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# Improving energy access in rural Bolivia:
## Potential for solar power uptake by agri-food SMES [1]

**Power grid connections often fall short for agri-food SMEs, but decentralized solar energy systems can cut costs and reduce risks.**

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## Summary

Agri-food Small and Medium Enterprises (SMEs) [2] need reliable and affordable energy for water pumping and pond aeration, refrigeration and freezing, milling and grinding, drying and water heating. Although rural electrification rates are relatively high in Bolivia, grid connections can fail to deliver energy where and when SMEs need it. This brief examines the conditions for effective energy access by agri-food SMEs and the potential for Decentralized Solar Energy Systems (DSES) to increase energy security. It draws on extensive fieldwork that includes 49 interviews across 31 site visits and the installation and monitoring of 11 solar PV systems in selected SMEs.

When correctly sized and installed, DSES -whether grid-tied and stand-alone- can improve reliability and reduce costs for energy, stabilizing production and improving product quality. Achieving impact at scale depends on aligning technology-service fit, inclusive know-how, and fit-for-purpose finance. This, in turn, requires coordinated action across energy, production, and rural development policies.

## The energy challenge

Over recent decades, Bolivia has expanded rural electrification. In 2024, roughly 66% of rural households had grid access. Yet **many rural agri-food SMEs lack the energy services needed to produce, store, and market food products** which are vital for food security and economic growth. For agri-food SMEs, being close to the power grid does not guarantee that electricity reaches the worksite, at the capacity and tariff needed to run their equipment.

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[1] Proyecto financiado por el IDRC CIRD en el marco de la red CEDCA.

[2] For simplicity, we use "agri-food SMEs" to refer to rural producers, family-managed firms, associative/cooperative enterprises, and other non-family micro, small, and medium firms.

A just energy transition depends on securing effective energy access for rural agri-food SMEs through technologies that are technically, economically, and environmentally viable. **This brief aims to identify the conditions—by end use and operating context—under which DSES can be viably incorporated into production.** We adopt a task-oriented lens, assessing whether energy at the production site meets requirements for location, capacity, continuity, and cost. Rather than assume uniform benefits, we show how configurations of infrastructure, user know-how, and finance determine whether DSES become productive assets or stranded investments.

The analysis draws on fieldwork with agri-food SMEs across Bolivia. We conducted 49 semi-structured interviews and 31 site visits with mostly family-managed SMEs and local technicians, as well as cooperatives and associations. These SMEs produce and process herbs, tropical fruits, farmed-fish, honey, cereals and legumes, dairy and meat, and other foods. Additionally, 11 DSES- solar photovoltaic (SPV) systems under 5 kW-were installed and monitored in selected SMEs.

Agri-food SMEs are the backbone of rural agri-food economies and domestic food markets. They operate on small, dispersed plots—often well under 50 hectares—with low to medium mechanization and mixed family and hired labor. Value-adding activities are usually modest and are organized through family units, cooperatives, or producer associations that mainly serve domestic markets, with some export niches. These features shape energy access: dwellings are often located several meters away from worksites, energy installations and protection are basic; producers juggle multiple energy carriers (electricity, LPG, gasoline) under tight budgets and time constraints, and equipment is mostly traditional and low efficiency.

## Key findings

### 1. Electricity connection is not the same as productive energy access

Being connected to the grid does not guarantee the energy access required for production. Across cases we found three common bottlenecks:

**Availability (layout and capacity):** meters sit at the dwelling while tasks occur hundreds of meters away; long internal runs and the absence of three-phase or feeder capacity may prevent pumps, chillers, and motors from starting and running where work happens.

**Reliability and power quality[3]:** rainy-season outages can last up to three days; voltage drop and sags interrupt processes and can damage equipment; last-mile LPG deliveries may be erratic-so many producers prefer to buy LPG cylinders at neighborhood shops despite up to 40% higher costs and longer trips.

***70% of fishponds in Chapare, Bolivia, are located more than 100 meters from dwellings.***

[3] Low-quality power refers to a grid electricity with frequent outages, but also strong voltage fluctuations, which disrupt production and can damage equipment.

**Affordability and design:** energy costs can be high relative to income; tariff categories rarely match seasonal peaks or cash flows, and limited understanding of tariff options hinders money-saving reclassification.

*For SMEs that process the Amazonian fruit cupuaçu the cost of the electricity required to run freezers can account for up to 40% of gross income.*

## 2. Lack of experienced technical support is the main bottleneck

Many problems that appear structural are in fact stem from last-mile and point-of-use know-how gaps. In an oregano seedling facility, adjusting motor speed (frequency) cut electricity use. In a French-fries plant, electrifying key steps avoided downtime caused by local LPG shortages. In several cases, producers were unaware that internal electrical lines can be safely extended to production fields with proper protection and grounding.

Local technical support and knowledge transfer focused on productive uses of energy are needed. With proper advice and installation many loads can run on existing connections or with modest upgrades, making electricity more attractive than other energy carriers.

### 3. Energy coping strategies are costly

To cope with grid power that is unreliable or not available at the point of use, agri-food SMEs turn to gasoline or firewood, delay harvests or processing, sell early at lower prices to avoid spoilage, or underuse—or switch off—equipment and rely on manual work. These stopgaps reduce the immediate risk of lost output but raise energy and labor costs; over time they depress productivity, squeeze margins, and increase time burdens and work stress for producers. At first glance, DSES emerge as a one-size-fits-all solution: when properly specified, they can fully solve some problems and only partially mitigate others, depending on the end use and operating context.

### 4. DSES improve energy access for agri-food SMEs

Well-designed DSES—typically solar PV systems under 10 kW, grid-tied or stand-alone—work best as a reliable supplemental source of high-quality power rather than a full grid substitute. They keep critical tasks running day to day and through grid or fuel shortfalls, lower operating costs (especially with a bidirectional meter), and raise overall productivity. Over time, these gains strengthen SMEs and household incomes, reduce time burdens, and support local livelihoods.

**Energy barriers and coping strategies for agri-food SMEs**

| SME ACTIVITY | ENERGY ACCESS BARRIERS | COPING STRATEGIES | DSES USE (CONDITIONS) |
|---|---|---|---|
| Fish-pond aeration | Power meters located far from ponds. Voltage drop along internal lines. | Gasoline blowers; underuse. | **On-grid PV** with internal wiring upgrades to reach the ponds. **Off-grid PV** for much distant ponds. Is only viable when aeration can be done in daylight. |
| Irrigation for herbs (pumping) | Power meter located far from plots; high and misaligned tariffs. | Gasoline backup; underuse. | **On-grid PV** with internal wiring upgrades to reach the plots. It can partially offset high peaks of consumption during the season. **Off-grid PV** for much distant plots. |
| Tropical fruit cold storage | Multiple small fridges; outages; high and misaligned tariffs. | Early sales of harvest at lower prices; underuse. | **On-grid PV** to cut bills. **Off-grid PV** only for small, time-shiftable cold loads. |
| Llama-meat processing | Seasonal blackouts; long power-line runs. | Halt production; overtime. | **On-grid PV** with voltage stabilization to keep critical steps running. Viable for short interruptions; not a full substitute for 24/7 cold chain. |
| Chili deseeding | Lack of fit-for-purpose equipment. | Use firewood; manual work. | **DSES** apply only after acquiring suitable equipment |
| Quinua production | Power meters located far from fields, fragmented plots. | No use of energy. | **Low DSES** viability for fixed systems due to dispersed loads. Consider portable solar tools for micro-tasks or shared infrastructure if plots can pool demand. |
| Banana flour production | High energy costs. | Electric drying in the final stage before packaging ensures product quality in high-humidity areas. | **On-grid PV** to lower electricity bills. |

DSES are most effective in specific end uses: (i) pond aeration and water pumping when meters are far from ponds or plots and voltage drop is an issue; (ii) daytime irrigation with low- to medium-head/flow; (iii) modular cold chain (pre-cooling, freezing, storage) to smooth seasonality and buffer outages; (iv) short-outage ride-through for drying, milling, and small-scale processing; (v) lighting and small motors for processing tasks once suitable equipment is in place; and (vi) portable or shared solutions for dispersed plots. In these applications, the largest gains come from reduced fuel use, higher uptime, and better product quality. However, **three conditions must align:**

- **Technology–service fit:** Equipment matched to task-specific electrical/thermal needs and to local supply conditions; internal electrical works treated as part of the project (voltage-drop, protection, metering, grounding).
- **Accessible, inclusive information:** Hands-on support so all users can specify, operate, and maintain systems; training schedules and languages that include women and youth.
- **Fit-for-purpose finance:** financial products and programs aligned with production calendars and covering connection assets (wiring, meters, three-phase extensions)—not only equipment.

Where any one of these layers fails, nominal access turns into energy vulnerability rather than productive capability.

## 5. DSES effects extend beyond the production site

DSES can **reduce fuel dependence and raise reliability**, with spillovers for productivity, household welfare, environmental outcomes, and connectivity:

- **Cost and productivity:** in fish farming, trips to purchase fuel disappeared and operating costs fell; continuous operation improved production and reduced fish mortality. In tropical-fruit ventures (açaí, cupuaçu), lower electricity bills made it less risky to operate freezers, blenders, and pulpers; producers avoided spoilage, could store products for the off-season, and earned higher revenues. In Yapacaní, stable energy brought additional ponds online and, in some cases, increased capacity per pond grew.
- **Reinvestment and household welfare:** savings were reinvested in productive assets (e.g., pulpers, planned pelletisers, additional cooling) and household goods (e.g., washing machines), improving time management and in some cases water use.
- **Digital spillovers:** real-time energy monitoring of DSES via Wi-Fi provided educational and social connectivity benefits, narrowing local digital gaps.

These effects are only sustained when DSES are embedded in wider arrangements that align technology-service fit, inclusive know-how and fit-for-purpose finance.

*In Chapare, savings from avoided gasoline purchases for fish farming due to the installation of solar PV covered the cost of a new washing machine within a year of reliable operation.*

## Concluding remarks

In Bolivia, SMEs face binding energy constraints that rarely appear in aggregate statistics, but strongly shape productivity, incomes, and the viability of rural productive activities. Our cases in fish farming, tropical-fruit processing, herbs and other agri-food products, show how unreliable, costly, and poorly adapted energy services limit mechanization and increase exposure to losses and spoilage.

In this context, DSES can do more than simply "greening" supply: when properly sized, financed and embedded in local production systems, they reduce operating costs, stabilize key processes and open room for upgrading and diversification—turning nominal access into effective productive capability.

However, no single actor can fix these problems; progress depends on common ground, better coordination, and practical experimentation.

- **Design for production, not just connections.** Regulators, utilities, and installers should ensure electricity reaches the worksite at the required capacity (on-site metering, three-phase where needed, internal wiring and protection included in projects).

- **Bundle interventions.** Donors, development finance institution and local financial intermediaries, installers, and producer organisations should pair reliable supply (grid and/or DSES) together with inside-the-farm fixes, hands-on training, simple user guides, clear information on electricity plans, and financing that matches how producers earn and spend across the year.

- **Align tariffs with seasonality.** Regulators and utilities can offer simple productive-use plans with options that reflect seasonal peaks. Help producers switch plans in practice (with in-person support or a helpline) and explain the trade-offs between fixed and per-kWh charges in plain language so they can choose what saves them money.

- **Finance connection assets, not only equipment.** Donors, development finance institution and local financial intermediaries, should structure credit/grants that pay for the "last-mile" items that make systems work—internal wiring, meter upgrades or relocation, and three-phase extensions—as well as panels and inverters. Align repayments with harvest and sales cycles, and use group purchases to lower upfront costs.

This coordination agenda translates the analysis into joint actions across regulators, utilities, donors, development finance institution and local financial intermediaries, installers, and producer organisations, creating the conditions under which DSES deliver clear net benefits for agri-food SMEs.