

## Study Protocol:

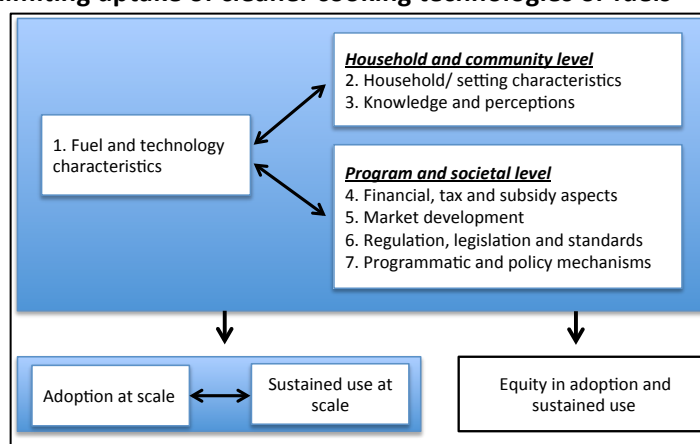
### Enhancing adoption and use of LPG: an implementation science approach to understanding key determinants and impacts of local interventions to address financial constraints. The LPG Adoption in Cameroon Evaluation-2 Study (LACE-2).

#### 1. Background

The burden of disease attributed to household air pollution (HAP) currently stands at around 4 million premature deaths per year, disproportionately carried by poorer communities and women and children from lower- and middle-income countries (Lim et al 2012). Key evidence reviews carried out for the recently published WHO guidelines recommend greater emphasis on access to clean fuels to address this burden, whilst recognizing the challenges of achieving this in lower income countries and settings, and the reality that most households use multiple fuels and technologies (WHO 2014). We undertook a mixed-methods systematic review (Puzzolo 2013) to synthesise the evidence on enablers and barriers to successful adoption and sustained use of clean cooking technologies and fuels (Rehfuess 2014; Puzzolo 2016). The review identified 31 distinct factors capable of acting as enablers and barriers to adoption and sustained use that populated 7 a-priori domains (Figure 1).

Conclusions from the review stressed that (i) all domains were important and jointly influenced adoption and sustained use of clean cooking technologies and fuels and (ii) integration between factors primarily acting at the household/ community level and factors acting at the program/ societal level are critical if programs are to reach their intended populations and be successful at scale and over extended periods of time.

**Figure 1: Framework of domains for 31 factors enabling or limiting uptake of cleaner cooking technologies or fuels**



Source: Rehfuess et al. 2014

Two critical areas of evidence require to be strengthened, to enhance political and donor commitment to expand adoption, sustained and exclusive use of clean fuel. Firstly that transition to clean fuels such as LPG can be achieved and sustained among lower income homes and communities and secondly that the use of clean fuels such as LPG in these settings will meet safety standards and will result in the substantial reductions in HAP required for preventing the disease burden.

In order to address these two questions, we are currently carrying out a study (*LPG Adoption in Cameroon Evaluation* (LACE): January-December 2016) in the peri-urban (Limbe) and rural (Buea) communities in the South West of Cameroon to investigate (a) enablers and barriers to expanding adoption, sustained and exclusive use of LPG, and (b) the impacts that varied patterns of LPG use are having on HAP and health risks. Key to this study is that Cameroon has a regulated, established and expanding market, and the government's stated goal of expanding LPG use from the present 6% to approximately 60% of the population by 2030. This goal is supported by a National LPG Working Group tasked with developing the policy and regulatory enhancements and all necessary investments and interventions along the LPG value chain to achieve this. This national initiative is supported by the Global LPG Partnership, which is partnering with our research group in both the current study, and this new proposal. Together, we are using the combined, evolving research knowledge and experience from government and the commercial sector to develop a model of the overall LPG market system in Cameroon, a valuable tool for identifying its strengths and weaknesses.

Initial findings from LACE and the survey work conducted by GLPGP have identified two key barriers to both adoption and sustained/ exclusive use of LPG in these communities: (a) obtaining finance required for initial purchase of LPG kit and ongoing purchase of cylinder refills and (b) the need for extended cooking times for key foodstuffs (beans, cassava) for which users are reluctant to expend LPG.

Adopting the framework from our systematic review (Figure 1) together with key concepts from Implementation Science, The LPG Adoption in Cameroon Evaluation-2 Study (LACE-2) will investigate (a) the impact of a practical solution (pressure cooker intervention) to the problem of foodstuffs with a long cooking duration in LACE communities and (b) the potential of a credit loan scheme (managed credit package intervention) on adoption and sustained use of LPG in LACE communities, drawing on the RE-AIM Framework – Table 1 (www.re-aim.hnfe.vt.edu).

**Table 1: Implementation Science Framework informing LACE-2 intervention approach**

<b>Implementation Science Framework: RE-AIM Dissemination and Implementation Model</b>	
<b>Summary:</b> RE-AIM model aims to focus on approaches that are likely to have the <i>highest population impact in real-world environments</i> . It has five domains to assess the potential population-level impact of an intervention:	
Domain 1	<b>Reach</b> – proportion of the target population who participate in the intervention.
Domain 2	<b>Efficacy</b> – success rate of an intervention when implemented according to guidelines.
Domain 3	<b>Adoption</b> – proportion of delivery organisations that adopt the intervention.
Domain 4	<b>Implementation</b> – extent to which an intervention is implemented as intended in real world settings.
Domain 5	<b>Maintenance</b> – an individual-level measure of the extent to which an intervention is sustained over time.

## 2. Aim and Objectives

Through application of our systematic review framework (Figure 1) and using Implementation Science to inform our approach, LACE-2 aims to advance understanding of barriers and enablers to increasing adoption, exclusive and sustained use of LPG and investigate potential solutions to key barriers to inform National Government policy in Cameroon and beyond.

Using a mixed-methods approach, specific objectives of LACE-2 are to:

1. Assess the impact on adoption and sustained use of LPG of a managed credit/loan scheme (provided by a local micro-credit institution) to fund initial purchase of start-up kit and first refill for LPG.
2. Assess the impact on adoption and more exclusive use of LPG of a pressure cooker to address the problem of foods requiring extended cooking periods.
3. Apply new participatory methods at community and household level including Photo Voice methodology to assess LPG acceptability and use over time.

## 3. Methods

### 3.1 Study setting

LACE-2 will be conducted in the South West region of Cameroon (Table 2). Limbe and Buea represent peri-urban and rural communities in Cameroon with established and expanding LPG markets. Research is currently being undertaken in these communities for the LACE project and this will help to inform the practical and financial community interventions and provide a setting for the Photo Voice study.

**Table 2: Proposed study region**

ID	Proposed area	Region	Current status of LPG use	Component of LACE-2
	Peri-urban and rural areas: <i>Limbe</i> and <i>Buea</i>	South-West Region (English speaking)	Early stages, with potential for expansion; close to filling centre and long-term consumers (Limbe area)	Building on work from LACE: 1. Loan/ credit intervention 2. Pressure cooker intervention 3. Photo voice study

## 3.2 Study design

### 3.2.1 Intervention 1: Managed loan scheme

The managed loan intervention study will be carried out in Batoke, a community in Limbe. The community, represented by its chief, expressed interest in taking part in the loan after preliminary discussions with GLPGP, our research partner. GLPGP have facilitated the involvement of a Cameroon community lending network (Mutuelle Financière des Femmes Africaines (MUFFA)). MUFFA are financial mutual community organisations for African women that (i) support African women with limited incomes, (ii) provide a framework in which micro-entrepreneurial women can conceive and develop their projects and (iii) structure and channel women’s economic potential to help them to fight against poverty. The MUFFA belongs to a vast microfinance network in rural areas under the patronage of the Afriland First Bank and the ADAF, and the MC<sup>2</sup> (Mutual Growth Communities) present in 9 of the 10 provinces in Cameroon. The new MUFFA group set up in Batoke has received all licenses and approvals for managing the micro finance pilot to support the purchase the equipment necessary to adopt LPG. GLPGP will advance the initial funding to the MUFFA registered group who will manage the signing up of households to the loan scheme, distribution of equipment and repayments of the loan during the loan scheme period.

#### **Intervention:**

The intervention community (Batoke) will receive a marketing campaign to advertise the benefits of LPG and the loan scheme together with demonstrations of using LPG for cooking. Following the marketing campaign a microloan package will be offered to interested households (the loan will cover the start-up kit (LPG cylinder, regulator, house and two burner stove) and one LPG refill. This will be available to approximately 150 households on a first come first served basis. The loan is for 50,000 CFA (\$81) and includes a 15% refundable deposit (to encourage repayments). A local LPG marketer (GlocalGAZ) will supply the equipment to households that sign up to the microloan pilot. Households signing up to the loan will pay a 10% refundable deposit prior to receiving the LPG equipment. The loan period will be 6 months and scheduled payments will be required on a monthly basis until completion of the loan.

#### **Design:**

The study design for evaluating the microloan pilot will be a ‘before-and-after design’ of loan beneficiaries (those accepting the loan) with a community level comparison between the intervention community (Batoke) and a comparable control community (similar in demographic and geographical composition) where the microloan will not be present.

#### **Beneficiary evaluation:**

##### **1. Baseline**

A baseline survey will be carried out for the approx. 150 households around the time they sign up for the microloan. This will collect information about the demographic and socio-economic characteristics of the households together with information on fuel use, cooking practices, perceptions of LPG as a fuel and health related to household air pollution (respiratory health, headaches, eye irritation and burns). Before installation of the LPG equipment a sub-sample of 30 beneficiaries (selected randomly from those providing consent) will receive 48hr exposure monitoring of kitchens and the main cook. This will be carried out using MicroPEMs (installed in the

kitchen according to established protocols and worn by the main cook on a bespoke apron). 48hr ambient monitoring of particulate matter (PM<sub>2.5</sub>) using microPEMs will be conducted at a central site within the community. An incentive will be given to these households of one free LPG refill (to be distributed at the end of the loan period).

## **2. Follow-up**

After 1 month a sub-sample of 10 households will receive qualitative semi-structured interviews to explore decision making processes around (i) adopting the loan and (ii) cooking and fuel practices. A mid-point evaluation will be conducted after 3 months collecting limited survey information on management of the loan and changes in cooking practices and fuel use. At the end of the loan period 48hr measurements of PM<sub>2.5</sub> exposure (kitchens and main cooks) will be repeated in the 30 consenting households. Additional ambient monitoring of particulate matter will be undertaken. All households will receive an additional quantitative survey enquiring about fuel use, cooking practices, perceptions of LPG as a fuel and health related to household air pollution (respiratory health, headaches, eye irritation and burns). Finally, 10 households will receive semi-structured interviews exploring their experiences of the microloan, adoption of LPG and changes in behaviour.

### ***Community Comparison:***

A rapid census survey (demographic and socio-economic characteristics, fuel use, cooking practices and perceptions of LPG as a fuel) will be undertaken in representative samples of approximately 500 households in the intervention community (Batoke) and a comparable control community (similar in composition and geography to the intervention community). This will be carried out at the same time beneficiary households begin to receive LPG equipment under the loan scheme. After the 6-month loan period the census surveys will be repeated to identify changes in fuel use, cooking practices and LPG perceptions during the LPG adoption period. A small sub-sample of 5 households that adopted LPG during this time (who did not take part in the microloan initiative) will receive a semi-structured interview to explore the context and decision making processes around this adoption. An additional sample of 5 households not using LPG at the end of the loan period will receive a semi-structured interview to explore perspectives around the microloan initiative.

The main outcome for the microloan evaluation will be the proportion of cooking carried out using LPG. Assuming that control households currently use LPG for 25% of cooking, it is hypothesised that the homes accepting the loan scheme for the LPG start-up kits and refills (intervention homes) will use LPG to meet 45% of their cooking requirements by the end of the loan period. With a significance of 5% and a power of 80%, 89 households would be required in intervention and control arms of the study. Allowing for approximately 10% loss to follow-up a total of 200 households (100 in each group) would be required for the study. Additional outcomes to be assessed in the study include (i) initial adoption/ purchase of LPG start-up kit and repeated purchase of refills (ii) loan repayments and default rates (i.e. household ability to repay the loan bit by bit) and (iii) reductions in concentration and exposure to HAP (PM<sub>2.5</sub> and CO).

### **3.2.2 Intervention 2: Pressure cooker study**

Households in Limbe identified as currently using LPG as a secondary fuel or as a primary fuel but with wood/ biomass as a secondary fuel (identified from the evaluation work conducted by LACE), will be selected from as the eligible population for the intervention study. 200 eligible homes will be randomly allocated to either receive a locally sourced pressure cooker, with training in use of the cooker and in cooking foods with LPG, or to just receive instruction in cooking foods with LPG.

#### **1. Baseline**

Detailed baseline assessment of fuel procurement, fuel use and cooking practices will be carried out prior to randomisation. After randomisation households offered the intervention will be given instruction in how to use the pressure cooker to cook (i) staple/ routine foods (rice, vegetables), (ii) long duration foods (e.g. beans, cassava) and (iii) large and varied meals (e.g. for extended family) to

meet the majority of cooking demands. Prior to allocation of the pressure cookers, participants from intervention and control households will be asked to keep a cooking diary of (i) people cooked for, (ii) foods cooked and (iii) fuels used for cooking over a 7-day period and their LPG cylinders will be weighed. During this 7-day period stove-use-monitoring (SUMs) will be carried out in a sub-sample of 30 intervention and control homes of their LPG burner (iButtons) and the open fire (kSUMS).

## **2. Follow-up**

The intervention study will be conducted over a 6 month period. Each month households will be asked about purchase of new LPG refills and their LPG cylinder will be weighed. At the end of the 6 month intervention period households will be surveyed concerning their fuel procurement, fuel use and cooking practices. They will also be asked to keep an additional 7-day cooking diary (identical to baseline). The 60 households (30 intervention and 30 control) that took part in the baseline stove-use-monitoring (SUM) will have additional 7-day SUM of their LPG burner (iButtons) and the open fire (kSUMS). 10 semi-structured interviews will be conducted of intervention (n=5) and control (n=5) households exploring perspectives around cooking traditional foods using LPG.

The main outcome for the study will be the change in proportion of overall cooking done using LPG. Assuming that households currently use LPG for 25% of cooking, it is hypothesised that the homes using pressure cookers effectively as part of their cooking practice (intervention homes) will increase the proportion of cooking carried out using LPG to 45%. With a significance of 5% and a power of 80%, 89 households would be required in intervention and control arms of the study. Allowing for approximately 10% loss to follow-up a total of 200 households (100 in each group) would be required for the study. Additional outcomes include (i) the change in the proportion of long duration foodstuffs cooked with LPG and (ii) overall user acceptance of and satisfaction with pressure cookers. Upon completion of the intervention study the 100 control households will all receive a pressure cooker (with instruction in safety and use).

### **3.2.3 Participatory methods using Photo Voice**

Photo Voice is a qualitative, participatory methodology that is particularly well-suited to identifying social phenomena in naturalistic settings revealing the perspectives and priorities of study participants (Wang et al 1997). PV aims to make visible the “hidden” context of everyday lives, not just through the use of photographic images themselves but through the interpretation of these images by the study participants who took the photographs. The Photo Voice study will help to understand the societal and cultural factors that influence (i) initial adoption and (ii) sustained and exclusive use of LPG as a fuel in a peri-urban well established LPG market in Cameroon (Limbe).

The Photo Voice study aims are:

1. To identify perceived facilitators and barriers to initial adoption of LPG (including purchase of start up kit), from a range of social, cultural and gender perspectives.
2. To identify perceived facilitators and barriers to exclusive and sustained use of LPG.
3. To empower communities to overcome perceived barriers in adoption and more exclusive use of LPG.

14 purposively sampled individuals who took part in the LACE study – representing LPG users (n=7) and exclusive biomass users (n=7) who have expressed an interest to use more LPG (in current users) or adopt LPG (in biomass users) - will be recruited and trained in use of digital photography. A five stage PV-methodology will then be employed to address the study aims: (i) initial focus group to describe PV objectives and phenomena to be recorded, (ii) participants take series of photographs to represent phenomena, (iii) photos contextualised by participants through interview, (iv) collective reflection of ‘data’ (photographs and narratives) in focus groups and (v) sharing of findings with a wider audience (village/ community exhibition). The PV study will be conducted over a 6-month period.

#### 4. Time frame

LACE-2 will be conducted over a 16-month period:

	2016	2017				2018
	4 <sup>th</sup> Q.	1 <sup>st</sup> Q.	2 <sup>nd</sup> Q.	3 <sup>rd</sup> Q.	4 <sup>th</sup> Q.	1 <sup>st</sup> Q.
Manged loan scheme: (Batoke and comparison community)						
PV research study: (Limbe – peri-urban)						
Pressure cooker study: (Limbe – peri-urban)						
Data analysis/ final writing up					x	x
Study completion						x

#### 5. References

1. Lim, S., et al., *A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010*. Lancet 2012. **380**: p. 2224–60.
2. Puzzolo E, et. al. *Factors influencing the large scale uptake by households of cleaner and more efficient household energy technologies. A systematic review*. 2013. London: EPPI-Centre, University of London.
3. Puzzolo E et al. *Clean fuels for resource-poor settings: A systematic review of barriers and enablers to adoption and sustained use*. Environ Res, 2016. **12**(146): p. 218-234.
4. Rehfuess EA, et al. *Enablers and barriers to large-scale uptake of improved solid fuel stoves: a systematic review* Environmental Health Perspectives 2014. **122**: p. 120–130.
- Rogers, E., *Diffusion of Innovations, fifth ed.* The Free Press, New York., 2003.
5. Wang, C. & Burris, M. a., 1997. Photovoice: Concept, Methodology, and Use for Participatory Needs Assessment. *Health Education & Behavior*, 24(3), pp.369–387. Available at: <http://heb.sagepub.com/cgi/doi/10.1177/109019819702400309> [Accessed May 9, 2015].
6. WHO, *Indoor Air Quality Guidelines: Household Fuel Combustion*, in Geneva: World Health Organization. 2014