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Clean Cooking to Empower Rural Women in the Energy Transition: Evidence from Guatemala

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Inter-American Development Bank
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Acknowledgments

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1

Executive summary



In Guatemala, firewood is still a common sight in kitchens, reflecting a broader pattern across Latin America and the Caribbean, where **millions of households continue to rely on biomass for cooking**. This reliance exposes families—especially women and children—to serious health risks and contributes to environmental pollution. It also limits the economic and educational opportunities available to women and girls, who often spend several hours each day collecting firewood and cooking.

To promote clean, accessible cooking methods, from January to July 2022, the Inter-American Development Bank (IDB) implemented a **pilot project** to transform cooking methods in 80 households by replacing firewood with **induction stoves** and **multifunctional electric pots** (financed by the project). The project also promoted **buying tortillas** from local tortilla shops as an alternative to making them at home, aiming to **reduce the time women spend cooking by up to 70 hours per month**.

The project was implemented in two peri-urban villages near Guatemala City: **San Juan del Obispo** and **Santa Cruz Chinautla**, where women spent an average of **40 hours per week** cooking and up to **USD23** per month on firewood. The main objective was to analyze the relationship between changes in fuel use and cooking practices and the time women spend cooking, and whether this negative relationship is associated with greater participation in productive, educational, or other activities. Additionally, the study examined whether the substitution of firewood with electricity for cooking is related to changes in household expenditures.

All 80 households participating in the study received a **multifunctional electric pot**. In addition, **20 households** that previously relied exclusively on firewood also received an **induction stove**. These households agreed to: (i) **cook exclusively** with these appliances for six months, and (ii) **stop making tortillas at home** and instead purchase them from tortilla shops participating in the study. These shops received a **liquefied petroleum gas (LPG)–fueled griddle and stove** to eliminate the use of firewood in commercial tortilla production.

The changes observed were assessed at two points: (1) at the end of the **6-month support period**, and (2) **18 months after project completion**, with results compared against baseline conditions.

Changes observed at project completion (6 months):

- All households (100%) used the **induction stoves** and **multifunctional electric pots** daily.
- Average **time savings: 2.5** hours per day (**≈ 71 hours per month**), driven by clean technology and behavioral changes (purchasing tortillas rather than making them).
- **Electricity expenditure:** no significant increase; the bill rose by an average of **USD 5 per month**.

Although there is no evidence of a statistically significant relationship between the adoption of cooking technologies and electricity spending, this result is relevant given users' initial concern about a substantial rise in their bill.

- **Energy savings:** households that previously purchased firewood reduced their monthly spending by **USD18** (from **USD23.23** on firewood to $\approx$ **USD5** in additional electricity costs).
- **Health:** 96% of users reported improvements (fewer respiratory symptoms, reduced eye irritation, fewer headaches, and less back pain).

Changes observed 18 months after project completion:

- All households (100%) continue to use the **induction stove**, and **80%** still use the **multifunctional pot** (nonuse is due to appliance malfunctions).
- Approximately **72%** of households no longer use **firewood** daily, reserving it only for specific events that require large quantities of food. A **"clean stacking"** pattern emerged: electricity replaced firewood for everyday cooking and was complemented by **LPG** in some cases.
- **92%** of households continue to **purchase tortillas** rather than make them, driven by time savings and convenience.
- **35%** of women use the time they save to engage in **income-generating activities**.

Key lessons:

- Technology transitions entail **changes in behavior**, not just appliances. The switch to **purchasing tortillas** was critical to freeing up women's time and eliminating daily firewood use.
- **Ongoing support** during the learning phase is essential.
- **Appliance costs** remain a barrier: **installment financing plans** should be explored, taking potential savings into account.
- According to participating households, eliminating the use of firewood over an open flame leads to short-term **health benefits**.
- **Partnerships with local actors**, such as Fundación Solar and the Guatemalan Electric Company (EEGSA), are key not only to introducing clean technologies, but also to ensuring that they are accessible, safe, and appropriate for local communities.

This pilot was developed by the **IDB** in collaboration with the **Modern Energy Cooking Services (MECS)** program and financed by the **Climate Investment Funds (CIF)**. The IDB is currently exploring scaling this pilot into a program for approximately **4,000 households** as part of the **"Efficient Use of Firewood and Alternative Fuels in Rural and Indigenous Communities"** program, financed by the **Mitigation Action Facility (MAF)** and implemented by the IDB and **Asociación Alterna**.



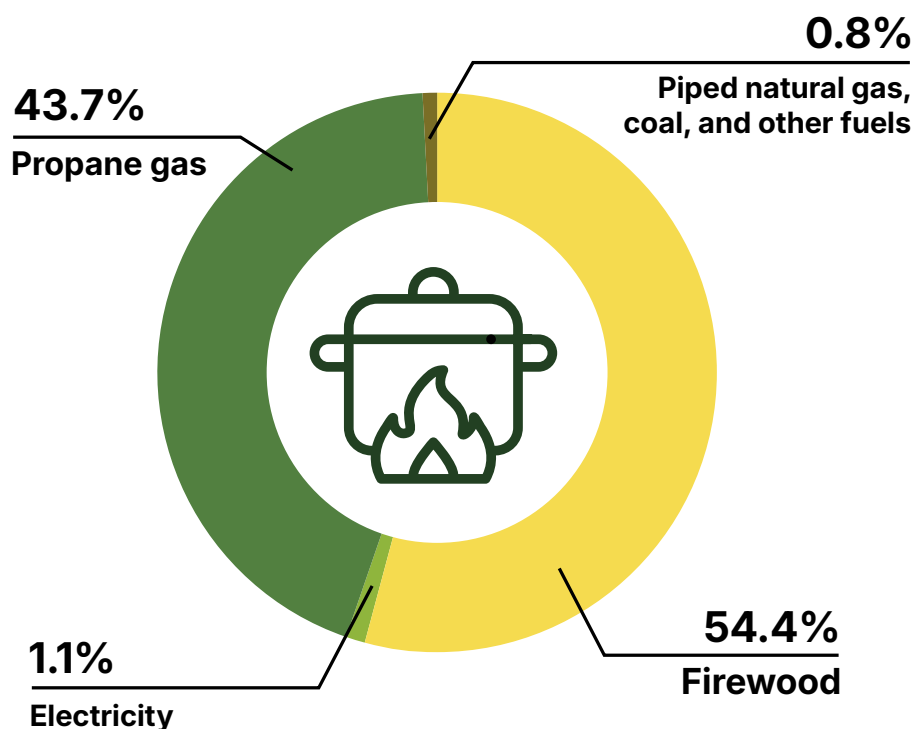
2

Background

In Latin America and the Caribbean, **70 million people** use firewood and other solid biomass fuels for cooking.¹ In Guatemala, **54.4% of the population relies on firewood**, especially in rural areas.² Nearly **1.16 million households** cook over **open fires**, exposing themselves to harmful smoke.³

Exposure to **household air pollution (HAP)** poses significant health risks, including heart disease, stroke, lung cancer, chronic obstructive pulmonary disease (COPD), and pneumonia.⁴ An estimated 69% of Guatemalan households that use firewood face a high risk of cardiovascular and respiratory diseases. According to the World Health Organization (WHO), more than **7,460 deaths in Guatemala in 2019** were attributable to HAP, including **488 children under five**.⁵

FIGURE 1 Energy sources for cooking in Guatemala



Source: Guatemala Census 2018.

Guatemala has the **highest firewood consumption** in Central America,⁶ generating a significant carbon footprint and threatening forest sustainability. Annual demand amounts to **16 million tons** of

1 WHO. WHO Global Health Observatory Database, 2022 data (accessed 2025).

2 INE. 2018. Censo Nacional de Población y VII de Vivienda. Guatemala.

3 INE. 2018. Censo Nacional de Población y VII de Vivienda. Guatemala.

4 PAHO. 2018. Ambient and Household Air Pollution and Health: Frequently Asked Questions. <https://www.paho.org/en/topics/air-quality-and-health/ambient-and-household-air-pollution-and-health-frequently-asked>

5 WHO. WHO Global Health Observatory Database.

6 ECLAC. 2007. Estrategia energética sustentable centroamericana 2020.

dry firewood,^{7,8} of which **98% is consumed by households** and **2% by industry**.⁹ Rural households account for **86.5%** of total demand. Approximately **49%** of firewood is sourced from **natural forests**,¹⁰ and it accounted for **69.5%** of total energy consumption in **2022**.¹¹



Women collecting firewood. Credit: Fundación Solar.

Achieving universal access to clean cooking is key to meeting **Sustainable Development Goal (SDG) 7**: “Ensure access to affordable, reliable, sustainable and modern energy for all.” Women are **disproportionately** exposed to the negative impacts of cooking with firewood. In addition to the health risks associated with firewood use, the time required to collect and cook with it limits **access to education** and **participation in the labor force**. **As deforestation advances**, household members have to travel farther to collect firewood, increasing both the time this takes and the **safety risks** involved. Limited access to firewood can also affect **nutrition** (diet changes, malnutrition) and the ability to **purify water**.¹²

The **annual cost of inaction, defined as the continued reliance on firewood for cooking**, is estimated at **USD10 billion** ($\approx$ **3% of GDP**): **USD6.7 billion** in health costs (morbidity and mortality), **USD3.1 billion** in gender-related costs (time spent collecting fuel, cooking, and cleaning), and **USD500 million** in climate costs (the social cost of carbon).¹³

Access to **affordable, reliable, sustainable, and modern** energy goes beyond supply: it requires solutions that **households can afford** and that are tailored to local contexts and needs.

7 Larrañaga, M. 2012. *Oferta y demanda de leña en la República de Guatemala/Woodfuel Integrated Supply/Demand Overview Mapping*. INAB, IARNA, and FAO.

8 Energy equivalent: approximately 39,994.9 kilo barrels of oil equivalent (kBOE).

9 Larrañaga, M. 2012. *Oferta y demanda de leña en la República de Guatemala/Woodfuel Integrated Supply/Demand Overview Mapping*. INAB, IARNA, and FAO.

10 Larrañaga, M. 2012. *Oferta y demanda de leña en la República de Guatemala/Woodfuel Integrated Supply/Demand Overview Mapping*. INAB, IARNA, and FAO.

11 Government of Guatemala. 2022. *Balance Energético 2022*. Ministry of Energy and Mining. <https://mem.gob.gt/wp-content/uploads/2023/08/BALANCE-ENERGETICO-2022.pdf>.

12 Office of Assistant Director-General (Forestry Department), FAO. 2013. “Forests, Food Security and Gender: Linkages, Disparities and Priorities for Action.” Background paper for the International Conference on Forests for Food and Nutrition, FAO, Rome, May 13–15.

13 World Bank, ESMAP, and MECS. *Clean Cooking Planning Tool*. <https://energydata.info/cleancooking/planningtool/mecs/GTM>.

Efforts to improve this access have tended to focus on **changes in fuel and technology use**. However, the challenge is **more complex** than this and includes:

- Gaps in access to **reliable, high-quality energy** between rural and urban areas.
- The **environmental impacts** of different cooking methods.
- **Poverty** and economic constraints.
- Impacts on **household health** associated with cooking technologies.
- The **time** women spend on these tasks.
- **Food, traditions, and cooking practices** that underlie cultural identity and community ties.



3

Project description

3.1 Introduction

To assess the effectiveness of this user-centered approach, the Inter-American Development Bank (IDB) implemented an intervention in two peri-urban villages in Guatemala from January to June 2022, in collaboration with the Modern Energy Cooking Services (MECS) program. The project was financed by the Climate Investment Funds (CIF) and implemented in partnership with Fundación Solar, a local nongovernmental organization with extensive experience in community-based work, in coordination with the Guatemalan Electric Company (EEGSA).

The project focused on transforming the cooking practices of 80 households by offering them the **opportunity to shift away from firewood and adopt induction stoves and multifunctional electric pots**. This was a comprehensive intervention that involved more than just a change in cooking technologies, taking into account the cultural practices and social challenges associated with making traditional foods (particularly tortillas) without firewood. The approach sought to reduce the time women spend cooking and the use of firewood, while accounting for local economic conditions and respecting traditional household practices.

The project's main objective was to assess how changes in fuel use and cooking practices reduce the time women spend on these tasks and analyze whether spending less time on them leads them to participate more in productive, educational, or other activities. The study also evaluated the economic and health-related effects of adopting clean technologies in participating households.

The 80 selected households resided in the communities of **San Juan del Obispo** and **Santa Cruz Chinautla**. These were organized into two groups based on the types of cooking fuel they used before and during the study period:

- **Group 1:** 20 households (10 in each community) that cooked exclusively with firewood and received an induction stove and a multifunctional electric pot.
- **Group 2:** 60 households (30 in each community) that used both firewood and liquefied petroleum gas (LPG) and received only a multifunctional electric pot.

To further reduce reliance on openfire wood, it was decided that the project would **outsource tortilla-making**, which women traditionally do at home in Guatemala. To this end, the project engaged **six local women entrepreneurs** to make and sell tortillas to participating households. To ensure these tortilla makers did not use firewood, they were provided with six LPG griddles—metal plates used for cooking tortillas—along with a gas cylinder and a stove for the nixtamalization process. Additionally, **eight support tortilla shops** were incorporated to address the geographic dispersion of the participating families.

3.1.1 Cooking practices in Guatemala

Diets in Guatemala revolve around **maize tortillas**, a staple that is at the heart of the country's culinary and cultural identity. Making tortillas by hand at home takes between **35 and 70 hours per month**, a burden that falls primarily on women.¹⁴

Tortillas are cooked on *comales* traditionally placed over a wood-burning stove or open fire. Although gas and induction *comales* exist for both household and professional use, making tortillas by hand remains extremely time- and energy-intensive. Significantly reducing the time Guatemalan women spend cooking therefore requires **buying ready-made tortillas rather than making them at home**.



Tortillas cooked on a comal over an open fire. Credit: Alterna ONG.

Around **40% of Guatemalans** currently purchase either handmade or machine-produced tortillas, mostly in urban areas. Many women in rural areas would also be willing to buy tortillas **if they were more affordable** relative to average incomes. A study conducted in Mexico estimated that machine-made tortillas cost approximately **USD0.75 per kilogram**, while tortillas made at home cost between **USD0.20 and 0.30 per kilogram**, depending on the materials and the source of the firewood used to cook them. However, this estimate does not account for the opportunity cost of women's time, estimated at **USD0.50 per kilogram of tortillas**.¹⁵

14 Troncoso, Karin, et al. 2019. "Adoption of LPG for Cooking in Two Rural Communities of Chiapas, Mexico." *Energy Policy*, 133: 110925. <https://doi.org/10.1016/j.enpol.2019.110925>.

15 Troncoso, Karin, et al. 2019. "Adoption of LPG for Cooking in Two Rural Communities of Chiapas, Mexico." *Energy Policy*, 133: 110925. <https://doi.org/10.1016/j.enpol.2019.110925>.

3.1.2 Selection of communities and participants

During the early stage of the project, **two peri-urban communities** were identified as pilot sites for the study. Approximately **40 families in each community** were invited to take part in the study, switching from wood-burning to electric stoves.

Community selection criteria

Two fundamental requirements were established:

- 1. Access to electricity:** Participating communities needed to have access to electricity. Because the project was carried out during the Covid-19 pandemic, areas near Guatemala City were prioritized to facilitate travel in case of lockdowns. These areas fall within the service coverage of **Empresa Eléctrica de Guatemala (EEGSA)**, a utilities company that distributes approximately 40% of the country's electricity supply and operates in the Guatemala, Escuintla, and Sacatepéquez departments, as well as in the areas of Santa Rosa and Chimaltenango.
- 2. Firewood as primary cooking fuel:** Communities were required to be in peri-urban areas where firewood remained the primary cooking fuel, preferably purchased rather than gathered by hand.

Based on these criteria, the communities selected were **San Juan del Obispo**, in La Antigua Guatemala municipality (Sacatepéquez department), and **Santa Cruz Chinautla**, in Chinautla municipality (Guatemala department). Socioeconomic conditions are similar in the two communities, although Santa Cruz Chinautla is more rural despite its proximity to the capital.

Household selection criteria

Once the communities had been selected, inclusion criteria for participating families were established.

- **Households had to include a woman who was responsible for cooking**, given that this role is primarily held by women in Guatemala.
- They also needed to **rely mainly on firewood** for cooking in order to assess the potential for replacing this with electricity.
- Households were required to **purchase the firewood they used for cooking** so that their spending patterns before and after the transition to electricity could be analyzed. However, the baseline survey found that **20% of the selected households gathered firewood** rather than purchasing it; these households were eventually retained in the study to enable the effect of this variable to be observed.

Tortillas had to be made at home in the selected households. As tortillas are a staple of the Guatemalan diet and require a significant amount of time to make, replacing home-made with store-bought tortillas would allow the study to evaluate time savings and participants' reactions to this behavioral change.

Selection methodology

Eligible households were selected through **random surveys, focus groups, and community workshops** in each location. A key challenge was finding households that relied exclusively on wood-burning stoves, as cooking with both firewood and LPG is commonplace in rural Guatemala. Households were therefore classified into two groups:

- **Group 1:** 20 households (10 in each community) that cooked exclusively with firewood.
- **Group 2:** 60 households (30 in each community) that used both firewood and LPG.

3.2 Appliances

Group 1 households received a **multifunctional electric pot** and an **induction stove**, along with a set of induction cookware. **Group 2** households, which previously used both firewood and LPG, received a **multifunctional electric pot** and a set of utensils designed to protect the pot's nonstick coating and optimize appliance use.

- The **induction stove** provided by the program had a single burner, adjustable power ranging from **200W to 1,200W**, and a programmable 1–3-hour timer.
- The **multifunctional electric pot** had a **power rating of 900W**, a digital control panel in Spanish, and **six automatic cooking programs** for different types of food.

Two-burner induction stoves were initially considered for inclusion, but this option was ruled out for the following **economic and technical** reasons. First, two-burner stoves are significantly more expensive, which would have limited the project's scalability because families would not be able to purchase them on their own with financial support. Second, they require a **220-volt electrical system**, whereas most households have a standard 110-volt installation. Upgrading their electrical supply would be too costly for the households taking part in the study.



Technologies delivered: (i) induction cookstove with a set of pots and pans; and (ii) electric pressure cooker.
Credit: Fundación Solar.

Commitments of participating households

Families received the stoves and pots on a conditional loan basis, with the option to keep them permanently at project completion if they demonstrated consistent, appropriate use.

In return, they were required to:

1. **Refrain from using firewood** for cooking and from making tortillas at home, instead they were to purchase them from tortilla vendors affiliated with the project.
2. **Track their tortilla purchases** using cards managed by the tortilla vendors throughout the entire six-month intervention period.
3. **Receive weekly visits** from project technical staff to address questions, monitor equipment, and document their experience.
4. **Provide accurate information** on energy consumption, their cooking practices, and their opinions on the new technologies.



Delivery of the new technologies. Credit: Fundación Solar.

Electrical system upgrades

Given the communities' socioeconomic circumstances, a **technical assessment of each household's electrical system** was conducted before the appliances were installed. An electrician inspected the wiring in each household and made any necessary modifications, including:

- Replacing damaged wiring.
- Installing circuit breakers.
- Installing polarized outlets.

Several households made additional **minor structural adjustments** to ensure the new appliances were installed safely and functioned correctly.



Installation of switches and replacement of cables. Credit: Fundación Solar.

Support for tortilla vendors

The six commercial tortilla makers included in the project each received an **LPG-powered griddle with a diameter of 102 cm and a star-shaped burner**, along with a **gas cylinder** and a **stove** for nixtamalization. In return, they were required to **keep daily records of tortilla sales** for participating households. The project also provided the vendors with **one quintal of maize (45.36 kg)** and **25 pounds of lime** for nixtamalization, ensuring they had an initial supply of inputs. A further **eight tortilla shops** were included in the project, strategically chosen to ensure all households could access tortillas regardless of their location. **The project did not subsidize tortilla purchases** or alter their market price to avoid market distortions and ensure that participants could continue buying tortillas after the intervention if they chose to do so. Due to the high demand for tortillas, eight support tortilla shops were incorporated, strategically distributed to serve the geographic dispersion of households. These shops did not receive comales, but they met the requirements for systematically recording tortilla consumption.



Strengthening of local tortillamaking enterprises. Credit: Fundación Solar.

3.3 Training sessions for households and women entrepreneurs

3.3.1 Practical workshops for women on using clean technologies

The women selected to participate in the project attended **hands-on workshops introducing clean cooking technologies**. Eight sessions were held with small groups of ten women, in compliance with the safety protocols established by the Ministry of Health and Social Security during the Covid-19 pandemic.



Introductory training sessions. Credit: Fundación Solar.

The training sessions provided a detailed explanation of how each component of the appliances works, how to operate the **control panel**, and how to **clean and maintain the appliances** to keep them running optimally. Participants were also instructed on **basic safety measures**, with an emphasis on not handling cords and plugs with wet hands, keeping appliances away from heat sources, checking electrical connections, and keeping children away from the appliances while in use.

During the workshops, facilitators **demonstrated** how to use the multifunctional pots and the induction stoves. As part of this practical component, participants learned to make **rice and chicken broth** in the electric pot and **fried eggs** on the induction stove. At the end of the workshops, participants highlighted how **fast, easy to use, and quiet** the appliances were, expressing particular appreciation for the fact that they do not require constant supervision.

3.3.2 Training and support for tortilla vendors



Learning by doing: local facilitators provide training on the use of new technologies while preparing traditional foods such as tortillas and chicken soup. Credit: Fundación Solar.

The six women entrepreneurs who received the LPG griddles took part in a technical training session on **use, maintenance, and safety**. This training included:

- A description of griddle components.
- Operating instructions for optimal heating.
- Safety measures for handling LPG and preventive maintenance.

The six entrepreneurs were enthusiastic about starting work on the project and **began using the griddles even before receiving formal training**. This demonstrated both **how easy the appliances are to use and the women's immediate uptake of them**.

The training session also reinforced the **commitments they had taken on**, including keeping **systematic records of tortilla purchases by participating households** using tracking cards to ensure data traceability.



Formalization of commitments. Credit: Fundación Solar.

3.4 Profile of communities and participants

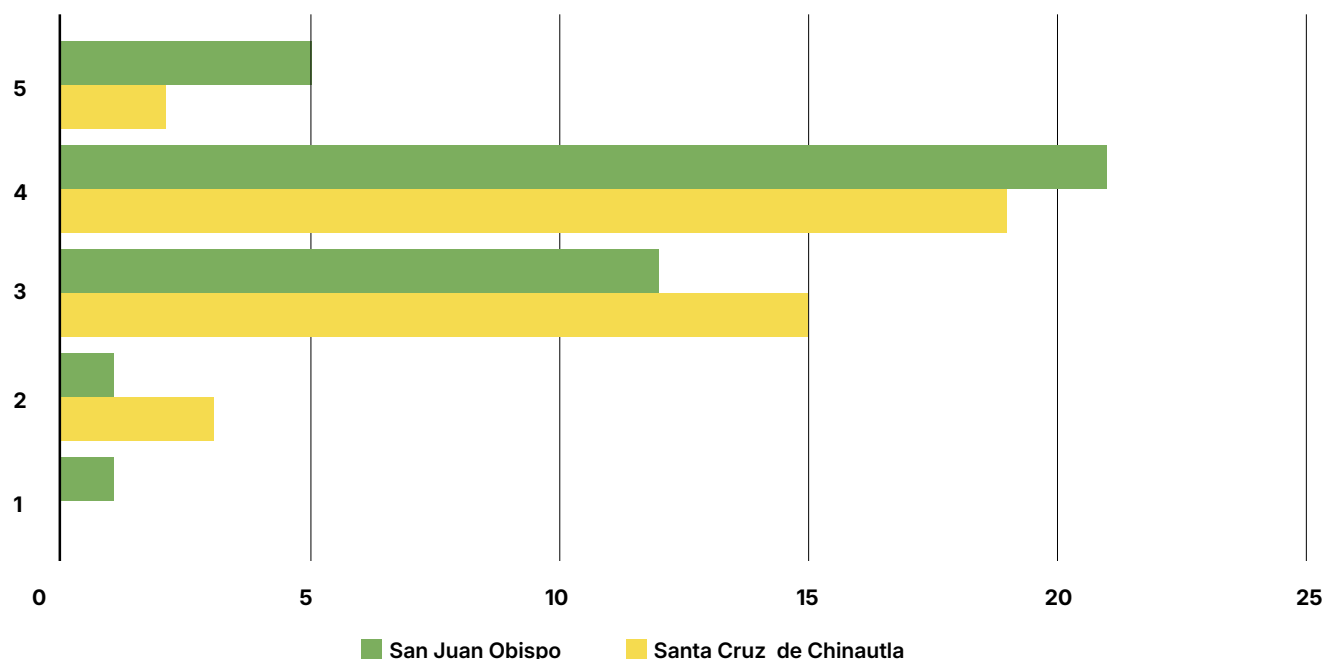
3.4.1 Chinautla and Antigua Guatemala municipalities

The communities of **San Juan del Obispo** and **Santa Cruz Chinautla** are in central Guatemala. Although the two communities are geographically close and share certain historical factors, their socioeconomic profiles differ.

Santa Cruz Chinautla, in Chinautla municipality (Guatemala department), has a population of **114,752** people living in **28,077 households**. **San Juan del Obispo**, in **Antigua Guatemala** municipality (Sacatepéquez department), has a population of **46,054** people in **11,131 households**.¹⁶

¹⁶ INE. 2018. *Censo Nacional de Población y VII de Vivienda*. Guatemala.

FIGURE 2 Socioeconomic profile of San Juan del Obispo and Santa Cruz Chinautla



According to the **baseline survey**¹⁷ conducted at the start of the project, **San Juan del Obispo** scored slightly higher on socioeconomic factors, with a larger share of households in **quintiles 4 and 5** than **Santa Cruz Chinautla** (see Figure 2).

Table 1 compares the two municipalities using data from the **2018 National Census**, revealing similarities in literacy rates, ethnic composition, and the share of the population that is economically active. However, important differences are evident in the share of **female-headed households**—higher in Antigua Guatemala—and in **access to technologies** (computers, cable television, and internet), which is also greater in Antigua Guatemala.

¹⁷ The first 10 questions on the survey were included based on the Progress Out of Poverty methodology. The answers to these questions can be used to analyze the probability of the surveyed household being under the poverty line and other internationally recognized poverty thresholds. <https://www.povertyindex.org/country/guatemala>.

TABLE 1 Comparison of Chinautla and Antigua Guatemala municipalities (2018 Census)

	Chinautla municipality (Santa Cruz Chinautla)	Antigua Guatemala municipality (San Juan del Obispo)
Municipality type	Peri-urban	Peri-urban
Population	114,752 inhabitants in 28,077 households.	46,054 inhabitants in 11,131 households.
Share of female-headed households	32.39%	28%
Share of women	51.8%	51.8%
Self-identified ethnic group	Ladino (non-Indigenous) (81.77%) Maya (17.3%)	Ladino (non-Indigenous) (87%) Maya (11%)
Average age of population	27.6	31.2
Literacy rate	93%	93%
Average years of schooling	7.8	8.8
Main cooking fuel in households	- Propane gas: 88% - Firewood: 11% - Electricity: 4% - Charcoal: 0.1% - Piped gas: <0.1%	- Propane gas: 79% - Firewood: 19% - Electricity: 2% - Charcoal: <0.1% - Piped gas: <0.1%
Percentage of households with a room used exclusively for cooking	71%	85%
Household assets	- Radio: 78% - Television: 94% - Computer: 31% - Cable TV: 63% - Internet: 25% - Stove: 99% - Refrigerator: 70% - Washing machine: 33% - Water tank: 36% - Hot water system: 14% - Motorcycle: 28% - Car: 29%	- Radio: 82% - Television: 94% - Computer: 45% - Cable TV: 77% - Internet: 30% - Stove: 100% - Refrigerator: 74% - Washing machine: 45% - Water tank: 23% - Hot water system: 23% - Motorcycle: 37% - Car: 33%
Economically active population	96%	97%
Unemployed people engaged in household work	55%	44%
Economic activities with the largest number of workers	- Service- and retail-sector workers, - Tradespeople and mechanics, - Elementary occupations, - Machine operators and assembly-line workers.	- Service- and retail-sector workers, - Elementary occupations, - Tradespeople and mechanics, - Farmers and skilled agricultural and forestry workers.

3.4.2 Santa Cruz Chinautla¹⁸

This community lies **12 kilometers** from Guatemala City. Although it is classified as a peri-urban community, it **remains largely rural**. Most of its population belongs to the **Poqomam Maya ethnic group**, and the community maintains a strong cultural identity that is reflected in its **crafts, cuisine, and traditional dress**.

There are significant structural shortfalls in its **public services**: much of its infrastructure has deteriorated and requires maintenance. Approximately **65% of homes** are built from **concrete block walls** and **sheet-metal roofs**, although these materials are often in poor condition. The project documented **precarious housing conditions and overcrowding**, with as many as **four families sharing the same plot of land, water and electricity services, and utility meters**.

The main local **economic activity** is **pottery**, with products sold outside the municipality, along with the production of **charcoal, vegetables, and maize**. The community also has retail shops and a bank branch. In **2012**, the **Ministry of Culture and Sports** declared the artisanal production of ceramics and pottery in Santa Cruz Chinautla to be part of **Guatemala's intangible cultural heritage**.

According to the **local health center**, the most common ailments in the community are **gastrointestinal and respiratory illnesses**, largely due to pollution in the river that runs through the area, which affects the quality of the water used for drinking and irrigation.

3.4.3 The women of Santa Cruz Chinautla

Only **10 of the 40 women** participating in the project reported being in paid employment at the start of the project, mainly as domestic workers, potters, bakers, or pharmacy staff. However, weekly interviews revealed that most engaged in **informal income-generating activities** such as making and selling pottery, farming, or selling basic goods. These activities typically take up only **a small part of the day** and do not always provide a steady income.

The following profiles are representative of the women participating in the project:

- **Ana María:** homemaker and president of the local school's parent association; lives in a home with an individual electricity meter.
- **Gloria:** teacher and owner of an online retail business; lives in a fully constructed house with its own electricity supply.
- **Sharon:** homemaker; occasionally sells products; lives in a semipermanent dwelling with its own electricity supply.
- **Paulina:** homemaker and potter; earns income from selling pottery; shares electricity meter with two other families.

¹⁸ Chinautla Municipal Council. 2019. *Plan de Desarrollo Municipal y Ordenamiento Territorial de Chinautla*, Guatemala 2020–2032. Guatemala: Municipalidad de Chinautla.

- **Gregoria:** homemaker, potter, and farmer; member of the school's parent association; shares a meter with two other families.

3.4.4 San Juan del Obispo

This community is in **Antigua Guatemala municipality**, at the foot of **Agua Volcano, 4 kilometers** from the city itself. Its population is predominantly *ladino* (non-Indigenous), although it also includes people of Indigenous origin.

The community is known for its **farming**, particularly **loquat growing**, and is nicknamed "The Land of the Loquat." Loquats are the village's main source of income and are used to produce artisanal wine and preserves.

Although it is a tourist destination and was granted "**Picturesque Town of Guatemala**" status in **2023**, **marked social inequalities** remain. Large, modern houses stand alongside more modest and even precarious dwellings, where **water and electricity supplies are often shared**.

San Juan del Obispo has **essential services** (running water, electricity, a health center, a police station, and schools), meaning it has better infrastructure than Santa Cruz Chinautla.

3.4.5 The women of San Juan del Obispo

Half of the 40 women from this community who participated in the project were in **paid employment**. Nine were domestic workers, four sold food or bread, three were teachers, one was a cook, and one harvested coffee.

Representative profiles:

- **Aleida:** owns a food shop; lives in her own house, which has an individual electricity meter.
- **Carmelina:** owns a fully constructed home where she makes and sells preserves and other goods and runs a metal workshop; she shares an electricity meter with the workshop and her son.
- **Jennifer:** makes and sells *pupusas* (stuffed tortillas); lives in a fully constructed home with safe electrical installations and her own meter.
- **María Luz:** teacher and owner of a semipermanent dwelling; shares an electricity meter with her son.
- **María Ángela:** homemaker; lives in a small, shared dwelling with her eldest son's family, with whom she shares a meter.



4

Methodology

The project methodology was structured around two main objectives:

- (i) **Provide comprehensive support** to participating households to ensure proper uptake and use of the new cooking technologies, and
- (ii) **Collect systematic data** to enable analysis of the results and impact of the intervention.

To this end, various monitoring and evaluation strategies were devised, including **weekly visits** by facilitators, **surveys** conducted at different stages of the project, **focus groups** and **interviews** with participants, and **monitoring of electricity consumption** in partnership with **EEGSA**. These strategies generated both quantitative and qualitative data on the project's effects on cooking practices, energy use, and women's daily lives.

The project outcomes were calculated by comparing data collected **before the project began, at the end of the 6-month implementation period**, and **18 months after project completion**. All the data gathered through interviews and focus groups was processed and analyzed using **ATLAS.ti** qualitative analysis software. Survey data were analyzed using simple statistical methods, namely measures of central tendency.

4.1 Weekly visits

Following the distribution of the appliances, **field facilitators** conducted **weekly visits** to each household to provide technical support and answer questions about the use of the induction stoves and multifunctional electric pots. During these visits, staff reinforced **safety and hygiene practices**, provided maintenance support, and gathered information on participants' opinions of the appliances, the benefits and challenges they observed, and whether any continued to use wood-burning or LPG stoves.



Field facilitators during weekly visits. Credit: Fundación Solar.

During the **first two weeks**, this support was more intensive, particularly for older participants, who found it harder to get used to the **control panels and automatic cooking programs**. The younger participants adapted more quickly. In Santa Cruz Chinautla, one participant even helped her neighbors to use the appliances on her own initiative when the facilitator was not present, reflecting **a process of collective learning and community uptake of the technologies**.

4.2. Household surveys

The project conducted **four main surveys** of participants, designed to sequentially measure changes in their conditions, practices, and perceptions:

- **Survey 1—Baseline (before the project):** Established the baseline conditions and profiled the women's cooking practices, socioeconomic conditions, and activities. Some **100 households per community** were surveyed.
- **Survey 2—After 1 month:** assessed levels of use and understanding of the appliances and gauged challenges relating to use and uptake.
- **Survey 3—After 6 months (project completion):** measured **uptake and impact indicators** and assessed the most significant changes in cooking practices.
- **Survey 4—18 months after project completion:** assessed the **sustainability and ongoing use** of the new technologies and whether households continued buying tortillas after the support period ended.



Periodic interviews. Credit: Fundación Solar.

4.3 Focus groups and interviews

Focus groups were essential for fostering active participation among the women and understanding their opinions on the changes brought about by the project.

- The **first focus group** introduced the project, addressed initial questions, and gathered information on how the community was organized, access to firewood, purchasing and collecting practices, and willingness to adopt clean technologies.
- The **second focus group** included **male family members** (husbands and sons), to include their perspectives on the changes in households and the use of firewood.
- During the **third focus group**, conducted at project completion, **participants' overall experiences were assessed**, the perceived impacts were documented, and participants were thanked for taking part.

In addition, **11 in-depth interviews** were conducted at project completion: **5 in each community** and **1 with a participating tortilla maker**, which were complemented by recordings of shorter interviews with the other users. These provided **valuable qualitative insights** into the adoption process, the impact on daily life, and perceived benefits.



Focus groups conducted after the delivery of the technologies. Credit: Fundación Solar.

4.4 Monitoring of electricity consumption

During the preparation phase, **a collaboration agreement was reached with EEGSA**, the electricity company serving both communities. The objective was to analyze energy consumption patterns **before and after the intervention** by comparing **electricity meter** readings for each participating household.

EEGSA also provided **individual meters** to measure how much energy the specific appliances distributed through the project consumed, separating this from the household's overall electricity consumption. A total of **40 electricity meters** were installed (**20 in each community**), distributed as follows:

- **10 meters in group 1 households** (those provided with an induction stove and a multifunctional pot).
- **10 meters in group 2 households** (selected randomly from among the families that were only given a multifunctional pot).

This monitoring provided precise data on **changes in household electricity consumption** and validated the savings associated with reduced firewood use.

4.5 Participant selection

Some **80 households (40 in each community)** were selected through a random, transparent process. These were selected using the **baseline survey administered to 100 households** in each community. The **four project enumerators** began at the center of each community, moving in different directions and administering the questionnaire to **every third household** until each had completed **25 surveys**.

Households that met the criteria were then invited to take part in the project. Approximately **35 households in each community** accepted the invitation immediately, and the **remaining five places** were filled through **referrals from women who had already agreed to participate** and who wanted to share the program's benefits with other women in their community.

While the sampling approach included random selection, participation was voluntary and partially based on referrals from other participants, which may introduce self-selection bias. Therefore, the sample is not intended to be statistically representative at the municipal level but is adequate for analyzing a pilot intervention.



5

Project outcomes

This section presents the effects of the intervention associated with the **adoption of new cooking technologies, time savings, women's participation in income-generating activities, changes in energy expenditures, and health improvements** observed during and after the intervention.

The findings summarized below bring together results from subsections 5.1, 5.2, and 5.3.



1. Behavioral change

At project completion, **100% of participating households were using induction stoves and multifunctional electric pots** and had considerably reduced their LPG consumption and almost entirely eliminated firewood use, except on special occasions.

Eighteen months after project completion, 92% of women were still buying tortillas rather than making them at home, citing **time savings** and **greater convenience**.



2. Time savings

The use of electric cookers, combined with purchasing tortillas and no longer gathering firewood, is associated to an average **time savings of 2.5 hours per day** (equivalent to **71 hours per month**).

Among the women who previously **purchased firewood**, the average time saved was **1.6 hours per day** or **47.5 hours per month**.

The freed-up time enabled participants to **rethink their daily routines** and **spend more time on personal, family, or income-generating activities**.



3. Greater autonomy for women

Eighteen months after project completion, 35% of the women said that they were using the time saved for income-generating activities such as making and selling **handicrafts, tortillas, or flowers, growing loquats, or tutoring children**.

These findings reflect significant progress in women's **financial autonomy and a diversification in women's incomes** within participating households.



Productive activities carried out by women. Credit: Fundación Solar.



4. Energy savings

Before the project, women who cooked with firewood **spent an average of USD23.23 per month on fuel**, which decreased to about **USD5 on electricity** after adopting the new technologies.

Users who cooked with LPG **decreased their use by 43%**, indicating an **effective transition to cleaner, more cost-efficient energy sources**.



5. Electricity consumption

The monitoring activities and meter readings **showed no considerable increases in electricity bills**. On average, **monthly electricity costs increased by USD5 (equivalent to 23.84 kWh)**, which users perceived as reasonable and sustainable given the savings they made on other fuels.



6. Health improvements

At project completion, **96% of participants reported improvements to their health**, mainly due to **reductions in respiratory illnesses, eye irritation, headaches, and back pains** associated with prolonged firewood use.

These improvements continued into the follow-up period, suggesting that the changes have had a **lasting positive impact on beneficiary households' quality of life**.

5.1 Time savings, technology adoption, and women's income-generating activities

5.1.1 Cooking practices before the project

The baseline survey profiled **cooking practices** in the communities before the introduction of electric technologies.

Women in **group 1**, who cooked exclusively with firewood, spent an average of **37 hours per week preparing food**, plus a further **3 hours collecting firewood** and **1 additional hour preparing it for use**. In total, they spent **41 hours per week** on the entire cooking process.

Women in group 2, who used both firewood and LPG, spent around **35 hours per week preparing food**, plus **3 hours collecting firewood** and **1 hour preparing it** for use, for a total of **39 hours per week**.

In 39% of households in San Juan del Obispo, firewood collection was carried out exclusively by women, and in 18% by men; in Santa Cruz Chinautla, this task **was shared by men and women in 31% of households**, while 69% did not collect firewood at all. The main challenges cited were **unsafe**

roads, poor trail conditions, cold weather, and the **advanced age** of some of the women collecting the firewood.

Differences were also observed in the time spent **making tortillas**. In Santa Cruz Chinautla, women spend an average of **18 hours and 21 minutes per week** on this, compared to **14 hours and 25 minutes in San Juan del Obispo**. This difference is explained by the fact that in Santa Cruz Chinautla, more women **bought maize to make the nixtamal themselves**, whereas in San Juan del Obispo, the use of **preprepared maize flour (Maseca)** was more common, reducing preparation time.

Tables 2, 3, and 4 present cooking times, firewood use and consumption, associated costs, and differences in tortilla preparation across the two communities.

TABLE 2 Time spent cooking in Santa Cruz Chinautla and San Juan del Obispo

	Santa Cruz Chinautla	San Juan del Obispo	Average of both locations
Group 1. Exclusive firewood users			
Average time spent cooking with firewood per week	33 hours and 53 minutes	40 hours and 43 minutes	37 hours and 18 minutes
Group 2. Users of firewood and LPG			
Average time spent cooking with firewood per week	19 hours and 40 minutes	30 hours and 29 minutes	25 hours and 5 minutes
Weekly average time spent cooking with LPG per week	9 hours and 36 minutes	9 hours and 55 minutes	9 hours and 45 minutes
Total	29 hours and 16 minutes	40 hours and 24 minutes	34 hours and 50 minutes

TABLE 3 Use and consumption of firewood in Santa Cruz Chinautla and San Juan del Obispo

	Santa Cruz Chinautla	San Juan del Obispo	Average of both locations
Challenges in gathering firewood	Theft, poor road conditions, difficulties crossing the river in summer, advanced age	Back pain, theft, the need to enter private land, poor road conditions, weather conditions, advanced age	N/A
Who gathers firewood?	- Women: 10% - Men: 10% - Entire household: 11% - Do not gather firewood: 69%	- Women: 35% - Men: 18% - Children: 5% - Entire household: 5% - Do not gather firewood: 37%	N/A
Average time spent preparing firewood for cooking per week	80 minutes	54.1 minutes	60.5 minutes
How much time is spent gathering firewood per week?	2 hours and 31 minutes	3 hours and 55 minutes	3 hours and 13 minutes
Who decides what cooking fuel is used in the household?	- Women: 87.5% - Women, with support from other women: 12.5%	- Women: 90% - Women, with their husbands' consent: 10%	N/A
Expenditure on firewood—Group 1 (exclusive firewood use)	USD29.8	USD16.4	USD23.1
Expenditure on firewood—Group 2 (firewood and LPG)	USD25.5	USD16.7	USD21.0

TABLE 4 Tortilla-making: frequency, inputs, costs, and time spent, by community

	Santa Cruz Chinautla	San Juan del Obispo	Average of both locations
# users by frequency of tortilla-making			
Daily	19	11	15
3 or 4 times per week	5	8	6.5
1 or 2 times per week	9	10	9.5
# users by inputs used			
Maseca (industrial maize flour)	5	4	4.5
Buys maize and Maseca	3	4	3.5
Buys maize	25	21	23
Grows own maize	2	1	1.5
Average number of tortillas made per week	242 (equivalent market cost GTQ81)	233 (equivalent market cost GTQ78)	237.5 (equivalent market cost GTQ79.5)
Average cost of making tortillas	USD9.21	USD6.5	USD7.9
Average number of people in the household consuming meals	5.3	4.8	5.05
Average time spent going to the mill per week	1 hour and 20 minutes	1 hour and 54 minutes	1 hour and 37 minutes
Average time spent making nixtamal per week	10 hours and 48 minutes	6 hours and 48 minutes	8 hours and 48 minutes
Average time spent making tortillas per week	6 hours and 13 minutes	5 hours and 43 minutes	5 hours and 58 minutes
Total time required to make tortillas, including cooking, making nixtamal, and trips to the mill to grind maize	18 hours and 21 minutes	14 hours and 25 minutes	16 hours and 23 minutes

5.1.2 Results and opinions after one month of implementation

One month after the project began, the results demonstrated **rapid uptake of the new technologies**: all participants had started using their new appliances, and **50% of group 1 households** had stopped using firewood entirely. In addition, **most participants in both groups had chosen to buy tortillas from local tortilla makers**.

Group 1, which began using induction stoves and multifunctional electric pots, reduced time spent cooking from **41 hours per week to 18 hours and 30 minutes**, a **reduction of 22.5 hours per week**.

Group 2, which complemented its use of LPG as a cooking fuel with electric pots, reduced cooking time to **15 hours and 30 minutes**, **saving 19.5 hours per week**. Although **52 of the 60 participants** continued to use LPG over the first month, their use declined **by about 40%**.

The reduction in time spent cooking was driven by both **the uptake of new technologies and by cultural acceptance of purchasing tortillas**—a significant shift in communities where making tortillas at home is a deeply rooted practice.

TABLE 5 Cooking practices after one month of implementation

	Santa Cruz Chinautla	San Juan del Obispo	Average of both locations
Average use of the induction stove per week	7 hours and 55 minutes	9 hours	8 hours and 7.5 minutes
Average use of the multifunctional electric pot per week	10 hours and 10 minutes	9 hours and 30 minutes	9 hours and 50 minutes
Average LPG use per week	5 hours and 58 minutes	5 hours and 35 minutes	5 hours and 46.5 minutes
Number of participants still using LPG	24 of 30	28 of 30	26 of 30
Number of participants still using firewood	4 of 10	6 of 10	5 of 10

Note: participants with an induction stove do not use LPG for cooking.

Participants' opinions on the benefits and initial challenges of using the new technologies

During the first month, participants identified **time and cost savings** as the main benefits, along with other practical advantages: the **convenience** of not having to constantly monitor cooking, **ease of use**, the **ability to keep food warm**, **the elimination of smoke**, and **a reduced risk of household accidents**.

How the time saved was used:

- **65.7%** of women used it for **income-generating or work-related activities**,
- **43%** for **spending more time with their children** or grandchildren,
- **40.8%** for **recreational activities**,

- **10%** for **household tasks**, and
- **3%** for **education or personal development**.

One notable development was a **change in the distribution of family members' roles**: in 16 households, **husbands began actively participating** in meal preparation, reflecting a positive cultural shift toward **shared responsibility for domestic work**.

All participants spoke positively about the multifunctional electric pots, noting that they **worked well**, helped make the kitchen **cleaner and more pleasant**, and **reduced the physical effort** required to make meals.



Participation of parents in training workshops and the use of the technologies. Credit: Fundación Solar..

The main challenges experienced in the first month related to:

- **Initial hesitancy and lack of experience** in using electrical appliances.
- **Minor technical issues** with the pots (25% in Santa Cruz Chinautla and 12.5% in San Juan del Obispo), due to **insects entering the electric circuits** or **manufacturing defects**.
- **Limited cooking capacity** (5 liter pots), which was insufficient for larger households.

TABLE 6 Challenges of cooking with electricity

Challenges	Santa Cruz Chinautla	San Juan del Obispo
Initially found it difficult to use or needed help from their children	25%	25%
Pot size	10%	10%
Estimating cooking time	2.5%	2.5%
Lingering smells/flavors	5%	5%
Initial hesitancy	5%	15%
Lack of training	0%	2.5%
Faulty pots requiring replacement or repair	25%	12.5%
Tortillas cannot be heated in the pot	2.5%	0%
Dependence on power supply	2.5%	0%

Note: Not all respondents reported experiencing challenges when cooking with electricity.

Initial concerns varied by community:

- In **San Juan del Obispo**, the main concerns were a **potential increase in electricity bills** or the appliance **malfunctioning or exploding**.
- In **Santa Cruz Chinautla**, the main concern was **potential damage to or theft of the appliances**.

Participants' opinions on the benefits and initial challenges of buying tortillas rather than making them

Differences were also observed in the benefits the participants associated with **buying tortillas**:

- In **Santa Cruz Chinautla**, the main benefit perceived was **time savings**, followed by **convenience** and **reduced physical effort**.
- In **San Juan del Obispo**, the key drivers of satisfaction were the fact that tortillas were sold at a **reasonable price** and **delivered to participants' homes**.

TABLE 7 Perceived benefits of buying tortillas

Perceived benefits of buying tortillas	Santa Cruz Chinautla	San Juan del Obispo
Time savings	27	10
Reasonable prices		18
Time saved making tortillas	8	10
Home delivery		6
The tortillas are hot when delivered		2
Less smoke in the home and less need to be standing by the fire	4	2
Ease	10	1
Can use time saved to do something else	7	

Note: some respondents provided more than one response.

Among the challenges reported, some participants thought the **purchased tortillas were small or expensive**, while others had **difficulty reheating them** without a traditional stove. Overall, **the shift to buying tortillas was widely accepted**, and **the perceived barriers declined with time**.

TABLE 8 Reported challenges associated with buying tortillas, both communities

Reported challenges associated with buying tortillas	San Juan del Obispo	Santa Cruz Chinautla
Expense	13	0
Size (too small)	9	4
Household consumes more tortillas than it buys and has to supplement with home-made ones	6	3
Prefer to make them themselves	5	2
Delivery is late	2	2
Hard to get used to	2	0
Do not consume tortillas	2	0
Receive fewer tortillas than expected	2	0
Flavor	1	4
Not enough tortillas on at least one occasion	1	4
No way of heating tortillas without a fire	0	4
Don't like the tortilla maker	3	2

5.1.3 Results and opinions at project completion

At the end of the pilot project, **100% of participants were successfully using** induction stoves and multifunctional electric pots in their daily routines.

Participants reported **average daily time savings of 1.7 hours**, including **44 minutes** from using the new technology and **53 minutes from buying tortillas** instead of making them.

If the **33 minutes spent gathering firewood** and the **8.5 minutes spent preparing** it are also included in the calculation, the **total daily time savings reached 2.5 hours**, equivalent to an average of **71 hours per month** for the two communities.

TABLE 9 Perceived time savings

	Santa Cruz Chinautla	San Juan del Obispo	Average both communities
Average time saved on cooking per day			
30 minutes or less	2	5	3.5
30 to 60 minutes	23	28	25
more than 60 minutes	13	7	10
Average time saved on cooking per day			
30 minutes or less	7	1	4
30 to 60 minutes	20	11	15.5
more than 60 minutes	13	22	12.5
Time saved on gathering firewood per day (minutes)	20.2	46	33%
Time saved on preparing firewood for cooking per day (minutes)	11	8	8.5

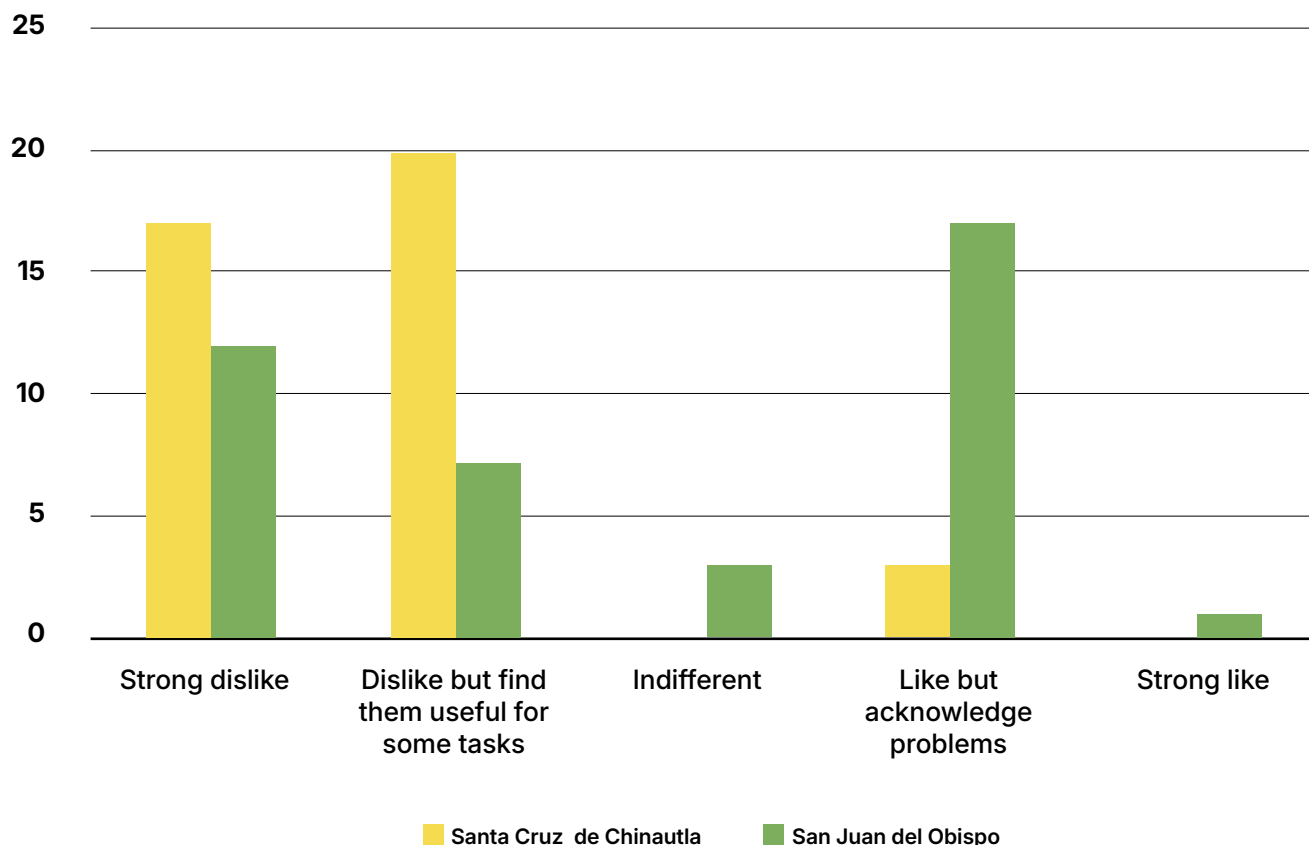
Changes in opinions on firewood use

After cooking with the electric appliances for six months, the women expressed a clearly less favorable view of using firewood.

In **Santa Cruz Chinautla**, **92%** reported that they did **not enjoy cooking with firewood**, compared to 47.5% in **San Juan del Obispo**.

In the latter, **42% of participants** said that although they still like cooking with firewood, they **acknowledge its drawbacks**—mainly smoke, heat, and physical effort. Only one participant openly stated that she “really liked cooking with firewood.” (See figure 3)

FIGURE 3 Level of satisfaction with wood-burning stoves at project completion



Cost of purchased tortillas

The switch to **purchasing tortillas** also triggered different opinions on economic factors in the two communities.

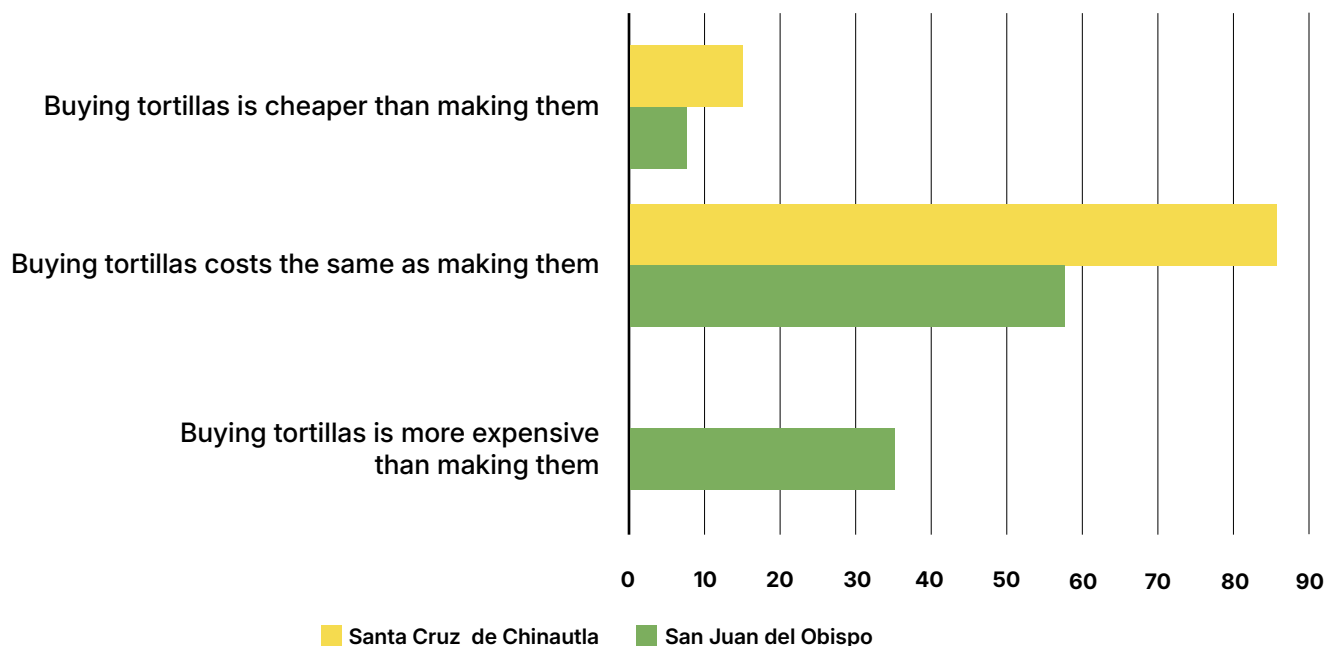
In **Santa Cruz Chinautla**, **100% of participants** felt that **buying tortillas cost the same or less than making them at home**.

In contrast, in **San Juan del Obispo**, **57%** said they thought **they spent the same buying tortillas as making them**, while **35%** thought they spent more, but **continued buying** them because it was more convenient.

This difference in opinions across the two communities is explained by the fact that **maize is 83% more expensive in Santa Cruz Chinautla**, which closes the price gap between making and buying tortillas.¹⁹

¹⁹ In Santa Cruz Chinautla, each household made 242 tortillas per week on average, at a cost of USD9.2, far more than in San Juan del Obispo due to the higher price of maize in the former community. In San Juan del Obispo, each household made an average of 233 tortillas per week at an average cost of USD6.5 per week. Buying 242 tortillas in Santa Cruz Chinautla costs USD10.3 (GTQ1 per 3 tortillas). Making them at home costs USD9.2, representing savings of USD1.2 per week. The same calculation in San Juan del Obispo yields weekly savings of USD3.5.

FIGURE 4 Perceived cost of buying tortillas (percentage)



Family involvement and shared responsibility for domestic work

The introduction of electric cookers encouraged **other household members to participate more** in making meals.

During the project, **18 husbands, 19 daughters, 6 sons, and 6 mothers** took part in meal preparation, suggesting an **emergent redistribution of household tasks** and greater **shared responsibility** for these.

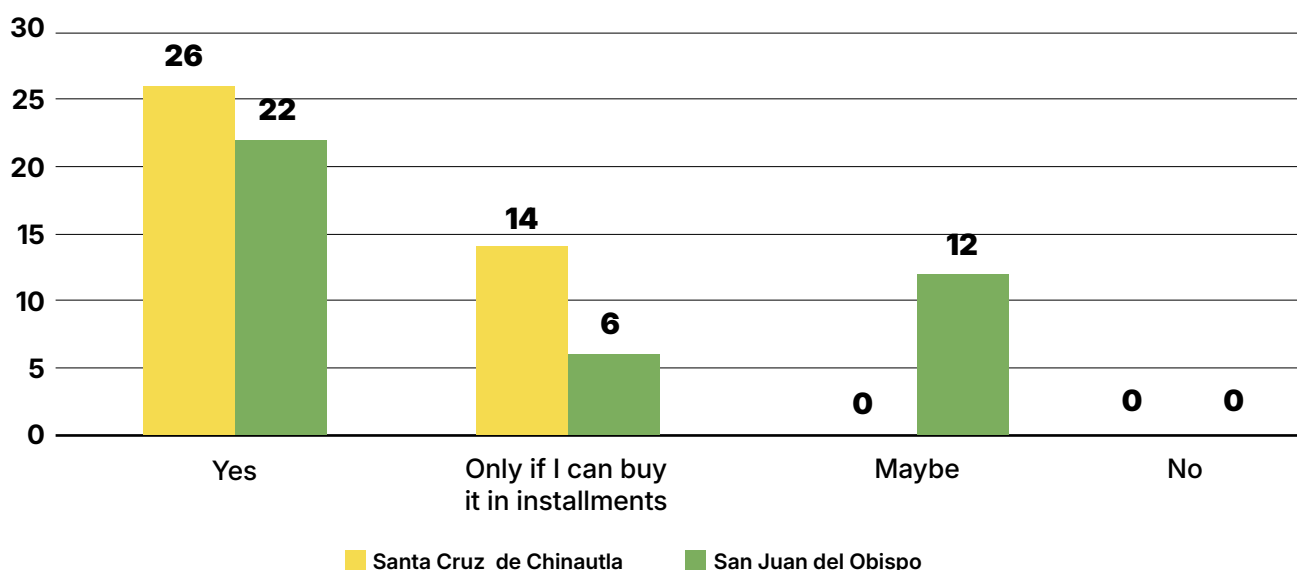
Willingness to purchase appliances in the future

When asked how they would feel about purchasing a multifunctional electric pot using their own money,

- **60%** of the women said **they would be willing to buy one**
- **25%** said they would do so **if financing or payment plans were available**
- the remaining **15% were unsure**, but none of the participants rejected the possibility outright.

These findings reflect **sustained acceptance of the new technologies** and a **positive attitude toward purchasing them**, particularly if **affordable financing mechanisms or microfinance programs are available**.

FIGURE 5 Users' willingness to purchase a multifunctional electric pot



5.1.4 Results and opinions 18 months after project completion

A **follow-up survey** was conducted among participants in **January 2024**, **18 months after the completion of the pilot project**. The aim was to assess the **sustainability of using electric cooking technologies, cooking habits, and overall opinions of the change** in the absence of technical support.

Sustained use of appliances

The survey found that **100% of households** continued using the **induction stove**, while **80% were still using the multifunctional electric pot**.



Women using the technologies with optimal care, including handmade covers to protect pots and cookstoves from dust and insects. Credit: Fundación Solar.

There were problems with the pots in **11 households (18%)**, leading to **frustration and dissatisfaction** that caused participants to stop using them. The most common issues were due to **inappropriate storage and maintenance practices**, including **lost parts, burned lids**, and **scratching of the nonstick coating**. Only **two participants reported problems with the induction stoves**, although they **continued to function** despite these.

Five participants attempted to **repair their pots**, although **high costs** and limited availability of **technical services** in the area limited their ability to do so.



Electric pressure cookers damaged due to inadequate storage and hygiene practices in eleven households. Credit: Fundación Solar.

Residual use of firewood

Some **72% of participants** no longer **use firewood every day**, relying on it **only for celebrations or family gatherings**.

The **remaining 28%** reported continuing to use it often or some of the time for the following reasons:

- The **electric pot stopped working**.
- They need **firewood for food-related businesses** (such as making pupusas, sauces, fried pork, and traditional jams and preserves).
- Personal preference for **making specific dishes or heating water**.
- A **family tradition** passed down through generations.

Selected participant testimonies:

"I only use firewood to cook beans because the electric pot stopped

"I use firewood to heat water because that's how my mother did it."

"I use firewood only when I make tortillas."

"I like making traditional jams and conserves using firewood."

"My pupusa business is still going strong; I need firewood to cook large quantities."

Continued purchasing of tortillas

Some **92% of households** continue to **buy tortillas** rather than make them, citing **time savings** and **convenience** as the main reasons.

Their comments included the following:

"We got used to buying tortillas and no longer have to gather firewood."

"It saves me lots of time, and I've gotten used to that."

"I make tortillas by hand if I feel like it or if I don't have cash to buy them."

"It's cheaper to buy them than to make them."

Diversification in the use of the appliances

After 18 months, the participants had significantly expanded their culinary repertoire with the new appliances, using them to make more **elaborate traditional dishes** such as tamales, stews, *atoles* (traditional hot drinks), soups, and desserts. **Table 11** lists the dishes that participating households make most often.

TABLE 10 Dishes most frequently made by participating households

• White beans with pork	• Roast chicken
• Beef or chicken stew	• Rice pudding
• Barbecue ribs	• Hot drinks such as <i>atole</i> (a maize-based drink) or <i>mosh</i> (an oatmeal-based drink)
• Chicken soup	• Chicken in cream sauce
• Tamales	• Steamed vegetables
• Chicken or pork <i>chuchitos</i> (small tamales)	• Shredded beef
• Pancakes	• <i>Pepián</i> (traditional meat stew)
• Spaghetti	• Chicken and rice
• Stewed beef or chicken	• Fried or scrambled eggs
• French fries	• Coffee
• Fried chicken	• Orange chicken



Examples of typical dishes prepared using the new technologies: atole, rice, chicken soup, dobladas, and beans.
Credit: Fundación Solar.

Reinvesting time saved

Some **35%** of participants said they use the time the appliances save them to engage in **income-generating activities** such as making and selling handicrafts, food products, or flowers, growing loquats, or providing private tutoring.

Some **34%** use the extra time for household tasks, **13% for playing with their children or helping them study, and 12% for leisure activities or rest** (visiting friends or family, watching TV, or reading). Only one woman reported using this time for formal education.

In addition, some participants reported **using the appliances for microenterprises**, such as making **empanadas, pickles, chocolate-covered bananas, and shaved-ice syrups**, demonstrating the technology's **versatility** and potential to generate **additional income**.

5.2 Financial savings on fuel

One of the most significant impacts of the project was the **savings participants made by replacing traditional fuels**.

The project findings revealed that electric stoves and pots are **more efficient and less costly** to run than LPG or wood-burning stoves, with savings particularly pronounced in homes that previously relied on firewood.

Women who used to buy firewood **were previously spending an average of USD23.23 per month**. By the end of the project, **their electricity bills were USD5 higher** than before, and they had stopped spending any money at all on firewood.

In households that previously relied on LPG, time spent cooking dropped by **43%**, resulting in a **proportional reduction in gas consumption**. During the project, **10% of participants who had previously used LPG stopped doing so entirely**, thereby eliminating spending on this.

These savings were primarily used to **cover other basic household needs**, such as food, other essential items, and medicines.

Some women observed that the new appliances had had a positive impact on their finances and health:

"Saving money on firewood and medicines meant I could catch up on my rent."

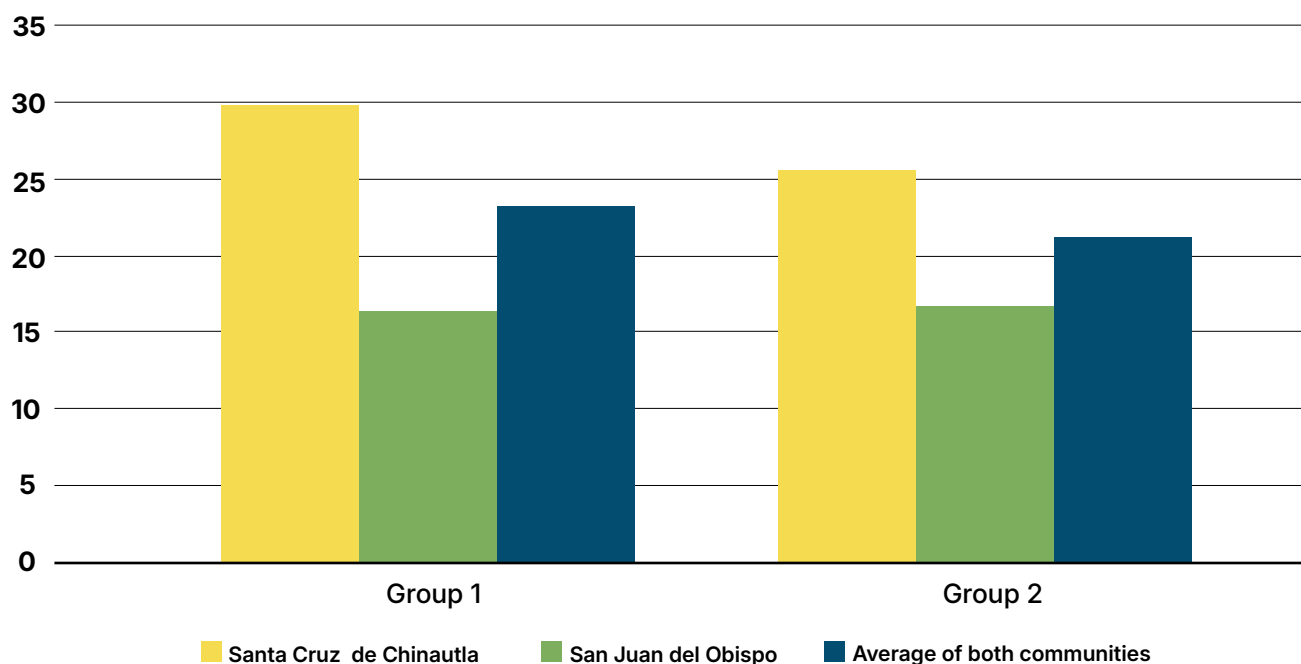
"My lung problems have improved since I started using the appliances and I don't have to buy medicines anymore."

5.2.1 LPG and firewood consumption

Money spent on firewood varied significantly between the two communities. In **Santa Cruz Chinautla**, firewood was **83%** more expensive than in **San Juan del Obispo**. Before the project, participants who cooked exclusively with firewood spent **USD29.8 per week in Santa Cruz Chinautla** and **USD16.4 in San Juan del Obispo**, while those who cooked with a combination of firewood and LPG spent **USD25.5 and USD16.7**, respectively.

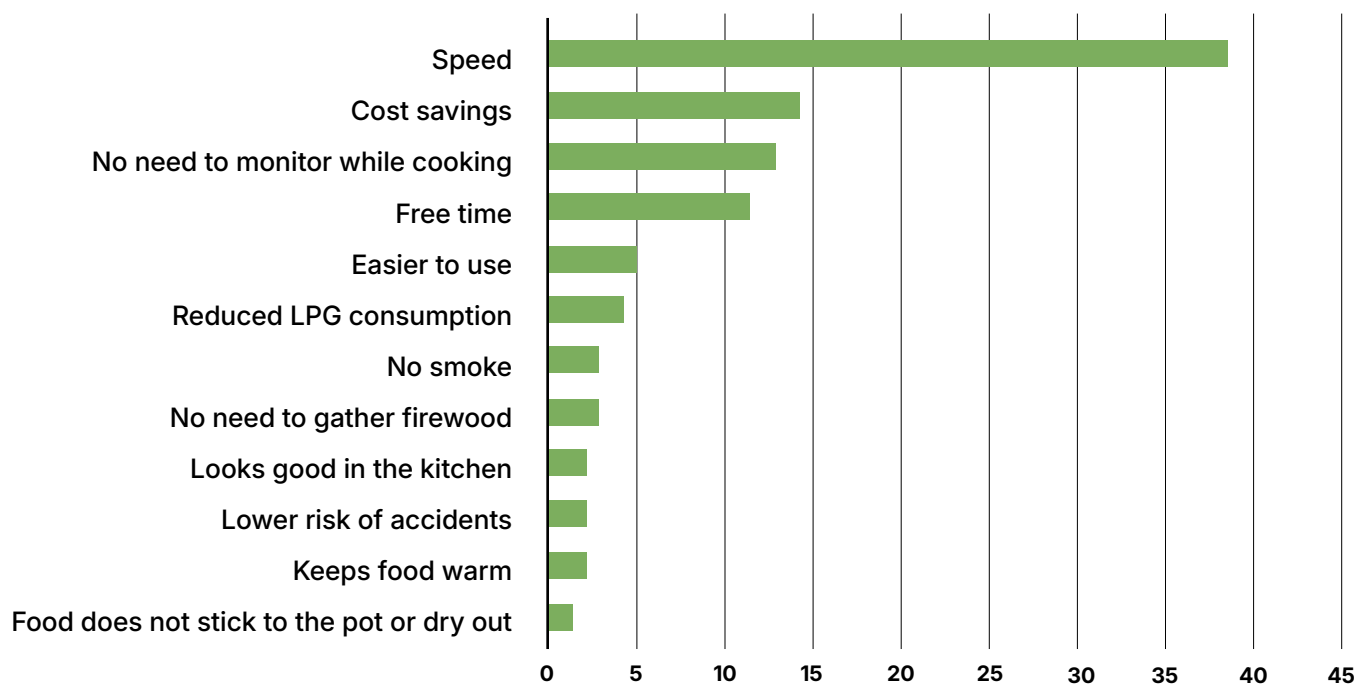
By project completion and at the follow-up point 18 months later, participants **were no longer spending any money at all on firewood**.

FIGURE 6 Monthly spending on firewood in USD at the start of the project



One month into the implementation period, participants reported **savings on firewood and LPG** as one of the **project's main benefits**—this aspect was mentioned by **19% of survey respondents, second only to faster cooking (38%)**.

FIGURE 7 Reported benefits of using induction stoves and multifunctional electric pots



Selected testimonials

"My electricity bill was GTQ58 (USD7.5), only GTQ23 (USD3) higher than before. But I'm saving GTQ101 (USD13) on gas. We're happy using the electric pot every day of the week."

"The gas lasts almost twice as long as before. I only have to get a refill every 20 days and I'm not buying firewood at all."

"We are really happy with the pot: we save money on firewood, our electricity bill hasn't gone up much, and the house is smoke-free."

Although the project did not quantify gas savings in monetary terms, average time spent cooking with LPG decreased by **3.7 hours per week in Santa Cruz Chinautla** and **4.3 hours in San Juan del Obispo**, representing a **43% reduction** in LPG consumption.

"My gas lasts two and a half or three months, compared to a single month before."

"We're saving a lot of gas; now it lasts twice as long."

5.2.2 Electricity consumption

One of the main concerns identified at the outset of the project was the **potential increase in electricity costs** from using electric stoves and pots. During the first month, **44% of participants** expressed concern that their **electricity bills might increase significantly** after switching from firewood or LPG.

"I'm afraid of using the electric pot too much because of the electricity bill, but my children say using it is better for me."

However, after receiving their first bill, the participants found that the increase was minimal (around **USD5 per month**), which significantly reduced perceived risk.

"I realized that the pot doesn't use that much electricity, and I like cooking with it because it saves me time."

Isolated cases of higher electricity bills

In some households, electricity bills rose slightly more because they **shared an electricity meter with another household**, which affected their eligibility for the **subsidized social tariff**.²⁰ This subsidy applies only to users who consume less than **125 kWh per month**.²¹ When this threshold is exceeded, as is the case when multiple households share a meter, the tariff increases artificially.

"I want to get my own electricity meter to avoid conflicts with my sister-in-law over the increase in the bill."

Monitoring and technical findings

After 18 months, readings from the meters installed by **EEGSA confirmed that participants' electricity consumption had increased only moderately**, as also confirmed by the users through their perceptions.

- In **Santa Cruz Chínautla**, there was an average increase of **USD5.3 per month (26.45 kWh)** compared to 2021.
- The increase in San Juan del Obispo was **USD4.1 per month (16.03 kWh)**.

²⁰ The subsidized social tariff applies to approximately 3.4 million Guatemalan households, equivalent to 94% of users in the country. Electricity tariffs change every three months in Guatemala: there were thus two increases during the project implementation period (January–June 2022). EEGSA's social tariff increased from 1.26 Kwh in January to 1.28 Kwh between February and April and 1.32 Kwh between May and June (Comisión Nacional de Energía Eléctrica. 2023. *Ajuste tarifario trimestral para el período de mayo–julio 2023*. Guatemala).

²¹ Comisión Nacional de Energía Eléctrica. 2023. *Ajuste tarifario trimestral para el período de mayo–julio 2023*. Guatemala.

These figures are based on data from the **40 meters installed** in participating households (20 in each community) to measure the specific consumption of the electric stoves and pots.

Participants' opinions after 18 months

In the follow-up survey, **57% of the respondents reported no noticeable increase in their electricity bills** after switching to the new technologies.

Among those who did report an increase:

- **50%** said the increase was **moderate or acceptable**,
- **38%** described it as **minor**, and
- **12%** thought it was **high**, but they were not unhappy about it as they associated it with **improved overall well-being**.

Selected testimonials

"The bill has only gone up by about GTQ10; I even have an electric coffee maker now."

"The bill has gone up a little, but I also have an internet connection now."

"Across the community, everyone's bills have increased; it isn't just because of the new appliances."

5.3 Health effects

Moving away from firewood as the primary cooking fuel significantly **improved participants' perceptions of their respiratory, eye, and back health**, as well as overall family well-being.

Health conditions before the project

At the start of the project, **nearly 25% of participants** reported **burns** from using wood-burning stoves, and a similar share reported **neck or back pain** associated with carrying firewood. Focus groups with participants confirmed they were experiencing other common health issues, including:

- **Chronic eye irritation**, with risk of permanent damage to the tear ducts (epiphora).
- **Respiratory conditions**, caused by continuous exposure to smoke.

- **Muscle pains and risks of falls or accidents** while collecting firewood.
- **Unsanitary conditions in kitchens**, exacerbated by the buildup of soot and smoke in the home.

Perceived improvements at project completion

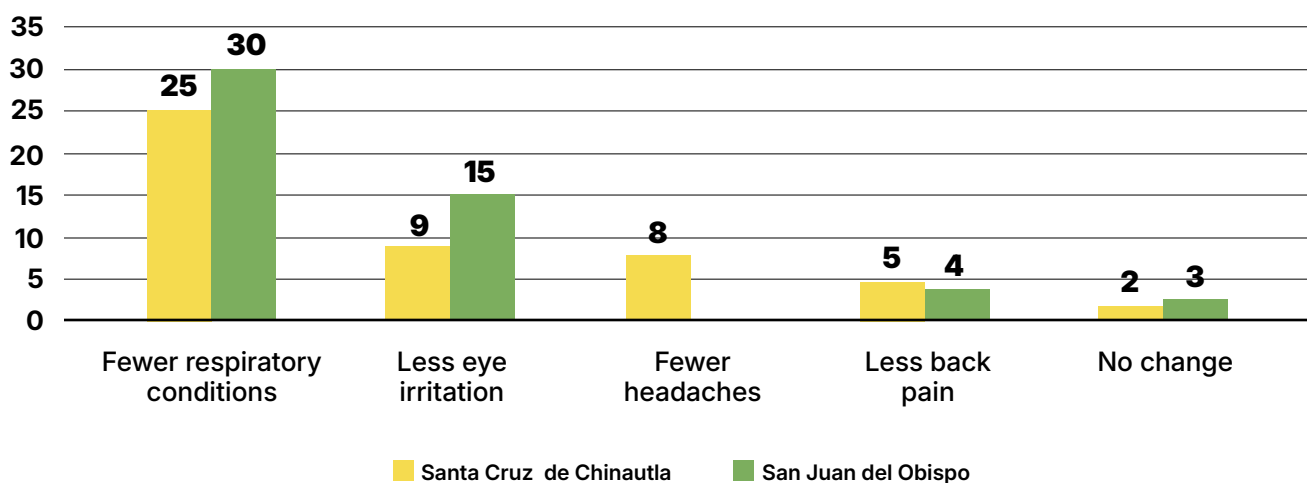
Despite the brevity of the project, participants reported clear, widespread improvements to their health. At the end of the intervention, **96% of participants** reported **positive changes in their physical well-being**, including **fewer respiratory illnesses, reduced eye irritation, and less frequent headaches and back pain.**

"I used firewood to cook and sell tortillas for years; now my health has improved a lot."

"My granddaughter knows how to use the electric pot, and I'm no longer worried about her getting burned."

"My husband is happy that I'm no longer exposed to all that smoke and can breathe better."

FIGURE 8 Perceived health improvements at project completion



Findings from the 18 month follow-up survey

The follow-up survey conducted 18 months after project completion confirmed that participants perceived **lasting health benefits**. A total of **72.2% of respondents reported fewer respiratory problems, coughing, and eye irritation** compared to before the switch to electric cookers.



"My electric pot stopped working a month ago, and I had to go back to firewood. I don't like it anymore: my mother's health has improved, and I don't want my children to get sick."

"My mother used to suffer from headaches and irritated eyes; that's no longer the case."

"The children catch fewer colds since I started using the pot and the electric stove."



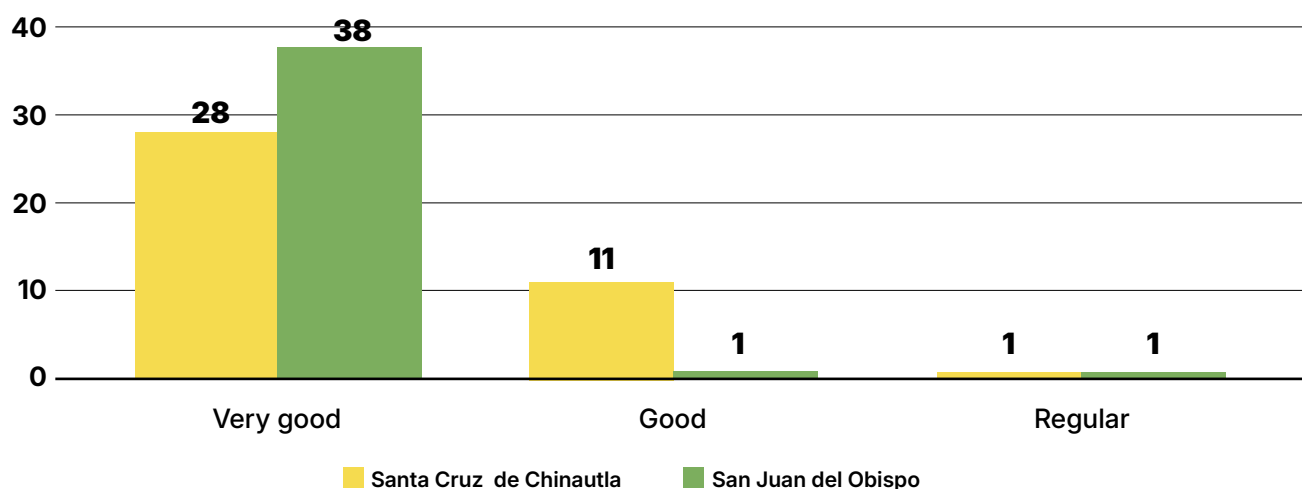
6

Adoption and Impact Indices

The final project survey included specific variables to calculate adoption and impact indices, following Karin Troncoso's (2014) methodology.²² These indices aim to systematize the changes perceived and reported by users within the context of the pilot project. They do not constitute an estimate of causal impact in an econometric sense, as the study design does not include a control group or a counterfactual approach, and should therefore be interpreted as descriptive tools. The findings are presented in figures 9 and 10.

The adoption index²³ was constructed based on levels of satisfaction with the new technologies, frequency of use, condition of the appliances, and willingness to replace them when they reach the end of their useful life. The results show very high adoption levels in both communities, particularly in San Juan del Obispo, where the index **reached 95%**. This outcome reflects high levels of reported satisfaction, daily or near-daily use of the appliances, and a strong interest in replacing them when they stop working.

FIGURE 9 Adoption index, both communities



The **impact index**²⁴ measures changes in participants' quality of life and considers variables such as the frequency of use of different cooking technologies (electricity, firewood, and LPG), the number of appliances used, level of satisfaction with traditional wood-burning stoves, perceived time savings, health benefits, and changes in stove locations.

The impact index scores were lower than those of the adoption index due to the coexistence of multiple cooking technologies. In particular, given that 75% of participants used LPG at the start of

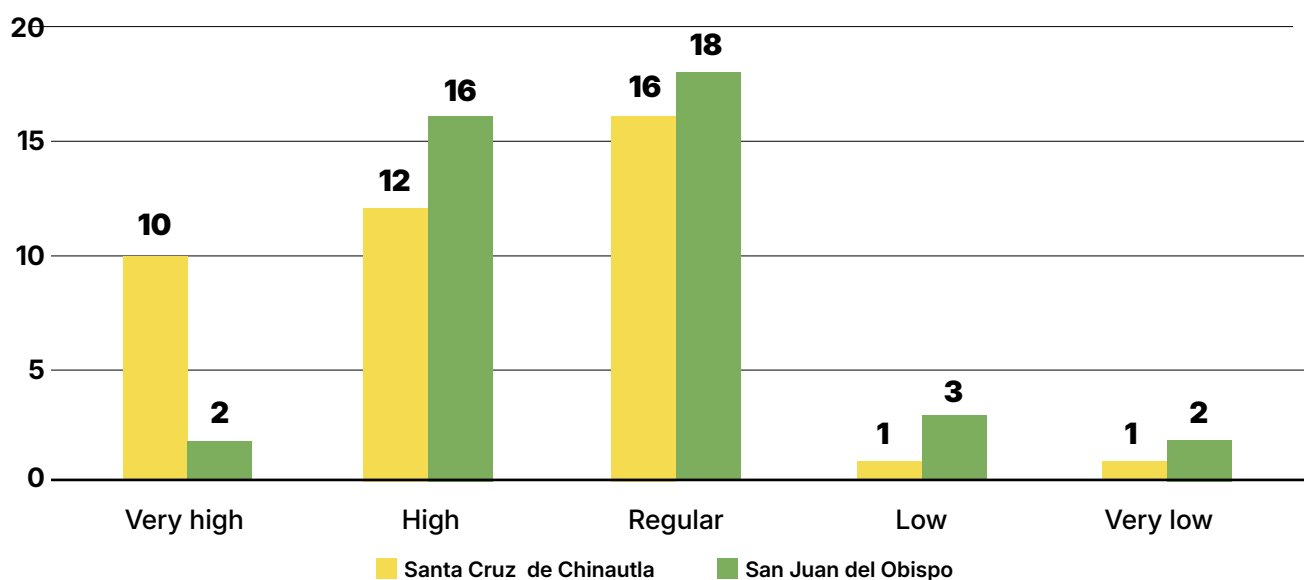
22 Troncoso, Karin. 2014. A Recipe for Developing Adoption & Impact Indices. Clean Cooking Alliance.

23 The adoption index was calculated following Troncoso (2014) as a weighted index based on four variables: frequency of use, condition of the equipment, level of satisfaction, and willingness to replace it. Each variable was normalized between 0 and 1 and weighted with coefficients of 4, 3, 2, and 1, respectively. The index ranges from 0 to 10 and can also be expressed as a percentage.

24 The impact index was constructed following the methodology of Troncoso (2014) as a composite index based on benefits perceived by users (such as time savings, reduced smoke exposure, improvements in health, and financial savings). Each variable was normalized on a 0 to 1 scale and weighted according to its relative importance. The resulting index corresponds to a weighted sum of these variables and is expressed on a scale from 0 to 10 (or as a percentage), reflecting the level of perceived impact of the project from the users' perspective.

the project, the relative change is smaller among this group than among households that previously relied exclusively on firewood. As figure 10 shows, Santa Cruz Chinautla has higher impact indices, associated with greater perceived health benefits and a larger number of households that significantly reduced their LPG use. Households with low or very low scores are primarily those that continued to use firewood regularly.

FIGURE 10 Impact index, both communities



7

Lessons learned and recommendations

- 1. The project's success stemmed from combining a technological shift with a change in tortilla-making practices.** Introducing a new cooking technology requires a comprehensive analysis of cooking habits and strategies to solve activities that cannot be easily replaced simply by changing fuel or technologies. In this context, purchasing tortillas from local tortilla makers was the key strategy that enabled participants to stop making them at home, freeing up their time and eliminating the need for firewood.
- 2. Support during the learning curve.** Providing technical support during the transition to the new appliances is essential. Learning to use the multifunctional electric pot, accurately estimating cooking times, and overcoming initial hesitancy about using the new appliances requires time and sustained support.
- 3. Appliance costs as a barrier to access.** The project would have been difficult to implement if participants had not been provided the appliances free of charge. Although both appliances generated strong interest among other families in the two communities, the cost of acquiring them remains a significant barrier to their use. Scaling this type of intervention will require exploring installment financing or microcredit schemes.
- 4. Short-term health improvements.** Moving away from firewood led to significant health benefits, according to the participants. Although the pilot did not include a specific clinical assessment of health impacts, the surveys showed that the vast majority of participants reported improvements in their own health and that of their families both at project completion and 18 months later. The reported benefits included fewer medical visits and nebulizer treatments, as well as fewer coughs, episodes of eye irritation, headaches, burns, and neck and back pain, the latter associated with carrying firewood.
- 5. Influence of the environment and household conditions.** Each household's environmental conditions and infrastructure affected how the appliances functioned. Some appliances developed faults due to dust buildup or insects getting inside them. These factors need to be taken into account, and users need to be given clear guidelines on use, including how to store the appliances after use and preventive measures to keep insects out of the kitchen.
- 6. Repair and maintenance issues.** Several participants attempted to repair broken electric pots after the project ended. However, high repair costs and the lack of local technical services prevented them from doing so. For larger-scale interventions to be effective, the availability of spare parts and repair and maintenance services needs to be considered to ensure users have adequate support after warranties expire.
- 7. Greater durability of induction stoves.** The induction stoves responded better to the environmental conditions in the two communities. All of these appliances were still functioning properly without any issues 18 months after project completion. In contrast, 11 of the multifunctional electric pots had stopped working and could not be repaired.

8. Ongoing use of traditional practices and “clean stacking.” During the project, a “clean stacking” pattern emerged, with electric appliances gradually replacing firewood in daily use. However, despite the time savings and benefits associated with the new appliances, few participants chose to get rid of their wood-burning stoves altogether, instead reserving them for special occasions such as large family gatherings, when traditional cooking practices are revived.

9. Evaluation of the size and functionality of the appliances. The size of the multifunctional electric pots (5 liters) meant that they were of limited use for larger households. Some families who only received an electric pot had difficulty boiling water. To address this need, electric kettles were distributed during the final month of the project, thereby avoiding the use of the pot for this task. Such complementary appliances are relatively cheap and help reduce wear and tear on the pot, thus extending its useful life.

10. Behavior changes associated with time savings. The time saved by the new technologies led to behavior changes. The women who made tortillas at home did so because they thought it was cheaper than buying them. However, their calculation did not factor in the value of the time they spent making tortillas rather than engaging in other income-generating activities. Once they realized how much time they would save and the opportunities these savings would bring, most chose to continue buying tortillas after the project ended.

11. Strengthening tortilla enterprises. The involvement of local tortilla makers in the project revealed how precarious and low-income this activity is. In practice, the low cost of the tortilla makers’ labor effectively subsidizes tortilla prices. Although the project improved their working conditions by providing vendors with utensils and LPG-fueled griddles and burners and by helping install them, future interventions should include measures to strengthen the economic sustainability of these enterprises.

12. Engagement of multiple stakeholders. The transition to clean electric cooking technologies requires coordinated action by multiple stakeholders. In this regard, collaboration with local NGO Fundación Solar was essential, given its experience working with the participating communities and its knowledge of the sector. Partnering with EEGSA was also key to assess real changes in electricity consumption and expenditure. Engaging with stakeholders like these could help lower the cost of induction stoves and multifunctional electric pots when these are distributed at scale.

13. Continuous local support to participants. Another factor that was fundamental to the project’s success was hiring a local coordinator in each community to visit all participating households every week, answer questions, and ensure that the appliances were functioning properly.



Annex

Tables from the one-month survey

TABLE 11 Reported benefits of cooking with electricity in both communities

Reported benefits of cooking with electricity	San Juan del Obispo	Santa Cruz Chínautla	Average
Faster cooking	25	29	27
Cost savings	9	11	10
Reduced LPG consumption	3	3	3
More free time	15	1	8
No need to monitor while cooking	9	9	9
Easier to use	3	4	3.5
Keeps food warm	3	0	1.5
No need to gather firewood	2	2	2
Food does not stick to the pot or dry out	2	0	1
No smoke	0	4	2
Lower risk of accidents	0	3	1.5
Looks good in the kitchen	0	3	1.5

Note: respondents could provide multiple responses.

TABLE 12 Use of time freed up by the adoption of the electric pot/induction stove, both communities

What do participants do with the time they save?	San Juan del Obispo	Santa Cruz Chínautla
Work or income-generating activities	24	28
More time with children/grandchildren	16	14
Leisure activities	16	12
Household tasks	11	7
Others	2	0
Households reporting a change in roles in relation to cooking activities	10	6

Note: respondents could provide multiple responses.

TABLE 13 Reasons for recommending the multifunctional electric pot, both communities

Why would you recommend the pot?	San Juan del Obispo	Santa Cruz Chinautla
Functionality (fast, easy, practical)	7	19
Health and safety	0	3
Supports women (reduces effort)	2	6
Cost-effective	1	4
Looks good	0	13
Only stated that they would recommend it without saying why	30	0

TABLE 14 Main concerns reported by participants when using the appliance, both communities

Participants' concerns	San Juan del Obispo	Santa Cruz Chinautla
Damaging the appliance	1	8
Fear that the appliance would be taken away	0	4
The electricity bill would increase substantially	9	4
Being burned by steam	1	0
Fear of the multifunctional pot	6	0
The food would burn	0	1



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