Final report

Microfinance for clean cooking

What lessons can be learned for scaling up LPG adoption in Kenya through managed loans?

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Project summary

This study investigates the uptake and impacts of a pilot initiative in Kenya (*Bottled Gas for Better Life*) to enable low-income households to access liquefied petroleum gas (LPG) for clean cooking through a microfinance loan. The loan covered the cost of a set of equipment enabling the user to start cooking with LPG.

By promoting access to clean cooking fuel over solid fuels (e.g. charcoal, firewood), the project seeks to understand policies that can promote better health through cleaner household air and improve standards of living in both urban and rural areas, while limiting forest degradation from charcoal and firewood production and use. This pilot contributes data and lessons that will allow stakeholders to determine whether LPG household use can and should be scaled up among the poor as part of regular microfinance lending operations across Kenya. Findings will be used to determine the need and potential for a larger scale, self-sustaining lending initiative that is commercially sustainable for local financial institutions and would enable more people across Kenya to cook with LPG.

Introduction

Lack of access to clean energy for cooking is responsible for a high mortality and impaired quality of life for millions of people in low and middle-income countries (LMICs), who are exposed to hazardous smoke from cooking with solid fuels and kerosene. Sub-Saharan Africa is particularly affected, with more than 400,000 deaths each year attributable to household air pollution (HAP) from solid fuels (HEI, 2019). The World Health Organization (WHO) Indoor Air Quality Guidelines recommend a greater emphasis on access to clean fuels to address this burden, while recognizing the challenges of achieving this in resource-constrained settings (WHO, 2014).

LPG is a clean-burning and portable fuel that has the potential to rapidly contribute to achieving the United Nations' Sustainable Development Goal 7 (SDG 7)—ensuring universal energy access—while also delivering better health for women and children (SDG 3), protecting the environment (SDG 13) and improving well-being and creating economic growth (SDG 8). LPG is currently used by 2.5 billion households for cooking in LMICs. The International Energy Agency (IEA) identifies LPG as a key fuel choice for substantially reducing energy-related pollutant emissions, projecting LPG as the clean cooking fuel to be used by 1.4 billion people in the developing world by 2030 (IEA, 2017).

The adoption rate of clean cooking fuels in Kenya was less than 12% in 2014 (DHS Report 2014), resulting in unsustainable demand for biomass fuel. However, the use of LPG as primary fuel for household cooking has grown from 3.5% of households in 2005/6 to 13.4% in 2015/16 according to data from the Kenya Integrated Household Budget Survey (KIHBS, 2018). 31% of urban households and 3% of rural households consumed LPG as a primary fuel and 9% and 5% respectively consumed LPG as a secondary fuel in 2016 (KIHBS, 2018).

The Government of Kenya has set a policy goal of 35% of the population using LPG for cooking by 2030 to reduce reliance on charcoal and kerosene. Working through state-owned National Oil Corporation of Kenya (NOCK), the government began offering LPG cooking equipment (6 kg cylinder with ringtop burners) at a discount to poorer rural households in 2018 through the "Mwananchi Gas program"[1]. However, the program was put on hold shortly before the formal launch (after a pilot in two counties) due to a number of operational and legal issues, and is being redesigned with smaller target numbers.

While at the macro-level many countries, including Kenya, have plans in place to scale up LPG supply (Van Leeuwen, Evans, & Hyseni, 2017), there is concurrent need for effective action at the micro-level to help credit constrained households, especially in rural areas, to adopt such clean cooking fuels. This study evaluated a pilot microloan intervention to help credit constrained households in rural Kenya afford the upfront cost (9,900 Ksh or US$ 96.20) of purchasing equipment to cook with LPG. The loan was to be re-paid in equal monthly installments over six months, including commercial interest rates. Beneficiaries of the program also received a demonstration and printed materials on how to cook with LPG equipment efficiently and safely.

[1] See: https://nationaloil.co.ke/gas-yetu-the-mwananchi-gas/

Aims and objectives

This study aimed to advance our understanding of how interventions such as microfinance may lower the entry cost barrier to become users of LPG for clean cooking, in order to inform national government policy in Kenya and beyond. Specific objectives for this study were to:

(1) Examine whether the provision of microloans for upfront LPG switching costs is effective in driving low-income households to switch from solid fuels/kerosene to cooking with LPG;
(2) Examine the effects of LPG uptake on self-reported health symptoms, well-being and time use;
(3) Determine if a commercially acceptable percentage of the loans is repaid so that lenders are encouraged to embark on a larger roll-out;
(4) Understand the household decision-making process in signing up for the loan;
(5) Pave the way for a more in-depth evaluation of an expanded second program phase to be designed based on the successful repayment rates from the initial pilot.

Literature review

HAP is considered a major cause worldwide of premature death and impaired quality of life (Smith KR., 2014; WHO, 2018). HAP has been linked to diseases in adults such as chronic obstructive pulmonary disease (COPD), lung cancer, cardiovascular disease and acute lower respiratory infection (ALRI) in children plus other health conditions including adverse pregnancy outcomes, cataracts in women, etc. Although HAP has many sources, the use of solid fuels for cooking (e.g. wood, animal dung, charcoal, crop wastes) and kerosene for cooking and lighting, are major sources, releasing harmful compounds including fine particulate matter ($PM_{2.5}$), carbon monoxide, and polycyclic aromatic hydrocarbons (Naeher LP et al., 2007).

Transitioning to cleaner fuels such as LPG for cooking – the focus of this evaluation – has been shown to cause a large reduction in HAP leading to health benefits and have impacts on time savings from faster cooking and eliminating the need to collect firewood. Much existing research on reducing HAP from cooking has focused on improved solid fuel cookstoves, with less attention placed on the benefits of switching to clean fuels, which have the potential to drastically reduce HAP (Puzzolo, Pope, Stanistreet, Rehfuess, & Bruce, 2016). Given that the relationship between HAP and health outcomes is non-linear (Burnett et al., 2014), large returns to health may only be achieved with energy sources such as electricity and LPG that can reduce HAP to low levels regarded as safe according to World Health Organization Guidelines (Rosenthal, 2018; WHO, 2014).

However, there are many barriers that prevent greater household adoption and sustained use of LPG for cooking, particularly in LMICs. Puzzolo et al. (2016)'s systematic review and other more recent studies (Hollanda & al., 2017; Puzzolo et al., 2016; Ronzi S et al., 2019) identify costs (for both the initial equipment and subsequent refills) as a key barrier, followed by a lack of reliable supply and inability to cook certain traditional dishes with LPG such as chapatti or tortillas. Recent studies also point to the length of and familiarity with LPG usage relating to higher LPG usage (Jain et al., 2018; Sharma, Parikh, & Singh, 2019).

In this research project, we evaluate an intervention to mitigate the high upfront cost of the LPG equipment (i.e. microfinance) while taking into consideration complementary factors identified in the literature, such as household knowledge and fuel availability (Puzzolo et al., 2016). Our study relates to Alem et al. (2015), which examines credit constraints in LPG adoption in an urban setting in Tanzania. The study found that credit constraints were a barrier to adoption and the provision of microcredit or fuel subsidy acted as enabler of LPG uptake with concomitant reduction in charcoal use (Alem,

Ruhinduka, Berck, & Bluffstone, 2015). Differently from the Tanzanian study, this project examines LPG adoption in a rural setting where biomass is accessible for free. In addition, the socioeconomic context as well as baseline knowledge of LPG and access to LPG sales points are different from an urban setting, and this evaluation is grounded on a real world commercial micro-lending program not designed for research purposes.

Methods

Intervention: A microloan pilot scheme was launched under the Global LPG Partnership (GLPGP)'s *Bottled Gas for Better Life* initiative to provide LPG equipment to up to 150 households through a managed loan, paid back over a 6-month period. The loan (with interest of 1.083% per month on the balance) covered the supply of LPG equipment, which included a two-burner stove, 13kg cylinder with an initial supply of LPG, regulator and hose. The larger cylinder and double burner stove were offered to encourage more sustained use of LPG (many LPG users in Kenyans use a 6kg cylinder with ringtop burner instead).

The average deposit paid by a participant at the beginning of the loan period was 2,706 Ksh (US$ 26.30). In addition, a small retail outlet with LPG cylinders was installed in the pilot community as part of the intervention to facilitate access to refills.

The scheme was launched by GLPGP in partnership with Equity Bank Ltd (the largest retail bank in Kenya) and Equity Group Foundation (the social arm of the Equity Bank Group) as the financial partner, and National Oil Company of Kenya as the gas and equipment provider. An informal "table banking" organization, the Socio-Economic Mobilisation Agency (SEMA)[2], also financed some of their members to acquire the LPG equipment. The intervention was rolled out between August 2018 and December 2018, and 69 households signed up for the program and received the equipment (an additional 40 were put on a waiting list). Our study was carried out within program parameters (number of microloan recipients, location, schedule) pre-determined by GLPGP and the Kenyan implementing partners.

To evaluate the impacts of the microloan intervention, we conducted a cross-sectional study with face-to-face and telephonic surveys completed approximately 5.2, 6.7, and 7.5 months after households received the equipment through the program.

Study setting and sampling design

The study population consisted of households that participated in groups of borrowers organized by Equity Bank and SEMA. These households were given the opportunity to participate in the *Bottled Gas for Better Life* microfinance program, by taking a loan through either Equity Bank or SEMA. They resided largely in an area within and around Magumu ward in Kinangop, Nyandarua County (the former Central Province of Kenya). About 16% of residents in Nyandarua County have no formal education, and 38% do not have education beyond primary school (Exploring Kenya's Inequality 2009). At the time of the study, SEMA operated about 63 groups in Magumu area alone.

[2] SEMA is registered as a social welfare organisation, and conducts the business of table banking. Members save and borrow money from their own revolving fund, in a group set-up, under a Project Coordinator who ensures members follow the agreed rules, are disciplined and all benefit. A typical group has 15 members, from one village and with a common economic activity such as farming or small scale trading.

Program beneficiaries were households of group members who voluntarily took up a loan to purchase LPG equipment or paid for the equipment in cash. In addition, we surveyed "group member non-beneficiaries" who also received information about the program but chose not to participate, as well as a convenience sample of "non-group member non-beneficiaries" who reside in the same area as the beneficiaries and group member non-beneficiaries. They were used as a control group. Our target respondent within the household was the person responsible for most cooking in the household and familiar with household spending on cooking fuels.

Data collection

We conducted a main cross-sectional face-to-face survey with program beneficiaries and group member non-beneficiaries, followed by two telephonic follow up surveys with program beneficiaries only. We surveyed all program beneficiaries and group member non-beneficiaries who were exposed to the LPG program messaging. Program beneficiaries were self-selected; they were group members who voluntarily chose to register for the program. We also surveyed a convenience sample of non-group member non-beneficiaries of 149 households, who were chosen from among pedestrians in one of the two population centers in which the groups regularly met.

The main survey was conducted over 3 weeks in March 2019, which was on average 5.2 months after receiving the equipment. The first phone follow-up was conducted in May 2019, which was on average 6.7 months after receiving the equipment. The second phone follow-up was conducted in June 2019, which was on average 7.5 months after equipment was received. The two follow-up surveys were administered primarily to collect information about loan repayment and expenditures on LPG refills.

For the main survey, we contacted members of each group that was given information about and access to the program. Each group was organized either under Equity Bank or under SEMA. Interviews took approximately thirty minutes. Most often they took place at or near the site of the meetings (weekly in the case of Equity Bank groups and monthly in the case of SEMA groups). Research staff working under REMIT-Kenya (a consultancy firm specializing in survey data collection) administered all surveys. Fieldworkers received training in March 2019. All survey interviews were conducted in Swahili and data was recorded electronically.

Results

A total of 69 households ("program beneficiaries") received LPG equipment through *Bottled Gas for Better Life*, of which 54 signed up for the loan ("loan recipients") and 15 paid for the equipment in cash. All program beneficiaries were surveyed (n=69). 35 took the offer from Equity Bank (including the 15 who paid up front in cash) and 34 took the same package through SEMA. Program beneficiaries who took the loan through Equity Bank were subject to an application process and credit check, while SEMA applicants were also subject to a screening process taking into account their existing loans and savings. Not all the loan recipients took loans for the full cost of the equipment (9,900 Ksh); some took smaller loans.

From the Equity Bank officials, we learned that 7 applicants were not granted a loan. Four of these were rejected because the applicant had other Equity Bank loans in arrears, and the remaining three because either the applicant or co-applicant failed the Bank's vetting process. SEMA, on the other hand, registered 74 members who were interested in obtaining the equipment on loan. Only 34 were able to

receive the equipment by December 2018. This is because SEMA's funds were limited and SEMA does not normally process new loan applications towards the end of the year/beginning of January, as members' contributions during that period are reserved for end-of-year bonuses and loans for school fees. The remaining 40 SEMA members were put on a waiting list.

In addition to the program beneficiaries, we surveyed 183 households ("group non-beneficiaries") who participated in a group whose members were given the opportunity to participate in the LPG microfinance program, but did not do so for reasons reported later in this section.

Key baseline characteristics are shown in Table 1 for program beneficiaries (n=69), Equity Bank and SEMA group non-beneficiaries (n=183), and non-beneficiaries that were not part of a lending group that received information about the program (n=149).

Program beneficiaries and non-beneficiaries appear largely similar along observables. The average respondent age for both groups was about 44 years, with slightly more women than men among the beneficiaries (66% female) as compared to the non-beneficiaries (55% female). Levels of education and monthly income were similar in both groups.[3] The median program beneficiary had a monthly income between 15,001 Ksh and 25,000 Ksh (US$ 146-243), while the median non-beneficiary had a monthly income between 5,001 Ksh and 15,000 Ksh (US$ 49-146), (see Figure 1). The most common sources of livelihood were farming (55% of group members reported farming as a source of livelihood) and self-employment (44% of group members reported running their own business).

Table 2 shows baseline characteristics of loan recipients and program beneficiaries who paid in cash—these groups also appeared to be largely comparable. There are no statistically significant differences between the program beneficiaries and the group non-beneficiaries. Non-group non-beneficiaries tend to be younger with lower and less seasonal incomes that tend to rely less on agriculture; other baseline characteristics appear to be balanced between beneficiaries and non-group non-beneficiaries.

Table 1 – Baseline characteristics of study participants (n=401)

	(A)		(B)		(C)			
	Program beneficiaries (SEMA and Equity Bank groups)* (N=69)		Group non-beneficiaries** (=183)		Non-group non-beneficiaries *** (=149)		P-value (difference in means, columns A vs B)	P-value (difference in mean, columns A vs C)
	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev		
Age	44.35	11.92	43.48	11.97	36.42	11.62	0.61	<0.01
Monthly income index[1]	2.72	1.03	2.82	1.33	2.33	1.11	0.61	0.03
Female (=1 if	0.55		0.66		0.64		0.11	0.19

[3] A household's monthly income index equals 1 if its monthly income is less than 5001 Ksh, 2 if it is between 5001 Ksh and 15000 Ksh, 3 if it is between 15001 KSh and 25000 Ksh, 4 if it is between 25001 KSh and 35000 Ksh, 5 if it is between 35001 Ksh and 50000 Ksh, and 6 if greater than 50000 Ksh.

female)								
At least primary school education (=1 if yes)	0.38		0.45		0.49		0.31	0.12
Farms own land (=1 if yes)	0.49		0.57		0.21		0.28	<0.01
Source of income is seasonal (=1 if yes)	0.86		0.79		0.69		0.25	0.01
Water piped in home (=1 if yes)	0.29		0.21		0.21		0.17	0.23
Has electric connection (=1 if yes)	0.87		0.87		0.86		0.92	0.84
Flush toilet (=1 if yes)	0.1		0.14		0.06		0.4	0.28

*****Includes those who took the loan (n= 54) and those who paid for the equipment in cash (n=15)
**Includes all group members (SEMA and Equity Bank) who were exposed to the messaging about the loan offer
*** Includes a convenience sample of non-group members who largely reside in the same communities as program beneficiaries and group member non-beneficiaries.

Figure 1 – Income of study participants

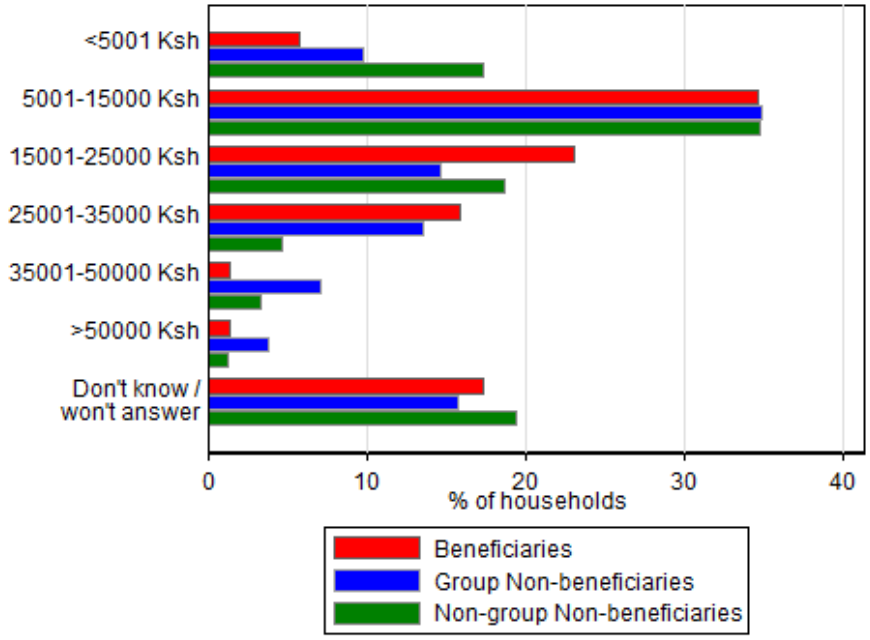
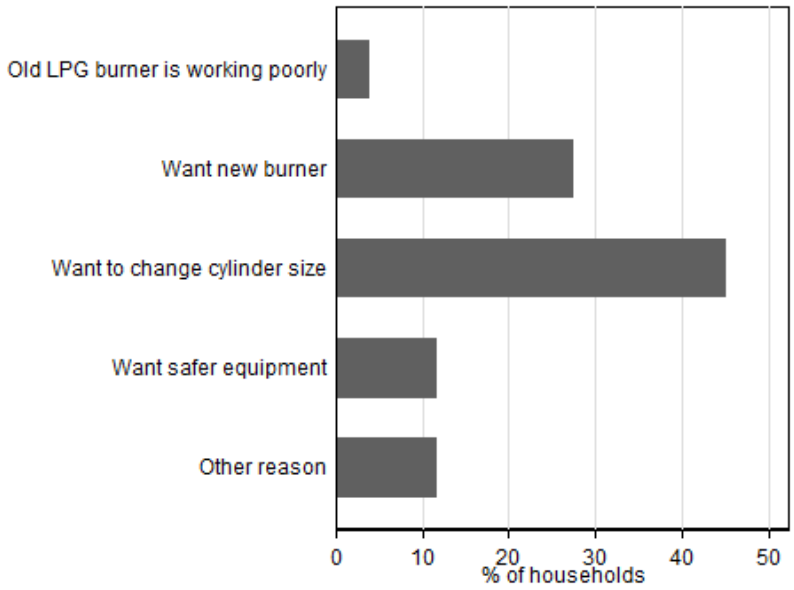


Table 2 – Baseline characteristics of program beneficiaries (n=69)

	Equipment paid in cash (n=15)		Registered for loan (n=54)		
	Mean	St. Dev	Mean	St. Dev	P-value for difference in means
Age	39.27	8.08	45.83	12.58	0.06
Monthly income index[1]	2.86	0.86	2.64	1.08	0.5
Female (=1 if female)	0.47		0.57		0.5
Respondent has at least primary school education (=1 if yes)	0.4		0.36		0.77
Farms own land (=1 if yes)	0.4		0.53		0.39
Source of income is seasonal (=1 if yes)	0.93		0.83		0.33
Water piped in home (=1 if yes)	0.2		0.32		0.37
Has electric connection (=1 if yes)	0.8		0.89		0.39
Flush toilet (=1 if yes)	0.13		0.09		0.67

Program take-up was driven by existing LPG users rather than new LPG users. 75% of the beneficiaries (n=51) had previously used LPG for cooking in their home prior to receiving equipment from this program, while 25% were new users. For comparison, among group non-beneficiaries, only 63% used LPG as a primary or secondary cooking fuel. Among those program beneficiaries who had previously used LPG, the median user had started using LPG between 1 and 2 years prior to our face-to-face survey. As shown in Figure 2, among those who were already using LPG, the most common reasons for registering for the program were to acquire a new (additional) burner or to change cylinder sizes (some respondents wished to upgrade to the larger 13kg cylinder). 7.5 months after the intervention, the vast majority of beneficiaries (88%) used a 13 kg cylinder.

Figure 2 - Reasons for registering for the loan program/wanting new LPG equipment among existing LPG user beneficiaries of the program



Group non-beneficiaries cited many reasons for not participating in the program. The most common reasons were that the respondent: already had LPG equipment (23%), did not have enough cash (16%), had another outstanding loan (11%), found the process too slow to deliver equipment (9%), and needed more information about the product or registration process (8%). Anecdotally, it was said that rains and flooding contributed to a lack of funds during this time across the region, and a few households were also said to be wary of the loan offer due to prior experiences where other banks had raised the interest rate after a loan had been approved.

Non-group non-beneficiaries

Among 149 respondents, 35 respondents (23.8%) had heard of the program. Those who had heard of the program overwhelmingly responded that the offer was a "very good value" (25 out of 35 respondents) or a "somewhat good value" (7 out of 35 respondents). However, none of these respondents had taken the offer. The most common reasons given were: not having enough cash (22.8% of respondents), having inadequate information about the program (22.8% of respondents), and already having LPG equipment (14.3% of respondents).

Fuel use for household energy needs

In our study sample, 75% of program beneficiaries (51 out of 68 beneficiaries who answered the question) had used LPG prior to the intervention.

Figure 3 shows the self-reported primary cooking fuel among program beneficiaries in the 6 months prior to delivery of the LPG equipment (left panel) and 5.2 months after delivery of the LPG equipment (right panel). This suggests that the program increased usage of LPG as the primary cooking fuel. Beneficiaries tended to use LPG as the main cooking fuel at higher rates even prior to the intervention relative to non-beneficiaries.

Figure 3: Reported primary fuel for cooking among program beneficiaries (n=69)

Prior to intervention	After intervention

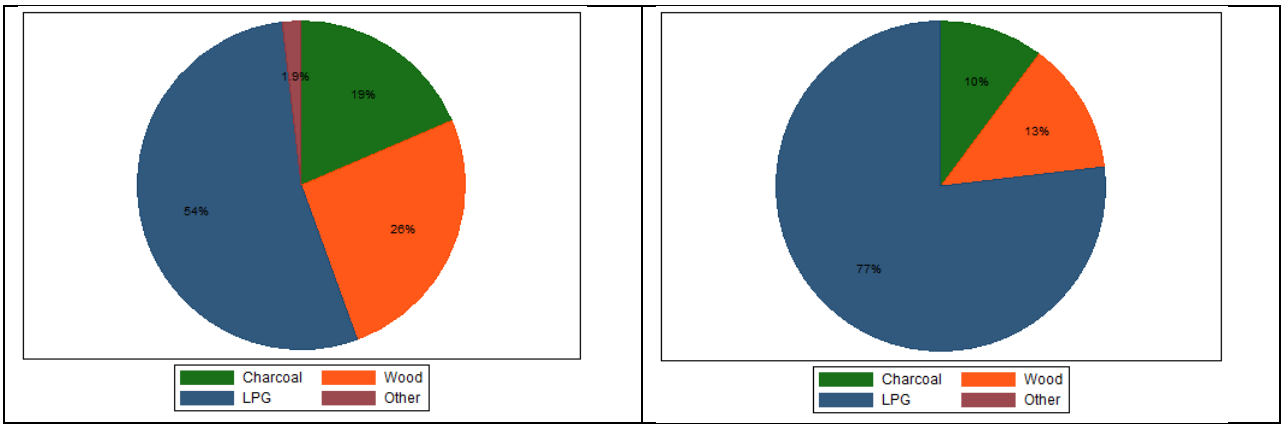
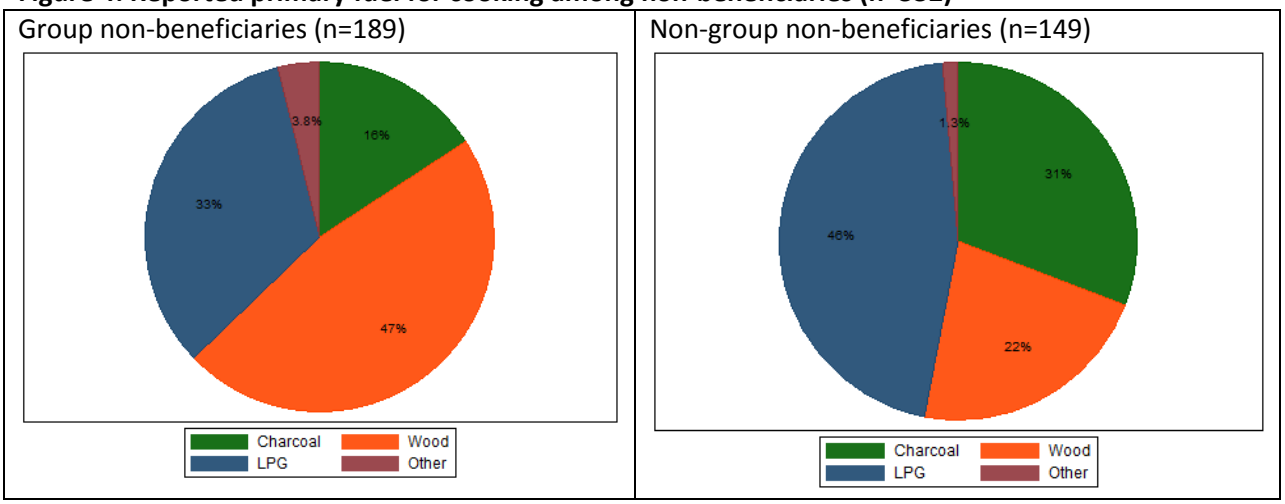


Figure 4: Reported primary fuel for cooking among non-beneficiaries (n=332)



Seven and a half months after the intervention, we found that 84% of program beneficiaries still use their old stove. This is consistent with prior work showing that stacking clean cooking fuels with other fuels is common practice (Pollard, Williams, O'Brien, & al., 2018; Puzzolo et al., 2016; Ruiz-Mercado & Masera, 2015; Thoday, Benjamin, Gan, & Puzzolo, 2018). The most common secondary fuel used was charcoal, followed by wood, and 14% of program beneficiaries reported collecting fuel for free. We find that after the intervention, beneficiaries reported wood, charcoal, and LPG as secondary fuels at higher rates, suggesting that the intervention increased the number of fuels that households routinely use for cooking. It could be inferred that while beneficiaries desired to use LPG, they were unable to use it exclusively for reasons such as cost or being unable to cook certain dishes using LPG.

The need to heat the home at night was also identified as an important characteristic among the study population. Among beneficiaries and group non-beneficiaries, we find that on average households use a heater for five months out of the year, and the vast majority of program participants (96%) used a cookstove for biomass fuels or an open fire. Having to use biomass for heating may influence the likelihood of a household to adopt LPG or transition to primary/exclusive LPG use for cooking.

LPG sustained use

On average, beneficiaries used LPG for 13.7 hours of cooking over the course of 10 cooking events in a

week (an average of 1.37 hour per cooking event), as compared to 11.2 hours of cooking over the course of 7 cooking events in a week for the household's next most-common cooking fuel (an average of 1.60 hours). In comparison, non-beneficiaries used less LPG in a week (7.4 hours of cooking) and more non-LPG fuel (15.0 hours of cooking). This suggests that the intervention was effective at increasing usage of LPG.

Our data shows that on average, a household paid 1681 Ksh (US$ 16.4) per 13kg refill (i.e. or US$ 1.3/kg), and refilled 2.4 times by 7.5 months after the intervention (approximately one 13 kg refill every three months). Among program beneficiaries, this implies an average annual expenditure on refills of 9165 Ksh (US$ 89). Average LPG consumption was calculated at 11.2 kg/capita/year.

42% of loan recipients who had purchased at least one refill said that paying for refills was difficult, suggesting that income or access to credit may constrain LPG usage. On average, beneficiaries reported traveling 49 minutes (round-trip) and spending 115 Ksh (US$ 1.10) on travel to obtain a refill. Home delivery of LPG was reported by only one beneficiary. However, when asked about reasons why they do not consume more gas, respondents rarely cite travel costs or difficulty getting gas as a major barrier (only 3 beneficiaries did so). Rather, the most common constraint that was cited was the cost of the gas refills.

Loan management and repayments

Repayment rates were relatively high. Among 54 program beneficiaries who took the loan, 93% had fully repaid by the time of the second phone follow-up at 7.5 months after the intervention. Among the three loan recipients who had yet to fully repay the loan, the average amount outstanding was 2,533 Ksh (US$ 24.60). 6% of loan recipients reported difficulty in making timely loan repayments (citing inadequate income) and 4% reported having to delay repayments.

As mobile banking is a well-established practice amongst Kenyans, those who took the loan through Equity Bank had the option to make monthly loan repayments and purchase LPG refills using the Bank's mobile money platform. According to Equity Bank, the convenience of mobile money encouraged better loan repayment practices and high repayment rates.

Health impacts

68% of beneficiaries self-reported improved health since starting to use the LPG equipment. This compares to 58% of non-beneficiaries who reported improved health since six months before the main survey. Frequently cited areas of change in health linked to cooking include discomfort in the chest and in the eyes. While only suggestive, this is consistent with the uptake of LPG leading to improved health symptoms for beneficiaries.

Only 3% of beneficiaries reported experiencing one or more burns while cooking with the new LPG equipment (one instance of touching the open flame, and two instances of a hot pot falling over). This compares to 7% of beneficiaries who reported experiencing burns when asked to think about the period prior to receiving the LPG equipment, and 10% of non-beneficiaries.

Household knowledge and perceptions

We find that most program participants perceived cooking with LPG as faster than expected (92% of households), easier than expected (85%), cleaner than expected (85%), and safer than expected (87%). Perceptions about the ease of replacing a cylinder were mixed, with 53% finding it easier than expected, while 31% found it harder than expected. Similarly, perceptions about the cost of refills were mixed with

near equal numbers finding it cheaper than expected (46%) versus finding it more expensive than expected (43%). However, many households did find refills to be more available than expected (46% as compared to 17% who found it less available than expected). This suggests that the experience of using LPG may affect knowledge and perceptions about the costs and benefits.

Limitations of the study

Our findings are subject to several important limitations. First, this is a cross-sectional study with a two-month follow-up, and so we cannot interpret differences between beneficiaries and non-beneficiaries as causal without strong assumptions. Second, we were not able to conduct a "before and after" evaluation with a survey administered prior to the intervention. This was due to logistical difficulties and delays in obtaining ethical approval for the study, and so all pre-intervention findings are based on recollection. Lastly, with only 69 program beneficiaries and 332 non-beneficiaries, our overall sample is small but covers all those exposed to the program and others from the wider community. This was driven by the implementation of the program itself, which had initial difficulties reaching potential customers through community gatherings and was not publicized by the local community chief. Targeting groups of customers organized by Equity Bank and SEMA, then, was a secondary option for the implementers, which required numerous small presentations of the program.

Conclusion and policy implications

Our study has investigated the uptake of a microfinance intervention for LPG start-up equipment (with double burner stove, 13 kg filled cylinder and accessories). 69 people took the equipment offer over a timeframe of 4 months in which the loan was offered, and an additional 40 households who were members of the informal table banking groups (SEMA) could not be granted the loan at the time of the pilot. Some potential reasons for relatively slow and lower take-up of loan offer in the Magumu ward pilot community are that (i) LPG was already quite diffused in the community; (ii) the area is a mountainous one and need for heating the home was reported for five months a year (cooking with biomass was found to be used as a source of heating in the colder months); (iii) the program was promoted primarily among group members of Equity Bank and SEMA (which is only a portion of the total population in the area); (iv) loan formalities and processing applied by standard banking systems (Equity Bank) may have discouraged registration.

In terms of population targeted, the program appeared to have limited success in introducing LPG to households that did not previously use LPG. Rather, most program participants had previously used LPG for cooking in their home and may have found the equipment offered through the loan an upgrade to their existing 6 kg cylinder with ringtop, which is the most common LPG equipment in Kenya.

While program take-up was lower than expected, positive results were observed among those who did participate. Overall, loan repayment rates were high (93% at the time of our data collection) and only 6% of loan recipients reported difficulty in making timely loan repayments. The survey data indicate that most intervention participants have a positive perception of LPG use, particularly regarding cleanliness, efficiency, ease of use, safety, and benefits to health. However, one issue identified that can be addressed at the policy level is the cost of refills.

Given the positive perceptions of LPG use, our findings suggest that household would benefit should LPG be promoted as a clean fuel on a larger scale in Kenya. However, future programs should:

1) Avoid unnecessary delays in loan processing or between loan approval and equipment delivery, as this was shown to cause attrition of some interested participants from the program;

2) Allocate sufficient resources towards awareness-raising about the loan offer, the benefits of LPG, and how to cook local dishes using LPG. As reported, a significant proportion of those who heard of the program but did not take it up cited inadequate information about the program. In addition, more attention to educating users about the cost advantages of LPG compared to other fuels is likely to encourage – beyond initial adoption – more sustained use of LPG over time. Finally, sensitization could be more targeted towards areas with a large population of non-LPG users to encourage switching to clean fuels.

There are already indications that the implementing partners see the program's strong potential for replicability and scalability. After the launch of *Bottled Gas For Better Life* in August 2018, Equity Bank partnered with a new LPG company in a separate program to provide first-time LPG users with loans to buy filled 6kg or 13kg cylinders, or a 6kg cylinder and single-burner stove package. Both Equity Bank—the largest retail bank in Kenya—and the new LPG supplier have a nationwide presence, indicating potential for further expansion of LPG microfinancing in Kenya. In addition, SEMA (as of July 2019) is organizing financing to purchase equipment for those members who had registered and were put on a waiting list due to SEMA's lack of loan capital, as well as for new applicants in the pilot area.

The fact that both financial partners see the value of scaling up LPG microlending on their own, outside of the Global LPG Partnership's *Bottled Gas For Better Life* program, shows that microfinance for LPG access has the potential to promote LPG access in a commercially viable manner. This should be taken into account in future policy efforts to increase the use of LPG, particularly for lower income populations. There is also an opportunity to extend it beyond households to include LPG for commercial use by small businesses, such as food vendors. Over time, lending institutions across Kenya could be encouraged to make LPG loans a part of their regular portfolios, making LPG available to a large population of households and businesses across the country.

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