FINAL REPORT

Scaling Up Demand for LPG in Guatemala:

Motivators, Barriers and Opportunities

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EXECUTIVE SUMMARY

NOTE: The default conversion used throughout the report is US$ 1 = GTQ 7.5

Study goal and objectives

The goal of the study is to facilitate Liquefied Petroleum Gas (LPG) scale-up among Guatemalan households with easy access to LPG. To reach this goal, the study pursues two objectives:

1. Identify key motivators for LPG use among urban and peri-urban households already using LPG.
2. Explore ways corporate and institutional programs can facilitate LPG adoption and scale-up among employees.

Main findings of the focus groups

Understanding LPG users' preferences and experiences with LPG for cooking is critical for broadening LPG use among urban and peri-urban households. A series of 10 focus groups was conducted in various locations in and around urban areas to better understand their point of view.

Key barriers to the transition to LPG of urban and peri-urban households are:

1. Safety concerns and poor quality LPG cylinders
2. Reputation of LPG retailers and suppliers
3. Lack of knowledge on how to cook with LPG
4. Lack of skill on how to use a pressure cooker, which is essential for cooking foods like beans that take a long time
5. Lack of easy cost comparisons between LPG and firewood cooking.

In terms of motivators, numerous and powerful benefits are associated with LPG: easy, practical, cleaner and faster than firewood. Higher income, education and paid work are associated with LPG adoption but are not a pre-condition for exclusive LPG use. Health and environmental benefits are acknowledged by households but are not key to LPG preference. Taste, access to LPG refills and the up-front cost of LPG cylinder and stove are not barriers to LPG use. Taste may persist as a barrier to LPG *adoption* based on non-users' *belief* that the food will taste different. In that sense, personal experience of LPG use is important to modify preconceived notions. A smaller cylinder would be considered relevant only as an "emergency reserve" by LPG users.

Characteristics of LPG users participating in the focus groups are as follows. LPG is used in households with a wide range of incomes, including those below the poverty line. Households are quite resilient to price volatility in both directions (increase/decrease). In lower income households, income instability combined with volatile LPG prices pose a more significant barrier than low income. The desire for the cylinder to last as long as possible contributes to continued reliance on firewood, especially when a large quantity of food must be cooked. Moreover, firewood continues to pay a role as an emergency source of energy when LPG is unavailable for technical or economic reasons.

Corporate Social Responsibility: opportunities for employers

Two key factors drive the idea of involving employers and institutions in the promotion of clean fuels and technologies, specifically LPG: Employers represent the potential to reach a large number of families easily through their

employees. Moreover, employers may facilitate employee purchase of LPG stoves and cylinders, thus removing a financial barrier for LPG adoption.

Three complementary types of activities could be envisioned for employers:

1. **Research and analysis:** assessment of employees' situations, monitoring of impacts.
2. **Raising awareness and building capacity** of employees.
3. **Facilitating stove and cylinder purchases.**

Clean cookstoves activities could be integrated in the JUNTOS Program, part of CentraRSE activities since 2014 (CentraRSE is the Guatemala Center for Corporate Social Responsibility). The program is focused on improving the quality of life of employees. Employers of the food industry sector may be interested since cooking is part of their professional activities. The LPG sector is also of interest since employers provide LPG cylinders to their employees but do not know if employees continue to cook with multiple fuels.

LPG consumption and organization of the sector in Guatemala

In 2011 LPG was used, alone or with other energy sources, in 1.4 million households, representing 70% of urban households (1.1 million) and 19% of rural households (0.3 million). National LPG consumption increases by 3 to 4% per year, but firewood consumption increases faster. Roughly half a million urban households have not yet adopted LPG.

LPG availability is not a barrier to consumption in urban and peri-urban areas. However, household use of multiple fuel types (fuel stacking) is prevalent even in urban areas.

Income does not strongly affect the amount of LPG consumed by households. Gas consumption is not closely correlated to price. Seasonal weather (rain) has a stronger impact on consumption than price.

The LPG industry is dominated by two large companies: ZETA and TOMZA gas. The most common cylinder size is 25 lb. Cylinder distribution is based on a centralized filling system, with consumers trading empty cylinders for full ones through neighborhood retailers. Around 3 million cylinders are in the market. The number of cylinders inspected annually represents a marginal part of total cylinders in the market. **Consumers routinely complain about low-quality, damaged and leaky cylinders.** Most stakeholders acknowledged the need for a cylinder inventory and removal of poor quality cylinders from circulation.

Cooking experiment

When used exclusively, a 25 lb LPG cylinder lasted 17 days, or 90 hours of cooking time, in a family of 3 adults and 1 child. The LPG cylinder weighed only 20 lbs. but was expected to weight 25 lbs. Cooking for 17 days with firewood exclusively totaled 35 more hours of cooking than with LPG (40% more), and GTQ38 (US$ 5) more (32% more) than with LPG.

Intervention avenues

A four-pillar strategy is proposed to accelerate the transition to exclusive LPG use in households cooking with multiple fuels, including LPG; and to promote adoption of LPG by households with stable incomes and cooking with purchased firewood.

- **Consumer information and marketing** on 1) the benefits of clean cookstoves and fuels, 2) cooking practices with LPG, 3) cooking cost analysis, 4) safe LPG handling for consumers and retailers.
- **Facilitate stove and cylinder purchase** in order to give non-users the opportunity to experience the benefits of LPG: to develop consumer finance options through employers, to promote a smaller cylinder, and to offer a free-trial period.
- **Regulation and review of LPG cylinders** to guarantee cylinder quality.
- **Engagement of industry and government** to recognize and act on their mutual interest in growing the market for clean stoves.

Changing deeply ingrained habits and long-held beliefs may take time and require a longer-term process with repeated messages focused on specific consumer groups.

1 OBJECTIVES OF THE STUDY

According to the International Energy Agency[1], nearly 2.7 billion people depended on burning biomass for cooking in 2012. This number is not expected to decrease without substantial change in energy policies. The World Health Organization[2] (WHO) estimates that over 4 million people die prematurely from illness attributable to household air pollution (HAP) from burning solid fuels and inefficient cooking technologies, and that more than half of all premature deaths among children under age 5 are the result of pneumonia caused by particulate matter (soot) inhaled from cooking smoke. In addition to these health impacts, inefficient fuels and cooking technologies impose a heavy burden on development, due to the time and energy required to gather biomass, mostly by women and children, and the environmental impacts of its consumption.

Around the world, efforts are underway to disseminate clean-burning stoves and fuels, a key pillar of sustainable energy access for all. Liquefied Petroleum Gas (LPG) is one such fuel. Its advantages include portability, high energy content, and combustion with few pollutants. LPG is not without disadvantages, such as high up-front cost and socio-cultural factors like incompatibility with slow-cooking foods (beans, nixtamal). There is significant untapped potential for scaling up LPG as a cooking fuel in middle- and low-income countries, with an appropriate policy and regulatory environment.

In Guatemala, about 70% of urban households use LPG for cooking, compared to only 19% of rural households. Availability is not a barrier to LPG use in most urban and peri-urban areas. Even in urban areas, however, over half of LPG users also continue to cook with firewood. The difference in household consumption of LPG across income levels is not substantial, which suggests that availability and affordability are not the only determinants of fuel choice.

Households will enjoy the health benefits of LPG only when it is the primary fuel for cooking. Gaining a better understanding of the drivers for reliance on LPG alone versus LPG and firewood is critical for motivating households to complete the transition from biomass to clean fuel. In this context, the main focus of the study is to understand the behavior of LPG users *based on their own experience*.

The **goal** of the study is to facilitate LPG scale-up among Guatemalan households with easy access to LPG. To reach this goal, the study pursues two objectives:

1. Identify key motivators for LPG use among households in urban and peri-urban areas already using LPG. This also includes understanding the factors that impede LPG users from cooking exclusively with this fuel. Possible factors include economic, socio-cultural and technical barriers.
2. Explore ways corporations and institutions can facilitate LPG adoption and scale-up among employees.

The work for this report was based on primary and secondary research: national statistics, individual meetings with national stakeholders (see Appendix 1) and 10 focus groups with 61 women, most of whom use LPG as their primary or secondary source for cooking.

[1] World Energy Outlook (WEO) 2014 - Traditional use of biomass database. http://www.worldenergyoutlook.org/resources/energydevelopment/energyaccessdatabase/

[2] World Health Organization. 2014. Household air pollution and health. http://www.who.int/mediacentre/factsheets/fs292/en/

2 FOCUS GROUPS

Knowing LPG users' preferences and experiences with LPG for cooking is crucial to understanding the key factors for broadening use among urban and peri-urban households. A series of 10 focus groups was conducted in various locations in and around urban areas to better understand their point of view.

KEY FINDINGS

Key barriers to the transition to LPG of urban and peri-urban households

- Safety concerns and poor quality LPG cylinders.
- Reputation of LPG retailers and suppliers.
- Lack of knowledge of how to cook with LPG.
- Lack of skill on how to use a pressure cooker, which is essential for cooking foods like beans that take a long time.
- Lack of easy cost comparisons between LPG and firewood cooking.

Strong and weak motivators

- Numerous and powerful benefits are associated with LPG: easy, practical, cleaner and faster than firewood.
- Personal experience is important to modify preconceived notions about LPG.
- Higher income, education and paid work are associated with LPG adoption but are not a pre-condition.
- Health and environmental benefits are acknowledged by households but are not key to LPG preference.

Non-issues

- Taste, access to LPG refills and up-front cost of LPG cylinder and stove are not a barrier.
- A smaller cylinder would only be considered useful as an emergency reserve.

Characteristics of LPG users

- LPG is used in households with a wide range of incomes, including those below the poverty line.
- Households are quite resilient to price volatility in both directions (increase/decrease).
- In lower income households, income instability combined with volatile LPG prices pose a more significant barrier than low income alone.
- The desire for the cylinder to last as long as possible contributes to continued reliance on firewood, especially when a large quantity of food must be cooked. Moreover, firewood continues to play a role as an emergency source of energy when LPG is unavailable for technical or economic reasons.
- A large majority of LPG users cook rice and pasta, *atole* (drinks), coffee, soups and meat exclusively with LPG. About half cook beans with LPG.

2.1 Methodology

2.1.1 Focus group discussion as a tool for qualitative research

Quantitative research focuses on numbers and statistics. Qualitative research investigates the reasons behind people's decisions. Focus groups gather together six to ten people to discuss a specific topic of interest guided by a

facilitator. **Focus group discussions provide more in-depth, personal and qualitative insights** into a topic than number-driven surveys or polls. They help us describe and understand people's opinions, experiences and attitudes. Discussion among participants also provides insight into how a group thinks about an issue, the range of opinion and ideas, and variations in beliefs and experiences. A homogeneous group is preferred to a diverse one to reduce inhibition and improve the quality of the discussion.

Limits of focus group discussion include the difficulty in extrapolating the feedback from one group to the larger population. Multiple focus groups help to overcome this limitation. The researcher knows a sufficient number of focus groups has been conducted (with the same set of questions) when few new ideas come up. Participants who dominate the discussion and the way questions are phrased are examples of factors that may influence the discussion and bias conclusions. To prevent this, an experienced facilitator to handle these situations is essential. Finally, personal and sensitive topics must be avoided.

Duration of focus group discussion is usually limited to 60 to 90 minutes, starting with engagement questions to make participants comfortable, continuing with exploration questions, and concluding with exit questions to verify that nothing was left out.

2.1.2 Methodology proposed in the study

Ten focus groups with 5 to 7 people were held in 5 locations where LPG is used by a relatively large proportion of households *(MAP 2.1. and Appendix 2)*: Villa Nueva (Guatemala), Sanarate (El Progreso), Escuintla (Escuintla), Santa Apolonia (Chimaltenango) and Ciudad Vieja (Sacatepéquez).

A local leader was identified in each location to be responsible for participant selection following the Consultant's instructions. Household selection criteria were twofold: 1) residence in urban or peri-urban area; and 2) reliance on LPG as the primary or secondary cooking fuel[3]. Household income was not a selection criteria for practical reasons and to better understand how income impacts LPG usage. Only women participated in the focus groups[4].

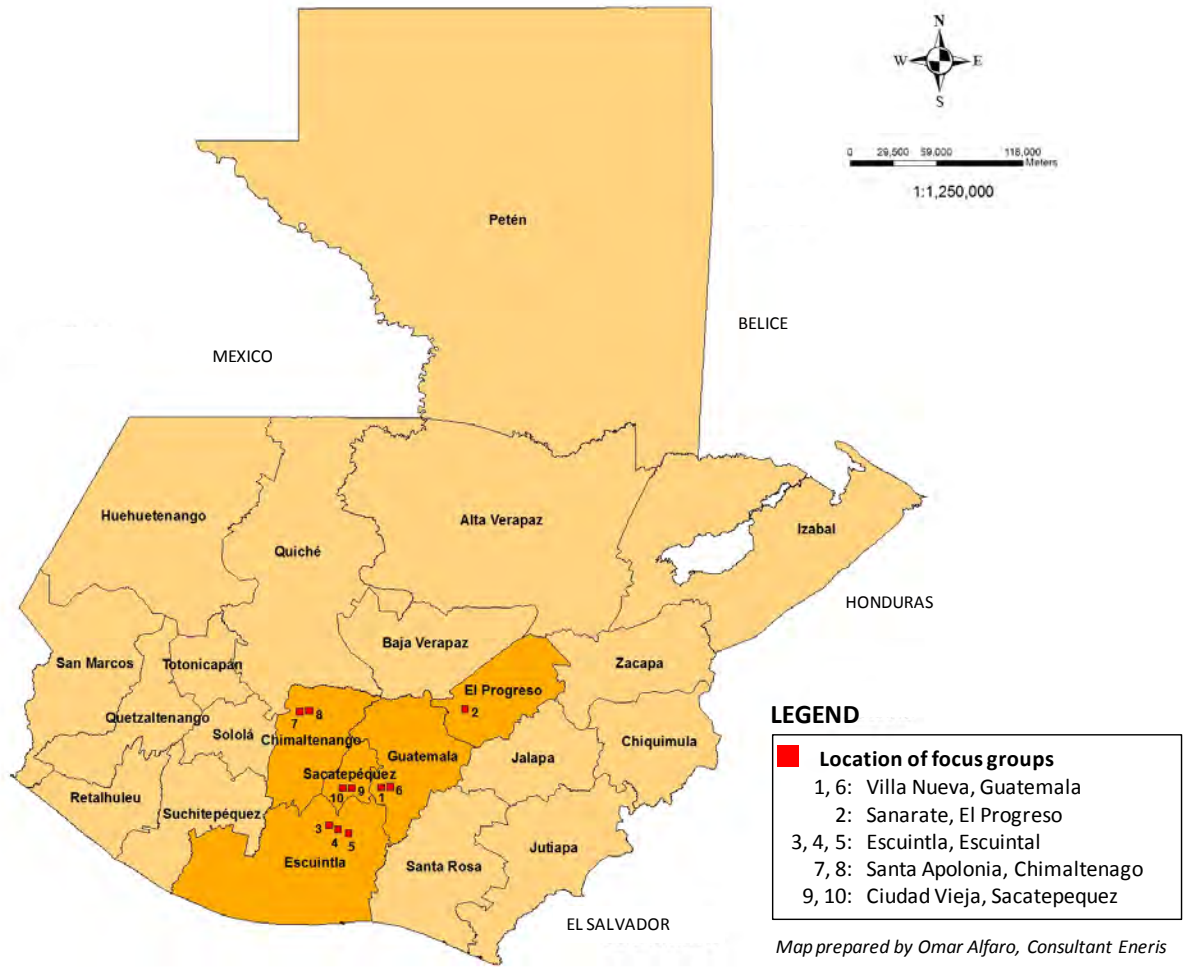
Two questionnaires were prepared for each focus group (see *Appendix 3*):

- **Focus group discussion guide** This questionnaire included 15 questions that covered current cooking practices, satisfaction with LPG for cooking, consumption, safety and security, and market dynamics.
- **Individual written questionnaire** completed by each participant, included information on household characteristics and some demographic information. The responses were confidential. This information allowed us to characterize the participants in terms of age, expenditures, income etc.

[3] A few women not using LPG were accepted as participants of the focus groups with the objective to contrast discussions with their perceptions and reactions when listening to LPG users

[4] Although men may have provided different answers to some of the questions (particularly questions related to security), the focus group outcomes suggest that gender was a determining factor in the initial decision to buy a stove and cylinder and to use LPG.

MAP 2.1. Focus Group Locations



Map prepared by Omar Alfaro, Consultant Eneris

2.2 Characteristics of the households[5]

NOTE: The default conversion used throughout the report is US$ 1 = GTQ 7.5

LPG is used in households with a wide range of incomes

For a large majority of the households interviewed, LPG was either the only or the primary cooking fuel (*FIGURE 2.1*). A few families used LPG as a secondary fuel source, and some only used firewood.

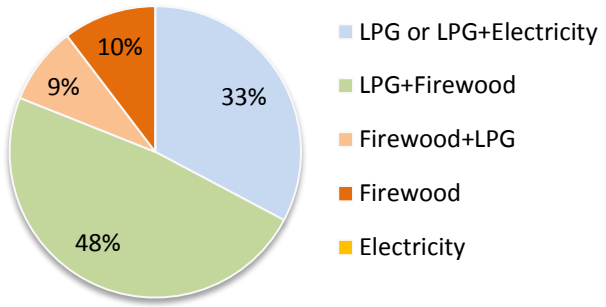
Most households self-reported their overall monthly expenditures as less than GTQ 3,000 (US$ 400), with many spending less than GTQ 2,500 (US$ 300) per month (*FIGURE 2.2*)[6].

Two thirds of households lived below the poverty line. The remaining households are divided between those living in extreme

[5] In Part 3 of the report, "households" refers to household represented in the focus groups.

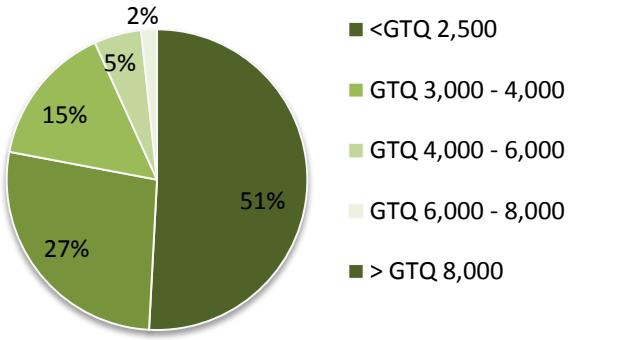
[6] This information was obtained in the confidential questionnaire. It was self-declared and not verified.

Figure 2.1. Household Fuel Type



*In the case of multiple fuel types, the primary fuel is named first.

Figure 2.2. Monthly Expenditures by Household*



*Self-declared (not verified)

poverty and those living above the poverty line. (This observation is consistent with the ENCOVI statistics presented in Section 3 of the report.) Among focus group participants, LPG use was not limited to higher income households. It was also a primary fuel source among lower economic segments in urban and peri-urban areas.

Higher income helps, but is not essential to transition to LPG

Household expenditures[7] represented in the focus groups range from less than GTQ 2,000 to 8,000 per month (US$ 260 to $1,060)[8]. All households with monthly expenditures above GTQ 5,000 (US$ 660)[9] used LPG exclusively. High expenditure level, however, is not a pre-condition for exclusive use of LPG. Some lower-expenditure households also used LPG exclusively.

For lower income households, income instability combined with volatile LPG prices poses a more significant barrier than low income alone

All households that did not use LPG had monthly expenditures below GTQ 2,500 (US$ 330)[10]. However, many participants with similar expenditures reported using LPG. In other words, low income was not a systematic barrier to LPG use. The absence of regular income, however, was. Income instability was a barrier for lower income households because of the high cost of an LPG cylinder. Households without stable incomes struggled to maintain a budget that allows them to purchase LPG on a regular basis. In these cases, firewood will continue to play a role as an emergency source of energy when LPG is unavailable for technical or economic reasons. Households with unstable incomes were also highly sensitive to the volatility of the LPG price.

Paid employment and education help, but are not pre-conditions for LPG use

Household occupations for women included housewife, vendor (food, clothes), housekeeper, teacher, nurse, and for men, driver, electrician, gardener, mason, security guard, janitor and technician. Work outside the home increased the value women assign to LPG (fast and practical) given their reduced time for cooking. Working outside the house was also an opportunity for women to learn from others

[7] Expenditures were used as a proxy of the income level of households.

[8] See previous footnotes.

[9] See previous footnotes.

[10] See previous footnotes.

about LPG cooking practices and safe behaviors. However, working outside the home was not a necessary condition for LPG adoption. Many women without outside employment also valued these same benefits.

Participant education levels ranged from primary school (4th year) to bachelor's degree ("*bachiller*"). Women with higher educational levels tended to use LPG, but this was not essential for LPG use. Some women with lower educational levels also used LPG as their primary source of cooking energy. As proposed by Kojima et al. (2011)[11], education could be a proxy for awareness of LPG benefits and costs. Awareness-raising activities, especially about the costs of cooking with LPG, could be effective in reinforcing its use.

Indigenous groups: more analysis needed

The analysis of indigenous women was not possible due to the limited number of indigenous participants interviewed, despite participation of an indigenous woman as a group leader. The paucity of indigenous participants may reflect the lower rate of LPG use in indigenous households. Cultural factors, such as the symbolic importance of fire, economic status, financial stability, and language constraints merit further exploration.

2.3 Cooking practices

Easy, practical, fast: many powerful benefits associated with LPG

All focus group participants describe cooking with LPG as easy, practical, necessary, faster, cleaner, and indispensable. Other benefits include ease of tending and adjusting the flame, the absence of smoke and its odor, and the ease of lighting the stove compared with firewood—a task that can take up to 20 minutes with wet wood.

Some spontaneous declarations illustrate participants' appreciation of LPG:[12]

> *"Si yo no tengo gas en mi casa ciento que me muero al cocinar".*
> ***"Cooking without LPG would kill me".***
>
> *"Uso gas porque no hay otra cosa mejor para cocinar".*
> ***"I use LPG because there is no better option for cooking".***
>
> *"Ya sabemos cuánto tiempo le tenemos que dar a nuestras comidas al momento de estarse cocinando con el gas, cosa que con la leña tendríamos que estar destapando las ollas para observar si ya se cosió o no la comida".*
> ***"We know how much time is needed to cook with LPG. When cooking with firewood, we must regularly check and taste the food".***

Consumers also shared a few slogans to promote LPG:

> *El gas, más rápido para cocinar."*
> ***"LPG makes cooking faster".***
>
> *"El gas, cómpralo y veras que rinde más [que la leña]."*
> ***"Buy LPG, and you will see that it performs much better [than firewood]".***
>
> *"Compra gas y ya verás que tu salud mejoraras".*
> ***"Buy LPG, and your health will improve".***

[11] Kojima M, Bacon R and Zhou X. 2011. Who uses bottled gas? Evidence from households in developing countries. Policy Research Working Paper 5731. World Bank, Sustainable Energy Dept, Oil, Gas, Mining Unit, USA, 61 p.

[12] Some spontaneous declarations of the participants illustrate their appreciation. They were chosen because of their relevant representation of what most of the women said.

Households that use LPG cut other expenses when money was tight

Women reported if there was a reduction in household income they would sacrifice other purchases (clothes, phone, time of TV, etc.), before cutting back on LPG as they considered it too essential. This demonstrates how important LPG is to households that already consume it. Once a woman has tried LPG, she usually wants to continue using it based on her direct experience of its benefits.

Consumer said:

> *"Entre el servicio que brinda el médico y comprar gas, prefiero comprar gas".*
>
> ***"If I have to choose between going to my doctor and buying gas, I choose gas!"***

Taste, a false barrier[13]

Many stakeholders expect taste to be a key barrier to LPG use. However, participants reported that taste is not a barrier to its use. Since such a unanimous finding was unexpected, the subject was explored though different questions, direct and indirect, at different moments of the discussion. The answer was consistent across all groups. Participants acknowledged that food cooked on LPG may taste *slightly different* than food cooked on a fire, but all agreed that ease, speed and convenience of LPG are much more important considerations overall. Moreover, if needed, participants said they know how to use spices to make the food tastier.

Several participants also reported that the cooking vessel (e.g., clay cooker) has more impact on taste and texture than the energy source does. For example, when cooking beans, clay pots make the liquid thicker and tastier with slow cooking. With less evaporation, there is no need to add water during cooking compared with other pots and this is appreciated by the participants.

Consumer said:

> *"Ni cuenta se da mi familia, si hago los frijoles con olla de barro o si los hago con gas, no lo distinguen, entonces nosotras somos las que elegimos".*
>
> ***"None of my family notices if I cook with LPG or firewood; we cooks are the ones who decide".***
>
> *"El sabor que da la leña no importa porque el sazón nosotras se lo ponemos a la comida".*
>
> ***"The taste that firewood gives is not an issue. We know how to make food tasty with spices".***

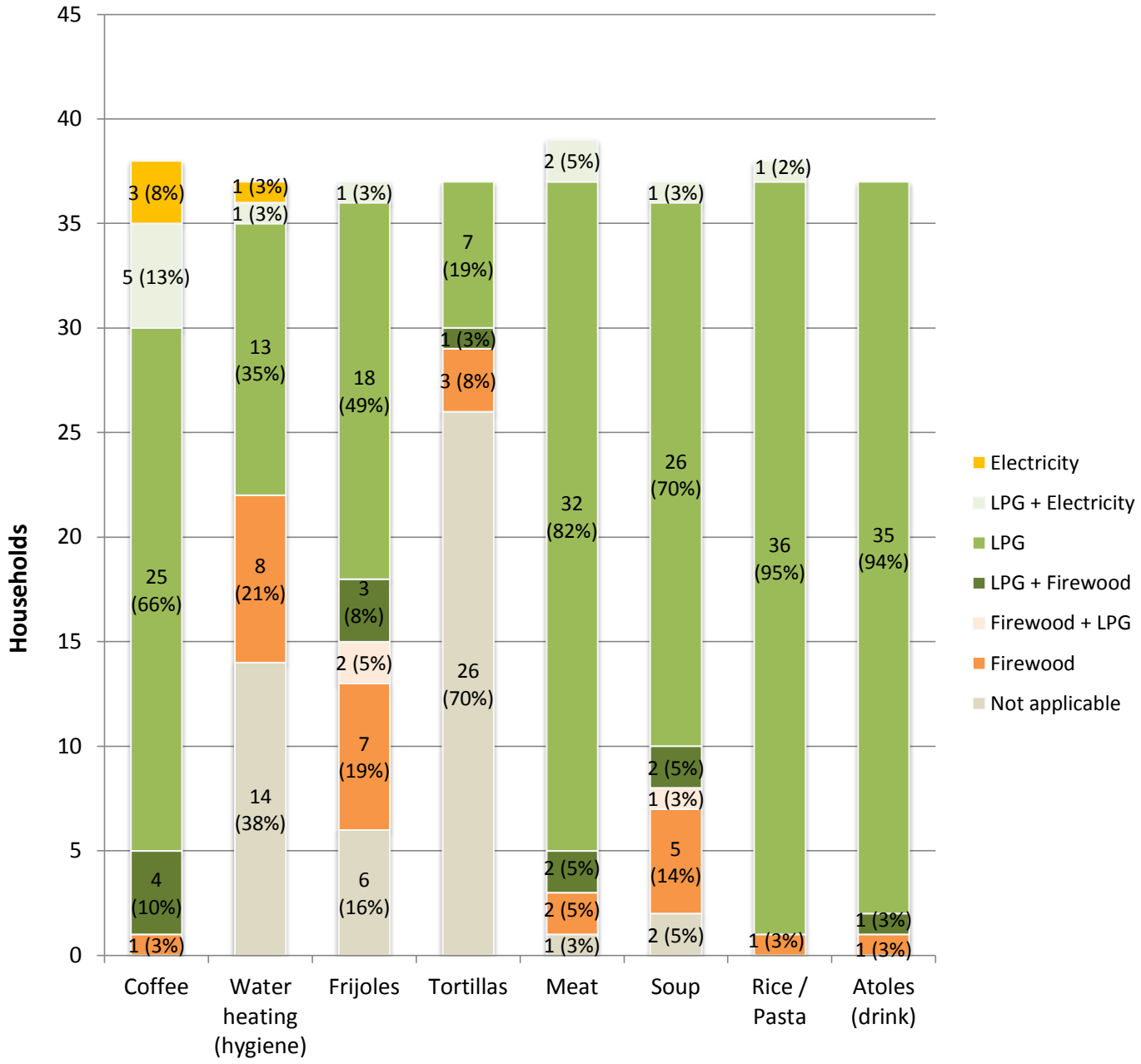
However, taste may persist as a barrier to LPG *adoption* based on non-users *belief* that the food will taste different. Although the study's objective was not to identify the drivers of LPG adoption, these discussions provided insight on early-stage adoption of LPG. Among them, *personal experience is important to change preconceived notions about LPG such as taste*.

Pressure cooker use, LPG cooking skills and cost comparisons between LPG and wood are keys to wider use

Most households used LPG primarily for cooking and not for heating bath water (*FIGURE 2.3*). A large majority of LPG users cooked rice and pasta, *atole* (drinks), coffee, soups and meat exclusively with LPG. About half the participants cooked beans with LPG. A large proportion bought tortillas rather than cook them, which gets around the problem of slow-cooking *nixtamal* (tortilla dough). Households

[13] Classified by households as one of least important barriers to LPG use.

Figure 3.3 Fuel Uses for Specific Cooking and Heating Activities



Percentages represent the share of households using a certain energy sources, or a mix of them, for each of the proposed water heating and cooking activities. They are based on the answers provided by all the women during the discussions of the focus groups.

that prepare tortillas often use LPG to grill them.

Discussions in focus groups emphasized the following factors.

The pressure cooker is an answer to the extended cooking time barrier: Women usually cook dishes that take a long time, such as beans and *nixtamal* (hominy kernels for tortilla dough) with firewood *(FIGURE 2.3)* because these foods consume a large quantity of LPG. When made at home, tortillas may be prepared with both firewood and gas, wood for *nixtamal* and gas for tortillas, depending on the household. For cooking traditional staples like beans and tortillas, pressure cookers are critical for reducing cooking time and LPG consumption**.** The reasons some participants do not use a pressure cooker include fear and uncertainty how to use it properly (e.g. without risk of burning when opening it). Several participants had heard of bad experiences with pressure cookers. Taste was not a reported as a reason for non-use.

Need to cook a large quantity of food: The desire for the cylinder to last as long as possible remains a dominant reason for continued reliance on firewood. When many people are invited over for Christmas or other celebrations, firewood continues to be the preferred fuel. Participants believed that cooking these dishes with LPG would empty their cylinder too quickly. In such cases, participants were not comparing the actual cost of firewood with gas. Most assumed that LPG costs more than firewood.it Without a way to measure how much gas is consumed by a specific meal, there is no way to compare the cost of cooking with gas to that of wood.

One consumer said:

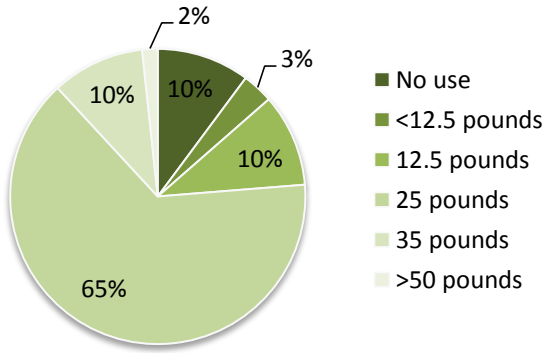
> *"Con el gas cocino una comida a la vez, en cambio en mi estufa de plancha (esta estufa no es ahorradora) con la misma leña cocino varios alimentos y en el mismo tiempo".*
>
> ***"I cook only one dish at a time with my LPG stove, while I can cook several dishes at the same time with my firewood stove".***

Skill and experience cooking with LPG help women overcome reliance on firewood: Among the advantages participants attributed to the *plancha* stove are multiple burners and lengthy heat retention which women perceives as more efficient than LPG. While LPG also enables them to heat several pots at once, the similarities end there. LPG and firewood require very different cooking practices. Participants have learned to cook with firewood over their lifetime. While particpants appreciate LPG's stability and easy adjustment, they lack familiarity with the fuel, including the knowledge and skill to cook with it. Two examples illustrate the need to adapt cooking behaviors: in an attempt to conserve LPG, one woman asked all members of her household to eat at the same time so she wouldn't have to reheat the food. Meanwhile, she covered each pot with a towel to reduce vapor and heat loss. During the focus groups, when some participants heard others complain about how much LPG some dishes consumed, others suddenly realized that they were using their stove incorrectly, as they were cooking on a high flame for too long and therefore wasting LPG.

Cooking habits: Some participants who understood the benefits of using LPG reported that the only reason they continue to cook some foods with firewood was habit.

Changing deeply ingrained habits takes time. Changing long-held beliefs about the cost of cooking with LPG may require a more focussed communication process with repeated messages about the economics of using gas versus wood.

Figure 2.4. Monthly LPG Consumption

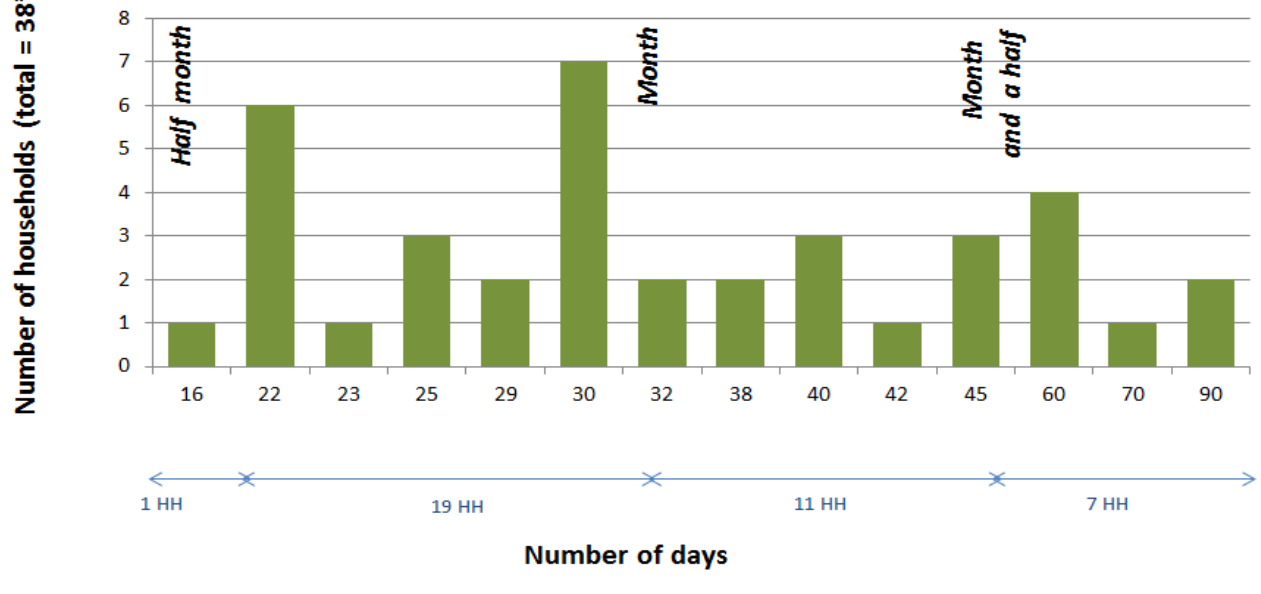


Expectation that a 25 lb. cylinder should last a month is a myth that needs to be overcome

A large majority of households use a 25 lb. cylinder. Just three out of the fifty-five households used a 35 lb. cylinder. Most users said their family consumed one cylinder per month (*FIGURE 2.4*). This confirms trends observed at the national level: national statistics show dominant LPG consumption of around 25 lb. across households. Households with the highest LPG consumption used LPG for residential and commercial activities (e.g., sale of food, tortillas).

However, when participants were asked how long a 25 lb. cylinder *actually* lasts, their answers varied from 16 to 90 days. Half reported between 22 and 30 days and half reported 30+ days, depending on household size and cooking habits (*FIGURE 2.5*). Most women reported that they replace the cylinder as soon as it is empty rather than cooking with firewood until the end of the month.

Figure 2.5. Duration of the 25 Lb. LPG Cylinder



* Only 38 households because information was not gathered in all focus groups

A strong belief persists that a 25 lb. cylinder *"should"* last one month. If a cylinder lasted less than a month, some concluded that cooking with gas uses too much fuel. Monthly household budgeting contributed to this situation. Some participants explained that they have been budgeting for one cylinder per month ever since they started using LPG—in some cases for more than 20 years! Two possible significant impacts should be considered:

Statistical impact: The ENCOVI surveys ask *"What quantity of LPG do you consume each month?"* The phrasing of this question may bias the response. Asking instead about the number of days a 25 lb. cylinder lasts would provide more precise and reliable answers.

Behavior impact: The expectation that a cylinder should last for a month may create a barrier for greater LPG consumption, causing resistance to change.

Households that regularly consumed more than one 25 lb. cylinder per month may not consider using a 35 lb. one because: 1) the higher cost a bigger cylinder; 2) the fluctuating costs and unstable LPG prices; and, 3) the difficulty finding such a cylinder. The fact that LPG is no less expensive when purchased in larger quantities undermines the incentive to purchase bigger cylinders. The option to trade an empty 25 lb. cylinder for a 35 lb. one might provide households with an incentive to trade up.

Health, environment and aspiration

When asked about LPG's benefits over firewood, only a few LPG users spontaneously mentioned health and environmental benefits. When health and environmental impacts of LPG were proposed as possible benefits, LPG users acknowledged them and were able to elaborate on the benefits (e.g. prevents deforestation, better for the eyes). However, they did not consider them at all as factors in their decision to use either LPG or firewood.

Participants did not view gas stoves as "modern" or aspirational products. Rather, they considered LPG stoves a basic household need. A washing machine, on the other hand, was an aspirational product for these households. This could be explained by the fact that most participants adopted LPG many years ago: households certainly considered gas stove as a modern and aspirational product when they purchased it the first time. They now consider it to be an essential home appliance.

The nearly invisible improved biomass cookstoves

None of the participants use an improved biomass cookstove. Three quarters of the participants were unaware that improved biomass cookstoves exist. Among participants who were aware, most thought they were too expensive and were only willing to pay less than GTQ 700 (US$ 90) to buy one. When cooking with firewood, participants either cooked over open fires or on a stove with a metallic *plancha*.

2.4 Accessibility and affordability

Up-front cost of LPG cylinders and stoves was not a barrier to adoption

Stoves and cylinders were either received as a wedding gift or purchased. Half the participants paid in cash, and the other half paid with credit offered by sellers. Participants did not consider the upfront costs (around GTQ 350 or US$ 45 for the cylinder, GTQ 230 or US$ 30 for a two burner stove, GTQ 1,500 or US$ 200 for a stove with oven) to be a barrier to purchasing the LPG cylinder and stove. When comparing these costs to the product's

usefulness, women considered stoves and cylinders to be a household essential.

It may be argued that households that can afford the cost of LPG refills are capable of paying the start-up costs with some financial assistance or a payment plan if needed. Among participants who did not currently use LPG but had a stable income, factors like the price of a LPG start-up package and safety concerns were the major obstacles.

For households in urban and peri-urban areas, access to LPG refills and repair was not a barrier. This situation is different in rural areas.

Biased perception of fuel costs

Few households had compared the actual cost of cooking with LPG to cooking with firewood. Those who had concluded that cooking with LPG is cheaper cook exclusively or almost exclusively with LPG.

Most participants considered cooking with LPG to be expensive because they perceived the single, large upfront cost of the LPG start-up package to be greater than several smaller expenses, such as the cost of purchasing firewood. These several smaller costs were viewed as more manageable and as having less impact on the household budget. However, some households believed that cooking with firewood was more expensive given its high price, especially during the rainy season. But few had been able to do a cost comparison of their own. Based on these findings, a two-part experiment was carried out to compare the costs of cooking with LPG and firewood fuel under real cooking conditions (see Appendix 4).

LPG price volatility: good resilience to higher prices especially among exclusive LPG households

After their initial reaction "*LPG is too expensive,*" participants were able to integrate LPG costs into their monthly budget, even with prices as high as GTQ 140. The price of LPG must be weighed against the degree of household reliance on the fuel. When prices rise, households that rely exclusively on LPG (highly dependent) said they would continue to cook with gas or increase their use of electricity. They were unwilling to lose the benefits of LPG and could afford the higher expense. Two participants also explained that they have no space in their house to cook with firewood. On the other hand, most households that use multiple fuels would reduce LPG use when the price of LPG increases.

In the event of increased prices, all users would seek more efficient cooking practices to continue using LPG as much as possible. Their priority is to continue LPG use even if the price increases.

LPG price volatility: inertia to change when prices decreases

During the study, the price of a 25 lb cylinder decreased from about GTQ 140 or US$ 19 (6 groups) to GTQ 92 or US$ 12 (4 groups). The possible consequences of this decrease were explored in focus groups and in a rapid survey of several LPG users who were not focus group participants. Respondents considered a fair price for 25 lb cylinder to be GTQ 100 - 120 (US$ 13 - $16). Nevertheless, households were slow to increase use of LPG when prices fell. They said they would replace firewood with LPG or reduce their use of firewood if they knew the price would stabilize in the "fair range" in the long term. In this case, the few participants who do not currently use LPG stated that they would be willing to try it.

Another obstacle to increasing LPG use is consumers' lack of confidence in the LPG sector overall. Historical volatility of LPG prices makes consumers suspicious about the reason behind these fluctuations. Most believe that when the price is low, refillers partially refill cylinders, reducing the price but requiring households to refill them more often. Price volatility and uncertain cost reduce consumer confidence in the LPG industry.

After 3-months of low LPG prices, little change in household use, except among those who compared costs

A decrease in the price of LPG during the study provided an opportunity to follow consumer behavior over 1-3 months' time. Participants in focus groups held one to three months after the price decreases confirmed that they did not change their cooking habits despite the lower LPG price.

Households who had made a careful comparison of the costs of LPG and firewood started cooking *nixtamal* and beans with LPG after prices remained low. These families were aware of the costs savings of LPG at this price compared to firewood. Amongst these families was a woman who prepares and sells tortillas from her home. She increased her profits by adopting LPG.

Interest in a smaller cylinder only as an emergency reserve

Participants did not find smaller cylinders appealing because they do not contain the quantity of gas needed by most households. Participants would consider purchasing a small cylinder only as an "emergency reserve" when the main cylinder is empty and the retailer cannot come right away. Very few households keep a second LPG cylinder for this purpose. Firewood is usually the emergency energy source.

Decision and economic power of women was not reported as an issue in these households

Gender issues and women's lack of decision-making power are frequent barriers to adoption of clean fuels and stoves. However, none of the participants reported difficulty in convincing their husbands to buy the stove and cylinder, even when the husband is the sole income provider. Researchers were surprised by this response and asked the question in different ways to validate the response. The same answer was consistent across all groups.

LPG cylinders in transport

2.5 Safety concerns and reputation of the sector

Safety concerns and poor-quality cylinders are linked[14]

Participants reported feeling unsafe using the LPG cylinder and stove, especially the oven. Most of the participants do not use the oven for this reason. Participants received no information or instructions on safe installation or use. Poor cylinder quality, damage and leakage all contribute to the poor impression users have of the LPG industry. Indeed, all participants agreed that cylinders were usually old and damaged. Most of them have heard cases of explosion, burns, and have

[14] Classified by households as one of the initial barriers to LPG use.

experienced leakages. These negative experiences reinforced mistrust and low confidence in retailers.

One non-user said

> *"No utilizo el gas por miedo a que les pase algo a mis hijos, ya que ellos son traviesos y pueda ser que explote el cilindro".*
>
> ***"I don't use gas because I'm afraid of something happening to my children, they are wild and the cylinder may explode."***

In principle, participants would like to be able to keep their own cylinder and refill it with the quantity of LPG they can afford. In practice, however, partially refilling cylinders would require a trip to the refill station rather than home delivery of a full tank.

Poor reputation of LPG retailers and suppliers[15]

Poor cylinder quality, partially-filled cylinders, leakage and LPG price volatility all contributed to consumer distrust of *expendios* (retailers) and LPG suppliers. As consumers, they felt taken advantage of and powerless to change the situation. In general, consumers were not willing to pay more for better service or quality cylinders. They believed that good service and quality cylinders should be included in the price. Some participants, however, were open to the idea of an extra Q10 to guarantee good service and cylinder quality.

Consumers said:

> *"Si compro el cilindro en las tiendas, me venden un cilindro nuevo, pero una vez vacío lo pierdo pues me lo van a cambiar por otro antiguo".*
>
> ***"If I buy the cylinder in the store, they sell me a new one, which I lose as soon as the cylinder is empty, since they will replace it with an old one".***
>
> "*La duración [del cilindro] depende de con que expendio se compre el cilindro, porque los expendios utilizan el gas, nos damos cuenta porque cuando nos venden el gas el sello o marchamo está manipulado*".
>
> ***"The duration [of the cylinder] depends on the retailer, since the retailers use some gas, we can see that the seal has been tampered with."***

The entire LPG supply chain is characterized by a deep lack of confidence among stakeholders: users distrust retailers and suppliers, retailers distrust suppliers, and suppliers distrust each other[16]. This situation is an important barrier to the development of the LPG market as a whole since confidence in different market segments is key to the sector's development[17].

Focus group at work

[15] Classified by households one of the initial barriers to LPG use.

[16] The LPG chain includes LPG importers, refillers (many of them are also importers), *expendios (*retailers) and finally the consumer.

[17] More discussions on this topic in: World LP Gas Association. 2014. Guidelines for the Development of Sustainable LPG Markets. Transitioning-Stage Markets. 36 p.

3 CORPORATE AND INSTITUTIONAL PROGRAMS

This section examines the potential role of Corporate Social Responsibility (CSR) programs to promote LPG use by employees of employers and institutions in Guatemala.

KEY FINDINGS

Three possible CSR strategies for employers

- Research and analysis: assessment of employees' situations, monitoring of impacts.
- Raising awareness and building capacity of employees and their families.
- Facilitating stove and cylinder purchase.

CentraRSE and other institutions

- CentraRSE is the Guatemala Center for Corporate Social Responsibility
- Clean cooking could be integrated in the JUNTOS Program which is focused on improving the quality of life of employees.
- Employers of the food industry sector may be interested since cooking is part of their professional activities.
- The LPG sector is also of interest since employers provide LPG cylinders to their employees but do not know if they continue cooking with multiple fuels.

3.1 CSR and clean cookstoves

Introduction to CSR

CSR refers to a business's activities, projects, programs and/or donations that further a social good without the expectation of direct financial gain[18]. CSR is expected to benefit organizations by enhancing their reputation and increasing financial performance by improving employee engagement, retention and skills. CSR activities may be motivated by philanthropy or by the goal of operating in a socially responsible way, taking into account both the financial/economic dimension in decision making as well as the ethical, social and environmental consequences. Social issues such as poverty and inequality play an increasing role in CSR activities.

Two perspectives: CSR programs for the community or employees

CSR programs offer a double perspective:

- **"External" focus:** These CSR programs focus on fund raising and contributing to projects *outside the employer or institution.* In its design and type of activities, external CSR is similar to the efforts of aid and development organizations.
- **"Internal" focus:** These CSR programs are *within the employer or institution*, focused on the employees through skill development, health programs, etc., and possibly on their families. This section focuses on the second perspective.

> ***"Employees are your resources. Anything you can do to change employees' lives, and make their lives***

[18] Definition provided by: United Nations Development Programme. 2014. Barriers and opportunities at the base of the pyramid. The Role of the Private Sector in Inclusive Development. 30p.

> ***better will, without a doubt, improve the company's productivity."***[19]
>
> - Mads Kjaer, principal owner of Kjaer Group A/S, a car export company, implemented a HIV/AIDS program for his employees.

Carbon finance, a successful approach for CSR programs focused on external communities

Carbon finance has succeeded in mobilizing significant funding for cookstove projects in external communities through CSR programs. Employers receive carbon credits in exchange for their investment in clean cooking. Demand for carbon offsets is split between offsets used by employers to comply with emission caps and offsets used to fulfill voluntary CSR targets. Climate Care (Uganda), UpEnergy (Africa, El Salvador, Nicaragua, and Mexico), Paradigm Project (Kenya, Ethiopia and Guatemala) are examples of cookstove programs funded through carbon finance.

Promotion of LPG for the poor in India with CSR funding

India, the first country to have CSR legislation, mandates that companies give 2% of their net profits to social development. Only CSR activities in India are taken into consideration, and activities meant exclusively for employees and their families do not qualify. CSR funds are used by the government to finance, amongst other programs, the sale of subsidised 5 kg. LPG cylinders to families living below the poverty line.

[19] ICEP and CODESPA. 2008. Business and Poverty: The global CSR case-book. How to develop global CSR strategies, manage risks and fi nd new opportunities. 262 p.

Promoting employee adoption and use of LPG

Two key factors drive the idea of involving employers and institutions in the promotion of clean fuels and technologies, specifically LPG [20]:

- **Employers have the potential to reach a large number of families easily through their employees.** Being able to access households is one of the main challenges in educating, raising awareness or modifying people's behaviors.
- **Employers may facilitate employee purchase of LPG stoves and cylinders**, thus removing a financial barrier for LPG adoption. [21]

Three complementary types of activities could be envisioned for employers:

- **Research and analysis**: Evaluation of household needs for clean cookstoves and fuels, and monitoring the impact of clean cooking on employee households (e.g., air quality, costs, benefits for the employers)
- **Raising awareness and building capacity:** Raise employee awareness of the inefficiencies and health impacts associated with cooking with firewood; present alternatives to cooking with firewood; educate employees in safe LPG cylinder and stove use and how to adapt cooking practices to LPG (e.g., using a pressure cooker, tips for cooking efficiently) by encouraging employees to share their experiences cooking with LPG; and develop and implement a

[20] Most of the ideas presented in this section may apply to clean fuels and cookstoves other than LPG .

[21] The objective is not to implement a capital subsidy for start-up cost but to find an appropriate financial arrangement to facilitate the payment of the start-up package by the employee.

practical cooking cost assessment analysis for households.

- **Facilitating stove and cylinder purchases:** Facilitate employee purchase and payment of the start-up package using salary deductions or from funds saved through employee-run cooperatives. This option requires a preliminary assessment to learn the current cooking practices of employees. The ongoing assessment in some employers of Guatemala within the JUNTOS program (see section 3.2.2) will provide insight into this. It is expected that employees living in urban and peri-urban areas already use LPG for cooking.

LPG stoves and cylinders

The employer or institution should have a lead role in these activities in order to develop and implement actions that align with their business practices and values. In other words, there is no "one-size-fits-all" CSR program. However all programs would share core principles.

3.2 CSR experiences and opportunities in Guatemala

3.2.1 Experiences from national stakeholders

With the objective of learning from current practices, this section presents a few examples of corporate and social responsibility activities implemented by Guatemalan employers, many of them involved in the gas sector.

ECOFILTRO—Water filter supplier

ECOFILTRO's CSR strategy includes two steps. First, ECOFILTRO installed water filters in the work areas so that employees could try them. Second, ECOFILTRO provided one filter to each employee. The cost of the filters was deducted from the employees' salaries, with no interest. Other employers have applied a similar approach with water filters. Employers that use this model typical include their logo on the water filter to advertise their contribution. ECOFILTRO considers this CSR strategy to be a minor one in their overall business model, compared to the large efforts needed for direct sales to NGOs or institutions which then disseminate the filters to households.

NIVI—LPG cylinder supplier

NIVI provides employees with up to 2 LPG cylinders with the option to complete payment over 6 months. Employees manage an internal savings fund which is quite common in about half of all Guatemalan employers. Employees of NIVI pay GTQ 5 to 15 (US$ 0.6 to $2) per month on a voluntary basis, depending on income. Ninety percent of employees participate. Using these funds, employees purchase items such as school supplies, glasses and large home appliances such as washing

machines at wholesale prices. NIVI provides support in managing these funds.

ZETAGAS—LPG supplier
ZETAGAS gives each employee a 30 lb. LPG cylinder refill. Moreover, ZETAGAS implements external CSR activities such as the following programs. The "*Cocina con Zeta Gas*" program in Villa Nueva teaches households how to cook with gas through demonstration activities. In the social program called "*Zeta Gas, Somos la Llama Ecológica*", ZETAGAS donates a stove and 25 lb. cylinder (approximately US$ 100), teaches participants how to cook with LPG, and promotes reforestation activities. Follow-up is expected to be done by local community groups (*Consejos Comunitarios de Desarrollo Urbano y Rural*).

SUPERCOCINAS—LPG stove supplier
Stoves are sold to employees at the industry price. In terms of external activities, SUPERCOCINAS donates stoves to schools to build confidence in the use of LPG. SUPERCOCINAS does not follow-up with the schools.

3.2.2 CentraRSE and the JUNTOS Program

CentraRSE was created in 2003 to support the adoption of CSR by Guatemalan employers. CentraRSE is a representative in Guatemala of the World Business Council for Sustainable Development (WBCSD). More than 100 employers are members of CentraRSE.

Activities of CentraRSE include:

- *IndicaRSE:* self-assessment tool based on CSR indicators.
- *CONVERTIRSE-2014*: 8th CSR conference of Central America organized in Guatemala.
- *Eco Eficiencia Empresarial*: collaborative platform to measure, understand and reduce the environmental impacts of business activities.
- *JUNTOS Program*: promotion of tools to improve the quality of life of their employees, and therefore increase the competitiveness of employers.

The JUNTOS Program[22] is of particular interest to this study. Focused on improving the quality of life of employees, JUNTOS was launched in Guatemala in June 2014. Connie de Paiz is the director, as well as the director of Panifresh. Preliminary results from data from Panifresh showed that several of their employees lived in very poor conditions despite a stable income.

The JUNTOS program is based on the initiative "Alianza de Empresas sin pobreza extrema[23]" (Alliance of employers without extreme poverty) implemented in Costa Rica where it was found that most households in extreme poverty included public and private sector employers. The tools developed by AED were shared at the Central American regional level in 2011.

The main steps of the JUNTOS program are: 1) Assessment of employees' quality of life (baseline study). 2) Selection of action priorities by each of the participating employers. 3) Implementation of interventions. Five categories of possible actions are identified: Nutrition, Education,

[22] http://centrarse.org/?p=2576
[23] http://www.empresassinpobrezaextrema.com/

Health, Housing, and Family Economy. Cooking has impacts on several of these categories, but it specifically impacts the Housing category.

Thirteen employers are currently committed to the JUNTOS program. Three employers are involved in food activities (bakery, sugar and rice industries, which may offer an easier framework to implement activities related to cooking at the workplace). There is a mix of urban and rural employees, which may result in interesting outcomes from the baseline study to be done by the employers.

3.3 Proposed actions for employers

Based on discussions with employers and CentraRSE and the activities of the JUNTOS program, several ideas of collaboration will be explored further, following these three axes: research and analysis; raising awareness and building capacity; and facilitating stove and cylinder purchase.

The ideal framework relies on collaboration with CentraRSE. Collaboration with employers that are not currently part of CentraRSE is also possible. In this case, employers with activities in the food sector may be easier to mobilize since cooking is part of their professional activities[24].

Cooperatives and associations (e.g., sugar, oil and coffee) could also be involved. Employers of the LPG sector are also a possible target of some of the CSR activities since they typically already provide LPG cylinders to their employees, but do not know if LPG is excused exclusively or with multiple fuels. CSR activities with employers in the LPG sector could focus on completing employees' transition to exclusive LPG use.

[24] Employers of the food and restaurant industries, like COMDALSA (restaurant franchises like Al Macarone) and PANIFRESH (bakeries) shared useful feedback on the idea of CSR programs related to cookstoves. Linking cookstove activities with the work of the employees would help the employer to justify their involvement. Actions could focus on cooking activities at work as well as safe use of gas and stoves since accidents are quite frequent. These activities would certainly have an impact on behaviors at home. INTECAP *("Instituto Tecnico de Capacitacion y Productividad"*) is involved in some security and safety activities with these employers. It could be a partner in future activities related to LPG.

TABLE 3.1. Proposed CSR actions for Employers

	Collaboration with CentraRSE and the JUNTOS program	Collaboration with other employers (e.g., food industry and cooperatives)	Collaboration with employers of the LPG sector
	Transition and Early stages	Transition and early stages	Transition Stage
Action category: *Research and analysis*	• *Collaborate in the baseline study:* Propose to JUNTOS to add a few questions focused on the cooking practices of their employees in their assessment questionnaire focused on cooking practices of the employees, if not already included. Collaborate in the analysis of the results and formulation of action plans. • *Propose monitoring of the impacts:* Develop and support the implementation of a plan to monitor the impacts of household cookstove activity implemented by the employer (e.g., air quality, costs). • *Synthesize and disseminate the lessons learned from the experience of CentraRSE**.	1. *Propose a baseline study:* Establish a short questionnaire to assess employees' cooking practices. Collaborate in the analysis of the results and formulation of action plans. 2. *Propose monitoring of the impacts:* Develop and support the implementation of a plan to monitor the impacts of household cookstove activity implemented by the employer (e.g., air quality, costs). 3. *Synthesize and disseminate the lessons learned* and replicate with to other employers.	Same as *Collaboration with other employers*.
Action category: *Raising awareness of employers*	1. *Deliver a short presentation or short informative note* of the problems associated with inefficient firewood cooking, its solutions, and possible employer contributions and benefits	Same as *Collaboration with CentraRSE*	Not needed

	Collaboration with CentraRSE and the JUNTOS program	Collaboration with other employers (e.g., food industry and cooperatives)	Collaboration with employers of the LPG sector
Action category: *Raising awareness and capacity-building of employees*	Implement capacity building activities for employees focused on: 1. *Awareness and cost assessment:* Create or reinforce employee awareness of the problem of inefficient firewood cooking and its solutions. Develop and implement a practical cooking cost assessment analysis for households. 2. *Safety:* Build or reinforce the capacities in safe handling of LPG cylinder and stove. 3. *Cooking practices:* Build or reinforce cooking practices adapted to LPG (e.g., pressure cooker, tricks for an efficient cooking), for example with experience-sharing activities amongst employees. Priority actions will be decided in collaboration with employers.	Same as *Collaboration with CentraRSE*	Same as *Collaboration with CentraRSE*
Action category: *Facilitating stove and cylinder purchase*	*Support employer implementation of measures* to facilitate employee purchase and payment of the start-up package (stove, cylinder, pressure cooker) with methods relevant and adapted to each employer, such as salary deduction or payment through the saving funds proposed by cooperative of employees.	Same as *Collaboration with CentraRSE*	Not needed

* CentraRSE could become a "leader" in programs for employees focused on clean cookstoves and fuels and prepare, in collaboration with Eneris, a "lessons learned" document, based on their own experience with employee programs, which could be then used by any other employer.

4 OBSERVATIONS ON THE LPG SECTOR OF GUATEMALA

This section presents research findings based on national statistics and reports, as well as interviews with national stakeholders.

KEY FINDINGS

Consumption dynamics

- In 2011, LPG was used, alone or in combination with other energy sources, in 1.4 million households. This amounts to 70% of urban households and 19% of rural households in Guatemala.
- Roughly half a million urban households have not yet adopted LPG.
- National LPG consumption is increasing by 3 to 4% per year, but firewood consumption continues to increase at a faster rate.
- LPG availability is not a barrier to consumption in urban and peri-urban areas. However, household use of multiple fuels (fuel stacking) is prevalent even in urban areas.
- Income does not strongly affect the amount of LPG consumed by households.
- Gas consumption is not closely correlated with price. Seasonal weather (rain) has a stronger impact on consumption than price.

Organization of the sector

- The LPG industry is dominated by two large companies: ZETA and TOMZA gas.
- The most common cylinder size is 25 lb.
- Cylinder distribution is based on a centralized filling system, with consumers trading empty cylinders for full ones through neighborhood retailers.
- Around 3 million cylinders are in the market. Consumers routinely complain about poor-quality, damaged and leaky cylinders.
- Most stakeholders acknowledged the need for a cylinder inventory and removal of poor-quality cylinders from circulation.
- The number of cylinders inspected annually represents a marginal part of total cylinders in the market.

4.1 Overview of the fuel and cookstove sectors of Guatemala

The main characteristics of the fuel and cookstove sectors of Guatemala are summarized as follows[25]:

Population, poverty and diversity

Of the 14.7 million people living in Guatemala, 51% live in rural areas, 48% live in urban areas. This translates to 1.4 million rural and 1.6 million urban households. Forty percent of the population is part of an indigenous group, with 23 different spoken languages. Fifty-four percent of the population lives below the poverty line,

[25] Based on the Guatemala Cookstoves and Fuels Market Assessment (2013) and the Guatemala Country Action Plan for Clean Cookstoves and Fuels (2014), coordinated by the Consultant, and supported by the Global Alliance for Clean Cookstove. Updated data is based on recent information obtained during the current study from the National Statistics Institute of Guatemala on the National Survey of Living Conditions (ENCOVI).

earning less than GTQ 9,000 (US$ 1,200) per capita per year. About 13% live in extreme poverty, earning less than GTQ 4,380 (US$ 580) per capita per year.

Fuel usage and cooking practices

About 71% of all households use firewood for cooking, alone or in combination with other fuels, of which 51% are urban households and 94% are rural households. They represent 2.1 million households, 0.8 million urban and 1.3 million rural households. Of these, 0.6 million urban households and 0.7 rural households purchase firewood and the remaining collect firewood. Both women and men collect firewood. LPG is used in 1.4 million households, alone or in combination with other fuels, of which 1.1 million (or 70%) are urban households and 0.3 million (or 19%) are rural households[26].

Annual wood deficit

Guatemalans consume about 16 million tons of dry firewood annually, which is more than 5 million tons in excess of production, reducing the country's forest cover.

Health burden of solid fuel use for cooking

Household Air Pollution (HAP) accounts for economic losses equivalent to around 1% of Guatemala's GDP. In 2010, HAP was estimated to have caused more than 5,000 deaths.

Organisation of the cookstove sector

Many cookstove projects and studies have been conducted in Guatemala, but information on projects and stoves remains fragmented and disorganized. Collecting and making the lessons learned accessible would be valuable to practitioners and decision-makers alike. Many past and current projects have involved highly subsidized cookstoves, which can compete with market opportunities.

Many different models of cookstoves are available, including portable stoves (e.g., ONIL, NOYA, DONA DORA, ECOCOMAL, ENVIROFIT, SUPERCOCINAS), and built-in *plancha* stoves. Among these models, ENVIROFIT and SUPERCOCINAS include gas stoves.

Two new committees were recently formed to address clean cooking issues, one governmental and the other commercial and non-profit. The *Guatemalan Cluster of Improved Cookstoves and Clean Fuels* brings together individuals and organizations that work in this area. Members include local and international manufacturers, distributors, and universities. The Cluster was formally constituted at the end of 2014. The *Inter-Institutional Wood and Energy Roundtable* is made up of national institutions and acts as a medium for dialogue and consensus-building on public policies to ensure the sustainable use of firewood. Its formal constitution is ongoing, involving a legal commitment by each member institution.

National policy framework

The *National Energy Policy (2013-2027)* proposes the installation of 100,000 efficient biomass stoves, a 15% reduction in industrial firewood consumption, a 10% increase in reforestation and substitution of firewood by alternative energy sources in 25% of households. The *National Strategy for the Sustainable Use of Wood (2014)* proposes the installation of 65,000 efficient

[26] More details on LPG consumption are provided in other sections of the report.

cookstoves over 10 years.

Other recent and ongoing studies

In 2014, the Global Alliance for Clean Cookstoves (GACC) supported development of the *Guatemala Country Action Plan for Clean Cookstoves and Fuels*. Following consultation with national stakeholders, it identified 25 interventions to enhance demand, strengthen supply and foster an enabling environment for clean cooking. After this study's release, GACC selected Guatemala as a focus country.
GACC is currently conducting *a market segmentation study* to define consensus groups, develop and consolidate the cookstove market and identify suitable strategies for addressing specific target groups. This study will also include information on non-LPG users. Results are expected in May 2015.

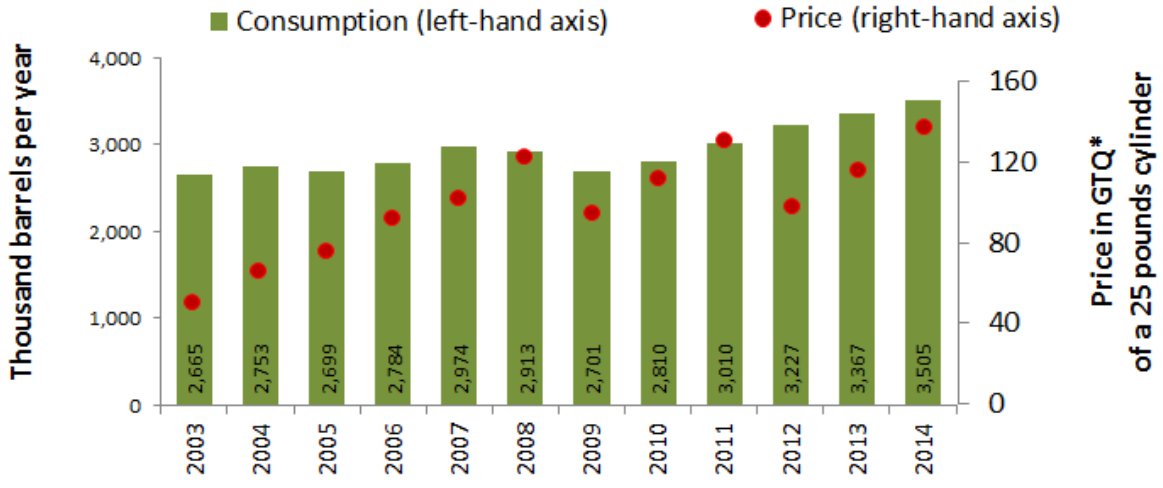
The World Bank's *Clean Cooking Solutions Roadmap and Investment Prospectus for Guatemala, Honduras, and Nicaragua* will assess the investments needed to support the market for clean cookstoves in these three countries. LPG stoves are one strategy towards this end.

4.2 Evolution of LPG consumption

Slow growth of LPG consumption

In 2014, total LPG consumption in Guatemala reached 3.5 million barrels, an increase of 4% over the previous year (*FIGURE 4.1*). From 2003 to 2014, the average annual increase in LPG use was just 2.5%. LPG suppliers consider this increase "natural" growth in the residential market. The increase is expected to continue, or even accelerate, with the development of new industrial and transportation uses for LPG. The overall increase hides decreases in LPG use in 2008 and 2009 following the international economic crisis. It also obscures the fact that **LPG's share in national energy consumption has remained constant over the last 10 years** (3.4% in 2005, 3.3% in 2013): consumers prefer firewood and petroleum products and demand for these fuels has increased more rapidly than LPG.

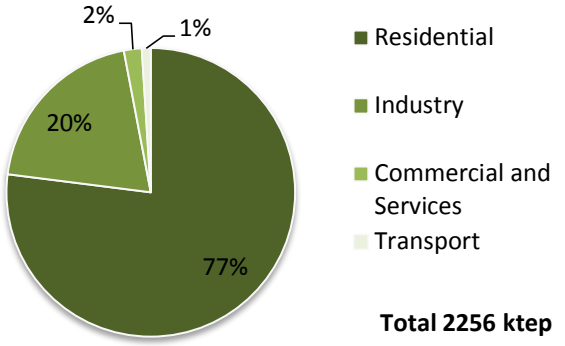
Figure 4.1. LPG consumption (all uses) and Price



*1 GTQ=Approx. US $75
Statistics from the Ministry of Energy and Mines, Direction of Hydrocarbon (mem.gob.gt)

LPG consumption is largely dominated by residential uses (77% in 2013). Transportation and industrial uses are projected to be key future markets (FIGURE *4.2*): LPG suppliers are more interested in these markets than in the residential ones.

Figure 4.2. Sectoral Share of LPG Consumption in 2013



Cooking with LPG is common in urban areas but firewood still attracts urban households

Not surprisingly, use of LPG for cooking is much more common in urban areas than in rural ones. In 2011, **more than 70% of urban households used LPG for cooking, compared to less than 19% of rural household** *(TABLE 4. 1).*

Departments (*equivalent to "Counties" in the U.S.*) with the highest number of urban households are Guatemala, Quetzaltenango, Escuintla, Huehuetenango, Chimaltenango and Sacatepéquez.

Departments with the highest proportion of LPG users in urban areas are Guatemala, Sacatepéquez, Escuintla, Izabal, Chiquimula and El Progreso. Strategies to increase LPG use in households cooking with multiple fuels, including LPG, would be particularly relevant in these departments.

Departments with the highest number (rather than proportion) of LPG users in urban areas are Guatemala, Quetzaltenango, Escuintla, Sacatepéquez and Chimaltenango. Together, they represent 60% of Guatemala's LPG users. Strategies to maximize LPG use in households cooking with multiple fuels, including LPG, would be particularly relevant in these departments.

Departments with the highest number of households that do not use LPG in urban areas are Guatemala, Quetzaltenango, Quiché, San Marcos, Huehuetenango and Sololá. Strategies to promote the adoption of LPG would be particularly relevant in these departments.

Departments with the highest proportion of firewood buyers in urban areas are Chimaltenango, Baja Verapaz, Quiche, Sololá and Totonicapán. Strategies to both promote adoption of LPG and upscale LPG use in households cooking with multiple fuels, including LPG, would be particularly relevant in these departments. Poverty levels and wood accessibility are part of the factors behind this situation. They would deserve a closer analysis.

TABLE 4.1. Characteristics of Urban Households

LPG users	70% (1,104,829)
Non-users of LPG	30% (475,621)
Firewood buyers	49%
No poverty	65%
Non-extreme poverty	30%
Extreme poverty	5%

% relate to total urban households
Data from the National Survey of Living Conditions (ENCOVI-2011), National Institute of Statistics. Data by *Departamento* and maps are included in Appendix 5.

From 2006 to 2011, the absolute number of LPG users increased in urban areas, but the share of urban LPG users decreased slightly (from 74% to 70%). On the other hand, the proportion of urban firewood users increased significantly, from 65 to 79% (*TABLES 4.2 and 4.3*). This may be a lingering consequence of the economic crisis of 2008-2009. Between 2006 and 2011, both the absolute number of LPG users and the proportion of households using LPG decreased substantially from 24% to 19% in rural areas. In summary, firewood continues to be an attractive cooking option for many urban households and the rural market for LPG remains precarious.

In terms of the market potential for LPG in urban and peri-urban areas, roughly **half a million (476,000) urban households have not yet adopted LPG.** Guatemala's National Energy Policy seeks to substitute firewood with clean energy in 25% of all households. LPG is expected to play an important role in that substitution.

4.3 LPG price

Prices are volatile

Between 2003 and 2014, the price of a 25 lb. cylinder increased from around GTQ40 (US$ 5) to GTQ 140 (US$ 18). In March 2015, it dropped back to less than GTQ 90 (US$ 12). It will be interesting to track overall LPG consumption as well as the number of new households using LPG in 2015 if lower prices persist. No consumption statistics are currently available.

Gas consumption is not clearly correlated with LPG price

In the past, **LPG price and consumption did not appear to be correlated** (*FIGURE 4.1*). Between 2003 and 2014, short-term price changes appear to have had little impact on consumption (*FIGURE 4.3*). Interviews with *expendios* (retailers) and consumers conducted in March 2015 support these observations. After 3 months of lower LPG prices, *expendios* did not note significant change in sales, and users did not report any change in their cooking habits. According to *expendios*, cylinder sales remained quite stable when prices ranged between GTQ 90-140 (US$ 12-18). Sales appeared to more sensitive to seasonal weather patterns, increasing during wet periods as wet wood is difficult to burn. The focus groups also suggested that household LPG use is relatively unresponsive to price changes, suggesting that other factors such as fear of explosions, distrust in suppliers and inability to compare LPG and firewood costs may have more influence on LPG use than the price of LPG.

Domestic LPG prices do not strictly reflect international price variations, but are the same throughout Guatemala

Overall, the national price of LPG tracks the international price. Short-termprice variations in Guatemala do not consistently reflect international ones (*FIGURE 4.4*). No price variation is observed across departments of Guatemala. Refillers' profits are a key driver of the LPG price variation, along with the price of imported LPG (*FIGURE 4.5*).

TABLE 4.2. Percentage of urban households cooking with firewood and LPG in Guatemala. Evolution from 2006 to 2011

Departmentos by alphabetic order	Percentage of urban households cooking with firewood*			Percentage of urban households cooking with LPG			*Departamentos* by alphabetic order
	2006	2011	2006 to 2011	2006	2011	2006 to 2011	
Alta Verapaz	65%	79%	↑	56%	45%	↓	Alta Verapaz
Baja Verapaz	75%	80%	↑	52%	52%	=	Baja Verapaz
Chimaltenango	74%	80%	↑	67%	62%	↓	Chimaltenango
Chiquimula	36%	44%	↑	86%	88%	=	Chiquimula
El Progreso	64%	65%	↑	71%	69%	↓	El Progreso
Escuintla	44%	55%	↑	76%	73%	↓	Escuintla
Guatemala	15%	25%	↑	89%	88%	=	Guatemala
Huehuetenango	73%	72%	=	50%	55%	↑	Huehuetenango
Izabal	47%	49%	=	75%	85%	↑	Izabal
Jalapa	73%	54%	↓	58%	62%	↑	Jalapa
Jutiapa	70%	61%	↓	67%	65%	=	Jutiapa
Petén	74%	70%	↓	61%	62%	=	Petén
Quetzaltenango	63%	67%	↑	66%	64%	=	Quetzaltenango
Quiché	88%	86%	=	35%	36%	=	Quiché
Retalhuleu	58%	67%	↑	65%	55%	↓	Retalhuleu
Sacatepéquez	58%	56%	=	73%	70%	↓	Sacatepéquez
San Marcos	61%	78%	↑	60%	43%	↓	San Marcos
Santa Rosa	59%	85%	↑	62%	51%	↓	Santa Rosa
Sololá	83%	93%	↑	36%	26%	↓	Sololá
Suchitepéquez	72%	63%	↓	55%	46%	↓	Suchitepéquez
Totonicapán	91%	93%	=	35%	31%	↓	Totonicapán
Zacapa	54%	56%	=	73%	66%	↓	Zacapa
Total Urban	65%	79%	↑	74%	70%	↓	Total Urban
Total Urban	*608,434*	*805,766*	*197,332*	*1,053,411*	*1,104,829*	*51,418*	*Total Urban*

*Purchased or collected

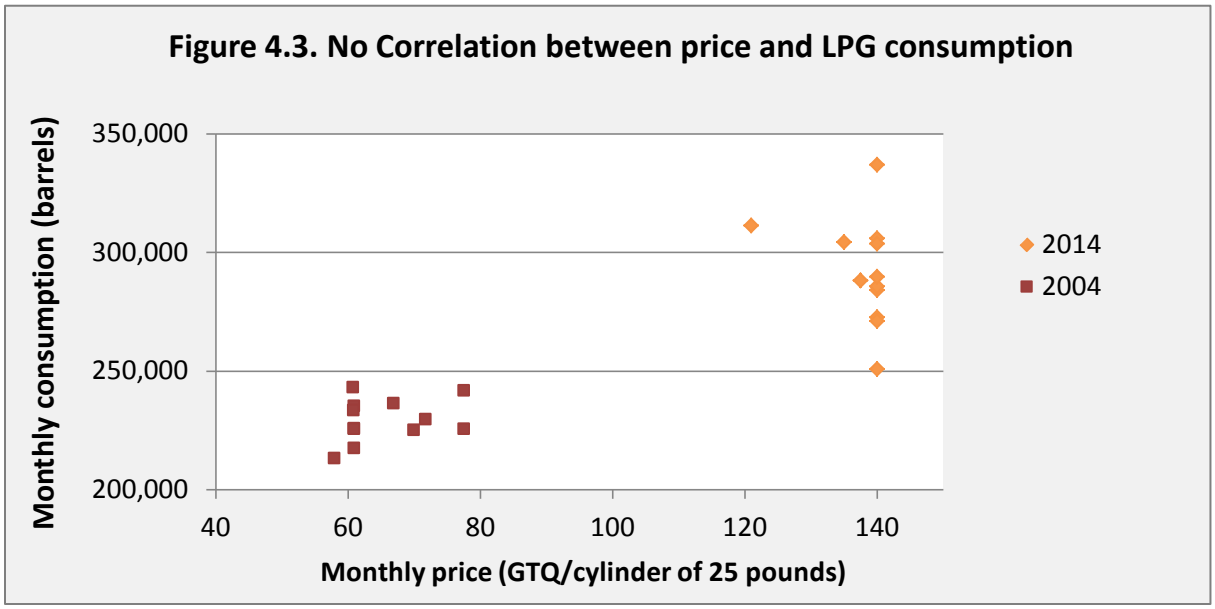
Data from the National Survey of Living Conditions (ENCOVI-2006 and 2011), National Institute of Statistics.

TABLE 4.3. Percentage of rural households cooking with firewood and LPG in Guatemala. Evolution from 2006 to 2011

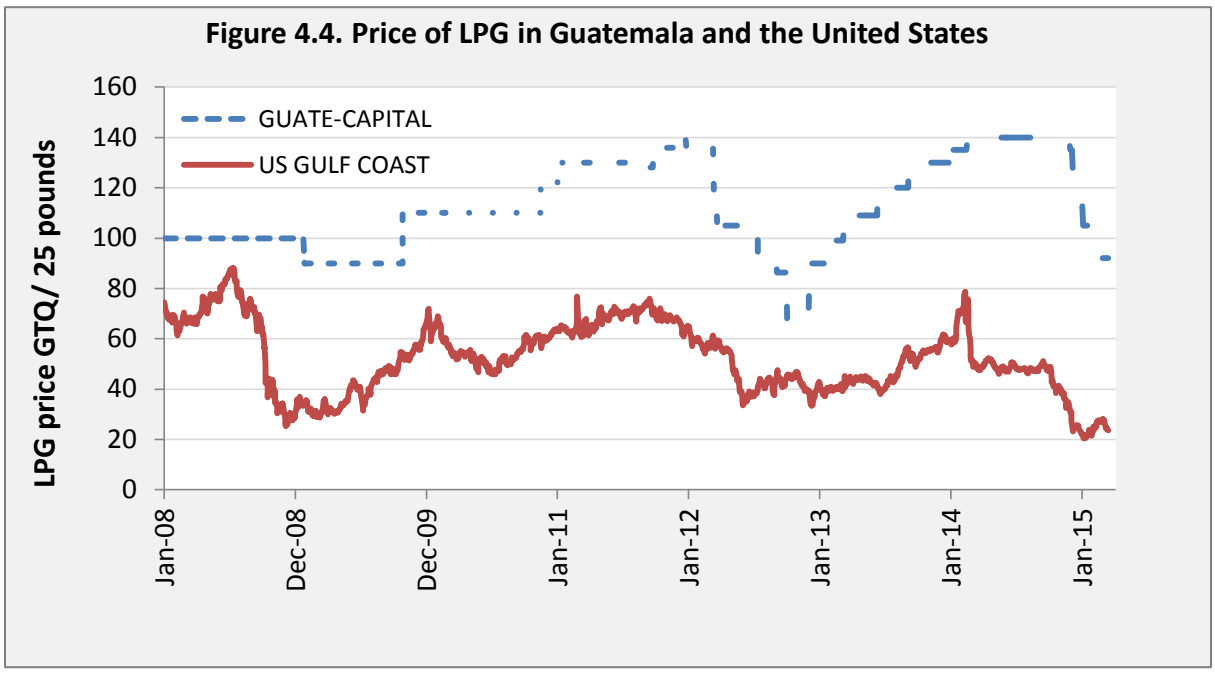
Departamentos by alphabetic order	Percentage of urban households cooking with firewood*			Percentage of urban households cooking with LPG			*Departamentos* by alphabetic order
	2006	2011	2006 to 2011**	2006	2011	2006 to 2011**	
Alta Verapaz	98%	99%	=	9%	2%	↓	Alta Verapaz
Baja Verapaz	98%	96%	=	18%	13%	↓	Baja Verapaz
Chimaltenango	96%	100%	↑	18%	7%	↓	Chimaltenango
Chiquimula	95%	97%	=	24%	20%	↓	Chiquimula
El Progreso	85%	87%	=	46%	44%	=	El Progreso
Escuintla	85%	85%	=	28%	45%	↑	Escuintla
Guatemala	56%	73%	↑	73%	58%	↓	Guatemala
Huehuetenango	98%	98%	=	15%	10%	↓	Huehuetenango
Izabal	87%	88%	=	46%	34%	↓	Izabal
Jalapa	99%	97%	=	9%	15%	↑	Jalapa
Jutiapa	96%	97%	=	34%	30%	↓	Jutiapa
Petén	94%	97%	↑	26%	12%	↓	Petén
Quetzaltenango	93%	94%	=	31%	17%	↓	Quetzaltenango
Quiché	99%	99%	=	6%	8%	=	Quiché
Retalhuleu	97%	96%	=	23%	20%	↓	Retalhuleu
Sacatepéquez	72%	88%	↑	57%	53%	↓	Sacatepéquez
San Marcos	97%	98%	=	20%	15%	↓	San Marcos
Santa Rosa	94%	97%	↓	20%	27%	↑	Santa Rosa
Sololá	93%	98%	↑	7%	13%	↑	Sololá
Suchitepéquez	95%	94%	=	16%	17%	=	Suchitepéquez
Totonicapán	99%	97%	=	9%	11%	=	Totonicapán
Zacapa	91%	88%	↑	33%	30%	↓	Zacapa
Total Rural	93%	94%	=	24%	19%	↓	Total Rural
Total Rural	*1,137,895*	*1,324,835*	*186,940*	*290,623*	*273,423*	*-17,200*	*Total Rural*

*Purchased or collected

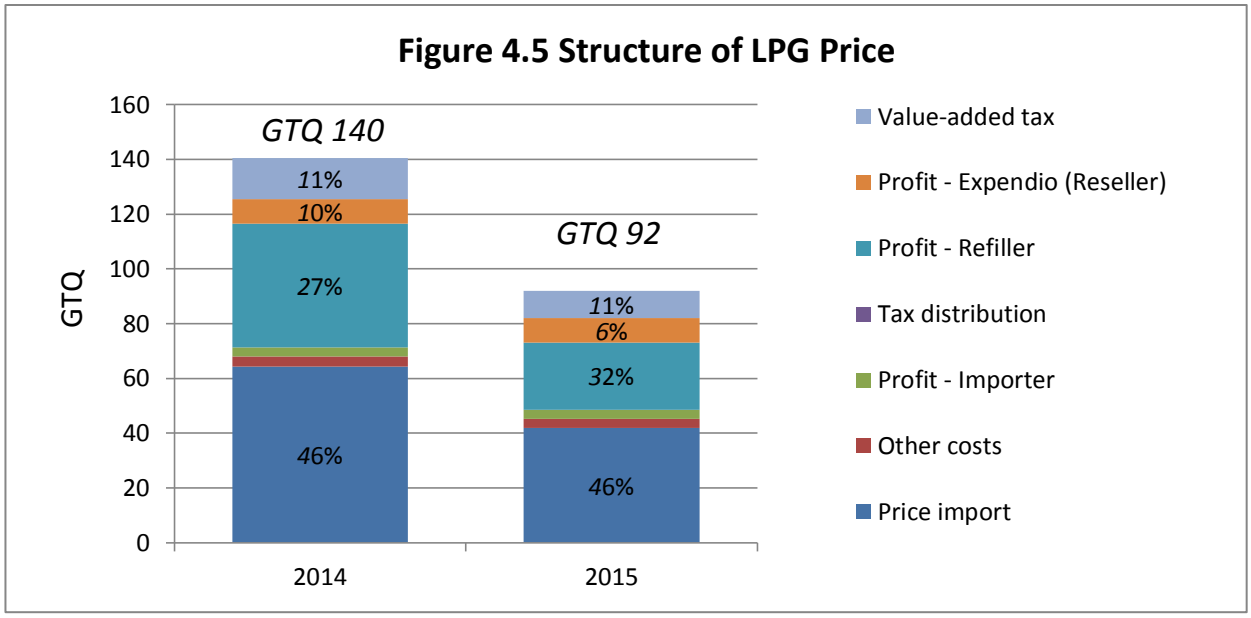
Data from the National Survey of Living Conditions (ENCOVI-2006 and 2011), National Institute of Statistics.



* Data available until March 2015
Statistics from the Ministry of Energy and Mines, Direction of Hydrocarbons (www.mem.gob.gt)



Statistics from the Ministry of Energy and Mines, Direction of Hydrocarbons (www.mem.gob.gt)



* Each line represents the monthly consumption and price of LPG during the corresponding year. Years 2003 to 2015 are included in Appendix 5
Statistics from the Ministry of Energy and Mines, Direction of Hydrocarbons (www.mem.gob.gt)

4.4 LPG use and income[27]

Motivators for initial and ongoing LPG use differ

A statistical analysis conducted by Kojima et al. (2011)[28] was based on data from the ENCOVI-2006. Several results of this analysis follow. Adoption and ongoing consumption of LPG are distinct goals, and appear to have very different drivers.

- Differences in the amount of LPG consumed by households across income levels were found to be small.
- Income, urban residence and rising firewood prices were more statistically significant factors for adoption than for ongoing consumption of LPG.
- The price of LPG was significant factor for ongoing LPG consumption but insignificant in adoption.
- LPG adoption was lower in households with an indigenous head but appeared to be an insignificant factor for ongoing use.
- Agricultural livelihood also reduced the likelihood of LPG adoption and consumption as access to biomass resources is associated with agriculture.
- Women's level of education was more significant for adoption than men's education level. Women's educational level was also more important for adoption than ongoing use.
- Access to electricity increased the probability of LPG adoption but not ongoing use. One interpretation is that electrification is a good proxy for

[27] A statistical analysis of the drivers behind the adoption and consumption of LPG, such as household income/ expenditures, LPG price, price of other fuels, household size, house size, assets, education level, cultural identity, rural/urban location, etc. was beyond the scope of the current study

[28] Kojima M., Bacon R. and Zhou X. 2011. Who uses bottled gas? Evidence from households in developing countries. World Bank. Policy Research Working Paper 5731.

adequate infrastructure for LPG. It may also be an asset indicator as households with electricity may have greater resources.

Household income does not strongly affect LPG consumption

Using data obtained from the ENCOVI 2011, the effect of household expenditures[29] on the quantity of LPG consumed was briefly explored in this study *(FIGURE 4.6)*. Results confirm that differences in the amount of LPG consumed by urban households across expenditure levels are small, with three levels of LPG use: 12, 25 and 35 lb. per household per month, corresponding to available cylinder sizes. Use of the 12 lb. cylinder tends to decrease as household expenditures increase. **This suggests that availability and affordability are not the sole determinants of LPG adoption** and consumption. Other factors, like family size, tradition and habits, lifestyle, as well as fear, distrust, etc. also affect LPG use. Focus groups helped explain the dynamics behind LPG use.

4.5 Industry structure

ZETA's and TOMZA's domination of the LPG sector

Guatemala's LPG industry is dominated by two large corporations, ZETA and TOMZA, both of which are related to the Zaragoza family of Mexico. Earlier studies of the Guatemalan LPG market[30] indicated that vertical domination of the LPG sector by the two groups prevails. LPG suppliers do not consider a future gas pipeline from Mexico a threat to the LPG market as LPG does not require the extensive distribution infrastructure that natural gas does.

A centralized cylinder distribution model with poor quality cylinders

Cylinders range from 10 to 100lbs., but he most common cylinder size is 25 lb. Guatemala's cylinder distribution model is based on a centralized system for refilling, distributing and returning empty cylinders to consumers. For replenishment, the customer exchanges an empty cylinder for a different full one. The customer owns the cylinder but cannot keep it. For instance, she may buy a new cylinder and receive a 10-year old cylinder upon refilling. In other words, the consumer is essentially renting the cylinder by paying for initial cylinder and the refill cost for the first cylinder. The lack of physical ownership means that the customer is not responsible for replacement at the end of the cylinder's life. The lack of legal cylinder ownership also creates a lack of legal responsibility to maintain or replace cylinders, valves, etc.[31]

Some 3 million cylinders are in the market and range widely in age and quality. Low-quality construction and cylinder leakage are common, according to focus group participants. Most stakeholders acknowledged the need for a cylinder inventory in Guatemala, as well as the removal of poor quality and leaky cylinders from circulation.

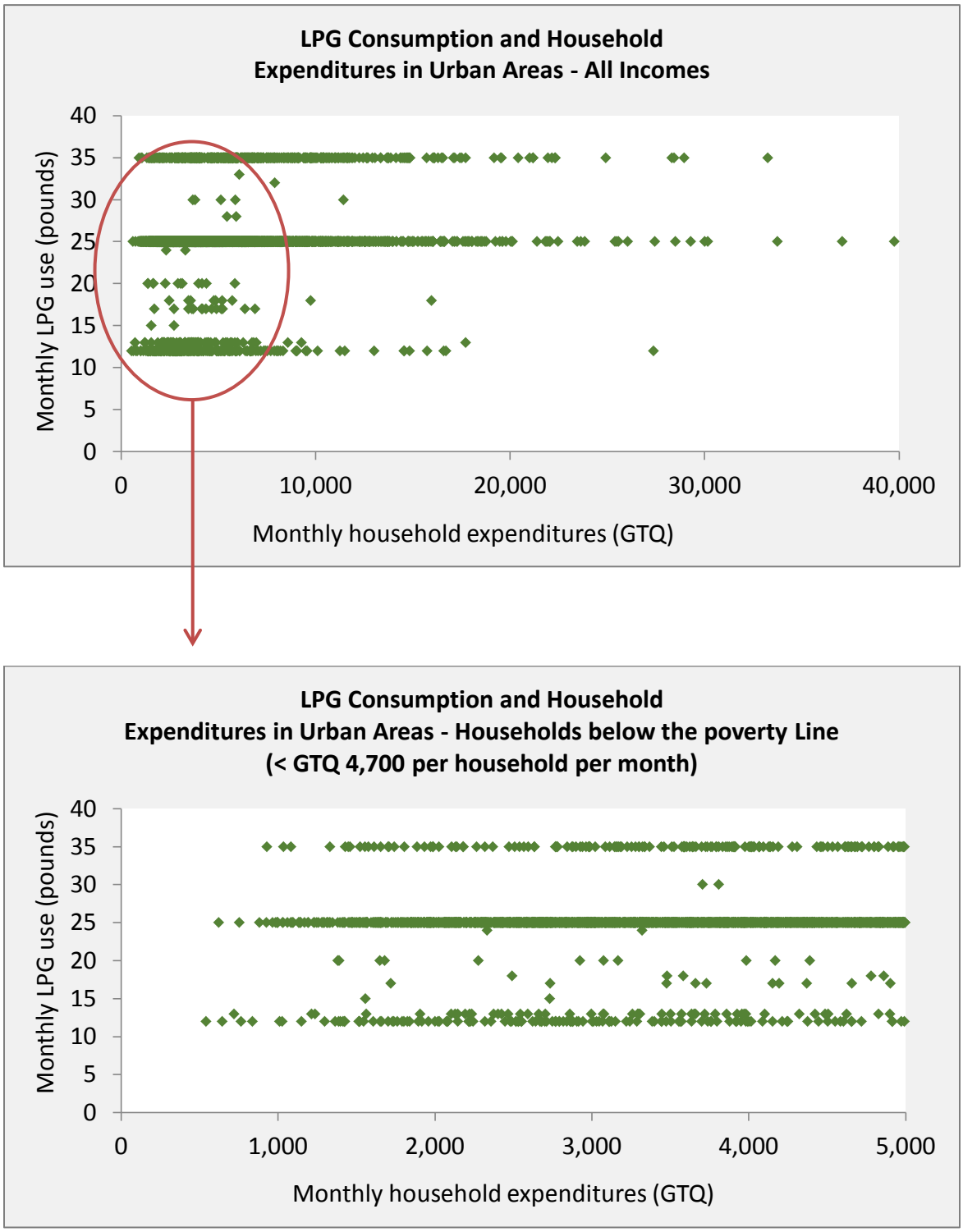
LPG suppliers reported that they systematically repair all cylinders that need repair. For example, Zetagas estimates that it repairs some 2,500 of their cylinders each day. However, **several retailers interviewed**

[29] Expenditures are used as a proxy of the income level.

[30] Matthews, William G. and Zeissig, Hilmar R. 2011. Residential Market for LPG : A Review of Experience of 20 Developing Countries. World Bank, Washington, DC.

[31] See previous reference.

FIGURE 4.6. Urban Household Expenditures and LPG Consumption



* Households with monthly expenditures above GTQ 40,000 represent a negligible part of all urban households
** Poverty is defined as monthly expenditures of GTQ 4,700 (US$ 626) or less per urban household.
Data from the National Survey of Living Conditions (ENCOVI-2011), National Institute of Statistics. Similar data are available for the entire expenditure range.

believed that up to half of all cylinders in Guatemala may leak, and many are only painted by suppliers rather than repaired. Some LPG sector stakeholders suggested that in order to guarantee cylinder quality, a specific institution should be responsible for cylinder repairs.

Another frequent complaint is that cylinders are not always completely refilled. One *expendio* explained that based on his own measurements, 75% of refilled cylinders weighed 20 to 24 lb, less than the full 25 lb. Several possible reasons for this were provided: incomplete supplier refills, use by the retailer before delivery, and leakage. It was not possible to verify any of these possible causes. The use of an anti-tamper or heat-shrink sleeve (e.g., a "*termosello*" used by Zeta Gas) is a way to demonstrate that the cylinder has not been used before delivery to the consumer. The Guatemalan government has not played a sufficient role in protecting consumers, however. Between 2011 and 2013, the Ministry of Energy issued sanctions to only 3% of the plants inspected.

Regulation of the sector

The Direction General of Hydrocarbons (DGH), under the Ministry of Energy and Mines (MEM), is responsible for regulation, surveillance, enforcement and control of the LPG distribution chain. LPG plant inspections are made in collaboration with the DIACO (*Dirección de Atención y Asistencia al Consumidor*). In 2011, 2012 and 2013, MEM reported that the number of cylinders verified annually was 2,560, 2,971 and 3,525, respectively. The number of cylinders inspected annually represents less than 0.1% of cylinders in the market.

Termosello - Zeta Gas
Picture by Omar Alfaro

A review of LPG regulations and the MEM's capacity for effective monitoring and enforcement deserves special attention. Among its responsibilities, the DGH issues licenses to *expendios*. At the end of 2014, according to data from MEM, the government counted about 10 licensed retailers for every 100,000 households. Experts at DGH are well aware that many retailers are unlicensed and believe this is due mostly to lack of information about licensing requirements since the license is free. When delivering the license, the DGH reported that they provide refillers with information on proper LPG use, cylinder maintenance and safety measures.

However, *expendios* interviewed during the study reported receiving brief instruction from their supplier only. One had received no education at all. *Expendios* also believed that they were only authorized to sell LPG only by the supplier they represent, and therefore did not need to contact the DGH regarding the license. One retailer explained that the licensing requirements were bureaucratic and time consuming - factors that could also contribute to the high number of unlicensed retailers. Clearly defined standards for licensing, sales and safety are needed from supplier to the consumer to improve the sector's reputation and performance

5 CONCLUSION: INTERVENTION AVENUES

Based on interviews with stakeholders, data analysis and focus groups, several interventions avenues are proposed to scale up the use of LPG by households in urban and peri-urban areas already cooking with LPG. The objective of this study was not to identify the drivers of adoption but rather the drivers of exclusive use of LPG. However, several study findings provide insight for adoption strategies and are also presented here. A special focus is given to opportunities offered by Corporate Social Responsibility, when relevant.

Completing the transition to LPG

Target: Households in urban and peri-urban areas and cooking with multiple fuels, including LPG.

Objective: Consolidate and complete the transition from firewood to LPG.

Barriers: Safety concerns, lack of knowledge on how to cook with LPG, lack of skill on how to use a pressure cooker, lack of easy cost comparisons between LPG and firewood cooking.

Intervention: Consumer information and marketing

1. Clean cooking marketing and promotion emphasizing the direct benefits to women.
2. Cooking practices (pressure cooker, cooking with LPG, efficient cooking techniques).
3. Cooking cost comparison: devise a practical cost comparison between firewood and LPG. Conduct with households, collect and analyze results. Gather participants' responses to the experiment through focus groups. Use their experiences in marketing messages communicating the cost benefit of LPG over firewood.
4. Safe LPG handling and cooking, for consumers and retailers: develop and test low-literacy materials for LPG sector (refillers and *expendios*) and for consumers.

CSR opportunity: Collaborate with Juntos program or other employers, including employers of the LPG sector to raise awareness of employers, raise awareness and capacity-building of employees on the four topics mentioned in the intervention, monitor impacts on households of cookstove adoption and use (air quality, costs, other impacts).

Adoption (early-stage LPG cooking)

Target: Households with easy access to LPG, stable income and cooking with purchased firewood.

Objective: Give non-LPG users a chance to experience the benefits of LPG first hand, modify biased preconceptions for example on taste, and develop confidence in the use of LPG.

Barriers: Cost of the start-up package, managing promotion.

Intervention: Facilitate stove and cylinder purchase

1. Develop consumer finance through retailers.

2. Promote a smaller cylinder, which makes sense in such a strategy focused on the early-stage uses of LPG, often limited to a few cooking needs.
3. Offer free-trial period. Studies[32] have also shown that a free-trial period reduces perceived risk and significantly increases stove purchases.

CSR opportunity: Collaborate with CentraRSE (Juntos program) or other employers, including employers of the LPG sector to implement measures to facilitate the purchase and payment by the employees of the start-up package (stove, cylinder, pressure cooker) with methods relevant and adapted to each employer (salary deduction, payment through the saving funds proposed by cooperative of employees).

Enabling environment

Target: Government and industry

Objectives: Engage the industry and the government in the definition and implementation of relevant strategies in the sector, and to improve the reputation of the sector and the confidence between LPG users, retailers and suppliers.

Barriers: Safety concerns and poor quality LPG cylinders, reputation of LPG retailers and suppliers.

Intervention: Engage industry and government

1. Organize a well-focused meeting with the industry in order to recognize and act on mutual interest in growing the market for clean stoves.
2. Review and/or reinforce the regulation of LPG cylinders: Conduct a cylinder inventory, engage the Ministry of Energy in the enforcement of the rules, review the ownership basis of cylinder, promote investments in cylinder replacement, safety and quality improvement (e.g. loans for cylinder replacement, research and technology development, etc.).

[32] The following study shows that simple market-driven models, like free trial and time payment, can increase adoption of clean cookstoves eleven fold. Levine D.I., Beltramo T., Blalock G., Cotterman C. 2012. What Impedes Efficient Adoption of Products? Evidence from Randomized Variation in Sales Offers for Improved Cookstoves in Uganda. CEGA Working Papers.

APPENDICES

Appendix 1. List of stakeholders met during in-country visits

Meetings with local stakeholders aimed several objectives:

- Inform about the LPG study and gather specific interest of the stakeholders in the study;
- Obtain data and learn about the situation of gas sector in Guatemala;
- Understand the consideration given to LPG for cooking by institutions;
- Learn about CSR programs and activities in Guatemala.

Governmental institutions

- National Institute of Statistics
  http://www.ine.gob.gt/
- Ministry of Energy and Mines, Energy Planning, Interinstitutional Wood and Energy Roundtable
  http://www.mem.gob.gt/viceministerio-del-area-energetica/
- Ministry of Energy and Mines, Hydrocarbon General Direction
  http://www.mem.gob.gt/viceministerio-de-mineria-e-hidrocarburos/
- National Competitiveness Program (PRONACOM)
  https://www.mineco.gob.gt/programa-nacional-de-la-competitividad-pronacom

Other

- Red de Instituciones de Microfinanzas de Guatemala (REDIMIF) http://www.redimif.org/
- Clúster of Clean Cookstoves and Fuels

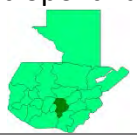
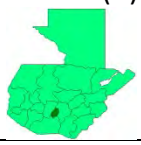
Gas industry

- GENTEGAS http://gentegas.com/
- GRUPO NIVI http://www.gruponivi.com/
- ZETA GAS http://www.grupozeta.com/
- ENVIROFIT http://www.envirofit.org/
- SUPERCOCINAS http://www.supercocinasguatemala.com/
- Independent consultant/investor in gas sector
- OSWAL GAS S.A.
- Various retailers
- Various firewood sellers

Focus on CSR

- ECOFILTRO http://www.ecofiltro.com/
- COMDALSA
- CENTRARSE http://centrarse.org/
- PANIFRESH http://panifresh.com.gt/

Appendix 2. Location of the focus groups

Group numbers **Date**	**Location** (city, dept, region)	**Use of LPG and firewood** (urban HH)	**Climate**	**Socio-economic data**
1, 6 Nov. and Dec. 2014	Villa Nueva, Guatemala, Metropolitina (I) 	LPG 88% Firewood 23%	Temperate Altitude: 1,458 m.	**Households:** 745,429 **Urb HH:** 657,789 **Pers/Urb HH:** 4.18 **Non-poor:** 81% **Non-poor-urb:** 83% Industrial activities
2 Nov. 2014	Sanarate, El Progreso, Nororiental (III) 	LPG 69% Firewood 66%	Dry corridor	**Households:** 36,318 **Urb HH:** 14,589 **Pers/Urb HH**: 4.33 **Non-poor:** 59% **Non-poor-urb:** 64% Commercial activities, international remittance
3, 4, 5 Dec. 2014	Escuintla, Central (V) 	LPG 73% Firewood 53%	Warm Altitude: 347 m.	**Households:** 158,581 **Urb HH:** 83,179 **Pers/Urb HH:** 4.37 **Non-poor:** 60% **Non-poor-urb:** 68% Tourism, port activities, highway to Mexico, sugarcane activity
7, 8 Feb. 2015	Santa Apolonia, Chimaltenango, Central (V) 	LPG 62% Firewood 80%	Temperate/ Cold Altitude: 2113 m.	**Households:** 113,634 **Urb HH:** 61,596 **Pers/Urb HH:** 4.92 **Non-poor:** 34% **Non-poor-urb:** 47% Agriculture, informal commercial activities, tourism
9, 10 Feb. 2015	Ciudad Vieja, Sacatepéquez, Central (V) 	LPG 70% Firewood 55%	Temperate Altitude: 1530 m.	**Households:** 67,489 **Urb HH:** 57,446 **Pers/Urb HH:** 4.60 **Non-poor:** 59% **Non-poor-urb:** 63% Tourism, handcraft.

Appendix 3. Questionnaires used in the focus groups (in Spanish)

Discussion guide

1. Bienvenida
2. Presentaciones / "Ice-break"
3. Objetivo
4. Principios del grupo

a. *Esperamos la participación de todos*
b. *Todas las ideas son buenas*
c. *Se garantiza la confidencialidad. Ningún nombre se mencionara.*
d. *Solo una persona habla a la vez.*
e. Preguntas? Otro requisito por parte de los participantes?

5. Preguntas

	Parte I - Forma actual de cocinar
1	Qué fuente de energía se usa más en su hogar para cocinar y calentar? Se usa otra fuente de energía también? Cuáles son los usos habituales de cada fuente? *Respuesta esperada: Uso …. para ….* *Incluir: Gas solo / Leña solo / Electricidad solo / Gas + Leña / Leña + Gas / Otro*
	Parte II - Nivel de satisfacción del uso de gas propano
2	Por qué no se usa el gas propano para tal o tal uso? Profundizar los temas siguientes: - Sabor: Quien, en casa, prefiere la cocina con leña? Ud., que prefiere? - El sabor es más importante que la comodidad del gas? - Que se usa para cocinar (olla de presión o no)? Por qué no se usa?
3	En el día de hoy, que le gusta del gas propano, y al contrario, que no le gusta? *Objetivo: Primero, conocer los factores mencionados de manera espontanea, sin influirles. Luego, preguntar lo que piensan de los otros factores de la lista[33] que les proponemos.*
3*	Pregunta añadida en los últimos 4 grupos, para entender mejor la importancia relativa de los factores. - Les proponemos una lista de beneficios, y tienen que ponerlos por orden de

[33] Beneficios posibles: Salud (humo, calidad del aire, pbs respiratorios), Factores medioambientales (deforestación), Más cómodo que la leña, Más rápido que la leña, Más barato que la leña, Más accesible que la leña, Producto moderno, prestigio, Otro?

Barreras posibles: Sabor, Coste inicial del cilindro y de la estufa, Precio del gas, Variaciones del precio del gas, Calidad de servicio de los expendios, Peso exacto de cilindro, Peligroso, miedo, Hábitos, Calidad del cilindro, Acceso fácil/difícil al gas propano, Acceso fácil/difícil a las piezas de repuesto, Otras?

	importancia según su experiencia. Hacer el ejercicio en grupo. - Lo mismo con las barreras. Hacer el ejercicio en grupo.
4	Cual sería un precio justo del GLP? A este precio, Ud. estaría dispuesta de usar solo el gas para cocinar? *Objetivo: entender mejor cuales son los usos "flexibles" (los que dependen del precio del GLP) y los usos fijos (siempre gas)* Al contrario, si el precio del gas sube hasta digamos Q160 el cilindro de 25 libras, que pasaría en su casa? *Mismo comentario*
5	Si por cualquier razón, hubiera un reducción de los ingresos en su hogar, cuales serian los gastos que redujeran primero (luz, salud, educación de los niños, basura, gas, otro)?
6	Si existiera un expendio que ofrezca un cilindro de calidad, de pero exacto, Ud. estaría dispuesta a pagar un poco más (cuanto) por este servicio?
	Parte III - Cantidad consumida y seguridad
7	Le parece seguro el uso del gas propano en su hogar? Cuál es su miedo más importante? Ud. ya ha tenido algunos problemas? Su cilindro le parece en buena condición? Ya ha tenido que cambiar el cilindro? Por qué? Como pasó el cambio? Ud. conoce las medidas de seguridad del uso del gas? Quien se les ensenó? Les gustaría saber (o saber mejor) las medidas de seguridad? *Es un tema importante, pero ya sabemos bastante. Podemos ir más rápido.*
8	Qué tipo de cilindro Ud. compra? Cuantos días le dura el cilindro? Qué pasa cuando el cilindro esta vacio? Se remplaza inmediatamente o solo después de algunos días? Se cocina con otra fuente de energía durante estos días? Que le parecería la posibilidad de usar cilindros más pequeños?
9	Como se cocina con la leña (fuego abierto, estufa ahorradora)? Ud. conoce las estufas ahorradoras de leña? Que ha oído de ellas? Ya ha pensado comprar una? Por qué?
	Parte IV - Decisión de compra inicial y seguimiento de las piezas *Se hacen muy rápido.*
10	Desde hace cuanto tiempo se usa el gas en su hogar? Quien decidió? Se compró al contado o a crédito? Por qué? Ya han dejado de usar el gas propano, en el pasado, y por qué?
11	Donde se compró la estufa? el cilindro? Fácil/difícil de encontrarlos? Donde se compran las piezas de repuesto? Fácil/difícil de encontrarlas?
	Parte V - Para concluir
12	Cuales serian las 3 palabras que describen mejor el gas propano, según Ud. (pueden ser descripciones positivas como negativas)? Cual sería un eslogan que, según Ud, representa bien el GLP. *Por ejemplo: "el gas es para mujeres modernas"*
13	Tiene cualquier otro comentario, pregunta, opinión que compartir?

Written questionnaire

FECHA: _____

Fuentes de energía

1	LEÑA ¿Qué cantidad de leña se consume cada mes, en su hogar? _____ ¿Cuánto cuesta cada mes? _____
2	GAS PROPANO ¿Qué cantidad de gas propano se consume cada mes, en su hogar? _____ ¿Cuánto cuesta cada mes? _____

Datos socio-económicos

3	¿Cuál es la ocupación laboral de las personas **que viven su hogar**? Esposo: _____ Esposa: _____ Otras personas: _____
4	Número de personas que viven en el hogar:
5	Usted es: ◯ Mujer ◯ Hombre
6	¿Cuál es su último grado académico? _____ ¿Cuál es el último grado académico de su esposo? _____
7	¿Cuáles son los gastos mensuales totales del hogar? ◯ < Q2000 ◯ Q2000-Q2500 ◯ Q2500-Q3000 ◯ Q3000-Q4000 ◯ Q4000-Q6000 ◯ >Q6000
8	OPCIONAL (respuesta no obligatoria) ¿Cuáles son los ingresos mensuales del hogar? incluyendo: sueldos o nominas, ganancia de actividades comerciales, etc. ◯ < Q2500 ◯ Q3000-Q3500 ◯ Q3500-Q4000 ◯ Q4000-Q6000 ◯ Q6000-Q8000 ◯ >Q8000

Estos datos se trataran de manera confidencial en el estudio

Appendix 4. Cooking experiment

Given the lack of household awareness of the actual cost of cooking with LPG compared to firewood, a two-part experiment was conducted *in real cooking conditions* in the household of the local consultant, Omar Alfaro[34]:

- Compare the cost and time of cooking all meals with LPG exclusively for X days versus all meals with firewood for the same number of days. Number of days is the duration of one 25 lb. LPG cylinder.
- Compare fuel consumption and cooking time for beans with LPG and firewood on different cookers.

These two experiments are illustrative only. Results should not be used as reference values. A more formal experiment with a protocol could be implemented with more households.

KEY FINDINGS

Cooking with LPG versus firewood exclusively

- The 25 lb. cylinder lasted 17 days, or 90 hours of cooking time, in a family of 3 adults and 1 child.
- The 25 lb. cylinder only weighed 20 lb., not the expected 25 lbs.
- Cooking exclusively with firewood for 17 days totaled 35 hours of cooking more (40% more), and GTQ38 (US$ 5) more than with LPG (32% more).

Cooking beans with different fuels and cookers

- The fastest and cheapest way to prepare beans is in a pressure cooker on an LPG stove - even when LPG prices are high.
- Cooking on an open fire is the slowest and most expensive way to prepare bens using any type of cooker.
- Cooking on an LPG stove is slightly faster than with firewood on a metal stove, except when cooking with the Teflon pot.
- Cooking beans in a clay pot results in a thicker and tastier liquid.

Part 1. Seventeen days with LPG compared to seventeen days with firewood

Methodology

The first experiment aimed **to measure all energy use and cooking time**. The test was conducted in a 4 person household (3 adults and 1 child). Beginning with a full cylinder, the family cooked with LPG until the cylinder was empty. Afterwards, the family cooked with firewood only for the same number of days. All kinds of food were prepared, including coffee, tortillas, soaps, meat, rice, fish, and eggs. The goal was to capture typical daily cooking behavior over a sufficient number of days, not to cook the exact same dishes. Detailed results of each meal cooked during this experiment are available.

Results

The 25 lb. cylinder lasted **17 days, corresponding to a 90 hours of cooking**

[34] Special thanks to the family of Omar Alfaro, who agreed in making these experiments over more than 2 months.

time. The weight was 20 lb. of LPG (the difference between the full and empty cylinder weights). Fuel cost was GTQ115 (US$ 15).

During the 17 day period of exclusive firewood use, cooking time totaled 125 hours, which was **35 hours more than with LPG (almost 40% more)**. Nineteen "*cargas*" (loads) of 18 oak logs each were purchased and consumed which cost GTQ 152 (US$ 20), **GTQ 38 (US$ 5) more than with LPG (32% more).**

Additional comments

The woman responsible for cooking during this experiment shared several observations that summarize the positive and negative facets of cooking with LPG and firewood:

- Cooking with gas is faster and more practical, given the fact that there is no need to start the fire and keep it burning
- The LPG flame is more stable and can be easily adjusted as desired.
- Expected heating intensity is always the same with LPG whereas it is not known in advance how wet or dry the firewood will be.
- Pots remain clean with LPG
- Risks of burns are reduced with LPG since there is no need to handle burning wood.
- Food cannot be maintained at a warm temperature when cooked with LPG and must be re-heated if not eaten promptly
- Price instability and cylinder maintenance make LPG less desirable

Results show the cost and time benefits of cooking with LPG. However, the educated woman who cooked during the experiment continued to prepare *nixtamal* and *tamales* with firewood several weeks after the experiment. When asked why she continued using firewood, she explained that habit was the only reason. Taste was not her reason for using firewood.

Part 2. Cooking *frijoles* with different fuels and cookers

Methodology

Since beans are a staple food and less frequently cooked with LPG, beans were chosen for the proposed experiment. The objective was **to evaluate the time and fuel required to cook 2 lb. of beans with various pots** (e.g. teflon with glass cover, pewter, aluminum, pressure cooker, clay) and different kinds of stoves) (*FIGURE A4.1*). In rural and peri-urban areas, clay pots are frequently used to cook beans. In urban areas, beans are more commonly cooked in an aluminum pot.

Cooking duration and fuel consumption were measured, although the time required to start the fire was not included, and it can be significant. It takes about 10 minutes to start a fire with dry firewood, and 20 minutes with wet firewood. Cost was based on the real cost of LPG (GTQ 115 or 15 US$ per 25 lb. cylinder) and firewood (GTQ 7 or US$ 0.90 per load of 18 logs of oak). Estimates are also provided with LPG prices of GTQ 90 (US$ 12) and GTQ140 (US$ 18.5), reflecting the range of LPG price observed during the last months (*FIGURE A4.2*.).

Results

Not surprisingly, the fastest and cheapest way to prepare beans is with a pressure cooker on an LPG stove - even when LPG prices are high. Cooking on an open fire is the slowest and most expensive way with

FIGURE A4.1. Stoves and Cookers Used in the Cooking Experiment

Case 1
Teflon + LPG

Case 2
Teflon + Plancha stove

Case 3
Pewter + LPG

Not available

Case 4
Pewter + Plancha stove

Case 5
Pewter + Open fire

Case 6
Aluminum + LPG

Case 7
Aluminum + Open fire

Case 8
Pressure cooker + LPG

Case 9
Clay + Open fire

any type of cooker. Cooking with an LPG stove is slightly faster than with firewood in a metal stove, except with the Teflon pot. The experiment with the Teflon pot was repeated twice with same results. No explanation was found to explain the increased cooking speed of firewood with the Teflon pot. In all cases, cooking with LPG was cheaper than firewood, even when the price of LPG is high and costs are closer. The only exception is when beans are prepared with the Teflon pot.

In terms of taste, the main difference was with the clay pot. Cooking beans in this pot resulted in a thicker and tastier liquid. The clay vessel slowed evaporation significantly, It was not necessary to add water during cooking compared to the other pots.

FIGURE A4.2. Cost of Preparing Beans

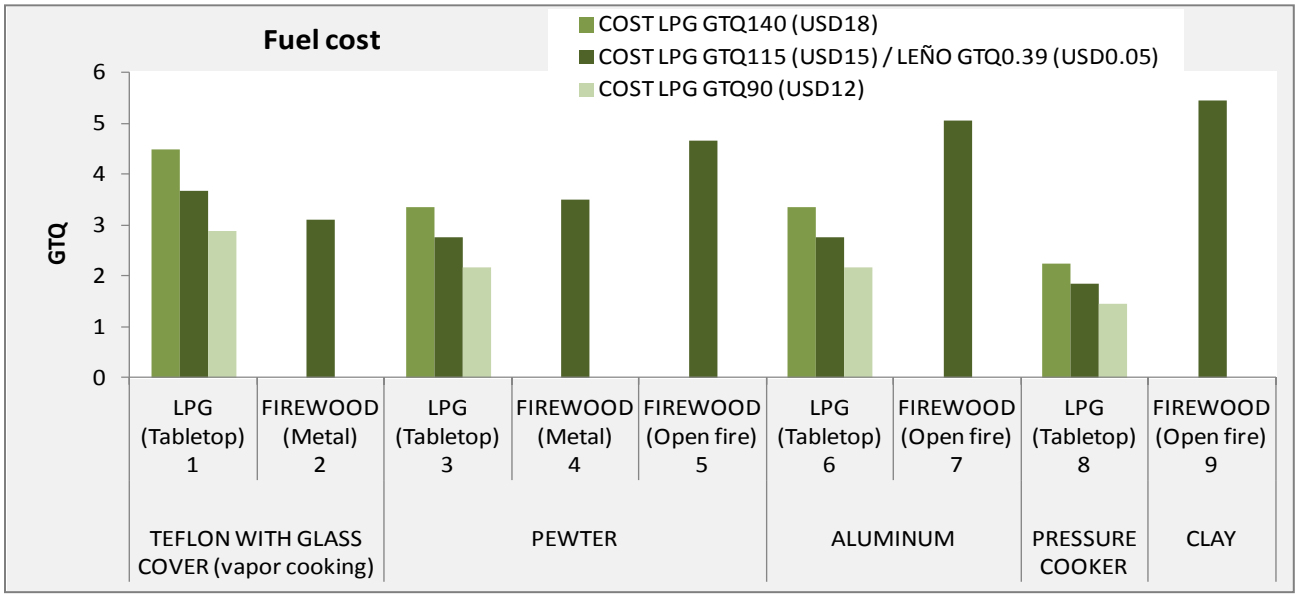
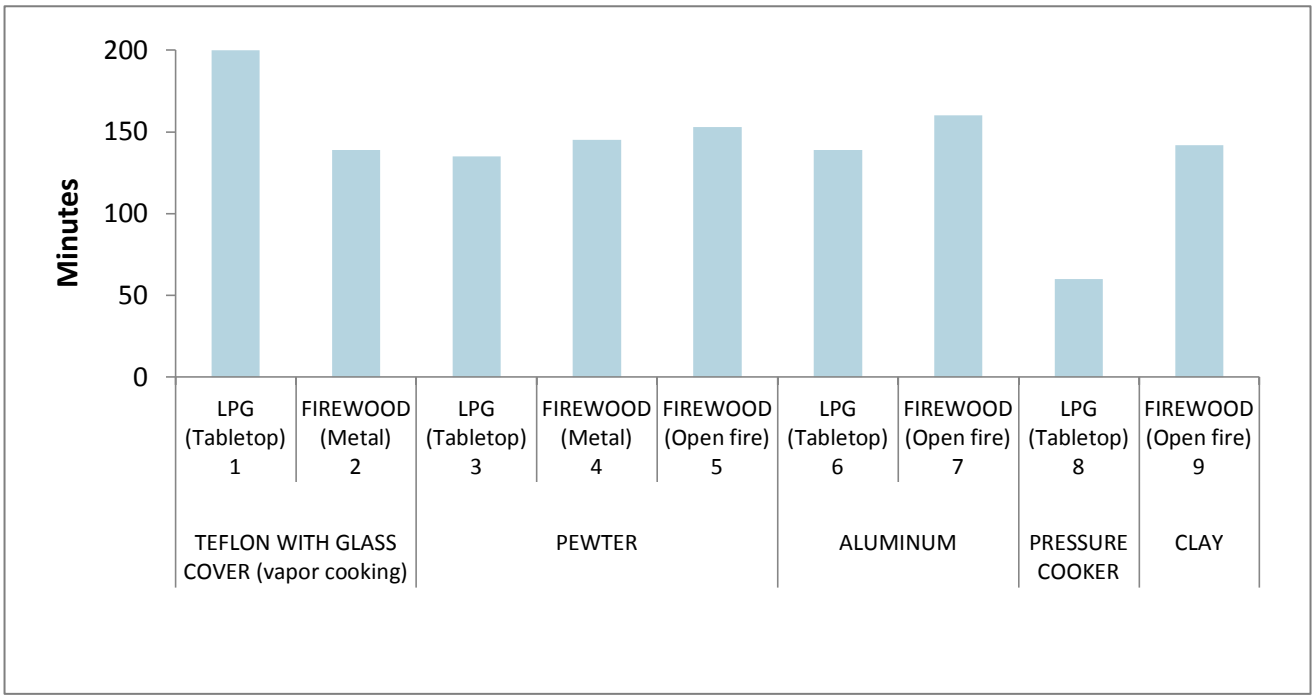


FIGURE A4.3. Cooking Time to Prepare Frijoles



Appendix 5. Additional data and maps

TABLE A5.1. Poverty Segments in Guatemala

Departamentos in alphabetic order	% OF URBAN HOUSEHOLDS IN: Extreme poverty	Non-extreme poverty	No poverty	% OF RURAL HOUSEHOLDS IN: Extreme poverty	Non-extreme poverty	No poverty	*Departamentos*
Alta Verapaz	7%	32%	60%	47%	43%	10%	Alta Verapaz
Baja Verapaz	15%	30%	55%	27%	45%	27%	Baja Verapaz
Chimaltenango	10%	42%	47%	16%	62%	21%	Chimaltenango
Chiquimula	4%	14%	82%	37%	42%	21%	Chiquimula
El Progreso	1%	35%	64%	6%	38%	56%	El Progreso
Escuintla	2%	30%	68%	3%	44%	53%	Escuintla
Guatemala	1%	16%	83%	2%	30%	69%	Guatemala
Huehuetenango	5%	38%	57%	11%	56%	32%	Huehuetenango
Izabal	4%	36%	60%	29%	40%	31%	Izabal
Jalapa	9%	45%	45%	23%	55%	23%	Jalapa
Jutiapa	6%	27%	67%	16%	44%	40%	Jutiapa
Petén	9%	36%	55%	20%	55%	25%	Petén
Quetzaltenango	6%	39%	56%	17%	50%	33%	Quetzaltenango
Quiché	9%	51%	40%	20%	57%	23%	Quiché
Retalhuleu	9%	36%	55%	15%	54%	31%	Retalhuleu
Sacatepéquez	2%	35%	63%	11%	51%	38%	Sacatepéquez
San Marcos	6%	42%	53%	19%	58%	24%	San Marcos
Santa Rosa	6%	44%	50%	14%	48%	37%	Santa Rosa
Sololá	21%	50%	29%	15%	70%	16%	Sololá
Suchitepequez	13%	44%	44%	30%	51%	20%	Suchitepequez
Totonicapán	17%	48%	35%	25%	56%	19%	Totonicapán
Zacapa	9%	24%	67%	37%	35%	28%	Zacapa
TOTAL	5%	30%	65%	21%	50%	29%	TOTAL

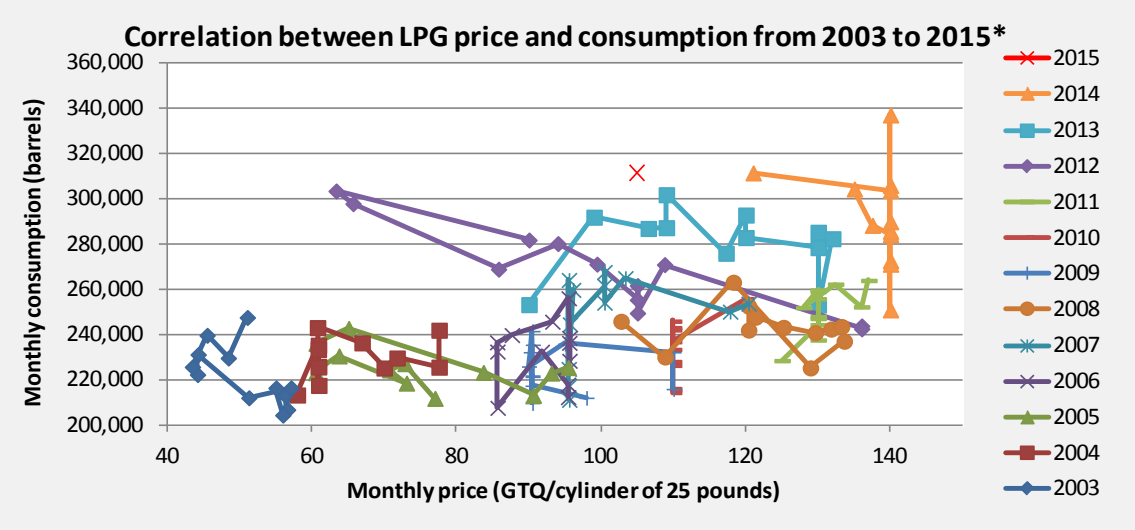
Data from the National Survey of Living Conditions (ENCOVI-2011), National Institute of Statistics.

TABLE A5.2. Characteristics of Urban Households by *Departamentos*

	Total	*Urban areas*								
	% urban house-holds	% LPG users	% Non-users of LPG	LPG users	Non-users of LPG	% Firewood buyers	% No poverty	% Non-extreme poverty	% Extreme poverty	
80% and more of the households purchased LPG for cooking										
Guatemala	88%	88%	12%	579091	78698	23%	83%	16%	1%	Guatemala
Chiquimula	29%	88%	12%	18387	2602	41%	82%	14%	4%	Chiquimula
Izabal	42%	85%	15%	32602	5762	48%	60%	36%	4%	Izabal
From 79 to 65% of the households purchased LPG for cooking										
Escuintla	52%	73%	27%	61014	22165	53%	68%	30%	2%	Escuintla
Sacatepéquez	85%	70%	30%	40277	17064	55%	63%	35%	2%	Sacatepéquez
El Progreso	40%	69%	31%	10089	4469	66%	64%	35%	1%	El Progreso
Zacapa	43%	66%	34%	14297	7408	55%	67%	24%	9%	Zacapa
Jutiapa	36%	65%	35%	22674	12312	56%	67%	27%	6%	Jutiapa
From 64 to 50% of the households purchased LPG for cooking										
Quetzaltenango	62%	64%	36%	64690	36333	65%	56%	39%	6%	Quetzaltenango
Jalapa	35%	62%	38%	13546	8208	52%	45%	45%	9%	Jalapa
Petén	34%	62%	38%	25493	15842	65%	55%	36%	9%	Petén
Chimaltenango	54%	62%	38%	37953	23643	80%	47%	42%	10%	Chimaltenango
Huehuetenango	32%	55%	45%	35802	29662	72%	57%	38%	5%	Huehuetenango
Retalhuleu	41%	55%	45%	13599	11280	65%	55%	36%	9%	Retalhuleu
Baja Verapaz	33%	52%	48%	9606	8920	80%	55%	30%	15%	Baja Verapaz
Santa Rosa	42%	51%	49%	16287	15552	79%	50%	44%	6%	Santa Rosa
Less than 50% of the households purchased LPG for cooking										
Suchitepequez	47%	46%	54%	21948	25370	57%	44%	44%	13%	Suchitepequez
Alta Verapaz	25%	45%	55%	20788	25903	78%	60%	32%	7%	Alta Verapaz
San Marcos	29%	43%	57%	23284	30963	77%	53%	42%	6%	San Marcos
Quiché	33%	36%	64%	19744	35399	84%	40%	51%	9%	Quiché
Totonicapán	48%	31%	69%	13205	28948	91%	35%	48%	17%	Totonicapán
Sololá	52%	26%	74%	10453	29118	91%	29%	50%	21%	Sololá
Total Urban	53%	70%	30%	1104829	475621	49%	65%	30%	5%	**Total Urban**

Data from the National Survey of Living Conditions (ENCOVI-2011), National Institute of Statistics.

TABLE A5.3. No Correlation between LPG Price and Consumption, 2003 – 2015



* Each line represents the monthly consumption and price of LPG during the corresponding year. Years 2003 (blue diamond) to 2014 (orange triangle) are included.
In 2015, data is available only for January (red cross).
Statistics from the Ministry of Energy and Mines, Direction of Hydrocarbons (www.mem.gob.gt)

TABLE A5.4. Wood balance

Department ordered by increasing wood balance	Balance (biomass tons/year)	Balance (biomass tons/year/capita)
San Marcos	-1,624,757	-1.59
Huehuetenango	-1,594,779	-1.39
Totonicapán	-594,149	-1.26
Sololá	-521,977	-1.21
Quetzaltenango	-752,738	-0.95
Jutiapa	-409,624	-0.94
Jalapa	-289,266	-0.92
Retalhuleu	-266,370	-0.88
Quiché	-817,652	-0.86
Chimaltenango	-484,707	-0.80
Chiquimula	-281,327	-0.76
Escuintla	-415,905	-0.59
Santa Rosa	-198,600	-0.58
Sacatepéquez	-115,951	-0.37
Zacapa	-38,310	-0.17
El Progreso	-23,044	-0.15
Guatemala	-431,687	-0.14
Baja Verapaz	-36,739	-0.14
Suchitepéquez	-48,011	-0.10
Alta Verapaz	353,572	0.32
Izabal	354,183	0.86
Petén	2,512,546	4.00
TOTAL	-5,725,290	-0.39

Data from the National Institute of Forestry (Instituto Nacional de Bosques, 2012: Oferta y demanda de leña en la República de Guatemala / Woodfuel Integrated Supply/Demand Overview Mapping)

TABLE A5.5. Retailers with license, 2014

	Retailers with license* by 100,000 households (end of 2014**)		Retailers with license* by 100,000 households (end of 2014**)
Alta Verapaz	8.5	Peten	2.5
Baja Verapaz	5.3	Quetzaltenango	11.1
Chimaltenango	7.0	Quiche	6.6
Chiquimula	6.8	Retahuleu	9.9
El Progreso	8.3	Sacatepequez	11.9
Escuintla	11.4	San Marcos	3.3
Guatemala	18.2	Santa Rosa	10.5
Huehuetenango	4.9	Solola	6.6
Izabal	1.1	Suchitepequez	8.9
Jalapa	11.1	Totonicapán	2.3
Jutiapa	6.1	Zacapa	9.9
		Total Guatemala	9.9

* They represent only a part of total retailers (number of retailers without licenses is unknown).
** These numbers are valid only at the indicated date. The market of retailers is quite dynamic, with frequent changes in the list of operating retailers.
Data received from the Ministry of Energy and Mines, Direction General of Hydrocarbons.

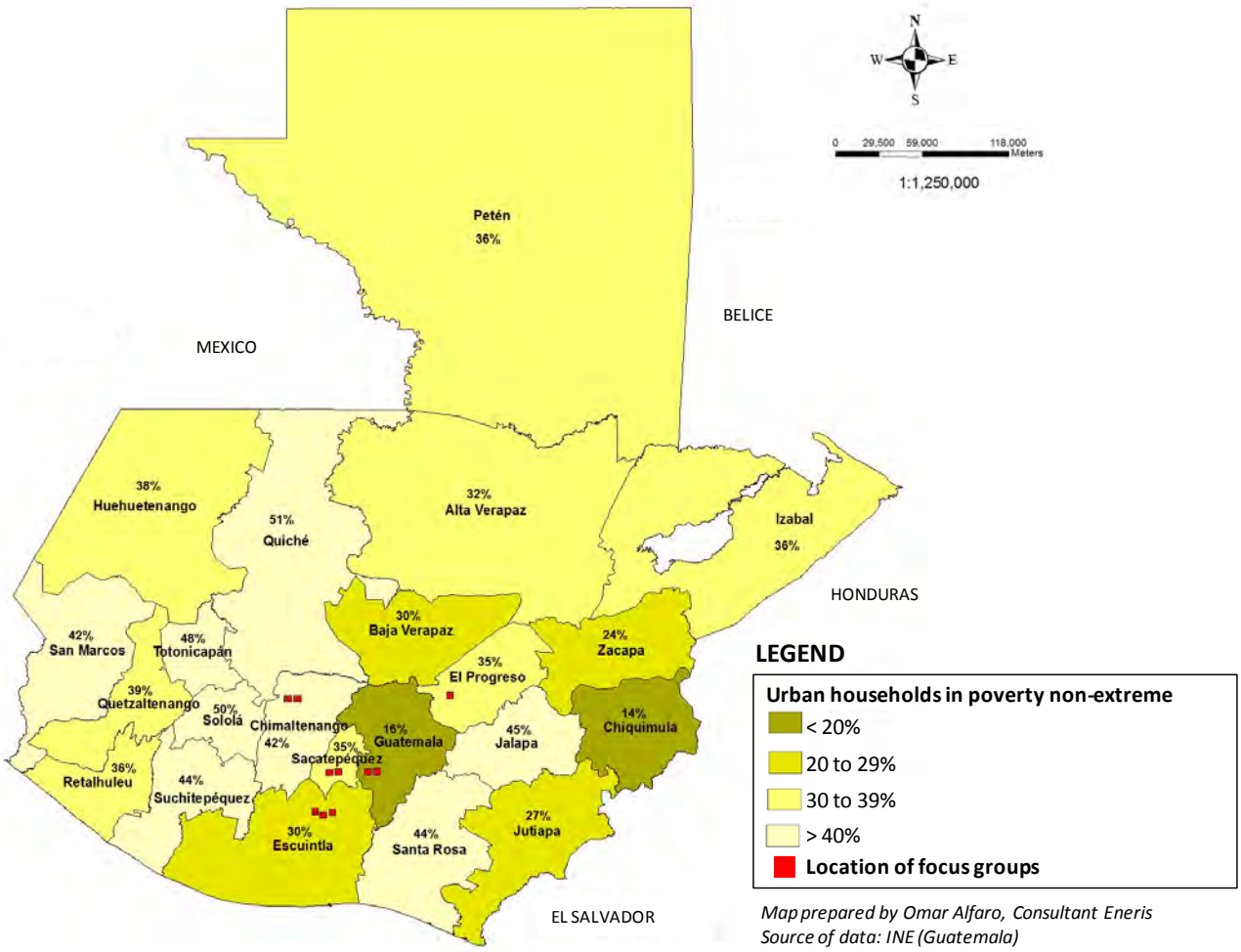
TABLE A5.6. LPG plants in 2014

No.	Name	Municipality	Department	Capacity (gallons)
RUTA 1 - CIUDAD CAPITAL / CAPITAL CITY				
1	Gas Zeta, S.A.	Villa Nueva	Guatemala	330,225
2	Guategás	Mixco	Guatemala	63,000
3	Gas Metropolitano	Guatemala	Guatemala	264,180
4	Gas Único	Guatemala	Guatemala	39,230
5	Tropigás de Guatemala, S.A.	Guatemala	Guatemala	270,144
6	Móbilgas	Fraijanes	Guatemala	2,320
7	Venta de Gas Propano La Ceiba	Guatemala	Guatemala	3,320
8	Gas Zeta Planta Atlántico	Guatemala	Guatemala	118,881
9	Gas Único	Guatemala	Guatemala	39,290
10	Gas Metropolitano	Guatemala	Guatemala	43,508
11	Mac Gas	Mixco	Guatemala	4,721
12	Orwal	Villa Nueva	Guatemala	12,000
13	Gases de Milpas Altas	Santa Lucía Milpas Altas	Sacatepéquez	1,320
14	Rapigás	Villa Canales	Guatemala	2,000
15	Gas Trinidad	Guatemala	Guatemala	1,500
16	Gas La Promesa	Palín	Escuintla	1,250
17	Gas Los Primos	Villa Nueva	Guatemala	3,600
RUTA 2 - OCCIDENTE / WEST				
18	Gas Metropolitano	El Tejar	Chimaltenango	53,000
19	Gas Chimalteco	Chimaltenango	Chimaltenango	13,265
20	Gas Zeta Planta Chimaltenango	Chimaltenango	Chimaltenango	40,000
21	Gas Interamericano	Patzicía	Chimaltenango	10,000
22	Gas Metropolitano, S.A., 4 Caminos	San Cristóbal Totonicapán	Totonicapán	59,950
23	Gas Zeta Planta Salcajá	Salcajá	Quetzaltenango	40,000
24	Tropigás de Guatemala, S.A.	Quetzaltenango	Quetzaltenango	64,000
25	Mipgas	Cantel	Quetzaltenango	2,000
26	Gas Único	Cantel	Quetzaltenango	60,000
27	Gas de Centro-Occidente	San Juan Ostuncalco	Quetzaltenango	3,900
28	Gas de Nor - occidente	Cabricán	Quetzaltenango	1,300
29	Negogas	Chimaltenango	Chimaltenango	2,600
RUTA 3 - SUROCCIDENTE / SOUTHWEST				
30	Zeta Gas de Centro América	Puerto San José	Escuintla	18,000,000
31	Guategás	Escuintla	Escuintla	33,025
32	Guategás	Escuintla	Escuintla	18,000
33	Gas Zeta, Planta Escuintla	Escuintla	Escuintla	30,000

No.	Name	Municipality	Department	Capacity (gallons)
34	Planta de Gas Chipó	Río Bravo	Suchitepéquez	2,400
35	Gas Metropolitano, Cuyotenango	Cuyotenango	Suchitepéquez	60,000
36	Gas Zeta Planta Retalhuleu	San Sebastián	Retalhuleu	42,000
37	Tropigás de Guatemala, S.A.	Retalhuleu	Retalhuleu	23,321
38	Guategás	Ayutla	San Marcos	30,000
39	Zeta Gas de Centro América	Ayutla	San Marcos	264,180
40	Gas Metropolitano	Ayutla	San Marcos	320,225
RUTA 4 - ORIENTE/EAST				
41	Gas Metropolitano, S.A.	El Progreso	Jutiapa	21,000
42	Gas Metropolitano, S.A.	Jalapa	Jalapa	21,000
43	Guategás - Chiquimula	Chiquimula	Chiquimula	30,000
44	Gas Zeta, Planta Zacapa	Estanzuela	Zacapa	40,000
45	Gas Metropolitano, S.A.	Zacapa	Zacapa	20,000
46	Gas Metropolitano, S.A.	Morales	Izabal	30,000
47	Gas Único	Puerto Barrios	Izabal	30,000
48	Gas del Pacífico, S.A.	Puerto Barrios	Izabal	1,700,000
RUTA 5 - NORTE/NORTH				
49	Gas Único	San Antonio La Paz	El Progreso	330,000
50	Mini Planta J & J	San Agustín Acasaguastlán	El Progreso	1,800
51	Gas Metropolitano, El Rancho	San Agustín Acasaguastlán	El Progreso	37,000
52	Gas Zeta, Planta Cobán	Cobán	Alta Verapaz	30,000
53	Gas Metropolitano	Cobán	Alta Verapaz	21,000
54	Gas Metropolitano	San Benito	Petén	22,078
TOTAL				
			TOTAL	22,707,533

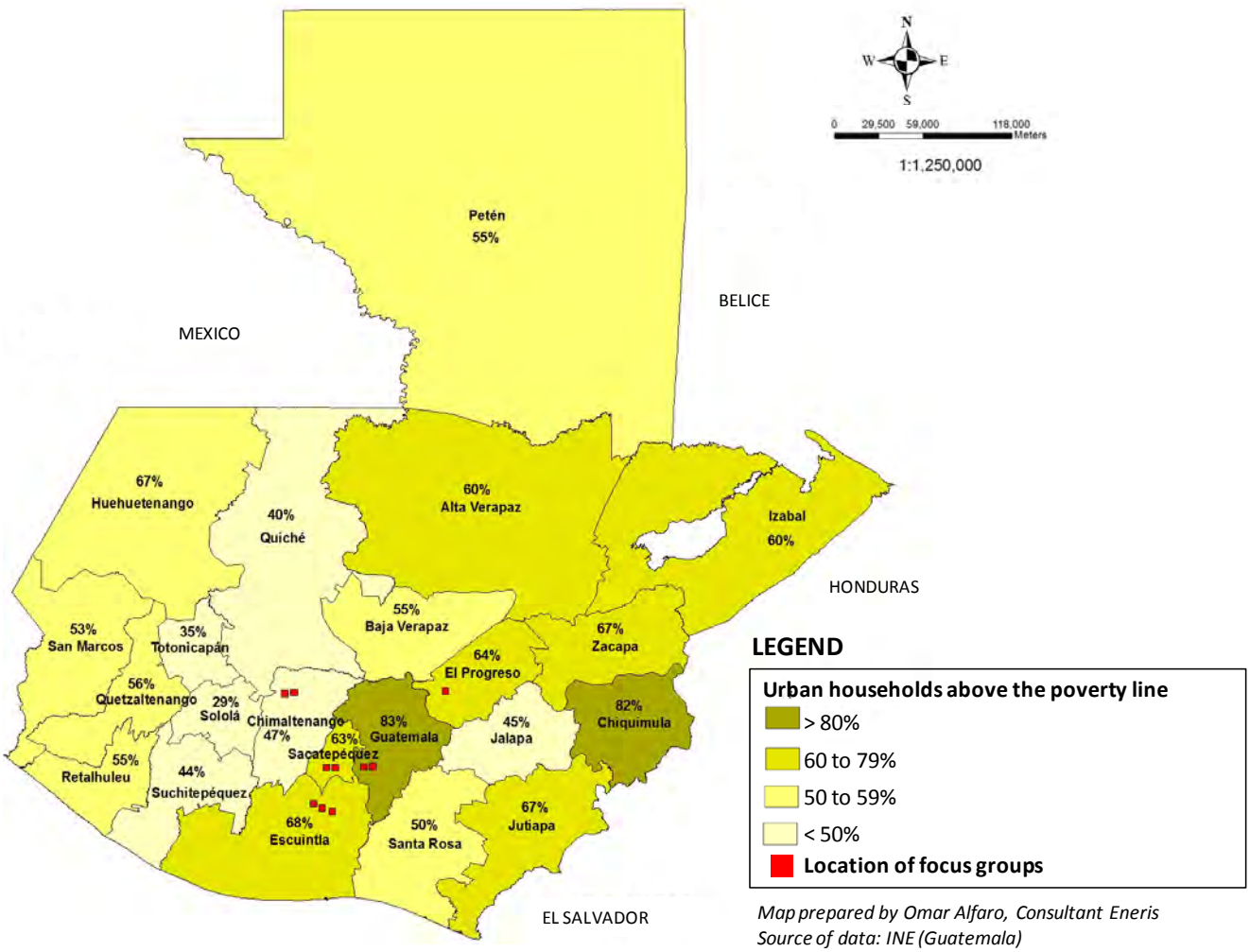
Data received from the Ministry of Energy and Mines, Direction of Hydrocarbons

MAP A5.1. Households in Non-Extreme Poverty* in Guatemala



*Poverty (excluding extreme poverty) is defined as expenditures between GTQ 4,380 (US$ 580) and GTQ 9,000 (US$ $1,200) per capita per year. Extreme poverty is defined as expenditures less than GTQ 4,380 (US$ 580) per capita per year.

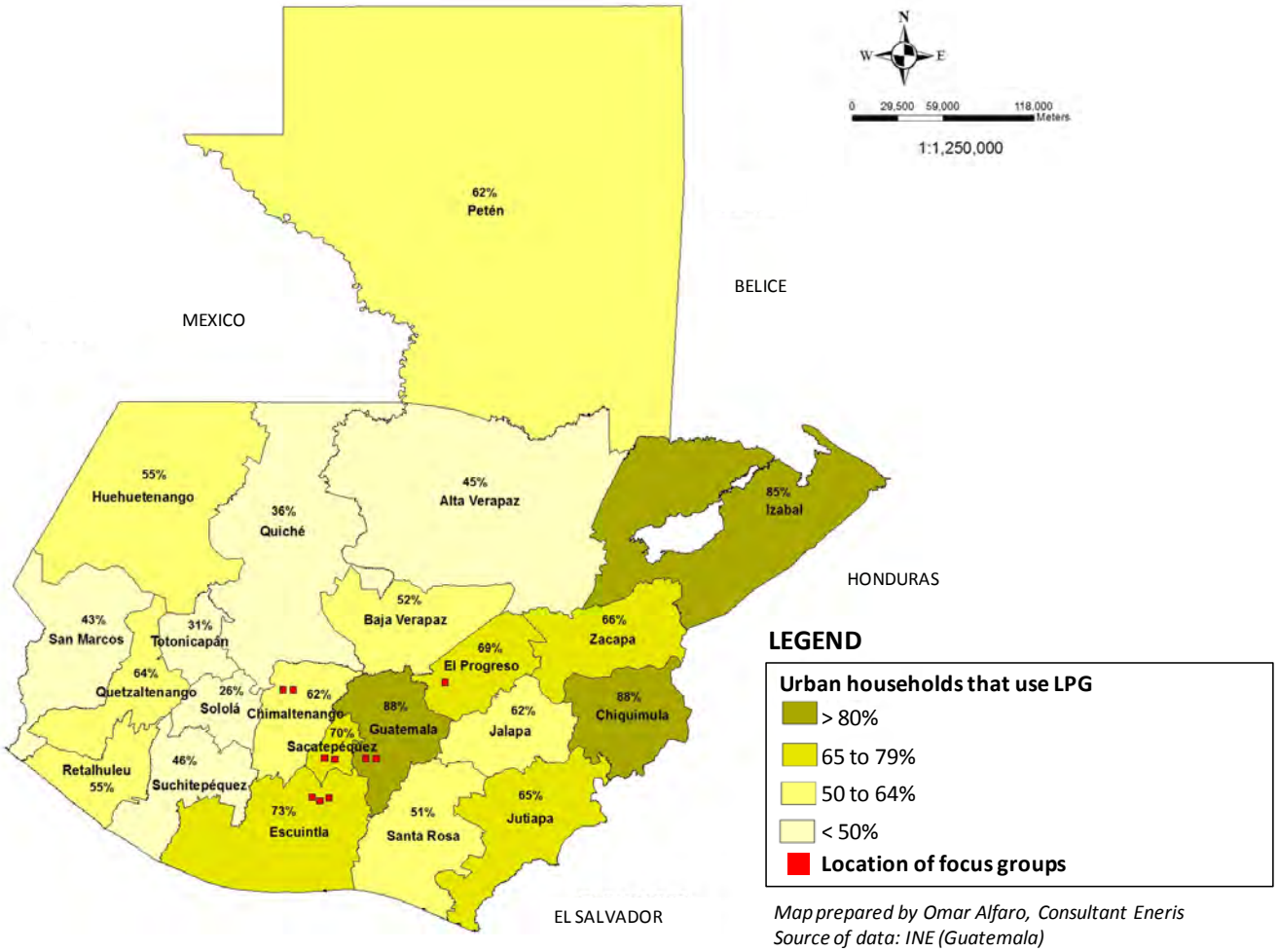
MAP A5.2. Households Above the Poverty* Line in Guatemala



Map prepared by Omar Alfaro, Consultant Eneris
Source of data: INE (Guatemala)

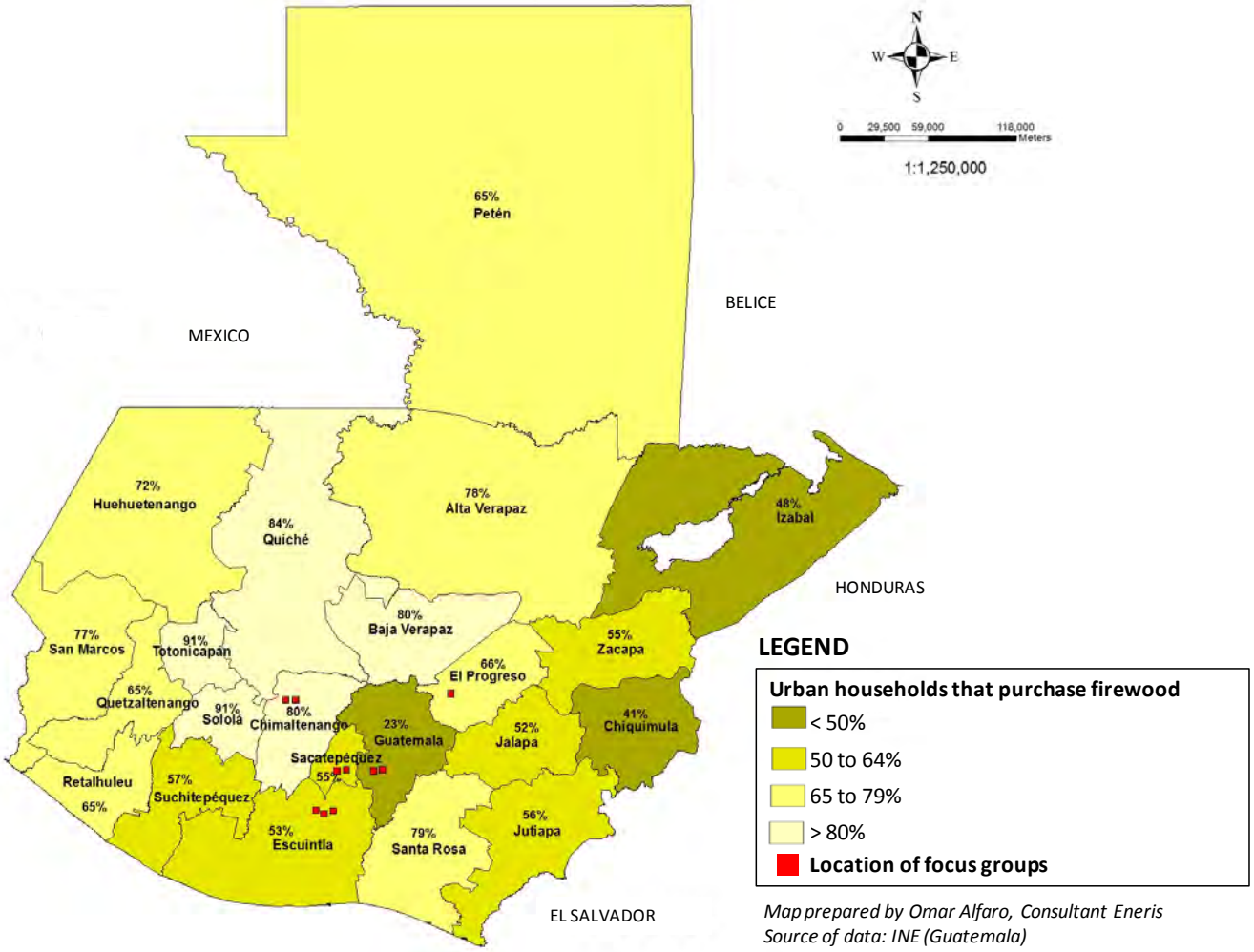
*Poverty defined as expenditures less than GTQ 9,000 (US$ 1,200) per capita per year

MAP A5.3. Urban Households that Consume LPG in Guatemala



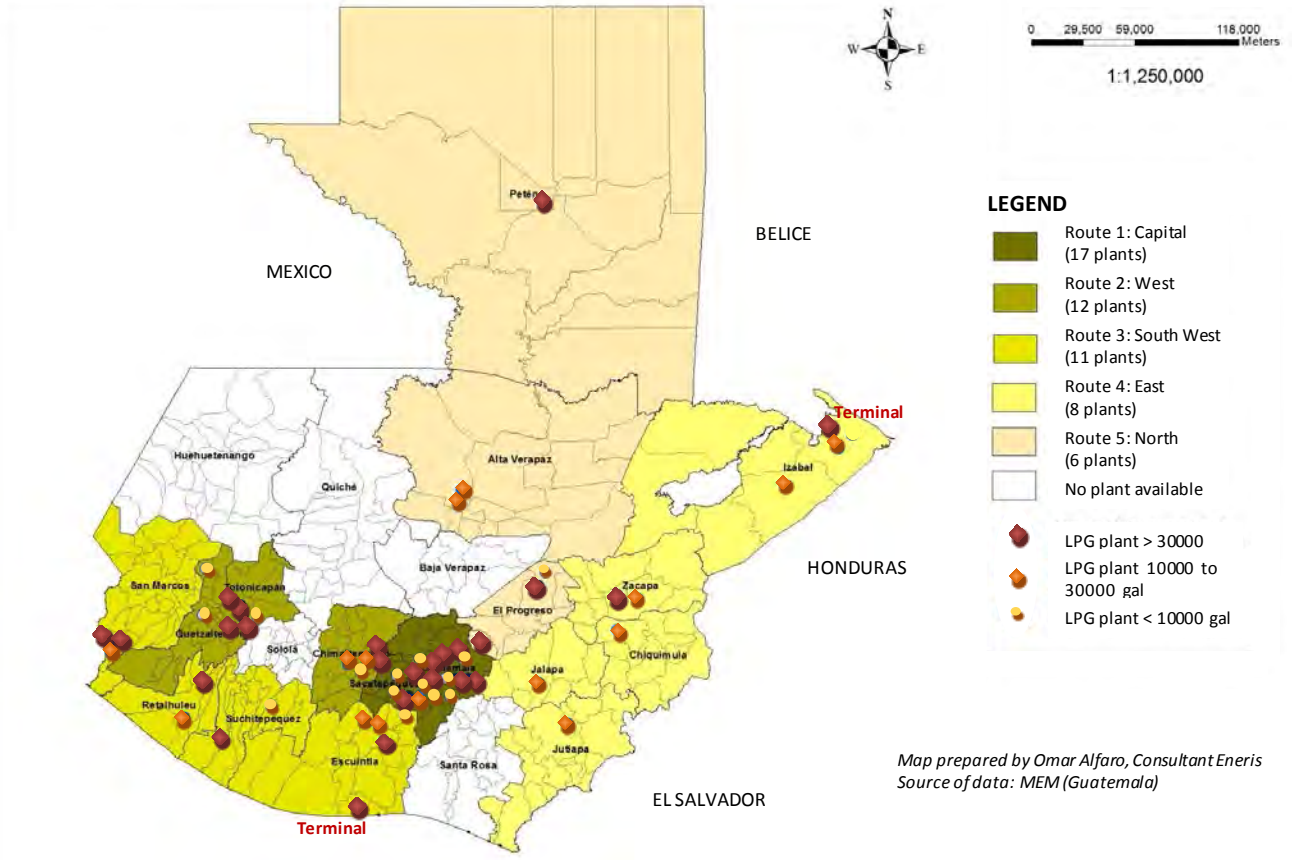
Map prepared by Omar Alfaro, Consultant Eneris
Source of data: INE (Guatemala)

MAP A5.4. Urban Households that Purchase Firewood in Guatemala



Map prepared by Omar Alfaro, Consultant Eneris
Source of data: INE (Guatemala)

MAP A5.5. LPG Plants in Guatemala



Map prepared by Omar Alfaro, Consultant Eneris
Source of data: MEM (Guatemala)

Appendix 6. International trends and recent references on LPG for cooking

International trends[35]

Supply and demand trends

Global Liquefied Petroleum Gas (LPG) production reached just over 280 million tons in 2013, up by 2.3% from 2012, while global LPG consumption rose to just over 265 million tons in 2013, up by 2.8% from 2012. North America and Middle East are the supply leaders. North American production capacities are expected to grow with the expansion in the shale gas sector. Demand is dominated by the chemical sector, especially in USA and Saudi Arabia, and by the residential/commercial sector and petrochemicals of Asia.

In industrial countries, LPG is used mostly for heating and cooking, especially in locations that are not connected to local gas distribution systems, for transportation and in the petrochemical industry. In developing countries LPG is mainly used as a cooking fuel.

Overview of key drivers and characteristics of LPG for cooking

The key factors that affect LPG adoption and use, identified in different studies, are as follows.

Benefits. Usual benefits associated with LPG are that it can be easily transported and stored, it does not need major infrastructure investment, it is more efficient and cleaner that firewood, it is convenient.

Information. Sustained education of the public, especially women, about the costs and benefits of fuel choice could promote a switch to cleaner fuels (internet, newspapers, TV, other media, face-to-face demonstrations). In low-income households, perceived health benefits of adopting improved stoves and financial benefits from fuel savings tend to be outweighed by the costs of improved stoves, even after accounting for the opportunity cost of time spent collecting biomass fuel.

Prices. LPG is predominantly used by the higher income groups in low- and lower-middle-income countries. Firewood prices would have to rise steeply before a household would consider substituting LPG for firewood. Initiatives with community kitchens, implemented in South of India, allow poor people to cook and pay in 15 minutes increments.

Subventions. Since the difference between the start-up cost and monthly LPG fuel cost is not large, subsidizing the upfront cost of LPG use may not enable many households to continue to use LPG in any significant quantity. A universal price subsidy for LPG would generally be regressive, being captured largely by middle- and high-income households, as well as vehicle owners where an automotive LPG market exists. Several countries, such as Brazil and the Dominican Republic, have moved away from price subsidies to LPG vouchers for poor families. In Brazil, through cross-subsidies from other petroleum products and regulated end-prices, LPG became

[35] This synthesis is based on references included at the end of this Appendix

highly affordable for the broad population. In 2002, under the weight of the subsidy costs, the government ended their universal subsidy program and deregulated the LPG market. As a consequence, the costs of LPG increased 20%. But in order to keep LPG prices within reach for poorer households, the government incorporated vouchers for LPG to the poor into their social welfare program, *Bolsa Familia*. In El Salvador, for similar reasons, the subsidies to LPG have been adjusted in 2011 and are now limited to households with low electricity consumption. The authorities now give the subsidy directly to consumers, either through the electricity bill for small consumers or via for a special card for households with no electricity. As a result, residential LPG consumption has decreased. In Nicaragua, some LPG distributors are exonerated from paying the VAT, and the government does subsidize fuel purchases for public transportation (taxis and buses). Through a series of policies focused around LPG subsidies, Senegal has successfully scaled up the use of LPG as an alternative to wood and charcoal for cooking (LPG is used as a primary fuel by 41% of the population). However, in 2009, Senegal was unable to pay for imports leading to a lengthy LPG supply shortage and a doubling of LPG prices. In Peru, the objective of the government is to deliver 1 million of LPG stoves and cylinders in poor households of the country.

Small cylinders. Small LPG cylinders are common only in countries with LPG price subsidies. Absent large subsidies, market forces have favored cylinders in the range of 10–15 kg as a compromise between refill costs and scale economy.

Safety. Other obstacles that arguably deter LPG use include short-selling, fires and other accidents, and fuel shortages. Weak regulatory frameworks for safety, inadequate information on safety issues, and weak enforcement of regulations are usual issues observed in countries. Several measures can tackle unsafe practices, such as a clear definition of cylinder ownership; assignment of legal responsibility for cylinder maintenance, repair, and replacement; effective enforcement; proper training of operators throughout the supply chain; establishment of a registry of certified installers and inspectors; extensive education campaigns for end-users; and penalties for companies that refill unsafe cylinders.

Cylinder management. Most countries have a centralized filling of cylinders in which the cylinder is owned by the LPG marketer and empty cylinders are returned to filling plants through the same network. This is easier to implement and better adapted to early-stage markets. Columbia recently put in place such a system, replacing the decentralized management system which was implemented, where the cylinder is owned by the user. The main motivations included the low quality of the cylinders, bad practices, and no identified ownership of many cylinders. Ghana, Haiti and the Dominican Republic have implemented a decentralized system.

Multi-fuel. Multi-fuel consumption (fuel stacking) provides a sense of energy security, since complete dependence on a single fuel or technology would leave households vulnerable to price or income variations and unreliable services, especially in the case of LPG.

Recent references on LPG for cooking

Cecelski E. and Matinga M. 2014. Cooking with Gas: Why women in the developing world want LPG and how they can get it. Report developed for the World LP Gas Association by ENERGIA International Network on Gender and Sustainable Energy. France, 71 p.
The report explores the benefits for women of LPG use for cooking, as well as the measures and interventions that governments and companies can implement, with the involvment of women, to increase the access to LPG as a cooking fuel

Malla S. and Timilsina G.R. 2014. Household Cooking Fuel Choice and Adoption of Improved Cookstoves in Developing Countries. A Review. Policy Research Working Paper 6903. The World Bank, Development Research Group, Environment and Energy Team, USA, 50 p.
This report reviews empirical studies that analyze choices of fuel and adoption of improved stoves for cooking in countries where biomass is still the predominant cooking fuel. The review highlights the wide range of factors that influence households' cooking fuel choices and adoption of improved stoves, including socioeconomic (access and availability, collection costs and fuel prices, household income, education and awareness), behavioral (food tastes, lifestyle), and cultural and external factors (indoor air pollution, government policies).

Kojima M. 2011. The Role of Liquefied Petroleum Gas in Reducing Energy Poverty. Extractive Industries for Development Series #25. World Bank, Sustainable Energy Department, Oil, Gas, and Mining Unit, USA, 95 p.
The study is based on three separate but complementary analyses of factors affecting LPG use in developing countries: (1) econometric analysis in 10 developing countries (Guatemala, India, Indonesia, Kenya, Pakistan, Sri Lanka, Albania, Brazil, Mexico, and Peru) that assessed the factors influencing LPG selection and consumption; (2) examination of LPG markets in 20 developing countries; and (3) data from households in 110 developing countries about energy choices related to cooking.

Kojima M., Bacon R. and Zhou X. 2011. Who uses bottled gas? Evidence from households in developing countries. Policy Research Working Paper 5731. World Bank, Sustainable Energy Department, Oil, Gas, and Mining Unit, USA, 61 p.
Household surveys in Guatemala, India, Indonesia, Kenya, Pakistan, and Sri Lanka were analyzed using a two-stage Heckman model to examine the factors influencing the decision to use liquefied petroleum gas and, among users, the quantity consumed per person.

Matthews WG. and Zeissig H. R. 2011. Residential Market for LPG : A Review of Experience of 20 Developing Countries. For the World Bank, USA, 196 p..
The study takes 20 developing countries from around the world and assesses the legal framework, industry and market structures and practices, supply arrangements and infrastructure, and pricing policies. The information from developing countries is supplemented by case studies of Ontario, Canada and Texas, United States to illustrate how markets with a strong legal framework and market governance operate.

Sepp S. 2014. Multiple-Household Fuel Use – a balanced choice between firewood, charcoal and LPG. GIZ, Germany, 41 p.
The report compares advantages, inconveniences and limitations of firewood, charcoal and LPG and illustrates how these sources should be considered jointly within a comprehensive, inter-sectoral energy strategy.

World LP Gas Association. 2013. Guidelines for the Development of Sustainable LP Gas Markets: Early-Stage Markets Edition. France, 73 p.
The purpose of these guidelines is to assist countries seeking to realise large-scale adoption and use of LP Gas by households and businesses on a commercially sustainable basis. It focuses specifically on countries where LP Gas use per capita is still low: below 10 kg per capita per year, and typically around 2 kg per capita per year. It focuses on: the Role of LP Gas cylinders; the unique and critical role of government, fiscal and pricing policies regarding fuels and equipment.

World LP Gas Association. 2014. Guidelines for the Development of Sustainable LPG Markets. Transitioning-Stage Markets. 31 p
The purpose of these guidelines is to assist countries seeking to realise large-scale adoption and use of LP Gas by households and businesses on a commercially sustainable basis. It focuses specifically on countries with advanced markets, where LP Gas consumption is typically around 15 kg per capita per year. It introduces recommendations for: safeguarding and building upon the benefits achieved during a positive early-stage LPG market development experience; supporting increased scale and scope of LPG use; detecting and preventing market dysfunction.