests**, makes many areas difficult to access. Rural communities in these regions, particularly in the **Altiplano** (highlands) and **Amazon Basin**, are often geographically isolated and lack proper roads or transportation infrastructure.	• Leverage technology like **satellites and drones** to support early-stage assessments of electricity access and geographical realities • Design solar kits in **modular formats** that are easier to transport and install • Instead of shipping fully assembled systems, **ship components in bulk to central locations** (e.g., regional centers or distribution hubs), where they can be **assembled and distributed locally**.
• There may be **insufficient numbers of trained technicians** to install and maintain solar systems. The scarcity of skilled labor in remote locations can result in **delays or poor-quality installations**, ultimately affecting the effectiveness and longevity of the systems.	• Establish **community-based models** for **maintaining and operating** solar systems. **Local cooperatives or community organizations** can manage the installation, operation, and upkeep of solar systems, thus creating a sustainable model that ensures long-term functionality. This approach was successful in **Tarija and Beni under the PER II program**.
• **Improved national certification standards** are needed to prevent poor quality products from entering the Bolivian market. Products should meet the standards of high quality design, extended life, easily repairable components, and recyclability.	• Strengthen the capacity of IBMETRO (Bolivian Institute of Metrology) and IBNORCA (Bolivian Institute of Standards and Quality) to establish and enforce standards that maximize longevity and reduce required maintenance over product lifetimes. • Ensure that standards consider recyclability and environmental impact.

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Standalone systems: Key Challenges

Planning, Regulatory & Monitoring

Challenges	Key considerations going forward
• The national **electrification plan may not be sufficiently detailed or comprehensive** when it comes to **integrating stand-alone solar systems** into the broader energy strategy.	• The government needs to establish a **comprehensive and coherent regulatory framework** for standalone solutions that clearly defines the **roles and responsibilities** of different stakeholders. • AETN should ensure that **standards for standalone energy generation & storage systems** are clear and that **tariff structures** ensure affordability while supporting the long-term sustainability of projects.
• Energy planning and implementation can be hindered by **challenges in coordinating between national, departmental, and local governments**. While the national government may have broad energy policies, **local governments often lack the resources or capacity** to carry out these plans effectively at local level.	• The **three levels of government should share and agree on electrification plans**. **Workshops** between administrations and with target communities should be hosted in a neutral environment such as a university. • **Local authorities** should be empowered with **training and resources** to effectively plan, implement, and monitor solar energy projects according to the agreed plan. This could include **capacity-building programs** focused on solar energy, project management, and financial planning for energy access.
• **Limited technical capacity** for rural electrification planning for standalone solar, including insufficient quality and recency of pre-investment studies.	• Provide **training and awareness workshops** for **technical staff of local governments** and technical institutions on how to use the **Rural Electrification Project Preparation and Evaluation Manual (MEEPER**), which VMEER uses to prioritize and manage rural electrification projects.
• Due to **frequent leadership changes over the past several years,** officials within the ministry may have **limited historical context and knowledge** regarding the status and challenges of the energy access space.	• Create **centralized databases and standardized documentation** to preserve institutional memory • Encourage partnerships with **NGOs, development agencies, and the private sector** to bridge gaps in knowledge and **ensure continuity** in long-term projects.
• **Monitoring the progress and impact** of solar systems in remote areas is **particularly challenging in Bolivia**, given the geographic isolation, lack of real-time data, and limited technological infrastructure. **Existing monitoring systems may be fragmented or not sufficiently robust** to track installations, performance, and user satisfaction.	• Develop programs and initiatives to **promote remote monitoring technologies** like smart meters and IoT sensors that allow project implementers to track system performance, detect malfunctions, and ensure that systems are functioning optimally.

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Standalone systems: Key Challenges

Community Engagement & Education

Challenges	Key considerations going forward
• Bolivia is a **multi-ethnic** and **multilingual** country, with a significant portion of the population speaking **indigenous languages** like **Quechua**, **Aymara**, **Guaraní**, and others, in addition to Spanish. These linguistic and cultural differences can pose challenges for effective **communication** and **engagement**.	• Launch **community-based awareness campaigns** that educate people about the benefits of solar energy, how it works, and how it can improve their lives. These campaigns should use **local languages** (e.g., Spanish, Quechua, Aymara) and **culturally appropriate communication** methods to ensure the message resonates with diverse audiences.
• Without integration of **gender and diversity** considerations, programs can fail to support equitable economic and community development.	• **Gender and diversity issues should be mainstreamed** into community engagement activities. Some activities could include: **financing equipment needed for women-led productive enterprises** and providing **technical training** for women on maintenance of standalone solar PV systems.
• In many rural areas of Bolivia, there is a general **lack of awareness** about **solar energy technologies** and **renewable energy** in general. Many communities are unfamiliar with how solar energy works, its benefits, and the potential of solar technologies to improve their lives.	• Set up **demonstration projects** in local communities to allow people to see solar systems in action. These pilot projects can help community members understand how the technology works, how to use it, and the **immediate benefits**, such as improved lighting, reduced energy costs, and cleaner air.
• **Communities may become dependent on external experts** for installation and maintenance. This can increase long-term costs and reduce sustainability, particularly if the nearest technicians are located in urban areas far from the remote communities.	• Use **train-the-trainer** models to build a network of local experts. After training **a few key individuals (especially women)** in each community, these trainers can then pass on their knowledge to others. This **builds local capacity** and ensures that solar systems can be maintained and repaired at the community level.

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Standalone solar: Funding Needs

USD $95 million investment in standalone solar is required to achieve universal access by 2030.[1,2].

- Annual cost per client is USD $202 ($126 CAPEX and $76 OPEX).

Investment in Standalone Solar by Department

Department	Investment (USD million)
Beni	18
Chuquisaca	8
Cochabamba	12
La Paz	12
Oruro	2
Pando	8
Potosi	7
Santa Cruz	24
Tarija	5

Sources of Funding[3]

Government

- National rural electrification budget
  - Funds allocated under the PEVD program
  - Funds allocated under PER III
- National Electricity Company (Empresa Nacional de Electricidad, ENDE)
- Subsidies from MHE and MOPSV, in coordination with local authorities
- Energy Access Program (Proyectos de Acceso a la Energía)
- Government backed credit-based schemes for rural electrification

General Public: Cross-subsidies from urban users to rural users

International Sources: WB, IDB,GIZ, UNDP, USAID

(1) Plan Integrado Nacional de Electrificación Rural de Bolivia, 2023 (2) **Indicative costing is based on the reference scenario in the least cost plan, and makes several assumptions regarding the number and cost of connections. These are subject to revision based on adjusted scenarios and market price discovery**

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Technology 2: Mini-grids

The plan for clustered households far from the grid

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For mini-grids, the least cost plan shows…

That mini-grids are the least cost solution for electrifying **5594** households. This represents 3% of required connections for universal access by 2030.

In the scenario presented in the geospatial plan, **USD $17 million** in investment would be required.

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Key Players: Government Partners for Mini-Grid Projects

Name	Description
MINISTERIO DE ENERGÍAS	**Ministerio de Energía (Ministry of Energy)** is responsible for the overall **energy policy** in Bolivia, including the **expansion of renewable energy and energy access** in rural and underserved areas. The Ministry works on developing national strategies for electrification, including the **integration of mini-grids** into the country's energy infrastructure.
ENDE	**Empresa Nacional de Electricidad (ENDE)** is Bolivia's state-owned electricity company, responsible for electricity generation, transmission, and distribution. It is often involved in the **development and operation of mini-grids**, particularly in remote areas.
AETN	The **Electricity and Nuclear Technology Regulatory Authority (Autoridad de Fiscalización de Electricidad y Tecnología Nuclear, AETN)** is the **electricity regulatory authority** in Bolivia. It establishes regulations and ensures that the provision of electricity, including through mini-grids, complies with national standards for quality, safety, and pricing. In July 2024, AETN introduced regulations and tariffs to facilitate the implementation of distributed renewable energy. This framework allows users to generate electricity in homes and buildings with renewable energy systems up to 500 kW, promoting the adoption of standalone solar installations.

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Key Players: Development Partners for Mini-Grid Projects

Name	Description
giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH	**GIZ** has supported Bolivia's renewable energy sector by **co-financing and implementing** hybrid mini-grid projects in remote communities. It provides technical expertise and training for local technicians.
IDB Inter-American Development Bank	**IDB** has been a key partner in Bolivia's rural electrification programs, **funding hybrid mini-grid systems** under initiatives such as PER III, with a $200 million loan in 2023 to expand sustainable energy access.
THE WORLD BANK	The **World Bank** has supported mini-grid development through its **Access and Renewable Energy Project** and earlier **IDTR programs**, which include the design and construction of hybrid mini-grid systems in rural areas.
gef global environment facility INVESTING IN OUR PLANET	GEF has funded hybrid renewable energy systems, including mini-grids, to improve electricity access in remote communities, particularly under Bolivia's PEVD program.

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Key Players: Execution for Mini-Grid Projects

Name	Description
ENDE	**ENDE** is responsible for **executing mini-grid projects** under the **PER III program** and other government-led initiatives. ENDE has **implemented hybrid renewable systems** in remote areas.
tta Trama TecnoAmbiental	**TTA** has partnered with Bolivian and international entities to **design and execute hybrid mini-grid systems**. It combines technical expertise and on-ground knowledge in Bolivia to implement projects. Under the SEI-TTA-Mora Consortium, TTA helped to provide comprehensive **EPC services for the Cerro San Simón hybrid mini-grid**.
Private renewable energy companies (suppliers, local engineering firms, and installers)	Companies like Enersol SA, SIE, Jinko, SMA, Cegasa, and Camedino play a critical role in implementation of mini-grid projects by **supplying components and supporting design & installation**. Jinko, SMA, and Cegasa all supported the Cerro San Simon solar hybrid mini-grid project, which has the largest Li-ion battery system in the country.

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Mini-Grids: Key Challenges

Political & Regulatory

Challenges	Key considerations going forward

• Bolivia's energy policies have traditionally focused on expanding the national grid, with **limited attention to off-grid solutions** like mini-grids. There is a **lack of clear regulations** or guidelines for mini-grids, including how they should be integrated into the broader energy system.	• Bolivia needs to **develop a comprehensive mini-grid policy** that sets out clear guidelines on mini-grid implementation, financing, operation, and integration with the national grid. This policy should define:
	  ○ **The regulatory framework for mini-grid development**
	  ○ **Grid access protocols** for mini-grids that wish to connect to the national grid.
	  ○ **Tariff regulations** that support mini-grid sustainability while ensuring affordability for consumers.

• Bolivia has experienced significant **political shifts** and changes in government priorities in recent years, which can lead to **policy instability**. Energy policies may change depending on the government in power, affecting the continuity of long-term projects.	• Create **centralized databases and standardized documentation** to preserve institutional memory • Encourage partnerships with **NGOs, development agencies, and the private sector** to bridge gaps in knowledge and **ensure continuity** in long-term projects.
• Energy planning and implementation can be hindered by **challenges in coordinating between national, departmental, and local governments**.	• The **three levels of government should share and agree on electrification plans**. **Workshops** between administrations and with target communities should be hosted in a neutral environment such as a university.
• There may be **limited capacity at the local or regional level** for **monitoring mini-grid performance** and ensuring compliance with regulations. Without proper oversight, mini-grids may suffer from suboptimal operation, poor service quality, or lack of proper maintenance.	• Empower **local energy authorities** to oversee mini-grid operations and ensure compliance with technical standards and regulations. Local governments should be **trained in mini-grid regulation and management**, allowing for better oversight and accountability. • Establish a **national technical support hub** or **service center** to provide ongoing support, training, and technical advice for local operators and technicians. This hub could act as a resource for troubleshooting, spare parts, and knowledge sharing.

Sources: (1) Interviews with Coalition Members, 2024.

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Mini-Grids: Key Challenges

Economic

Challenges	Key considerations going forward
• The **remote nature** of many rural areas in Bolivia means that transportation and logistical challenges can increase the **cost of regular monitoring**.	• Incorporate **remote monitoring systems** to detect and solve problems faster, leading to fewer service interruptions, better reliability, and reduced costs.
• There may be a **shortage of trained technicians** in remote regions, leading to the need for **expensive, specialized labor** from urban centers. This can **increase operational costs** and make maintenance less timely and efficient.	• Invest in **local capacity-building** to develop a skilled workforce in the areas of **mini-grid operation**, **maintenance**, and **technical support**. This will not only reduce costs but also ensure the sustainability of the systems by empowering local technicians to take over maintenance duties.
• One of the critical economic challenges facing mini-grids is the **collection of revenues** from customers. Many rural households may not have the capacity to pay **monthly bills**, especially in lower income departments like Potosí and Beni.	• To boost demand and improve profitability, mini-grids can be designed to meet the **energy needs of local businesses** in addition to residential consumers. This can help achieve **higher revenue per grid connection** and ensure the financial sustainability of the system.

Sources: (1) Interviews with Coalition Members, 2024.

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Mini-Grids: Key Challenges

Operational

Challenges	Key considerations going forward
• Due to the remote locations of many mini-grid installations, **access to spare parts**, **technical expertise**, and **trained personnel** can be limited. The **supply chain** for spare parts and other essential materials can be unreliable or inefficient.	• Set up regional service and maintenance centers in strategic locations near clusters of mini-grid installations. • Foster partnerships with local businesses and governments to establish hubs to store and distribute spare parts. • Invest in local capacity-building to develop a skilled workforce in the areas of mini-grid operation, maintenance, and technical support. • Establish mechanisms wherein trained technicians from surrounding regions can offer support or repairs to other communities.

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Mini-Grids: Key Challenges

Social & Cultural

Challenges	Key considerations going forward
• Bolivia is a **multi-ethnic** and **multilingual** country, with a significant portion of the population speaking **indigenous languages** like **Quechua**, **Aymara**, **Guaraní**, and others, in addition to Spanish. These linguistic and cultural differences can pose challenges for effective **communication** and **engagement**.	• Launch **community-based awareness campaigns** that educate people about the benefits of solar energy, how it works, and how it can improve their lives. These campaigns should use **local languages** (e.g., Spanish, Quechua, Aymara) and **culturally appropriate communication** methods to ensure the message resonates
• Without integration of **gender and diversity** considerations, programs can fail to support equitable economic and community development.	• **Gender and diversity issues should be mainstreamed** into community engagement activities. Some activities could include: **financing equipment needed for women-led productive enterprises** and providing **technical training** for women on maintenance of standalone solar PV systems.
• Many rural communities see national grid electricity as a symbol of modernity, progress, and social status, while **mini-grids may be perceived as a temporary, inferior solution**. They may associate the grid with reliability, comfort, and governmental legitimacy, and see mini-grids as less reliable or substandard.	• Highlight the **practical benefits** of mini-grids, such as **improved lighting**, **better educational opportunities**, **reliable healthcare**, and the ability to **charge mobile phones**. • Emphasize the **reliability** of mini-grids, their **sustainability**, and how they can contribute to long-term **economic growth**. • Leverage **demonstration projects** as a proof-of-concept that can be “advertised” to other communities by the beneficiaries.
• People may be **unfamiliar with mini-grid technology** and may have concerns about its **reliability and durability.** In Bolivia, communities often are **not informed** about what their recourse is for issues or who to talk to get connected to systems in the first place.	• Establish transparent and **frequent dialogue** between mini-grid developers, local governments, and communities throughout the planning, development, and operational stages to directly address concerns. • Ensure **in-person engagement** through community forums or public discussions, where people can ask provide input, ask questions, and share feedback. • Run culturally appropriate awareness campaigns to provide clear guidance on how to get connected and how to address failures.

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Mini-grids: Funding Needs

USD $17 million investment in mini-grids is required to achieve universal access by 2030.[1,2]

- Annual cost per client is USD $754 ($401 CAPEX and $352 OPEX).

Investment in Mini-grids by Department[1]

Year	Investment (USD million)
Beni	6
Chuquisaca	1
Cochabamba	1
La Paz	2
Oruro	-
Pando	3
Potosi	0.2
Santa Cruz	4
Tarija	0.3

Sources of Funding[3]

Government

- National rural electrification budget
  - Funds allocated under the PEVD program
  - Funds allocated under PER III
- National Electricity Company (Empresa Nacional de Electricidad, ENDE)
- Direct subsidies from MHE and MOPSV
- State-backed financing schemes and credit programs
- Local government contributions
- Public-private partnerships (PPPs)

General Public: Cross-subsidies from urban users to rural users

International Sources: WB, IDB, GIZ, UNDP, USAID

Plan Integrado Nacional de Electrificación Rural de Bolivia, 2023 (2) **Indicative costing is based on the reference scenario in the least cost plan, and makes several assumptions regarding the number and cost of connections. These are subject to revision based on adjusted scenarios and market price discovery**

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Technology 3: Grid Extension

The plan for households near enough to the grid or clustered at volumes which justify investment in grid distribution infrastructure

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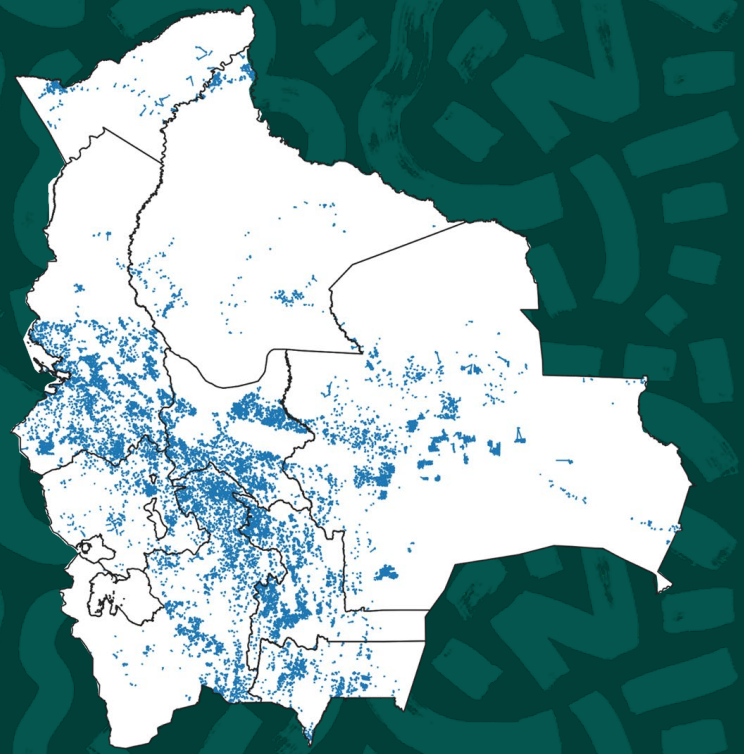
For grid extension, the least cost plan shows…

That grid extensions are the least cost solution for electrifying **159,435** households. This represents 84% of required connections for universal access by 2030.

In the scenario presented in the geospatial plan,

USD $605 million is the estimated investment required in order to reach this target.



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Key Players: Government Partners for Grid Extension

Name	Description
	Ministry of Hydrocarbons and Energy (Ministerio de Hidrocarburos y Energía, MHE) is the central government body responsible for energy policy, strategy, and regulation in Bolivia. This ministry plays a central role in coordinating energy sector projects, including grid extension, renewable energy development, and infrastructure investments.It oversees Bolivia's energy sector reforms and works with other stakeholders to improve access to electricity, especially in rural and underserved areas.
	Bolivian Electricity Company (Empresa Nacional de Electricidad - ENDE) is a state-owned company that manages the electricity generation, transmission, and distribution sectors in Bolivia. It operates a significant portion of the national grid and is a key player in implementing grid expansion projects, particularly in rural and remote areas. ENDE also works on the development of new generation plants and transmission lines to enhance national electricity coverage and reliability.
	Electricity and Nuclear Technology Regulatory Authority (Autoridad de Fiscalización de Electricidad y Tecnología Nuclear, AETN) is the regulatory body for the electricity sector in Bolivia. It ensures compliance with laws, regulations, and technical standards for electricity generation, transmission, and distribution. ARCE plays a critical role in overseeing grid extension projects and ensuring that they meet safety, environmental, and operational standards.
	Regional and Local Governments (Prefectures and Municipalities) are often involved in the planning, implementation, and financing of grid extension projects, especially in rural and indigenous areas. These governments work with national entities to address local energy needs and to ensure that infrastructure projects align with community development goals. Regional authorities may have their own energy initiatives that complement or support national efforts to expand the electricity grid.

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Key Players: Development Partners for Grid Extension

Name	Description
WORLD BANK GROUP	The **World Bank** is a major player in **financing and supporting energy sector projects** in Bolivia. Through its various arms (such as the International Bank for Reconstruction and Development, or **IBRD**), the World Bank has provided **loans and grants** for rural electrification and grid expansion.
IDB Inter-American Development Bank	The **IDB** offers **financing and technical assistance** for energy infrastructure projects in Bolivia. The IDB has supported **grid extension efforts, particularly in remote areas**, and is involved in projects that promote energy access and renewable energy development. The IDB has financed initiatives related to rural electrification and the **modernization of Bolivia's electricity grid** to improve its reliability and sustainability.

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Key Players: Execution for Grid Extension Projects

Name	Description
ENDE	**ENDE** is responsible for designing, constructing, and maintaining infrastructure for grid extension. It executes major electrification initiatives, such as **PER III**, that involve **expanding electricity access** in remote regions through grid extensions.
Private sector energy companies (suppliers, local engineering firms, and installers)	SIEMENS CESI cobee Numerous private companies have been involved in the design, construction, and sometimes operation of rural electrification projects, often in collaboration with ENDE. Companies like **Siemens, CESI,** and **COBEE** have played key roles in building and extending transmission lines.

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Grid Extension: Key Challenges

Geographic

Challenges	Key considerations going forward
• A significant portion of Bolivia's population resides in **mountainous areas**, particularly in the **Andes** region, where communities are situated at very high altitudes (up to 4,000 meters above sea level or more). These areas present substantial challenges for **grid extension** due to difficult terrain, steep slopes, and **harsh weather conditions**.	• Leverage aerial transmission technology like **suspension towers and compact transmission lines** to minimize physical obstacles and reduce width of right-of-way clearances • Invest in **insulated, durable cables** that can withstand high-altitude UV exposure, snow, and wind. • **Involve local communities** in the planning, construction, and maintenance phases. This provides local knowledge of terrain, reduces labor costs, and fosters local support for the project. • Above all else, **consider standalone, off-grid solutions** where geographic challenges are prohibitive.
• Bolivia's **lowland regions**, including parts of the **Amazon Basin** and **Chaco** region, are **sparsely populated** and often **difficult to access** due to dense **forests**, **swampy areas**, and lack of transportation infrastructure. This geographic isolation poses logistical challenges for grid extension.	• **Coordinate with transportation development projects** to build access roads that support grid extension efforts, providing dual benefits of electrification and improved connectivity. • Above all else, **consider standalone, off-grid solutions** where geographic challenges are prohibitive.

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Grid Extension: Key Challenges

Technical & Economic

Challenges	Key considerations going forward
• Bolivia has a **low population density** in rural and remote areas, which means that **transmission lines have to cover long distances** to reach communities. The long distances between power plants and remote areas cause **significant power losses** due to resistance in the transmission lines.	• Where possible, **replace or upgrade conventional lines** to higher voltage ratings to reduce losses over extended distances • Leverage the analysis from the **geospatial plan** to understand where grid extension is impractical and other approaches are more suitable • Consider a **distributed generation system** with **smaller local power plants** (e.g., small hydro, solar) combined with localized **substations**
• Extending the grid to remote areas, especially in difficult-to-reach regions like the Amazon and Chaco, requires **significant investment** in **power lines**, **transformers**, **substations**, and **other infrastructure**. The cost is exacerbated by the **low population density** in these areas, meaning fewer users to share the costs.	• Foster collaboration between investors and utilities to **share the capital burden**. By offering incentives, such as **tax breaks or long-term contracts**, the government can **attract private investment** in rural grid infrastructure. • Use a **modular approach** to grid extension, starting with **small, localized networks** and expanding gradually as demand increases. This approach allows for **phased investment** and reduces upfront costs.

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Grid Extension: Key Challenges

Regulatory & Institutional

Challenges	Key considerations going forward
• Bolivia has experienced periods of **policy instability**, with shifting political priorities and changes in government that affect long-term energy planning and regulation.	• Develop an up-to-date **national electrification plan** that is consistent and independent of political cycles. To ensure policy continuity, **involve multiple stakeholders**, including **regional governments**, **private sector**, and **civil society**, in drafting and implementing energy policies. • Consider developing an **independent regulatory authority** that is insulated from political influence and staffed by technical experts
• Grid extension **involves multiple stakeholders**, including national and local governments, public utilities, private companies, and community organizations. The **lack of coordination and alignment** between these groups can lead to inefficiencies, delays, and duplicated efforts.	• Clearly **define roles & responsibilities** in policy and planning documents • Establish a **centralized institution** or agency to **coordinate grid extension efforts** and ensure national and regional alignment • The three levels of government should share and agree on electrification plans. Workshops between administrations and with target communities should be hosted in a neutral environment such as a university. • Organize **regular stakeholder meetings** to discuss progress, resolve conflicts, and align priorities. • Use a digital platform to track ongoing and planned projects, share updates, and flag potential overlaps or delays.
• Many local governments in rural and remote areas lack the **technical capacity** and **financial resources** to manage grid extension projects effectively. In some cases, local utilities may not have the expertise to operate or maintain new infrastructure, especially in remote regions.	• Local authorities and utilities should be **empowered with technical training and resources** to effectively manage and operate projects. • Create opportunities for local governments to learn from successful projects in other regions through **peer-to-peer exchanges** and **best-practice documentation**. • **Establish a fund**, with contributions from the national government and international funders, to **finance regional projects**. Local governments could apply for these funds in **collaboration with public utilities**.

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Grid Extension: Funding Needs

USD $605 million investment in grid extension is required to achieve universal access by 2030.[1,2]

- Annual cost per client is USD $578 ($386 CAPEX, $124 OPEX $68 for upstream energy purchases).

Investment in Grid Extension by Department[1]

Year	Investment (USD million)
Beni	23
Chuquisaca	83
Cochabamba	102
La Paz	130
Oruro	24
Pando	13
Potosi	81
Santa Cruz	121
Tarija	27

Sources of Funding[3]

Government

- National Electricity Company (ENDE)
- Direct subsidies from MHE and MOPSV
- State-Backed Financing Schemes and Credit Programs
- Local Government Contributions
- Public-Private Partnerships (PPP)

General Public: Cross-subsidies from urban users to rural users

International Sources: WB, IDB, GIZ, USAID

Plan Integrado Nacional de Electrificación Rural de Bolivia, 2023 (2) **Indicative costing is based on the reference scenario in the least cost plan, and makes several assumptions regarding the number and cost of connections. These are subject to revision based on adjusted scenarios and market price discovery**