

The Global LPG Partnership

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The European Union



Clean Cooking for Africa Program

National Feasibility Study: LPG for Clean Cooking in Cameroon

Prepared by the Global LPG Partnership

October 2019

Clean household cooking in Cameroon, with microfinanced LPG equipment



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Editorial Note: About the time frames used in this report

The analyses, findings and recommendations in this report address the timeframe 2019-2030. From the vantage point of October 2019, given that there is the probability that all the steps set forth in this Feasibility Study to be taken in 2019 and the immediate following years will not be accomplished on such a timely basis, and that this might jeopardize the achievement of the projected LPG penetration rate and usage volumes for household cooking by 2030, it would be worthwhile for the reader to consider the 2019-2030 target years of activity to be Years 1-12.

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Glossary and Abbreviations

BC	Black Carbon
BCRM	Branded Cylinder Recirculation Model Best-practice model for the structuring and regulation of LPG markets for growth, safety and bankability ¹
BP	LPG Bottling Plant
CCA	Clean Cooking Alliance (formerly, the Global Alliance for Clean Cookstoves)
CCCM	Consumer-Controlled Cylinder Model
CDM	Clean Development Mechanism
CFA	Central African Franc (also XAF)
CO	Carbon Monoxide
CO ₂	Carbon Dioxide
DALYs	Disability-Adjusted Life Years
DHS	Demographic and Health Survey
DFI	Development Finance Institution
EU-ITF	European Union Infrastructure Trust Fund Primary source of financial cooperation funds supporting the Clean Cooking for Africa Program
FNGOs	Financial Non-Governmental Organizations
fNRB	Fraction of Non-renewable Biomass
GACC	See CCA
GBD	Global Burden of Disease
GHG	Greenhouse Gases
GLPGP	The Global LPG Partnership The Project Execution Agency for the Clean Cooking for Africa Program
GS	Gold Standard
GWP	Global Warming Potential
HAP	Household Air Pollution
HH	Households
IAQG	Indoor Air Quality Guidelines (defined by the World Health Organization)
IFI	International Financial Institution
Institutional capital	Pension funds, sovereign wealth funds, foundations, large family offices, DFIs, IFIs, MDBs, banks and proprietary capital
ISLE	Indicators of Sustainable LPG Expansion

¹ See www.wlpga.org/wp-content/uploads/2015/09/wlpga-guidelines-for-the-development-of-sustainable-lp-gas-markets.pdf

KfW	KfW Development Bank Administrator of the EU-ITF financial cooperation funds supporting the Clean Cooking for Africa Program
kge or kgeq	Kilogram-equivalent A measure used in expressing weighted-average cylinder sizes
KT	Kilotonnes
LACE	LPG Adoption in Cameroon Evaluation Study Carried out by the University of Liverpool in coordination with the Clean Cooking for Africa Program
LMICs	Low and Middle Income Countries
LMC	LPG Marketing Company (also LPGMC)
LPG	Liquefied Petroleum Gas LPG is comprised of propane (C ₃ H ₈), butane (C ₄ H ₁₀), or a blend of both. LPG combusts to give heat with near-zero emissions. LPG is a gas when unpressurized and becomes a liquid under modest pressure across a wide range of temperatures. LPG is created as a by-product of oil and gas production and oil refining
LPGMC	See LMC
M&E	Monitoring and Evaluation
MDB	Multilateral Development Bank
MICS	Multiple Indicator Cluster Surveys
MFI	Microfinance Institution
MJd	Megajoules delivered to a cooking pot
MINEE	Ministry of Energy and Water Resources
MoH	Ministry of Health
MT	Metric tonnes
NAMA	Nationally Appropriate Mitigation Action Climate change mitigation measures proposed by developing country governments to reduce emissions below 2020 business-as-usual levels and to contribute to domestic sustainable development, as called for in the Bali Action Plan of the UN Climate Change Conference of the Parties
NG	Natural Gas Natural gas is comprised primarily of methane (CH ₄) and may contain fractional quantities of other gases such as LPG
NGLs	Natural Gas Liquids Components of natural gas other than methane, which may be separated and handled distinctly from natural gas. LPG is a type of NGL
NIHR	National Institute of Health Research
N ₂ O	Nitrous Oxide
NIS	Institute National de la Statistique du Cameroun
OC	Organic Carbon
PDC	Private and Development Capital

PM _{2.5}	Particulate Matter of a diameter of up to 2.5 micrometres
PRG	Partial Risk Guarantee
Quasi-equity	Convertible debt, convertible securities, revenue shares, warrants
SCDP	Société Camerounaise des Depots Petroliers Petroleum Depot Company of Cameroon
SDG	United Nations Sustainable Development Goals See www.un.org/sustainabledevelopment/sustainable-development-goals
SEforAll	Sustainable Energy for All UN-affiliated organization responsible to assist countries in achieving Sustainable Development Goal 7 (universal access to clean, modern energy)
SSA	Sub-Saharan Africa
TNMOC	Total Non-Methane Organic Compounds
UN	United Nations
Unit margin	The profit to a seller from the sale price of (revenue from) one unit of a product less the variable costs associated with that product
USD	United States Dollars
WHO	World Health Organization
WLPGA	The World LPG Association The international trade association for the LPG industry
XAF	See CFA



Cooking with biomass fuel in Cameroon

I. Introduction

LPG and the vast, deadly, environmentally destructive “clean cooking problem”

2.8 billion people across the developing world have no access to clean, modern energy for their main energy-consuming task: cooking. They rely instead on solid fuels like wood and charcoal, or on kerosene. Their reliance on solid fuels causes millions of premature deaths each year, causes large-scale loss of health, significantly harms forests, retards economic development and contributes to climate change. In this report, this reliance, together with its severe, negative consequences, are called the Clean Cooking Problem.

Addressing this 2.8-billion-person challenge became one of the pillars of United Nations Sustainable Development Goal 7 (SDG7). It is also a stated policy priority of the governments of over 20 low- and middle-income countries (LMICs), together representing one quarter of the world’s population.

The International Energy Agency, in its World Energy Outlook 2017, reported that if universal energy access for cooking is to be achieved by 2030, it will be achieved for 1.4 billion of these 2.8 billion persons through access to, and use of, LPG. That is, LPG would become the solution to the Clean Cooking Problem for, potentially, half the world, over at least the next 12 years.

What is LPG?

Briefly, LPG is a gas with very high energy content, similar to natural gas, that can be transported very efficiently in small, sturdy bottles, called cylinders, for combustion by consumers to create heat. LPG is often called “cooking gas” in developing countries, where cooking is its primary use. Chemically, LPG is comprised of the gases propane or butane, or a mix of the two. Approximately 2 billion people worldwide are LPG users today, according to the World LPG Association, an international trade body.

The Clean Cooking for Africa Program

Supported by a grant from the European Union Infrastructure Trust Fund and administered by German development bank KfW, the Global LPG Partnership undertook to address in detail the question of how feasible and scalable LPG could be as a clean cooking energy solution in three partnering African countries, and how such scale-up could be effectively carried out and financed across the full LPG value-chain.

These three countries are Cameroon, Ghana and Kenya.

Collectively, this multi-country effort is called the Clean Cooking for Africa Program. The program further contemplates, where properly justified, to direct appropriate resources for implementing national-scale LPG solutions.

The purpose of this report

This report, part of a series of five, examines the feasibility and potential role and scale of LPG as a major clean cooking energy solution for Cameroon through 2030. It also estimates the range of beneficial social,

environmental and economic impacts potentially realized from deploying an LPG solution at scale in Cameroon through 2030.

The Government of Cameroon has set a national policy goal of 58% of the population using LPG for cooking by 2030, up from approximately 31% in 2017.

The Clean Cooking for Africa report series also seeks to contribute meaningfully to the global evidence base that informs energy-development debate and decision-making for addressing SDG7 and the Clean Cooking Problem, and to highlight areas for follow-on research to strengthen the evidence base yet more.

Reliable data about LPG sectors and consumers in the LMICs is not yet plentiful. However, enough data existed or were created through fieldwork to make a feasibility assessment possible in the three partner countries. The sources of data and of assumptions used are referenced throughout this report to allow interested readers to examine further and confirm for themselves the soundness of the report's findings and conclusions and the reasonableness of its recommendations.

Companion report

A companion report, the *Cameroon LPG Investment and Implementation Report*, examines in much greater depth the essential investment projects required for scale-up of the Cameroon national LPG sector, the associated risks and rewards, and how their financing could be best achieved.

For whom this report is written

This report is intended to provide evidence, analysis, guidance and recommendations to five main categories of reader:





- Policymakers and governmental agencies;
- LPG industry participants, in particular those operating in Cameroon;
- Public sector and private sector investors;
- Other stakeholders in the clean cooking and LPG sectors with respect to Cameroon; and
- The global research community.

The report attempts to balance the needs and interests of all five audiences.

Beyond 2030

The Clean Cooking for Africa Program limits its time horizon to 2030, on the premise that the LPG solution is likely to be transitional. If the answer to the question of whether LPG is a viable, large-scale, rapidly deployable, and overall socio-economically beneficial and environmentally and climate-benign solution to the Clean Cooking Problem in many, or most, countries is yes through at least 2030, then LPG is at a minimum a bridge to a fully renewable, clean, modern and effective cooking-energy solution that may emerge in the future. With the entry into commercial markets of meaningful, competitively priced quantities of bio-LPG during 2018, the lifespan of investments in LPG-based solutions for clean cooking may well extend far beyond 2030.

Potential LPG Impacts in Cameroon to 2030

People cooking cleanly		12 million more
Lives saved		19,000
Trees saved		470 million
CO ₂ reduced		40 million tonnes
New investment		€ 274 million

Consumer savings in 2030 from cooking with LPG

Investment need

€ 0

€ 150,000,000

€ 300,000,000

€ 450,000,000

€ 600,000,000

€ 750,000,000

II. Executive Summary

The Government of Cameroon has set a policy goal of 58% of the population using LPG as their main cooking fuel, and for other uses, by 2030. The main reasons are to reduce pressure on Cameroon's forests from use of unsustainably harvested wood fuels and production of charcoal for cooking; to make substantial progress toward Sustainable Development Goal 7 (universal access to clean, modern energy); and to improve the lives of Cameroon's people and accelerate Cameroon's development.

Today, approximately 31% of Cameroon's population uses LPG as a primary cooking fuel.

This report reviews Cameroon's progress, issues, and planning toward its policy goal; assesses under what conditions and to what extent the policy goal is most likely to be achieved; and presents a roadmap for completing the enabling environment for, structuring the financing of, and specifying the implementation of the projects throughout and adjunct to the LPG value-chain necessary to reach the policy goal.

Demand

A key finding is that, for a meaningful portion of the potential user population, the LPG demand quantity in Cameroon is supply-constrained: specifically, cylinder-constrained. This is true of many Sub-Saharan African LPG markets which have not yet reached a mature and sustainable stage. This indicates that LPG adoption can be expanded significantly by increasing LPG availability to new consumers. To increase per-user LPG use, such that LPG becomes not just a cooking fuel but the primary cooking fuel, and to address the population beyond that segment, a second key finding is that additional measures, such as improved affordability and consumer education, would stimulate significant additional usage (in the range of 35 KT to 50 KT extra consumption in 2030) and slightly more adoption (up to 2% more of the population in 2030).

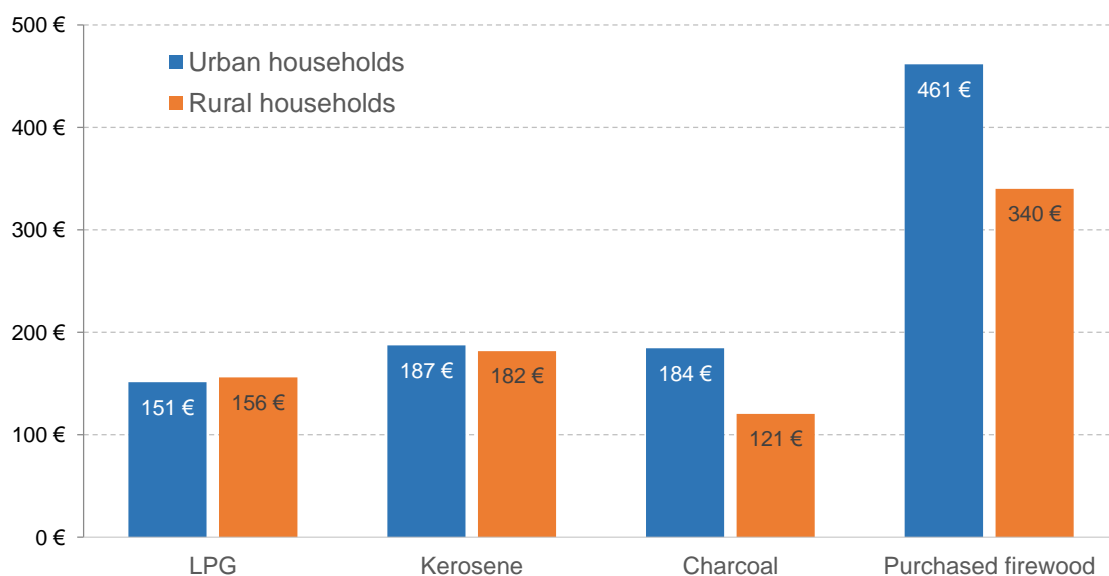
A detailed modelling of demand potential in Cameroon indicates that the demand potential among candidate households could reach 59% of all households by 2030, if supply were unconstrained and essential market reforms and investments made. These factors are discussed in more detail in Part VI of this report.

This is consistent with local industry projections, although industry has taken a view of per-user LPG consumption by 2030 that is approximately 20% above the level projected in the modelling presented in this report. That larger per-user usage amount is reflected in the national LPG Master Plan, which aggregated the projections of local industry, but has been deprecated in this report based on the analyses presented herein.

The modelled growth in residential LPG consumption would be in the range of 2.8X to 3.2X of the 2017 level, rising from approximately 95 KT in 2017 to between 270 KT and 303 KT in 2030. By comparison, the industry's projection captured in the national LPG Master Plan, which utilized an LPG industry-specific methodology and made a higher assumption of per-user consumption growth, was 383 KT in 2030.

An examination of fuel costs and consumption data in representative locations throughout Cameroon showed that LPG competes favorably on a cost-per-meal basis with kerosene, purchased firewood, and non-rural charcoal. LPG is less price-competitive with respect to rural charcoal, which on average is significantly less costly per unit than urban charcoal.

Figure 1. Average annual household fuel cost when cooking with LPG, kerosene, charcoal and firewood



However, LPG is chosen by consumers not only on the basis of cost, but also on the basis of preferences. Increase in preference for LPG, particularly among higher-income households, would lead to a greater and faster adoption and greater consumption in a reformed market with adequately expanded supply. This case is modeled in the upper end of the range presented above.

Part VI (LPG Demand Potential to 2030) of this report describes in detail the demand projections, modelling, and associated methodologies.

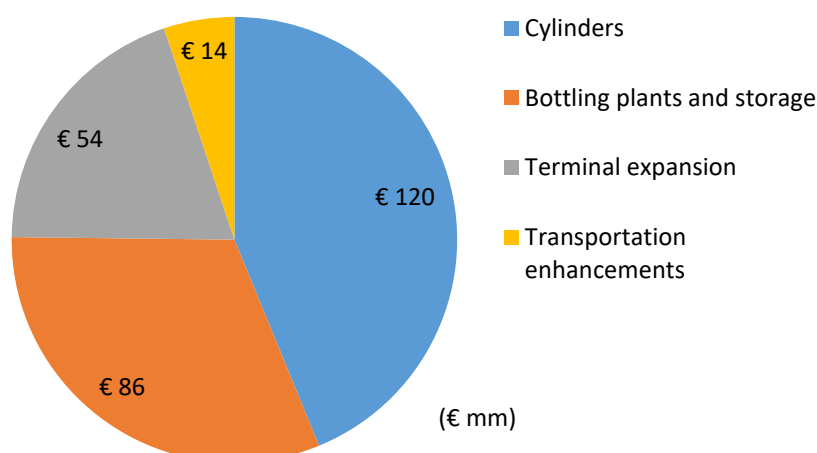
The governmental policy goal, which represents both a policy ambition for benefit to Cameroon and its people and the consensus view of the Cameroon LPG industry about future demand potential and industry's ability to meet it, exceed the upper bound projection of future demand that can be unlocked, as described in detail in Part VI (LPG Demand Potential to 2030) beginning on page 69. There is close agreement regarding LPG's penetration of the population to 2030 across the lower bound and upper bound demand forecasts, the industry projections, and the governmental policy goal. The divergence concerns how much LPG each new user will use, year over year.

Investments

The total capital investment required to expand the LPG supply chain to serve the projected penetration of the population, using the upper bound projection for sake of assuring adequacy of supply, is estimated at € 274 million, excluding production, allocated as follows:

Table 1. Capital investment requirements to 2030 for LPG sector scale-up

Category	Capital Requirement (mm Euro)	Supply Chain Node
Cylinders	€ 120	Marketers
Bottling plants and storage	€ 86	SCDP ² / Marketers
Terminal expansion	€ 54	SCDP or competitor
Transportation enhancements	€ 14	Distribution (trucking)
Total	€ 274	



As is the case in all LPG markets worldwide, the key asset for LPG market expansion is the inventory of cylinders, without which there can be no growth in residential LPG users.

Such investment would be staged in annual increments over 10 years. When the key leading indicator of market saturation used by the LPG industry, the cylinder rotation rate, begins to trend downward, further investments made on a commercial basis would be slowed or stopped in order to meet the financial return requirements of investors. Any further expansion of the value chain would then depend on additive incentivizing measures put in place for industry and/or for consumers.

Thus, the total capital investment requirement might be lower, if consumption per user tracks closer to the lower bound demand projection than the upper bound projection over the long term.

In the view of experienced experts in LPG development in the developing world, demand projection based on surveys tends to under-forecast over the long term (where appropriate reforms and investments are made), whereas aggregated forecasts from LPG marketing companies in LMICs tend to over-forecast over the near and medium terms. For sake of conservatism, and with an intention to define and describe realistic investment potential and financial return potential for prospective funding sources for LPG investments in Cameroon, the analysis in this report opts to utilize the lower of the two cases. That is, the

² SCDP is the national utility company for LPG (and other hydrocarbon) storage and LPG filling, utilized by most LPG marketing companies.

expectations captured in the governmental policy goal, and all associated investment sizing, have been scaled downward—recalibrated—to fit within the demand projections.

To reduce the risk of falling short of the policy goal by 2030, it may therefore be necessary for preference-stimulating measures to be implemented, such as affordability measures and consumer educational measures, which can accelerate both adoption and usage of LPG. (It is beyond the scope of this report to investigate and propose such measures in detail.)

A key recommendation of the national LPG Investment Committee was that the Government should devise a funding mechanism, such as a levy on all national LPG consumption, for shifting a major portion of the cost of new LPG cylinders off the balance sheets of the LPG Marketers, with the savings also passed on to consumers, to improve the bankability profile of the Marketers regarding cylinders, increase the rate at which Marketers can acquire and deploy cylinders, and decrease the cylinder deposit cost to the consumer³. It should be noted that, even if the Government does not choose to enact such a levy, those Marketers which outsource their filling function to SCDP, on average, have the financial capacity to absorb a per-tonne charge equivalent to the levy, while still generating a return to equity above the 20% IRR target identified by prospective capital sources as an investment requirement, although certain future investment tranches would have to be slightly delayed in consequence to ensure continued positive Marketer cashflows.

Part VII (LPG Supply Chain Development and Planning) of this report discusses these investment projects and supply chain design in detail.

Gross vs. net investment requirement

There are two main ways in which the total financing requirement would be less than the total capital expenditure requirement.

The first way is for Marketers to borrow internally against the cylinder deposits obtained from their end-customers. Under law and by practice, the cylinder deposit amount in Cameroon is set to 80% of the cost of the cylinder to its Marketer. The funds provided by the customers are, in principle, a liability of the Marketer, to be returned to the consumer when s/he cancels service and returns the cylinder to the Marketer. In practice, Marketers redeploy most or all of the consumer deposit funds internally. This makes the consumer, in effect, a major financing source for Marketers. As modelled and discussed in Chapter 16 (beginning on page 138), this causes the net amount needed for cylinder financing to be closer to 20% of the capital cost of the cylinders than 100%. The aforesaid levy mechanism, if implemented, would effectively shrink this floor value to 12%, while reducing the deposit amount for the consumer from 80% of the cylinder cost to 48%.

In practice, the financing requirement for cylinders will fall somewhere between the hypothetical net (a floor value⁴) of € 24 million and the gross of € 120 million.

³ The proposed levy amount is € 37/tonne over 10 years, to fund a 40% discount on the acquisition cost of new LPG cylinders borne directly by Marketers and, through up-front deposits, by consumers.

⁴ The amount to be financed can never be as small in practice as the hypothetical net value, because of timing differences in the outgoing and incoming cashflows related to acquisition and deployment of cylinders and collection of deposits, and because of churn in the customer base and the need to maintain a deposit reserve against the churn. Additionally, an uneven rate of

The second way is for funding sources to re-invest their returned capital into later investment tranches after recovering it from earlier tranches. This is mainly relevant for debt providers. It is not possible to estimate in advance the extent to which the funders participating in the first tranche will participate equally in the second tranche, nor in the third. However, to the extent that capital can be recycled across tranches, the total capital committed will be a smaller quantum than if fresh capital were invested in each later tranche. From a funder's perspective, this would mean considerably less capital at risk, even if the total amount on offer over the three tranches would be the larger amount.

Policy and regulation

The Government of Cameroon has implemented the Branded Cylinder Recirculation Model (BCRM) in most respects. The fundamentals of BCRM in Cameroon, with one important exception, are generally sound, although there are numerous opportunities for enhancements that can improve safety and bankability sector-wide. The critical and optional enhancements to regulation and enforcement are captured in the Cameroon national LPG Master Plan, which was accepted and announced by the Government in December 2016.

The exception, as described in the Master Plan, is the existence of a particular category of brand-independent distributors, locally termed "Wholesalers". As shown in Table 20 on page 109, Wholesalers currently handle approximately one third of the national LPG retail volume. They are permitted to accept, and do accept, returns of cylinders of multiple brands, and in so doing they exert control over the cylinders' recirculation flow amongst consumers, retailers and marketing companies. Under BCRM principles, the power to control the flow of cylinders is to vest with the Marketer, not the distributor. Wholesalers in Cameroon often use this power to benefit themselves at the expense of the interests of the LPG Marketers which make the all-important investments in cylinder inventory for the country. Wholesaler abuse of the power to control cylinder flows, where it occurs, increases the cylinder investment risk for those Marketers that have Wholesalers operating in their distribution channels.

The Master Plan recommends a consensus regulatory and enforcement solution to improve the completeness and quality of BCRM in the country, including diminishing and, eventually, reforming the Wholesaler segment of the national LPG distribution system.

As of this writing, the Government has not yet implemented the key policy and regulatory recommendations of the Master Plan. Therefore, there is not yet certainty about all aspects of the future enabling environment.

Part V of this report discusses the nature and status of the policy and regulatory reforms recommended in the Master Plan, the rationale for these reforms, and anticipated consequences for safety, supply availability, affordability, and bankability and growth financing for the LPG sector.

In particular, for the first stage of investment projects, Government action on the enabling environment is deemed beneficial by local industry and the Clean Cooking for Africa/GLPGP expert team, but not essential. The Government must also address a risk related to how state-owned companies will finance their respective LPG projects. Either the Government must assure it can and will finance them, in cases where

growth (such as an exponential rate of growth), as some individual Marketers have projected regarding themselves, would amplify these timing effects.

they and the Government determined that state funding is the best, or only proper, approach, Government must permit them to be included in the efforts to mobilize financing from external sources, and to what extent.

For proceeding to the second stage, results from the first stage should clearly indicate that the second stage will be viable and is justified. In addition, it will be important for the Government to have taken action on key enabling environment reforms, including especially its affirmation one or more of the following: (a) its willingness and ability to expand the present LPG subsidy budget in continuing proportion to anticipated consumption levels in advance of each new fiscal year, (b) that it will reform the LPG price structure to create substantial savings in the subsidy, as recommended by the National LPG Investment Committee, or (c) that it will reform the subsidy to target it to lower-income households, thereby allowing poorer families to receive a proportionally greater benefit while delinking the subsidy growth from the sector's growth. All of these measures would reduce both the size and the growth of the subsidy.

For proceeding to the third stage, results from the second stage should indicate that stage three will be viable and is justified. (In addition to the Governmental actions relevant to stage two, the planned Kribi LPG import terminal project must also have been completed during the second stage.)

These stages are described in Part VII of this report and, in additional detail, in the companion *Cameroon LPG Investment and Implementation* report.

Financing

Two important considerations in the financial structuring and arranging for the required investments are

- The capacity of the LPG sector companies to absorb and deploy capital. This is especially relevant in countries, such as Cameroon, where unit margins are fixed by governmental regulation. The aggregate free cashflows existing, or potentially existing, in each of the main supply chain nodes over time affect the capacity of companies at that node to absorb and deploy capital, and thus the rate at which growth can occur and be sustained.
- The financial return, risk characteristics, and sector-wide counterparty risks related to the cylinder investments. Because cylinders are a mobile asset, financing sources may be less willing to provide financing for their acquisition and, when doing so, may seek higher rates of return and/or greater security (when debt instruments are used) in order to offset the risk. The Branded Cylinder Recirculation Model mitigates some of these risks. Additionally, lower levels of transparency and of demonstrable balance sheet strength characteristic of the players at some nodes of the supply chain increases counterparty risk.

Any financial structuring solution must take these factors into account.

The Cameroon financial sector does not have the capacity (particularly when limited by its sector allocation rules) to finance the entirety of Cameroon's LPG value chain expansion using entirely domestic resources. Therefore, outside capital must be attracted. The Government, under IMF limitations, is also limited in its ability to contribute fiscally to LPG sector development.

The recommended financing approach reflects 75% debt and 25% equity financing for cylinders and debt for the bottling plants, pallets and cages, with the debt calculated at an 8.9% interest rate and the equity at a minimum 20% internal rate of return (IRR) in order to be attractive to both domestic and international

capital sources. These financial cost estimates should be seen as indicative, and not final rates and maturities, at this point in the national planning process. They are intended to show the magnitude of the effects of the cost of financing on repayment of borrowed/invested funds.

Part IX (Financing) of this report describes the investment projects from a financing and investing perspective and discusses the financing issues, main risks and mitigations, and the most viable financial structuring alternatives for the investments, including the role for blended capital and the potential role for carbon finance.

As discussed in Part IX and in detail in the companion *Cameroon LPG Investment and Implementation* report, the global development system can play a key role in mitigating investment risks, crowding in non-concessional capital, and providing technical assistance resources which improve the bankability of LPG investments, thereby helping to enable and to catalyze the full capital stack and full quantum of capital needed to realize the investments necessary to serve the projected demand and create the desired social, economic and environmental impacts.

This Part also describes a microfinance pilot project designed with relevant Cameroonian stakeholders as the operational and financial partners, intended to overcome the barrier of up-front cost for poorer households to acquire the LPG equipment needed to begin using LPG, and the results obtained.

Key findings included (i) the new LPG users used LPG at a 21.2kg annualized rate, above the usage assumption of the upper-bound demand projection (Chapter 12), (ii) the repayment rate was approximately 95%; and (iii) consumer education and sensitization, including on how best to cook local dishes with LPG, were important to the consumers and important for achieving good adoption, usage, and repayment results.

Staging of financing

As described in Part VII, the financing of the major projects is structured into the following main financing and implementation tranches. Each tranche can be thought of as a standalone portfolio of linked projects for investment:

Table 2. Investment financing tranches

	Tranche 1	Tranche 2	Tranche 3
	2019-2022	2023-2026	2027-2030
Cylinders	53,709 €	46,563 €	19,780 €
SCDP Bottling Plants/Storage	24,847 €	15,448 €	231 €
Non-SCDP Bottling Plants/Storage	28,019 €	17,420 €	261 €
Terminal Expansion ⁵	20,000 €	34,000 €	0 €
Transportation Enhancements	3,818 €	5,091 €	5,091 €
Total Capital Investment	130,393 €	118,523 €	25,362 €

⁵ The terminal expansion could be pushed fully into tranche two, as long as interim floating storage is utilized to address the import storage gap that the terminal expansion would fill permanently. The recommended year for the new terminal facilities to be put into service is no later than 2024. For further discussion, please see the *Cameroon LPG Investment and Implementation* report.

It is recommended that investment into the Cameroon LPG sector, as outlined in this report and described in detail in the *Cameroon LPG Investment and Implementation* report, be contemplated by funding sources in line with these tranches, each of which can be treated as a standalone project portfolio.

With demonstrated, acceptable results from the first tranche, the viability and justification for the second tranche (in full or in part) would be freshly assessed and appropriate funding committed in due course. And, similarly, for proceeding to the third tranche from the second.

However, it is also recommended that funding sources for the first tranche, where possible, commit in principle to participating in the funding of the later tranches—conditional on acceptable outcomes from the earlier tranches—in order to give a level of assurance or comfort to the operational modalities, the Government, and to co-investors regarding the potential to continue the expansion of the LPG sector up through 2030 to deliver the full set of potential benefits described in this report.

Certain important assumptions that affect the later tranches that will become more certain over time, including: (i) recommended Governmental actions to improve the enabling environment, (ii) that the Government can continue to fund, or will reform, the growing national LPG subsidy, (iii) actual per-user LPG consumption levels (that is, whether the consumption that develops tracks closer to the lower bound or to the upper bound of the scenario projections presented in this report), and (iv) progress on completion of new LPG importation and production infrastructure (i.e., the Kribi terminal project), which is desirable to have in service as of 2024 (the fifth year of implementation).

Major risks and mitigations

Chapter 21 of this Part discusses the major risks and means of mitigating them. Each main risk represents an opportunity to improve the LPG ecosystem's performance and bankability. Among the most important are the following:

- Political will to put into effect the key recommendations of the LPG Master Plan, including enhancements to distribution rules and to the national pricing formula;
- Government support of the reform and scale-up process, including (i) ensuring subsidy continuity for the portion of the population that truly needs it and (ii) ensuring state-owned enterprises and agencies participate fully in the implementation of major LPG projects and programs; and
- Addressing bankability and financing challenges facing the LPG sector, in particular the LPG Marketers in attracting and deploying capital for the required expansion of LPG cylinder inventories.

Investment program summary

The following table summarizes the key elements of the recommended investment program and its assumptions.

Table 3. Key investment program characteristics and assumptions

Total new user population to be served by 2030	12 million, equal to an additional 25% of the population
Total capital investment requirement to 2030	€ 274 million

Target leverage	75% notionally comprising 40% concessional, 35% non-concessional debt
New Bottling Plant Capacity	303 KT annual peak filling capacity 217 KT annual average throughput 16 KT fuel storage
New cylinders in circulation (12.5kgeq)	4.3 million
Major impacts to 2030	470 million trees saved 40 million MT of CO ₂ eq averted 19,000 lives saved Significant cost savings for households switching to LPG from purchased firewood and, in urban/periurban settings, from charcoal Increase in annual national LPG subsidy amount of € 18 million, absent any subsidy reform
Key assumptions	At a minimum, the Government maintains its relatively successful enforcement of the BCRM market model The scope and scale of influence of Wholesalers does not increase significantly over time End-user LPG pricing and supply chain margins remain regulated and increase by no more than approximately 4.5% to help fund the expansion of the national cylinder inventory Relative stability of long-term LPG commodity input price ⁶ The Government is able to honor its LPG subsidy obligation as the market grows, or if not, is able to target the subsidy to the population that is truly in need, in order to ensure continued LPG affordability for the price sensitive market segment and to ensure the size of the total subsidy is affordable for Government LPG can be made available over time, on a commercial basis, in underserved geographic areas (defined as those where LPG is already accessible within 20 minutes of home by the user), but will not necessarily become commercially available where LPG has no presence today ⁷ Historical demographic and economic trends affecting household fuel purchasing behavior will continue in force LPG asset costs will remain stable across the investment time horizon The Cameroon inflation rate and foreign exchange rates will not dramatically change Adequate foreign currency supply will remain available to import LPG

⁶ The price of domestically produced and imported LPG is the same

⁷ This assumption is incorporated in the Feasibility Study demand scenario models and reflects that geographic areas with effectively zero LPG penetration today are the areas which lack the necessary road networks for LPG distribution to occur, and/or lack an adequate cash economy to make LPG retailing viable there.

Impacts

A key motivation of Cameroon Government to promote national LPG adoption and use; of the Global LPG Partnership, the EU ITF and KfW to study, to assist, and potentially to direct resources to, Cameroon's LPG scale-up efforts; and of the global development community generally, is to translate wisely spent funds into demonstrated, significant social, environmental and economic impacts for the host country.

This report examines two scenarios of LPG market development through 2030 and estimates the expected impacts from these against a business-as-usual case in the following categories. The lower-bound and upper-bound of these scenarios are shown here:

Environmental:

- **Averted deforestation:** 35 to 54 million trees saved annually relative to base case projections in 2030 and over 300 million trees saved between 2020 and 2030.
- **Carbon dioxide equivalent (CO₂eq) emissions⁸ averted:** 5.0 to 5.6 million MT of CO₂eq emissions reduced annually in 2030 and over 40 million MT of CO₂eq emissions averted cumulatively between 2020 and 2030.
- **Black Carbon equivalent (BCeq) emissions⁹ averted:** 5.5 to 8.0 million MT of BCeq emissions averted annually in 2030 and over 46 million MT of BCeq emissions averted cumulatively between 2020 and 2030.
- **The economic value of averted CO₂eq emissions in terms of carbon financing:** € 45 – € 147 million cumulatively between 2020 and 2030, using the 2018 prevailing price of carbon.

Health:

- **Averted premature deaths:** 18,985 deaths could be averted cumulatively between 2020 and 2030 due to increased LPG usage.
- **Avoided Disability Adjusted Life Years (DALYs):** 926,484 DALYs.
- **Economic value of averted deaths and avoided DALYS:** € 207 million between 2020 and 2030.

Consumer economics:

- **Average annual savings per household from switching to LPG:** € 22 switching from charcoal, € 26 from kerosene, € 310 from purchased firewood in urban/peri-urban areas, € 184 from purchased firewood in rural areas.
- **Average annual spending increase per household from switching to LPG from gathered firewood:** Up to € 156, if LPG were to be used exclusively.
- **Total annual savings among all switching consumers:** € 780 million to € 1.2 billion as of 2030.

⁸ CO₂eq emissions include carbon dioxide equivalent emissions from carbon dioxide, methane, and nitrous oxide. These were calculated using IPCC conform standards. Further details are provided in section 2.2

⁹ BCeq emissions includes black carbon equivalent emissions from black carbon, organic carbon, carbon monoxide, and total non-methane organic compounds. Further details are provided in section 2.3.

- **Economic value of labor time gained:** 470 million hours gained, worth € 52 million per year, as of 2030.

National economics:

- **Cumulative tax revenue (assuming no rate or law changes):** Decrease of € 150 to € 220 million in 2030.
- **LPG subsidy (assuming no subsidy reforms):** Increase by CFA 36 to 48 billion (€ 54 to € 72 million) per year in 2030.
- **Trade balance (assuming no rate or law changes and constant local LPG production):** Expansion of trade deficit by CFA 87 billion (€ 56 million) to CFA 117 billion (€ 75 million) as of 2030.
- **Job creation:** 17,976 – 24,097 net new jobs in the LPG sector, but an unquantifiable reduction in the charcoal and woodfuel sectors.

Part X (Environmental, Health, Social and Economic Impact Potential) of this report describes in detail the impact projections, modelling, and associated methodologies.

Monitoring and evaluation

Part XI (Monitoring and Evaluation (M&E) Framework) of this report defines a set of indicators, called the ISLE indicators, for tracking progress in Cameroon's LPG development and the social, environmental and economic impacts thereof. This Part also provides current values for the indicators, where values were obtainable.

Recommendations

This report concludes with summary recommendations for further efforts (and corresponding resources) to assist Cameroon in the implementation and financing of its national LPG master plan, for future expansion of microfinance for LPG in the country, and for research efforts to strengthen the evidence base regarding the proper role and potential of LPG as a clean cooking solution. These recommendations are discussed in deeper detail in the *Cameroon LPG Investment and Implementation* report.

Conclusion

Cameroon's policy goal of achieving LPG use as a primary cooking fuel for 58% of its population by 2030, and delivering meaningful social, environmental and development benefits to the country and its people, can only be achieved if (i) key reforms to the LPG market structure and regulation are well concluded and effectively implemented and enforced, (ii) essential investments are adequately defined with capable and bankable counterparties and financing structures, (iii) the LPG subsidy can be maintained (or refocused on those in actual need as it gets larger), and (iv) other incentivizing measures, which can include consumer financial empowerment such as microfinance, education, and other steps, are taken in support of LPG adoption. Well-considered use of development system capital to help mitigate risks, crowd in risk-averse non-concessional capital, and provide technical assistance will be important to Cameroon's overall success.

Absent demand-side measures, LPG is nonetheless projected to become either a primary or a secondary cooking fuel for about 58% of the population by 2030, but such measures would be important for ensuring that LPG becomes the primary cooking fuel for that 58%. It was beyond the scope of this report to propose specific demand-side measures in detail or estimate the sensitivity the primary/secondary mix through 2030 to such measures. An indicative outline of potential demand-side measures is presented in Part VII of the *Cameroon LPG Investment and Implementation* report.

III. LPG and the Clean Cooking Problem

1. The Clean Cooking Problem

The global community has recognized the central role of access to clean, modern energy for development with the adoption of the 2030 Agenda for Sustainable Development by the United Nations in 2015.

With the second decade of the 21st Century nearly over, more than 3 billion people still suffer the harmful and often fatal effects of cooking with solid fuels and kerosene. Household air pollution (HAP) caused by burning these fuels far exceeds the safe levels defined in the World Health Organization (WHO) Indoor Air Quality Guidelines (IAQG). According to WHO10, nearly 4 million people die prematurely each year from these effects of HAP, and many more suffer from chronically worsened health. Recent evidence on the relationships between HAP exposure and health risk indicates that levels of household particulate matter must be reduced nearly to WHO guidelines levels if a large portion of this health burden is to be averted.

A major portion of the woodfuels and charcoal consumed for cooking purposes come from unsustainably harvested biomass. This adds to already significant pressure on forest cover, in the form of increased deforestation and forest degradation. Loss and degradation of forest cover may, in turn, weaken agricultural productivity in adjacent land areas.

The pollutants from cooking with solid fuels also contribute to shorter-term climate warming through black carbon and methane.

Obtaining and cooking with solid fuels is also more time consuming than obtaining and cooking with fuels such as LPG, which are commercially obtainable (or are delivered to the home), provide “instant-on, instant-off” heat energy for cooking, and require de minimis maintenance and cleaning of cooking appliances and cooking areas.

In Sub-Saharan Africa (SSA), four of five people use wood fuel or charcoal as their main source of cooking energy. In view of the rapid population growth in Africa (projected to more than double to 2.5 billion by 2050)¹¹, the total number of solid fuel users will increase, together with all the associated negative health, environmental and development consequences, unless urgent and effective action is taken.

In this context, a growing number of governments of countries in Sub-Saharan Africa and other regions have set ambitious policy goals and plans for scaling up the use of liquefied petroleum gas (LPG) as a cooking fuel. Their reasons include meeting the Sustainable Energy For All (SEforAll) goals and Sustainable Development Goal (SDG) 7 of universal access to modern energy; improvements in public health from reduction of the health burden from HAP caused by cooking with biomass and kerosene; improvements in quality of life for their people; economic development; and forest protection.

¹⁰ WHO (2016). Burning Opportunity: Clean Household Energy for Health, Sustainable Development, and Wellbeing of Women and Children Report. Geneva: World Health Organization.

¹¹ United Nations, Department of Economic and Social Affairs, Population Division (2015). World Population Prospects: 2015 Revision, Key Findings and Advance Tables. Working Paper No. ESA/P/WP.241.

All of these goals are applicable to Cameroon. Indeed, Cameroon was the first country in the world to create and governmentally approve an LPG Master Plan, created to guide the rapid, safe and sustainable development of the Cameroon LPG sector.

2. Clean Cooking for Africa Program Overview

Government ministries and agencies in Cameroon and a number of other countries have sought advice on the development of policies and investments required for enabling the expansion of effective, safe, and sustainable markets for LPG cooking fuel.

For three in Sub-Saharan Africa, namely Cameroon, Ghana and Kenya, this support is being delivered through the Clean Cooking for Africa Program of KfW, funded through the European Union-Infrastructure Trust Fund and implemented by the Global LPG Partnership.

Countries seeking to achieve major transitions in household energy must respond to the needs, resources and circumstances of their populations, which will vary markedly across urban and rural settings, by socio-economic status, and over time. A variety of fuels and technologies may be required, with roles for both modern fuels such as LPG and electricity, as well as improved biomass cooking technologies.

In recent years, LPG has been selected by a growing number of low and middle income country (LMIC) governments to be the primary cooking fuel for expanded access to clean and modern energy for their populations.

Cameroon is among the leaders in Sub-Saharan Africa in national planning for a national transition to clean and modern energy for cooking for its people.

The **Clean Cooking for Africa Program** assists selected African partner countries in planning, financing and executing national-scale transitions from the use of solid fuels and kerosene for cooking to clean, safe, modern cooking using LPG. This assistance includes:

- National planning processes, conducted in partnership with the partner-country governments and relevant stakeholders, to create or enhance the enabling environment for successful, sustainable LPG scale-up, and to plan and financially structure the required corresponding investments in LPG infrastructure and distribution systems; and
- Relevant studies to define and justify the proper role and scale for LPG as a national clean cooking solution, whose findings may guide the planning of LPG transition.

This report reflects the results, through the date of its writing, of such planning and studies in Cameroon.

3. The Role of LPG

What is LPG?

According to the World LPG Association, LPG stands for “Liquefied Petroleum Gas”, whose acronym is widely used to describe two prominent members of a family of light hydrocarbons called “Natural Gas Liquids” (NGLs): propane (C_3H_8) and butane (C_4H_{10}), either individually or in a blend. While “liquefied gas” may seem a self-contradiction, liquidity is the unique character of LPG that makes it a widely-used fuel. At normal temperatures and pressure, LPG is gaseous. It changes to a liquid when subjected to modest pressure or cooling. In liquid form, the tank pressure is about twice the pressure in a normal truck tire. This makes LPG very safe when properly handled. LPG is a by-product of two large energy industries: the processing of natural gas liquids and the refining of crude oil.

Thus, LPG is a supply-driven commodity. It must always be disposed of by its producers. Globally, the market is cleared of surpluses by the petrochemical and plastics sector, which can use LPG as a feedstock. Currently, a global surplus of LPG supply over demand is expected to persist until approximately 2026-2028¹².

In 2018, the first commercial quantities of bio-LPG were introduced into the global market at prices competitive to NGL-sourced or refinery-sourced LPG.

LPG has a number of qualities which make it an effective, large-scale off-grid gas energy solution in complement to the other large-scale clean energies, electricity and natural gas. This is summarized in the following table:

Figure 2. Key characteristics of LPG, natural gas and electricity solutions¹³

Household Energy Source	Key Characteristics	Primary Uses in Developing Stage Energy Market	Primary Uses in Mature Energy Market
LPG	<ul style="list-style-type: none"> • Low capital intensity • Infrastructure quick to deploy • Affordable, especially in urban/peri-urban areas • Portable • Salable in small units • Safe (with proper systems and handling) • High heat delivery 	<ul style="list-style-type: none"> • Cooking/heating 	<ul style="list-style-type: none"> • Non-urban cooking/heating • Industrial • Occasionally, transport

¹² See the Annexes, Chapter 34 for a discussion of LPG pricing and availability beyond 2026-2028.

¹³ GLPGP: World Gas Conference (2015)

Household Energy Source	Key Characteristics	Primary Uses in Developing Stage Energy Market	Primary Uses in Mature Energy Market
Grid Electricity	<ul style="list-style-type: none"> • High capital intensity • Time-consuming to deploy • Occasionally affordable • Safe (with proper systems) • Low-to-medium heat delivery 	<ul style="list-style-type: none"> • Urban lighting, cell phones, electrical appliances including cooking, mechanical work 	<ul style="list-style-type: none"> • Lighting, cell phones, electrical appliances including cooking/heating, mechanical work
Off-grid Electricity: Minigrids	<ul style="list-style-type: none"> • High capital intensity per kw • Usually more costly than grid-based • Potentially rapid deployment 	<ul style="list-style-type: none"> • Small business use, cell phones, household lighting and low-power (non-cooking) electrical appliances 	<ul style="list-style-type: none"> • Small business use, cell phones, households electrical appliances, sometimes including cooking (with larger-scale systems)
Off-grid Electricity: Solar PV	<ul style="list-style-type: none"> • Rapid deployment • Low to medium capital intensity per kw • Pay-as-you-go can be an option 	<ul style="list-style-type: none"> • Cell phones, household lighting and low-power (non-cooking) electrical appliances and productivity devices (e.g., sewing machines) 	<ul style="list-style-type: none"> • Cell phones, household lighting and low-power (non-cooking) electrical appliances and productivity devices (e.g., sewing machines)
Natural Gas	<ul style="list-style-type: none"> • Very high capital intensity • Time-consuming to deploy • Very affordable • Primarily grid-based • Safe (with proper systems and handling) • High heat delivery 	<ul style="list-style-type: none"> • Power generation 	<ul style="list-style-type: none"> • Urban household cooking/heating • Power generation • Industrial and transport

LPG is an essential solution to achieve WHO emissions guidelines and to reduce pressure on forests

To achieve WHO guideline levels of particulate matter requires community-wide use of clean fuels. In the transition towards universal use of clean fuels, countries will evaluate and execute on strategies that address the energy needs of their varied populations over time, involving a portfolio of energy carriers and technologies to meet cooking and other household needs.

In its *Special Report: Health and Climate Change*¹⁴, WHO states: “It is not necessarily straightforward to choose the optimal household energy, and it may sometimes involve trade-offs. For example, while [LPG] is a fossil fuel, it emits almost no particulate air pollution and emits less climate pollutants than many other household energy sources. There may therefore be rapid health gains and sustainability if it replaces more

¹⁴ WHO (2018). www.who.int/iris/handle/10665/276405

polluting fuels and technologies, as opposed to crowding out investment in renewable energy.” It is therefore important for Cameroon, and other LMICs, to define an optimal portfolio of energy carriers and technologies for the household sector, which portfolio will require adjustment over time as relative technological capabilities, scalability, and costs evolve.

Over the next one to two decades in Sub-Saharan Africa, this energy and technology mix is expected to include LPG and, where feasible, reliable electricity capable of delivering the wattage necessary to cook and to boil water. For those unable to transition quickly to clean liquid or gaseous fuels or to adequate electricity supply, improved (e.g. rocket-type) and advanced (e.g., fan-assisted, pellet fueled) biomass stoves are expected to have a transitional role, even though in daily use they do not deliver the emissions levels called for by the WHO guidelines.

Among existing liquid and gaseous fuel options, LPG can make an important contribution. It has the potential to deliver substantial benefits for health, climate, the environment, and development. As with biomass fuels and stoves, building the enabling environment and developing an effective and cost-efficient market and value-chain are required for success with LPG. Correct and safe handling and use of LPG is also a key requirement.

A number of national governments, including India, Cameroon, Ghana, and Kenya, have made it a priority to serve a majority of their populations with LPG for reasons including (i) addressing energy-related air pollution, (ii) forest preservation and (iii) economic development.

LPG is benign for the climate

At a global level, however, the fact that LPG is created as a by-product of the production and refining of fossil fuels requires evaluation of its environmental impacts.

Issues around the overall affordability and accessibility for poorer and more rural populations also need to be addressed.

The findings described in this report indicate that the use of LPG instead of traditional biomass fuels and kerosene in Cameroon would contribute little or no net climate warming effect and would protect forest resources. Lifecycle assessments (performed by others) have found that LPG as a cooking fuel performs similarly to advanced biomass stoves for net CO₂ emissions in settings where biomass fuel harvesting is partially renewable, and better than these technologies for black carbon and other short-lived pollutants.

This is because (i) LPG has a lower Carbon-to-Hydrogen ratio (C:H of about 1 to 3) than any other hydrocarbon fuel except for natural gas (e.g., coal has a C:H ratio of about 2 to 1); (ii) LPG combusts very efficiently compared with other fuels, thereby keeping emissions lower; (iii) LPG has high completeness of combustion, which results in black carbon and other climate-active pollutant emissions being much lower than from biomass-burning stoves and open fires; (iv) LPG stove emissions performance generally remains the same over time and is relatively independent of user-operating factors; and (v) LPG fuel supply places no burden on forest resources.

Affordability of LPG

Where all or most cooking fuel is purchased, which occurs mainly in urban and peri-urban settings, LPG is price competitive with kerosene, wood fuel, biomass pellets and charcoal on a cost-per-meal or cost-per-month basis.

These alternative fuels to LPG are typically bought in small daily quantities. While overall costs of LPG may be similar or superior over time, the transaction size for refilling an LPG cylinder may be a barrier for some low-income households. A number of options are available to address LPG refill transaction size. One that is well-established is use of smaller (e.g., 3 kg) cylinders. Newer initiatives involving pay-as-you-go LPG use and microfinance of, and/or mobile payment for, LPG refills are in early commercial operation in some SSA countries. Some households may also need financial assistance or tools to cover the initial acquisition cost of an LPG stove, cylinder and associated equipment, because traditional stoves are in general less costly than the equipment required for cooking with LPG. (See Chapter 18 (Consumer Empowerment) beginning on page 154 for more information.)

For poorer and more rural populations currently gathering all or most of their fuel, the initial and ongoing costs for LPG refills can be barriers. Targeted subsidies or other forms of financial support, which preferentially assist poorer households, have a role in facilitating acquisition and use of LPG for such consumers. This type of targeted financial assistance is already a key component of policy on LPG access in several countries with large scale LPG use, such as India, Brazil and Peru.

Creating a universal LPG refill price through regulatory measures (that is, a price that, through transportation cross-subsidy, is the same for all consumers no matter where they are located in the country) also benefits rural consumers, who tend to be both poorer and more remote from LPG refilling facilities.

Long term LPG price stability

As discussed in Chapter 21 (Summary of Main Project Risks, Mitigations and Mitigation Sources) beginning on page 200, adequate LPG is expected to be available for importation through at least another ten years. This ignores the additive potential to the surplus of bio-LPG, introduced in commercial quantities at competitive price points by multiple producers during 2018. Should the global LPG surplus end, net importers such as Cameroon must then compete for LPG with sectors such as plastics and chemicals, which choose among feedstocks including LPG based on price. That sector consumes approximately one third of global LPG production for feedstock use at current price levels. Historically, as LPG prices have risen compared to feedstock alternatives, plastics and chemical producers switch from LPG to other feedstocks. This rebalances global LPG supply and demand across all other consuming sectors. If global LPG prices rise after ten years due to an end to production surpluses, Cameroon can continue to expect adequate availability of imported LPG, albeit at a potentially higher price. See Annex Chapter 34 on page 317 for a fuller discussion.

Proven technical and operational feasibility of LPG in LMICs

LPG is a well-established technology for cooking. The World LPG Association estimates that 2 billion people use LPG for cooking, heating, and other uses. LPG has already become a large-scale solution for clean cooking in a numerous low and middle income countries¹⁵.

Challenges for scaling up LPG on a national basis are addressable through effective policy, regulation and enforcement of regulation, ensuring adequate supply, developing robust distribution networks (limited by where the road network makes distribution viable), and, optionally, developing and implementing sustainable fiscal policy to support more equitable access.

User benefits of LPG

For the user, the speed and controllability of LPG cooking, combined with the convenience of storage, result in substantial convenience and time savings. This has particular implications for women, children, and others currently engaged in collecting and cooking with biomass fuel and cleaning their cooking appliances and cooking areas after use. The added convenience and time savings offer the potential for making more of employment and education opportunities.

LPG may also be viewed culturally as an aspirational fuel that some households would use, if available, based on their association of LPG with modernity—the “modern” of SDG7—even when cost savings from LPG use do not arise for them. While it is not possible to quantify this factor from available data, and it is excluded from this report’s analytics, desire for LPG as an aspirational energy choice frequently arises anecdotally in interviews with Cameroonian consumers, policymakers, industry veterans and other stakeholders. (Many of which policymakers, industry veterans and other stakeholders being LPG consumers as well.)

¹⁵ A non-exhaustive list of examples of LMICs which have achieved safe and sustained use of LPG for cooking by no less than 50% to upwards of 90% of their populations for cooking (and other uses) include Bolivia, Brazil, El Salvador, India, Indonesia, Malaysia, Morocco, Thailand and Vietnam. SSA countries which are approaching this range of LPG use include Cote d’Ivoire, Gabon and Senegal.

IV.A Brief History of LPG in Cameroon

Although LPG has been sold in Cameroon, primarily by international oil companies, since before the country was reunified politically in 1961, a major milestone in LPG development occurred in 1973, when the Cameroon LPG operations of Shellgas, BP Transcogaz, and Elf were merged into a pure, nationwide LPG company, Camgaz. At that time, there were four main LPG players in Cameroon: Camgaz, Total, Oil Libya, and MRS Corlay (a corporate descendant of Texaco).

A national decree was promulgated to regulate storage and distribution of petroleum products in 1977. SCDP (Société Camerounaise des Dépôts Pétroliers) was then established in 1979 as the national petroleum-products logistics company, with one of its intents to act, over time, as a common LPG storage and filling utility for the sector. SCDP continues in that role today.

In 1990, SCTM (Société Camerounaise de Transformation Métallique), a national metalworking and cylinder manufacturing company, expanded into LPG marketing and became over time the dominant LPG marketing and distribution player.

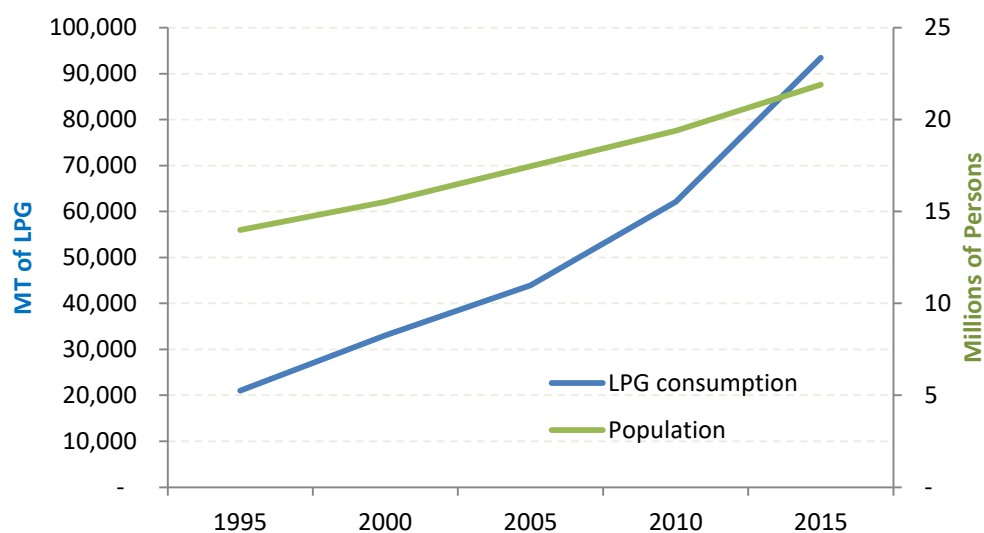
The present national petroleum code was enacted in 1999, with various subsequent amendments.

Starting in the 2000s, problems involving cylinder misappropriation and LPG shortages began to affect the market. These eventually led to Government efforts to convene stakeholders to develop solutions, with mixed results.

- On 23 December 2000, there was a significant seizure of gas cylinders in Yaoundé and Doula referred to as “operation Nasse”, occurring because some businesses reduced the number of LPG cylinders in circulation to create a false shortage in an effort to illegally raise prices.
- In 2002, for a period of several months, there was a shortage of SCTM cylinders in the market that caused significant stock-outs for consumers, who were observed to travel great distances in search of filled LPG cylinders.
- In January 2003 and February 2005, following prolonged periods of shortage, MINEE brought together business leaders in the LPG sector to address the chronic shortage situation. Among the discussion topics were interchangeability of cylinders and short-filling of cylinders (where cylinders are sold as “full” when they are, in fact, less than full).
- In July 2007, with the shortage situation worsening, the media took up the issue of cylinder interchange. (This is a common, but erroneous, solution often considered by LMICs when there are prolonged shortages.)

Despite these conditions, new players, mainly foreign-owned, entered the market during the mid 2000s, adding cylinders, and LPG consumption overall grew steadily, at a faster rate than the population:

Figure 3. Historical LPG consumption (1995-2015)

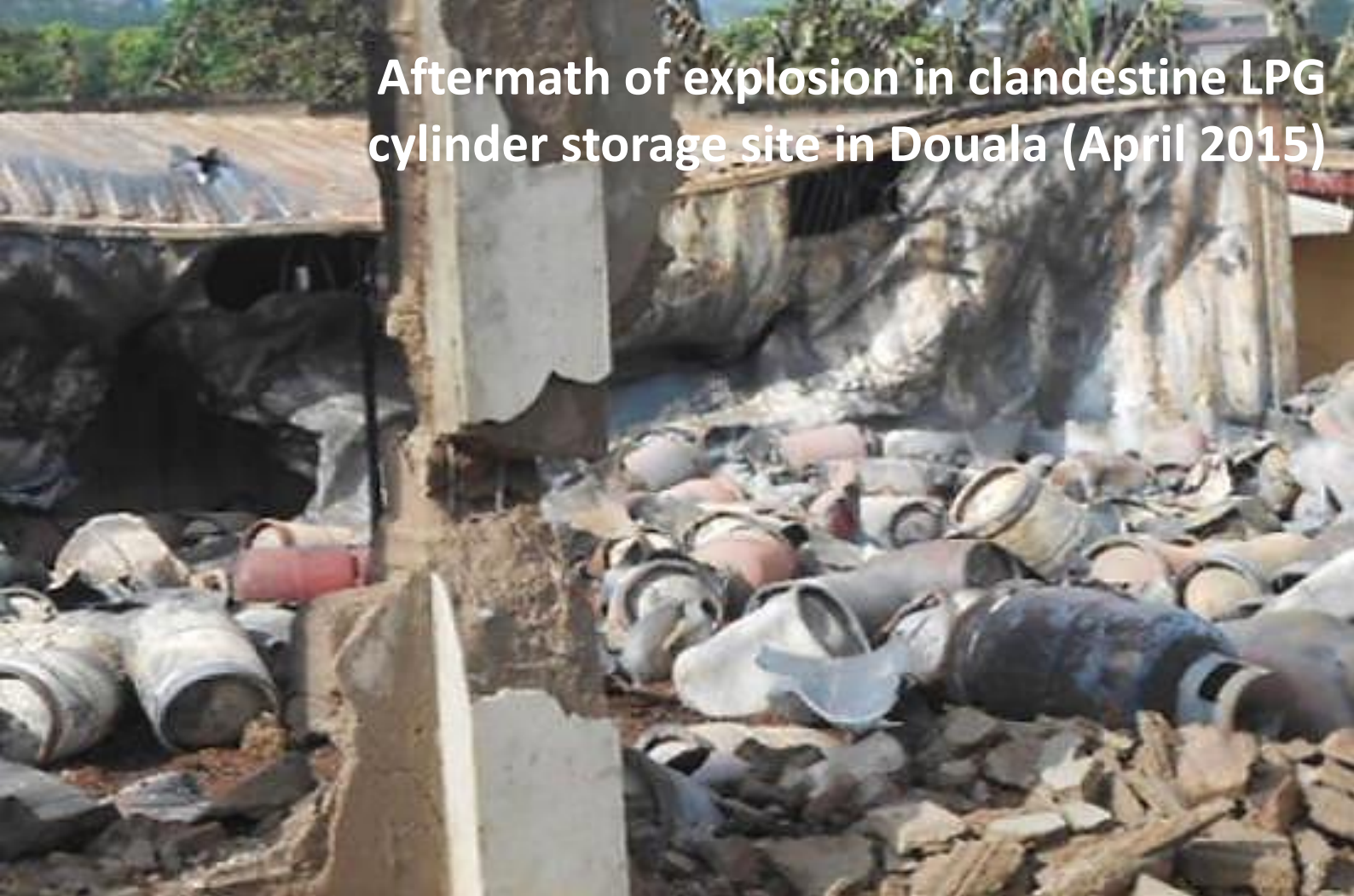


However, shortages continued to occur. In a widely-cited July 2015 news article, the media opined: "...because of the insecurity problem related to the importation of domestic gas cylinders, thousands of cylinders were effectively taken out of the system. This led to a situation which has unfortunately aggravated the scarcity of cylinders for some years. Therefore, the attendant measure conducted by MINEE forced some marketers to import new cylinders. For the rest, a source at MINEE also indicated that wholesalers who were taking advantage of the counterfeit network found themselves penalized, since all cylinders not meeting laid down standards were withdrawn for destruction. They are the ones who give the impression that there is a shortage of cylinders, because they are reluctant to put more money back into their business in a bid to purchase cylinders meeting standards..."

Against this backdrop, the Government partnered formally with GLPGP, with support from the Clean Cooking for Africa Program, to develop a comprehensive, multistakeholder plan to reform and expand the LPG market to its fullest potential, motivated both by voter concerns about LPG availability and policy concerns about the effect of continued reliance on wood fuels for cooking on the nation's forests and environment, among other reasons.

Part V of this report describes this planning process and its main outcomes and recommendations.

Aftermath of explosion in clandestine LPG cylinder storage site in Douala (April 2015)



V. LPG Enabling Environment

The Government of Cameroon has an adequate enabling environment for the safety, bankability, growth and oversight of its LPG sector, implementing the Branded Cylinder Recirculation Model (BCRM). There are certain areas, described below, where enhancements to Cameroon’s implementation of BCRM are feasible; are desired by the LPG sector; have been recommended by the Government-led, multistakeholder national LPG planning committee and GLPGP/Clean Cooking for Africa expert team; and have been accepted for eventual implementation by the Government.

4. Models of National LPG Systems

Globally there are two main models for organizing residential LPG markets: the Consumer-Controlled Cylinder Model (CCCM) and the Branded Cylinder Recirculation Model (BCRM).

CCCM is used together with BCRM in the United States and Canada. CCCM is also used for a small portion of the LPG market of Germany. It has been tried, or has been devolved into, in some developing countries. Aspects of CCRM invaded the BRCM model in Brazil in the 1970s and resulted in a major increase in accidents and fatalities that shook public confidence in LPG and risked market implosion, until BCRM was properly reconstituted and enforced through concerted joint government-industry action. CCRM has been attempted in Haiti without success. It is the dominant model in Nigeria, which has suffered decades of boom-bust investment cycles in LPG with negligible growth in LPG use per capita, despite being a major LPG producing country and one of Africa’s wealthier countries. A discussion of the main issues associated with the CCCM is presented in the Annexes, Chapter 32 beginning on page 314.

In all developing countries which have succeeded in achieving meaningful levels of residential LPG use per capita, BCRM has been the model.

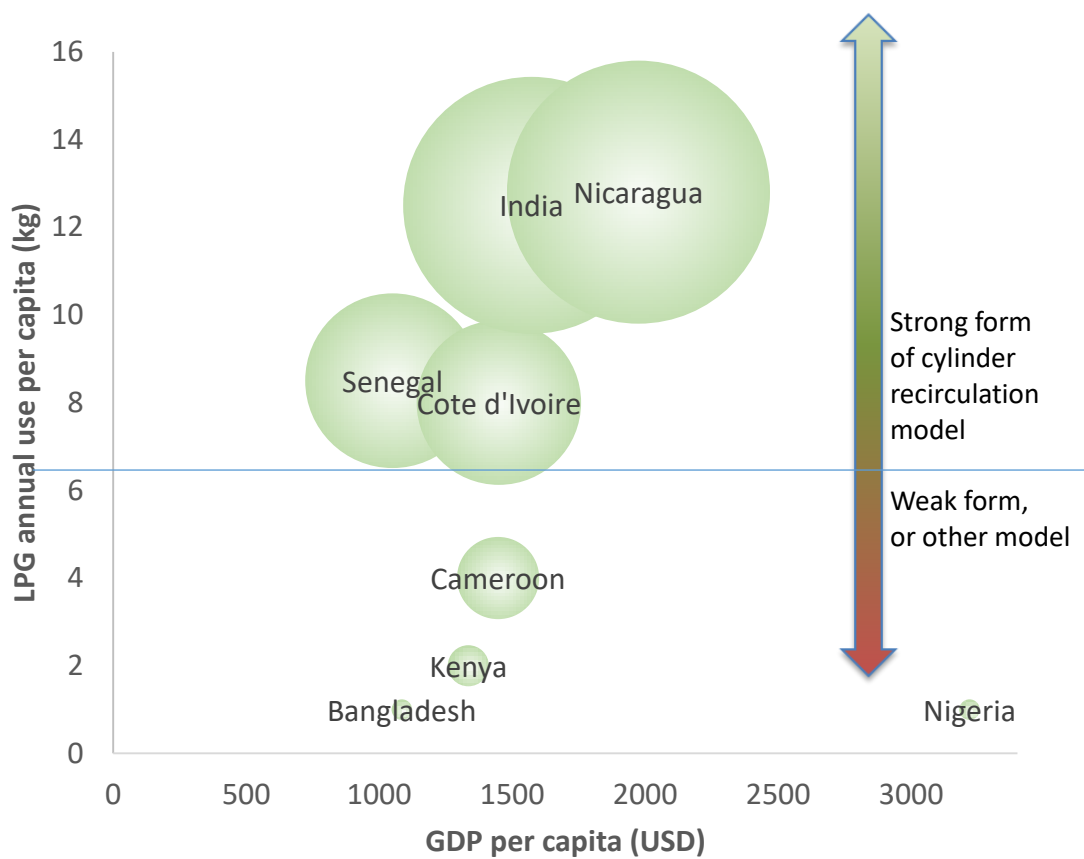
BCRM can be implemented rigorously (“strong form”) or loosely (“weak form”).

The following figure (Figure 4) shows LPG development progress, measured in kilograms per capita of annual LPG use, plotted against GDP for a selection of developing countries, and categorizes these according to the strength of their BCRM model. (A method of scoring BCRM strength is presented later in this Part.)

As discussed in Chapter 7 (Cameroon Market Model Scorecard), Cameroon actually practices a moderately strong form of BCRM, and the country should be performing better on the per-capita LPG usage axis than it has done—closer to Cote d’Ivoire and Senegal, for example, where BCRM is well implemented and where the LPG sectors have experienced robust investment in safe, sustainable growth and have matured accordingly.

Cameroon does have opportunities for enhancements to its implementation of BCRM that could improve safety, bankability, supply chain efficiency, and market growth potential, all of which are discussed in this report. However, the financial and investment risk aspects of Cameroon’s LPG ecosystem turn out to be of high importance as well. With these addressed, Cameroon can then accelerate its progress even more through measures to stimulate additional demand, beyond the significant unmet demand already present in the country.

Figure 4. Comparative LPG adoption and use vs GDP in selected countries, by market model



5. Conditions and Consequences of the BCRM LPG Market Model

Wherever implemented in a self-consistent, well-enforced, and adequately financed way, BCRM eventually leads to widespread adoption of LPG with an acceptable level of safety (acceptable to the consumers, industry and governments in question).

BCRM is endorsed and promulgated by the World LPG Association, the global LPG industry organization.

Examples of major successes in LPG market development using BCRM include: Brazil (starting in 1979 following a near-collapse of the LPG market due to enforcement failure that led to thousands of monthly LPG fires and explosions), Morocco, Vietnam, Malaysia, India, Japan, Turkey and Senegal.

BCRM comprises a number of key principles which are listed below.

- The LPG marketing company invests in, owns, inspects, maintains, and refills (away from populated areas) its own, branded cylinders and is responsible and liable for their safety. The marketer is also exclusively licensed by the government to market LPG. This linkage, between and among cylinder investment, cylinder refill income over the cylinder's life, liability for the cylinder's safety, licensing, and the brand, create the needed incentives for LPG marketing companies to invest to expand their cylinder inventories in order to create new customers and to spend to maintain safety throughout the value chain.
- The government must enforce the foregoing structure to ensure compliance by legitimate, licensed players and to create significant disincentive (through inspection, legal prosecution, significant penalties for conviction, and other means) for illegitimate players to coopt for their own ends the cylinders of legitimate players, thereby breaking the linkage.
- All cylinders in the market are branded cylinders.
- The consumer obtains his/her first cylinder from a marketer's distribution channel in exchange for a deposit, which is typically set below the cost of the cylinder with a maximum percentage specified by law or regulation. The cylinder remains the property of the marketer. When the consumer's LPG runs out or low, the consumer returns the empty cylinder to a refill point in the marketer's distribution network to exchange it for a full cylinder, at the prevailing price for a refill.
- Margins, if regulated, must be adequate to cover the costs of the operation of the supply chain across all its nodes, and to allow for adequate debt service, returns to equity investors, and investment in growth.
- Safety standards, in particular regarding the condition of cylinders and handling and transport of LPG, must be defined clearly and well enforced.
- Allowing cylinders to cross between marketers' branded distribution networks is discouraged, because it can lead to coopting and hoarding (taking off the market) of competitors' brands of cylinder.

BCRM is enhanced with certain optional characteristics, including:

- Industry consolidates, leading to fewer but more capable and bankable players which lead the sector's growth and help perpetuate essential BCRM practices. The presence of an effective LPG trade association is also useful for the latter purpose.
- Transportation cross-subsidy to cause prices paid by remote customers to equal prices paid by centrally located customers.
- Pro-poor mechanisms, which may include micropayment and pay-as-you-go schemes, targeted subsidies, and the like.
- Consolidation of regulatory authority regarding the LPG ecosystem into a small number of agencies, or one LPG superagency. This facilitates business formation and expansion and facilitates effective enforcement of BCRM and its elements.
- Sharing of major infrastructure for storage and filling. If done, this focuses competition on acquiring and servicing customers, instead of on acquiring LPG.

Cameroon practices most of the above BCRM elements, with the major exception that crossing of cylinders between marketer's branded distribution networks is both permissible and widely practiced. This exception weakens the "B" (brand) and "R" (recirculation) tenets of the model and creates barriers to effective investment in, and execution of, market expansion. These strengths and weaknesses are discussed in the next two Chapters.

6. Recommended Regulatory Enhancements

The Government-approved National LPG Master Plan, developed among Government ministries and agencies, GLPGP, and relevant Cameroonian stakeholders, defines a number of recommendations for enhancement to law and regulation or to the enforcement of law and regulation that would improve the risk profile of the sector with respect to safety, operational effectiveness, accountability, scalability and bankability.

As of this writing, the Government has not yet implemented these recommendations, except that a national filling plant safety audit process has been prepared with GLPGP, to be carried out with funding to be provided by the African Development Bank.

The key recommendations are as follows:

Safety-related recommendations

To ensure unsafe cylinders, including in particular those with leaking valves, are taken out of circulation:

- Filling plants must withhold gas cylinders not meeting the safety specifications for requalification.
- Establishment of a mechanism for certification of filling plants for requalification of gas cylinders not meeting the safety specifications for requalification.
- The cylinder must be regularly retested using hydrostatic methods and other applicable tests to verify that it is sealed and leak-free.
- Filling plants must verify the cylinder is leak-free prior to every instance of filling.
 - The cylinder is filled as per its authorized holding capacity without the need to overfill the cylinder by more than 85% volume. This is to enable expansion and to prevent whatever breaking due to this expansion, and
 - The cylinder is leak-free after filling with its valves and accessories.
- Prohibit by law for any person to refill any empty gas cylinder at a petrol station (similarly to how they might fill up a vehicle's petrol tank).
- Cylinders must only be filled in certified and approved facilities, where cylinders can be emptied if a leak is detected, with access prohibited to the public (neighboring examples: Ghana and Nigeria).
- Permitted filling conditions, including weight and calibration value, must be defined solely by the cylinder manufacturer. (These conditions are promulgated to the filling plants that receive the authority to fill.)
- Filling operations may be performed solely by, or under the authority of, the owner of a given cylinder, namely, the LPG Marketer which invested in this cylinder.
- Full gas cylinders must be stored in climate-controlled storage areas and warehouses equipped with working fire extinguishers and free from any device of condition that can initiate a fire.
- Require that cylinders which are transported in quantity are transported, unladed and delivered utilizing pallets, to minimize the possibility of cylinder damage during transport and handling.

- Ensuring that LPG storage facilities and filling plants which generally hold an inventory of more than 15 tons are equipped with a system that can douse the LPG storage tank(s) with water for about two hours, until firefighters are able to arrive and take over operations, maintaining temperatures below the LPG boiling point.
- Encourage storage facilities to adopt and utilize remote-controlled shutdown systems for the LPG supply to the filling equipment, in case of fire.

LPG specification recommendations

Current specification

LPG marketed in Cameroon is solely commercial butane, consistent with the joint ministerial order AC002360 MINEE and MINMIDT of 1 April 2015. The specification is pressure-based, not chemically based. Annex VII states that LPG and non-commercial Butane are defined as: "50° C Vapor Pressure: Maximum 7.5 kg / cm², measured according to international standards AFNOR M41010 or ASTM D1267.

The specification is aimed at minimizing fuel impurities, ensuring a minimum heat value, and ensuring pricing of imports properly reflects that propane (if included in the mix) should be at a lower price than butane, per tonne.

Recommendations

To achieve those aims, two additional specification features are commended for enhancing the current standard, namely:

- Hydrocarbon mixture: composed mainly of butane and butenes and containing less than 16% by volume of propane and propene. (Note: this is consistent with the 7.5 kg/cm² maximum.)
- Density: equal to or greater than 0.574 kg / l at 15° C, which corresponds to 0.53 kg / l at 50° C, consistent with the corresponding ASTM.IP tables.

The standard should also state that the LPG offered for sale must be odorized by ethyl-mercaptan or equivalent, so that leaks may be detected via an odor. A safety sheet could also be attached to the standard.

Market model recommendations

- Make explicit in the law that the licensee for LPG marketing – acquisition and ownership of fuel and cylinders, and responsibility for cylinder safety and refilling – be the LPG Marketer; that the Marketers are the exclusive owner of cylinders in the country; and that the Marketers have the sole right and the responsibility to have cylinders refilled at authorized filling facilities of their choice.
- Make explicit that Marketers may market LPG cylinders directly through retail outlets, by home delivery, or by an exclusive network of distributors; non-exclusive distribution by Wholesalers should be phased out over time, with Wholesalers migrating to the role of Distributor. (This topic is discussed in detail in Chapter 14 (The Value Chain and Recommended Enhancements) beginning on page 104.)

Regulatory structure

The National LPG Master Plan recommends a simplification and streamlining of the regulatory agency environment through the consolidation of multiple agency functions into a single national agency for LPG.

The current fragmentation of the development of regulations and of oversight result in a suboptimal and inconsistent implementation and enforcement of BCRM.

LMICs with well developed and well regulated LPG sectors with effective internal consistency, such as Mexico and El Salvador, and those seeking to achieve that result, such as Kenya, have adopted (or are moving toward adoption of) a single law or legal instrument for the sector and a single regulatory body governing it (and potentially the petroleum sector as a whole).

It was determined in the national master planning process that such consolidation would be cost-benefit neutral or net favorable, although detailed study to verify that assumption was beyond the scope of the master planning committee remit, and of this report.

7. Cameroon Market Model Scorecard

There is no universally accepted way to score a country's LPG market model, as enforced. Thus, any scoring system will have a degree of arbitrariness. That said, the following is one way to score Cameroon's current implementation of BCRM, and the enhancements delineated in the Cameroon National LPG Master Plan but not yet implemented:

Table 4. LPG national market model and structure scorecard: Cameroon in 2018

Core BCRM features	Conforming	Intermediate	Non-conforming	Result	Score
Marketer owns cylinder	H Y	M	L N	Y	1
LPG license is for marketers only	Y		N	Y	1
All cylinders are branded	Y		N	Y	1
Exclusive distribution chain	Y	Hybrid	N	N	0
Recirculation of cylinder to closed facility with inspection	Y	Hybrid	N	Y	1
Enforcement against cross-filling	H	M	L	M	0.5
Margins are adequate (and frequently refreshed, if regulated)	Y		N	N	1
Safety standards and enforcement	H	M	L	M	0.5
Cylinder deposit scheme is defined and enforced	Y		N	Y	1
Inter-marketer cylinder exchange	N	Strict	Loose	Loose	0
Marketer fragmentation	Score: (sum [top 4 market shares])			0.69	0
Valve differentiation	Y		N	Y	1
Subtotal					9
Supportive features					
Uniform pricing	Y		N	Y	1
Pro-poor support	Y	Untargeted	N	Untargeted	0.5
Common shared infrastructure (utility model)	Y	Selective	N	Y	1
Fragmentation of authorizing/enforcing agencies	Score: (1 / number of agencies)			0.08	0
Subtotal					2.5
Total Score (Maximum Possible Score)					11.5 (16)
Score (scaled to 0-100)					72

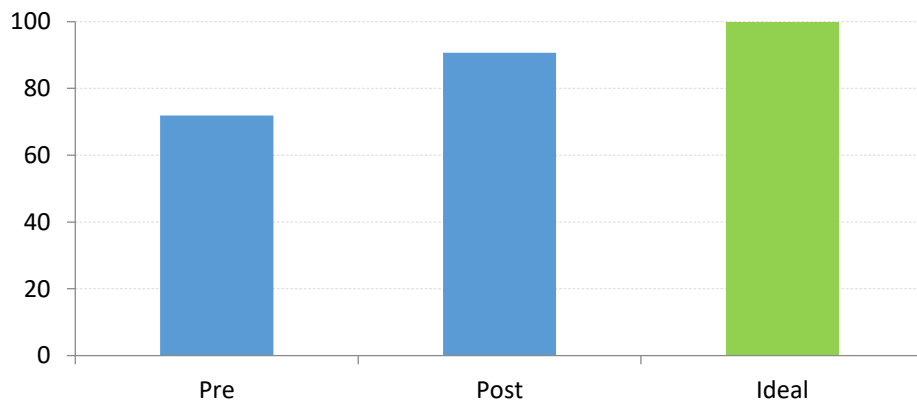
The following is the scoring of Cameroon's LPG market model, upon eventual implementation of the LPG Master Plan recommendations:

Table 5. LPG national market model and structure scorecard: Cameroon Master Plan

Core BCRM features	Conforming	Intermediate	Non-conforming	Result	Score
Marketer owns cylinder	H Y	M	L N	Y	1
LPG license is for marketers only	Y		N	Y	1
All cylinders are branded	Y		N	Y	1
Exclusive distribution chain	Y	Hybrid	N	Y	1
Recirculation of cylinder to closed facility with inspection	Y	Hybrid	N	Y	1
Enforcement against cross-filling	H	M	L	H	0.5
Margins are adequate (and frequently refreshed, if regulated)	Y		N	Y	1
Safety standards and enforcement	H	M	L	H	0.5
Cylinder deposit scheme is defined and enforced	Y		N	Y	1
Inter-marketer cylinder exchange	N	Strict	Loose	Strict	1
Marketer fragmentation	Score: (sum [top 4 market shares])			0.69	1
Valve differentiation	Y		N	Y	1
Subtotal					11
Supportive features					
Uniform pricing	Y		N	Y	1
Pro-poor support	Y	Untargeted	N	Untargeted	0.5
Common shared infrastructure (utility model)	Y	Selective	N	Y	1
Fragmentation of authorizing/enforcing agencies	Score: (1 / number of agencies)			1.0	1
Subtotal					3.5
Total Score (Maximum Possible Score)					14.5 (16)
Score (scaled to 0-100)					91

A graphical comparison of scores (Figure 5) shows the increase toward the idealized model, if Cameroon's contemplated reforms are implemented comprehensively and self-consistently and are well-enforced.

Figure 5. Comparison of Cameroon market model scorecard results from planned BCRM enhancements



8. Key Agencies for the LPG Sector

While the distribution of gas in Cameroon is operated by private corporations, the state retains the right to monitor its supply and to control prices. In Cameroon, the oil industry in general, and the LPG sector in particular, contain three main classes of market participants: Government, quasi-public corporations of the LPG sector, and private operators¹⁶.

The Government has political, regulatory, technical and financial oversight as follows:

- The President of the Republic has broad oversight responsibility for the national hydrocarbons sector as a whole and has direct technical and financial control of the National Hydrocarbons Corporation (SNH), the Cameroon state oil company. The Presidency also approves as a matter of practice all pricing decisions with respect to LPG.
- The Prime Minister coordinates the actions of all ministries.
- Twelve ministries, agencies and quasi-public entities and two special-purpose private companies which are, in essence, common carriers, have responsibility for various aspects of the LPG sector and supply chain. This represents a relatively high degree of administrative and regulatory complexity. These organizations are as follows:

Table 6. Current supply chain agencies and common-carrier actors

Abbr.	Full Name	Role	Comments
Ministries			
MINEE	Ministry of Energy and Water Resources	Lead agency for all administrative and technical activities of the petroleum products industry, including LPG. Develops and implements new legislation. Oversees all regulatory activities in the petroleum products sector. Although independent of MINFI, MINIMIDT and MINCOMMERCE, MINEE pursues consensus with those agencies on common, cross-cutting issues, which include authorization and licensing, pricing recommendations, and oversight of importation and financing (including the LPG subsidy mechanism). MINEE specifically supervises Sonara and SCDP.	Changes in MINEE leadership and senior staff in 2017 and 2018 created discontinuity and variability in focus and level of action with respect to implementation and financing of the LPG Master Plan, primarily reflected in a reduced pace of decision-making.

¹⁶ World Bank (2007)

Abbr.	Full Name	Role	Comments
MINFI	Ministry of Finance	Responsible for oversight of, and shareholder in, SNH (national oil company), Tradex (main petroleum products marketer; import aggregator for the LPG sector), and HYDRAC (quality assurance of petroleum product imports); responsible for fiscal policies and customs control in the petroleum sector, including LPG.	
MINMIDT	Ministry of Mines, Industry and Technological Development	Responsible for industrialization; oversees ANOR, the Agency for Standards and Quality; supervises aspects of cylinder-filling together with MINEE; responsible for oversight of cylinder manufacturing.	
MIN-COMMERCE	Ministry of Trade and Industry	MINCOMMERCE oversees CSPH, the Hydrocarbon Price Stabilization Fund, and enforces Cameroon's competition laws, including in the LPG sector.	
MINTRANS	Ministry of Transportation	MINTRANS oversees the transportation of petroleum products, including LPG. It specifically oversees CAMSHIP (littoral transport) and CANRAIL (rail).	
ANOR	Agences des Normes et la Qualite	The Agency for Standards and Quality sets and enforces norms and standards, including for LPG equipment, under MINMIDT.	

Quasi-public entities

CSPH	Caisse de Stabilisation des Prix des Hydrocarbures	The Hydrocarbon Price Stabilization Fund compensates for volatility in the input price of petroleum products into the sector, including LPG, and, because pricing is set by regulation below international parity, thus implements the national subsidy mechanism, as well as LPG cross-subsidies such as the transportation equalization tax. CSPH also regulates the distribution subsector (including pricing compliance) and, in cooperation with Tradex, manages tenders for LPG (and other hydrocarbons) for the input quantity not assigned to Sonara. CSPH is under MINICOMMERCE.	
SNH	Société Nationale des Hydrocarbures du Cameroun	The state oil company. Its relevant subsidiaries are Tradex and Hydrac.	

Abbr.	Full Name	Role	Comments
SONARA	Societe Nationale de Raffinage SA	The state oil refinery company. Sonara is allocated a 20% share of the national market for LPG supply, the remainder sourced from abroad through CSPH/Tradex tenders. Sonara is supervised by MINEE.	The 20% share is anticipated to be required to be reduced based on the LPG market growth identified in this report, and in the Master Plan, outpacing Sonara's capacity to expand LPG production meaningfully beyond current levels.
SCDP	Société Camerounaise des Dépôts Pétroliers	A 51% state-owned company, SCDP is responsible for bulk storage of LPG nationwide and handles cylinder filling on a public-utility basis, in whole or in part, for most LPG Marketers. SCDP is accountable to MINEE and supervised by MINEE and MINMIDT.	
HYDRAC		A 51% state-owned company, responsible for petroleum product quality and quality assurance nationally.	
TRADEX		A 44% state-owned company and a subsidiary of SNH, Tradex, is a petroleum-product importer, exporter and distributor, and a leading LPG Marketer.	Tradex is one of the local LPG operating partners in the Cameroon GLPGP/Clean Cooking for Africa LPG microfinance program.

Common carrier private companies

CAMSHIP	Cameroon Shipping Lines	Exclusive maritime shipper of petroleum products including LPG from Sonara in Limbe to SCDP primary storage facilities in Douala.	
CAMRAIL	Cameroon Railway Corp.	Exclusive rail shipper of petroleum products including LPG from SCDP Douala storage facilities to SCDP satellite facilities in Yaounde, Bélabo and Ngaoundéré.	

Governmental process for LPG imports

Importation requests are sent by LPG Marketers to MINEE. Upon approval by MINEE, an import allocation is determined by CSPH and approved by MINCOMMERCE. Payment is processed through MINFI.

It is speculated by knowledgeable stakeholders that there is a tacit understanding among the agencies and quasi-public companies that LPG import volumes should be managed in a way that does not cause a major increase to the use of Government fiscal capacity required for the LPG subsidy. Thus, possibly, the Government itself may be, or may become, a gatekeeper to LPG sector growth. This issue is discussed in more detail in Chapter 21 (Summary of Main Project Risks, Mitigations and Mitigation Sources) beginning on page 200.

Relevant regulation, law and standards

Regulations, laws and standards governing the LPG sector are shown in Annex Chapter 31 (LPG-Related Laws and Regulations) on page 312.

9. Complementary Policy Initiatives

Taxes, duties and subsidies

The current LPG pricing regime (including taxation, levies, etc.) is shown in Chapter 10 (Pricing) beginning on page 58. It contains both a stabilization tax (effectively, the subsidy mechanism for LPG fuel) and VAT applied to various costs within the supply chain.

Waiver of the VAT components would have a modest positive effect on end-user pricing of about 1.5%. Considering that the recommended increase (via levy) to reduce cylinder acquisition costs by 40% is equivalent to 4.6% of the end-user price, a VAT waiver would reduce that increase by one third.

Waiver of duties and VAT on LPG equipment would likewise have a positive effect on affordability for consumers.

Woodfuels are subject to parafiscal taxation, which the Ministry of Forestry and Wildlife estimated at CFA 1 billion on a taxable woodfuels profit stream of between CFA 117 billion to CFA 152 billion in 2018, equal to an effective tax rate of between 0.66% and 0.85%.

A revision to the Cameroon Finance Law enacted on 11 December 2018 (aw No.2018/022) includes wood products in the national VAT regime for the first time, including wood intended for charcoal production. This application of VAT will encourage switching from charcoal to other cooking fuels, such as LPG.

The GLPGP/Clean Cooking for Africa expert team has also recommended to the Government that it consider at the appropriate time transitioning from a generic subsidy on all LPG fuel to a targeted subsidy based on household need, as other LMICs (notably India) have successfully done.

National Sustainable Energy for All process and clean cooking policy development

SEforAll

The SEforAll process in Cameroon, commenced in 2016, completed a Rapid Assessment document¹⁷ which identifies the need for modern and renewable energy solutions for cooking and heating to reduce dependency on biomass fuels. These solutions may include solar-based, biogas, and improved-cookstove technologies as well as LPG. However, these alternatives are not sized nor prioritized in the assessment document. The two formal planning documents required under the SEforAll process, the Action Agenda and the Investment Prospectus, remain in development, with a goal of completing them during 2019. The national SEforAll committee made a determination early-on to utilize the national LPG Master Plan with respect to the aforementioned planning documents.

According to an interim SEforAll technical report, approximately 7.5% of Cameroon households currently use some form of improved biomass cookstove (ICS), but this level of ICS penetration is unlikely to increase without policy and concrete measures to industrialize the production, marketing and sales of such stoves.¹⁸

¹⁷ See www.se4all-africa.org/fileadmin/uploads/se4all/Documents/Country_RAGAs/Cameroon_RAGA_FR_Released.pdf

¹⁸ SEforAll (2016), SE4All (2016); *Cameroon: Note Technique Sure L'Access a L'Electricite et aux Energies Modernes de Cuisson*.

In view of this report's upper-bound projection of LPG penetration reaching around 60% of the population by 2030 if all of the recommended reforms and investments are implemented timely, there will be a notional 40% of the population who, through at least 2030, may benefit from access to complementary cooking technologies for more-sustainable, marginally healthier combustion of biomass fuel.

Complementary clean cooking policy development

While the Government has been actively developing and pursuing policies with respect to electricity access, renewable electricity, and energy efficiency, it has not yet given similar priority to development of a complementary policy regarding biomass cookstoves. However, there have been efforts by NGOs and the local private sector to develop such solutions on small scales. As an example, the Hygiene and Sanitation Company of Cameroon (HYSACAM) and the Netherlands Development Organisation (SNV) have been developing domestic biogas digester use in the Adamawa, Centre, West and Northwest regions.

Biofuel policy

The Cameroon Government has established a target of producing 77 million litres of biodiesel and 77 million litres of bioethanol¹⁹, building from over 100,000 hectares of land already cultivated by palm plantations. (The production of biodiesel from palm oil and other vegetable and animal-based feedstocks can be used to generate bioLPG as well.)

The amount of domestic bioLPG that could be co-produced at the aforesaid scale would be determined by the chemical process utilized and whether the output is biopropane or biobutane. Notionally, the 77 million litres of biodiesel could create coproduction on the order of a million kg per year of bioLPG.

The potential for inclusion of bioLPG in the national biofuel strategy and associated projects is beyond the scope of this report, but is an appropriate topic for further investigation.

¹⁹ Muh, E., Renewable and Sustainable Energy Reviews (2017), [dx.doi.org/10.1016/j.rser.2017.10.049](https://doi.org/10.1016/j.rser.2017.10.049).

10. Pricing

Primary objectives of the price structure in a developing LPG market are

- To prevent price abuses by the distribution system; and
- To balance fuel affordability for consumers with returns required by investors.

Additional objectives can include whether prices vary by distance from LPG sources, or not, and whether the market will be a high-service or low-service market. High service, for example, could include in-home exchange of a filled LPG cylinder for an empty cylinder (that is, home delivery). High service and low service trade off forms of access and availability for the consumer (and stronger cylinder asset control for the supply chain participants) against end-user fuel affordability.

Higher unit margins also strengthen three key investment factors in LPG companies:

1. The sustainable growth rate (the maximum rate at which customers may be added without creating negative cashflow) of the enterprise is higher;
2. The breakeven volume for a new enterprise is lower, thus reducing the investment risk;
3. The potential for generating required returns to investors and the capacity to service debt are increased.

Regulated pricing

Cameroon has been employing regulated, subsidized LPG pricing, as shown in the table below.

Under this pricing scheme, the unit margins at each node in the supply chain are predetermined via regulation, using a national LPG price build-up formula.

Based on global LPG sector experience, there are six main choices of price system:

Table 7. Price structure modalities

LPG Price System	Description	Example Countries
Regulated, fixed margins, International Parity Price (IPP) ²⁰ , no subsidy	The government regularly updates the price structure as the applicable International Parity Price changes (typically monthly)	India, Indonesia, much of Latin and South America, Belgium, Spain
Regulated, fixed margins, actual sourced price, no subsidy	Maximum prices are revised regularly by each marketer as the international price is updated, according to the price formula (typically monthly)	Ghana, today
Regulated, fixed margins, common sourced price, no subsidy	The government regularly updates the price structure as the international price varies, per marketer	Kenya for petrol

²⁰ IPP is a regional index price adjusted for standard cost of transportation from the regional price hub

LPG Price System	Description	Example Countries
Regulated, fixed margins, fixed end-user price, IPP with variable subsidy	One permanent national end-user price remains in effect until the government chooses to revise the pricing formula	Morocco, Tunisia, Brazil, Argentina, Cameroon
Regulated, fixed margins, variable end-user price, fixed subsidy on IP formula	The government regularly updates the price, which is discounted by a fixed subsidy amount, as the IPP changes	Dominican Republic (prior to removal of subsidy)
Non-regulated	The market sets its own prices	Kenya, France, Italy, Germany

The regulated price structures may be further modified by adding a cross-subsidy mechanism to account for varying inland transportation costs, such that the end-user price is kept relatively uniform throughout the country without disincentivizing the distribution network from serving remote users in favor of close-by users. Cameroon has employed such a mechanism.

Its main components are source price, fixed margins corresponding to each supply chain node, various taxes and levies, and a subsidy that reimburses LPG marketing companies for the cost gap between the LPG they purchase and the price for which they sell it.

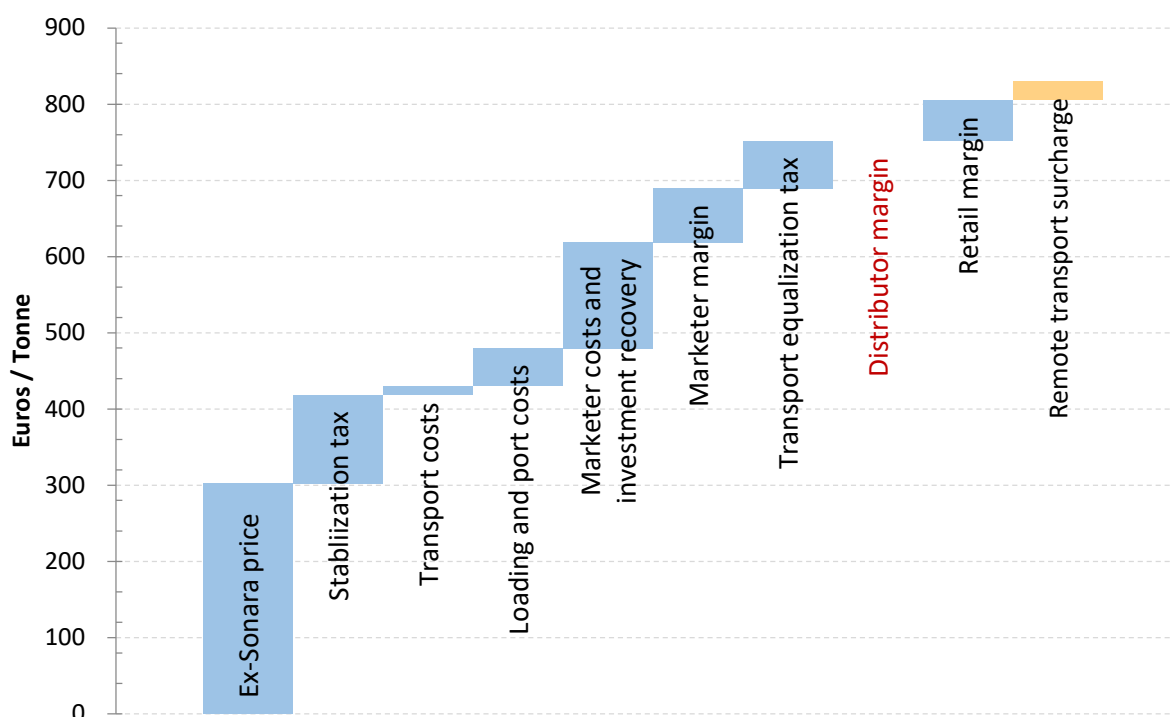
Under consideration is an LPG levy to be added to the pricing formula for the purpose of capital cost recovery of the major investments to be made in cylinders and other infrastructure needed to attain the national goal of 58% of the population using LPG for cooking by 2030. The effect of this levy is estimated to increase end-user LPG prices during the 10-year recovery period by € 37 per tonne, approximately 4.6% of the present end-user price. This prospective levy is taken into consideration in the forecasting of demand and the structuring and modelling of investments described in Parts VI (LPG Demand Potential to 2030) and IX (Financing), respectively.

Current pricing

The latest ministerial order defining the national LPG pricing formula is 00025/MINCOMMERCE /CSPH of 26 February 2015, which updates Ministerial orders 006/A/MINDIC of 28 January 2004 and 041/MINCOMMERCE of 10 July 2014. (A full list of applicable laws and regulations is given in Annex Chapter 31 (LPG-Related Laws and Regulations) beginning on page 312.)

The following figure shows the price buildup formula presently in effect:

Figure 6. Current LPG price build-up formula



Price Element	Amount (€/T) ²¹	Description
Ex-Sonara price	301.9	Ex-refinery price, set to approximate International Parity Price (import terminal price) minus the stabilization tax amount
Stabilization tax	116.1	In effect, the governmental subsidy on LPG fuel, which isolates the rest of the supply chain from the true commodity price and equalizes the import price with the post-tax ex-Sonara price; this amount varies over time with the regional LPG import price
Transport costs*	11.8	Covers domestic bulk transport (rail, road, littoral) to filling facilities
Loading and port fees*	49.4	(Self-explanatory)
Marketer costs and investment recovery*	139.6	Covers Marketers' operational costs, overheads, and cylinder-related costs, including depreciation and maintenance
Marketer margin	70.9	Maximum that a licensed LPG marketer may recover from its sales
Transport equalization tax	61.9	A geographic cross-subsidy that levels the price of LPG among the main cities where filling occurs, regardless of distance from the point of supply
Distributor margin	0.0	Note that this is zero. The formula assumes that Marketers self-distribute (which is largely the case for those with petrol station networks) or absorb the cost of their own distributor networks
Retail margin	53.5	Maximum that a retailer may recover from its sales
Total for anchor cities²²	805.2	This is the end-user price, equal at Q4 2018 exchange rates to CFA 520,000; a 12.5kg cylinder refill is thus CFA 6,500
Retail transport cost (average)	24.8	Extra € 0.18/tonne/km to cover cylinder transport cost between SCDP filling plant cities and remote towns and villages

*These elements include a VAT component

²¹ International pricing elements are defined in USD, in which the LPG commodity is traded; the additional elements are defined in CFA. Exchange rates applied: CFA/Euro, 645.8.

²² The applicable anchor cities, containing SCDP filling plants / storage facilities, are Douala, Yaounde, Bafoussam, Ngaoundere, Maroua, Ndoumbi (filling and storage) plus Garoua (storage only).

The sum of the Ex-Sonara price, stabilization tax, transport costs, and loading and port fees is defined to be equal to the Ex-Bonaberi price. Bonaberi is the hydrocarbon products import terminal owned and operated by SCDP. The intent is that Marketers pay the same bulk LPG price whether they acquire LPG from the Sonara refinery or via the Bonaberi terminal.

It must be noted that the actual International Parity Price is not transparent in this formula. Therefore, it is not possible with certainty to know the exact amount of the governmental subsidy in any period. (It can be determined through calculation and cross-reference by the entities involved in importation: CSPH, as the price stabilization fund, and Tradex, which acts as the intermediary for LPG import procurements for all Marketers.)

The strategy for the national LPG service model is implicit in the margin structure

A critical issue in setting unit margins through regulation is the service model intended for the country. Margin choice implies service level.

With high unit margins for the marketing/filling/distribution part of the supply chain, services such as home delivery become viable. High unit margins, per industry norms, would be in the range € 200-400 per tonne. With low unit margins, in a range of € 50-100 per tonne, only a basic service level is viable, and the focus of the supply chain participants is, of commercial necessity, on increasing volume, both in order to cover fixed costs (including any debt service) and, with additional volume, to generate financial returns to owners and investors.

In the case of the current pricing formula in Cameroon, the current Marketer all-in margin of € 210.5 (which also covers cylinder cost recovery and must additionally cover distribution costs) is close enough to the “low unit margin” case that a basic level is what is generally viable.

Recommended pricing formula

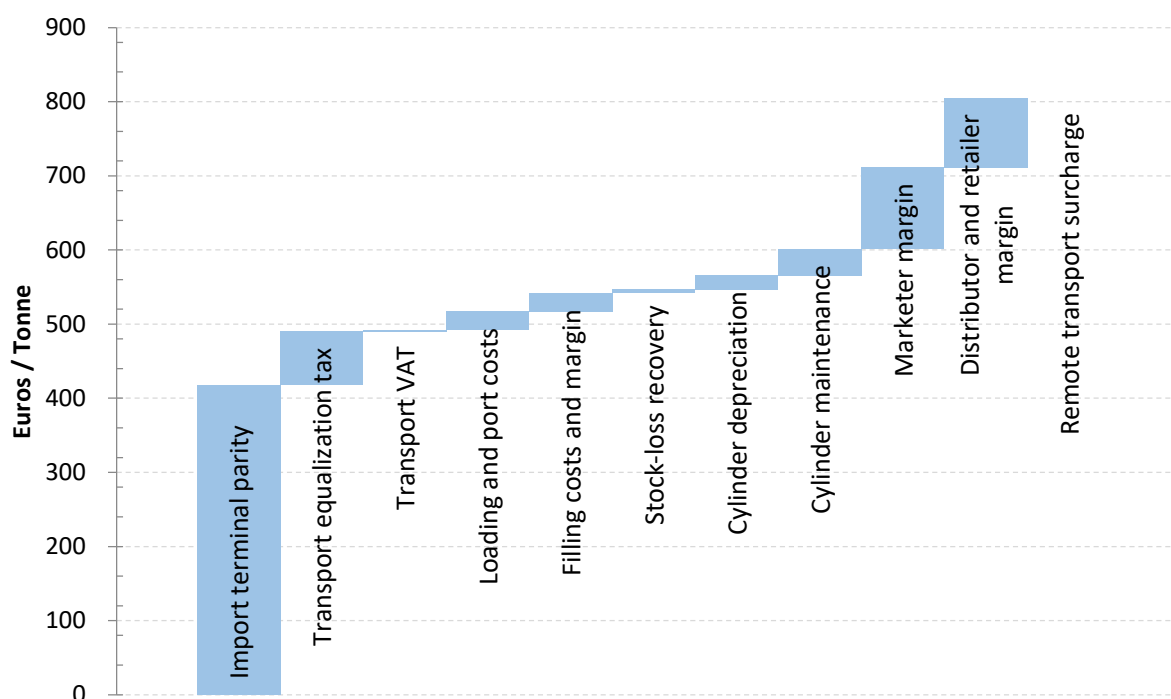
The Master Plan and the working recommendations of the Investment Committee call for a simplification of the pricing formula that would create added transparency, directly link to the International Parity Price, and provide the possibility for renegotiation of LPG import contracts on potentially more favorable terms. Such an outcome would reduce the potential stress on governmental fiscal accounts from increases in the subsidy burden as the LPG market rapidly grows as well as potentially create extra sector revenues which could be applied to strengthening margins and/or to offsetting cylinder acquisitions costs without raising end-user prices.

The recommended alternative builds up from the import parity price and adds the elements required by the operation and expansion of the supply chain for sector growth. At the end-user level, prices are charged per kg for the amount of fuel in a full residential LPG cylinder, rather than per tonne.

These costs and margins are Cameroon-specific, intended to increase transparency and accountability throughout the supply chain, better (and formally) allocate margins among all supply chain participants, and result in the same end-user price.

This alternative is detailed in the following figure.

Figure 7. Recommended LPG price formula



²³ International pricing elements are defined in USD, in which the LPG commodity is traded; the additional elements are defined in CFA. Exchange rates applied: CFA/Euro, 645.8.

Why some level of price increase may be desirable in the near and medium term

It may seem counterintuitive to plan an increase in end-user LPG prices as part of a program to increase LPG adoption and use rapidly nationwide, especially with respect to the rural poor.

However, the present level of free cash flow generated for the LPG Marketers by the LPG ecosystem from each tonne of LPG is not adequate to meet four preconditions for their successful investment in rapid, sustainable scale-up of LPG cylinder supply and to serve corresponding demand:

1. Ensure cylinder safety and LPG handling safety to an acceptable level throughout the value chain;
2. Ensure that the full range of essential business functions needed in a large-scale, well-functioning LPG ecosystem are performed with adequate completeness and acceptable quality;
3. Enable investment at the rate necessary to achieve one or both of (i) the unmet demand projection and (ii) the national policy goal for LPG adoption and use by 2030; and
4. Support expanded availability of LPG in rural areas.

These four preconditions are in a rough hierarchy: First, without an acceptable level of safety, fear of explosions stagnates the development of the market by depressing demand. Second, if cost coverage is inadequate, key tasks are underperformed or not performed, and the ecosystem develops more slowly and more problematically. Third, if investment cannot occur fast enough, serving unmet demand (let alone meeting the policy goal) can take far longer than 2030 to be realized, if ever. This can be because LPG businesses' cash flows are inadequate to attract enough capital and/or affordable capital, or because they are inadequate to allow LPG businesses to grow at the desired rate without facing growth-driven insolvency on a cash basis. Fourth, because costs and risks associated with serving rural areas are higher than urban and peri-urban areas (due to the combination of geographic remoteness, lower population density, lower incomes on average, and higher availability of freely gatherable firewood in rural areas), weak sectoral cashflow generated from urban and peri-urban areas may limit the sector's ability to expand as deeply as possible into rural areas.

Much as an electric utility must find a way to cover its costs of expansion of facilities through its rate base, so must the LPG sector cover its costs of infrastructural expansion.

Therefore, paradoxically, to serve many more poor and rural households, it is desirable to raise the LPG price, for the near and medium term, in Cameroon.

Such an increase would be for two very specific purposes, per the consensus recommendations of the LPG Investment Committee: first, to offset the up-front cost of cylinders for industry and the consumer by spreading a portion of that cost over the total LPG volumes of the country over 10 (or more) years, and second, to reduce the investment risk associated with cylinders. That investment risk has two main elements: the mobility of the cylinder asset (making tracking and repossession problematic, particularly when Wholesalers exercise control over cylinder recirculation), and the modest free cashflows of the LPG Marketers, which limit their capacity to grow the rate at which they can absorb and deploy cylinder assets.

This recommendation is discussed further in the section entitled *Balancing LPG cylinder affordability with LPG fuel affordability* on page 64.

It is not necessarily the case that the consumer must bear the entire burden of such a cost offset through the end-user price. The use of concessional capital for financing LPG sector growth, improvements in LPG sourcing, sectoral economies of scale that are achieved over time, Governmental interventions (e.g., targeting of subsidies), risk-sharing and cost-sharing structures, establishment of key projects as cost centers where possible (on a utility model) rather than as profit centers, and other mechanisms, can serve to reduce the cost burden on end-users, and in particular, on poorer and more rural end-users.

The most directly relevant of these mechanisms and trade-offs are discussed in more detail throughout the remainder of this document.

Once very rapid expansion of the LPG sector has occurred and effective, efficient operational disciplines are in force in industry and government, competitive forces and/or governmental action can benevolently adjust the allocation of costs and rents throughout the value chain.

Advantage of the cylinder deposit scheme

Under BCRM, cylinders are purchased by LPG marketing companies and made available at some percentage of the cylinder acquisition cost to the consumer, in the form of a cash deposit.

Effect on the consumer

The deposit entitles the consumer to possess a cylinder of a certain brand, and to have his/her cylinder (typically a physically different cylinder with each refill) refilled, inspected and maintained for safety by the LPG marketing company. The consumer is insulated from wholesale and retail price mark-ups as well as from the full acquisition cost of the cylinder itself. The maximum percentage of the cylinder cost that a consumer must pay toward a cylinder may be set by law or regulation (such as 80%, in Cameroon) or by competitive forces (such as approximately 20%, in Morocco). The consumer may recover his/her deposit by giving up the cylinder to the appropriate LPG Marketer's retailer or distributor.

Effect on industry

The cylinder deposit scheme mitigates the net cost to the LPG supply chain of deploying new cylinders under BCRM, by offsetting a material portion of the cylinder capital cost outlay. This source of cash decreases significantly the asset intensity of the LPG supply chain, from a cashflow perspective.

Balancing LPG cylinder affordability with LPG fuel affordability

The Government has the option to trade off an improvement to cylinder affordability for both industry and consumers with maintaining the present end-user fuel price.

Conventionally, the entirety of the capital cost of a cylinder is borne by, and divided between, industry and the consumer up front, as each new cylinder is acquired and enters the market. However, it is possible to spread a portion of the cost of the cylinder over a multiyear period by transferring a portion of its capital cost to the LPG fuel revenue stream.

Among the simplest mechanisms to do so is to introduce a capital cost recovery levy which is added to the price build-up formula. As described more fully and precisely in Part VIII, a levy of approximately € 0.037 / kg (€ 37 per tonne) applied to national LPG consumption over a ten year period, used to offset the

acquisition costs of new cylinders, would provide enough funding that the up-front capital cost of new cylinders to industry, and to consumers (via deposit), could be cut by approximately 40%.

Because such a levy would apply to all LPG consumed in the country, not only to the LPG associated with new users, a relatively small levy amount applied to the relatively large quantity of LPG already consumed could create a disproportionately large first-costs benefit for the new LPG users (and for the associated cylinder inventory investments by industry).

Making such a trade-off is being considered by the Government. Any decision affecting LPG pricing is ultimately a political decision and requires the approval of the Presidency. The structuring and potential economics of such a cylinder investment scheme involving partial levy-based cylinder funding are discussed in Part IX (Financing) beginning on page 149.

11. National LPG Planning Process from 2015

The Government of Cameroon partnered formally with GLPGP to devise a new national LPG policy and plan, with work starting in April 2015. The Government constituted a national multistakeholder *ad hoc* LPG planning committee (Committee) under the leadership of the Minister of Energy and Water Resources (MINEE), facilitated and coordinated by GLPGP under the Clean Cooking for Africa Program, to discuss and define the recommended policy and implementation details. This had broad representation, as follows:

Ministries and partners represented on the LPG Master Planning Committee included:

- Ministry of Energy and Water (MINEE) (as chair)
- Ministry of Industry, Mines and Technological Development (MINIDT)
- Ministry of Environment, Nature Protection and Sustainable Development (MINEDEP)
- Ministry of Public Health (MINSANTE)
- Ministry of Commerce (MINCOMMERCE)
- Ministry for Promotion of Women and Families (MINPROFF)
- National Oil Refining Company (SONARA)
- Société Camerounaise des Dépôts Pétroliers (SCDP), the national petroleum depot company
- Groupement Professionnel du Pétrole (GPP), an industry association of Cameroon downstream petroleum sector companies, including LPG companies
- National Hydrocarbon Society (SNH), the state oil company of Cameroon
- Caisse de Stabilisation des Prix des Hydrocarbures (CSPH), the price-stabilization (subsidy) fund
- UN Sustainable Energy for All (SEforAll)
- The Global LPG Partnership (GLPGP) (as facilitator and coordinator)

Four subcommittees addressed (i) pricing and transport; (ii) supply chain and filling; (iii) distribution and licensing; and (iv) safety and norms. Another subcommittee liaised with the private sector, dealing with scale-up planning, finance and communications.

The completed Master Plan was officially announced by the Government in December 2016. Cameroon is the first country in Sub-Saharan Africa to create a comprehensive, standalone LPG Master Plan.

The following summarizes the main Master Plan recommendations:

1. Substantially increase the national inventory of LPG cylinders, from about 2.3 million to 9 million, with associated expansions of storage, filling, distribution and transport, and retail outlets. The Plan target is to increase LPG consumption from the current value of around 4 kg/person/year to between 12 and 15 kg/person/year, a level consistent with widespread, but non-exclusive, use of LPG for cooking. An accessibility goal of one retail outlet per 3,000 population was determined, with its goal to make filled cylinders available to most households within a five minute walk from their home.
2. Enhance existing regulation and enforcement with respect to cylinders specifications, safety, and management (in particular, obligations and rights of LPG Marketers and clear definition of the role and

operation of brand-exclusive Distributors, displacing the dominant role today of Wholesalers); the status of retail outlets; filling plant safety (including conducting safety audits of all filling plants); and re-enforcement of the regulation that all cylinders must be filled solely under the direction and control of their brand-owner.

3. Revise the structure of the SCDP, a 51% state-owned entity that is responsible for storing petroleum products, holding reserve stock, and serving the country with depots, with respect to LPG. It was recommended to create a business unit within SCFP dedicated to LPG that would manage and monitor nationwide the process of filling (including training of operators) on behalf of the entire sector; road and rail transport of LPG; and the avoidance and mitigation of LPG fuel shortages.
4. Creation of an additional LPG import terminal at Kribi (located in the Southwest Region), which has deeper water than the existing main terminal at Bonaberi (near Douala) and, therefore, could accept lower-cost LPG deliveries made possible by the use of larger LPG vessels carrying larger cargoes. Accepting larger ships would also increase the number of international suppliers able to respond to tenders for LPG importation.
5. Revise the national LPG pricing formula to improve transparency, create opportunities for reducing the cost of internationally sourced LPG, provide adequate margins to Distributors for the first time, and ensure a uniform national end-user price. (Pricing in practice is higher in rural and more remote areas away from depots, placing poorer consumers at a disadvantage.)
6. Reduce taxation on cylinder importation, accessories, and gas cookers as much as possible, to make these items more affordable for consumers until such time as adequate, affordable domestic production thereof can develop to a large scale.
7. Establish an LPG regulatory entity at the national level. It was recommended that there should be a regulatory entity with responsibility for coordinating inter-ministerial, inter-agency actions on LPG on a wide range of issues, including on LPG supply, standards, safety, pricing, distribution, and retail. In conjunction, approvals, oversight, and bureaucratic procedures for the LPG sector would be streamlined and consolidated. It was also recommended to establish an official website, accessible to the public, as a resource for up-to-date information on pricing, authorized distributors, retail outlets, and other pertinent facts.
8. Empower and educate consumers regarding LPG. These recommendations included conducting promotional campaigns on the benefits of LPG and on effective and safe use; developing sales plans with Marketers (linked to safety training) in areas where distribution is currently poor, and developing of microfinance offers to assist consumers with the initial purchase of LPG equipment.

A follow-on *ad hoc* LPG Investment Committee, responsible for implementation, was established and began work in May 2017. That work is ongoing as of this writing. However, a change in Minister and in senior staff of MINEE in late 2017 and 2018 resulted in MINEE taking a more hands-off approach to implementation issues, instead approaching the Master Plan as a guide for industry and the financial sector to implement LPG scale-up.

A main focus of the LPG Investment Committee work has been methods and structures for enhancing the bankability of the LPG sector with respect to major new investment in LPG cylinders. A number of recommendations and options were prepared and presented to the responsible Ministers, the Prime

Minister and the Presidency during 2017 and 2018, albeit without any final decision taken (for any one option, or against all options) by the Government as of this writing.

The regulatory reforms and enhancements called for in the Master Plan, and its recommendation for a pricing mechanism to offset a percentage of the cost of new cylinders over time to 2030, have not been enacted as of this writing.

Areas of assistance to MINEE through the Clean Cooking for Africa Program

GLPGP signed an MOU with the Government of Cameroon in December 2014 to govern providing technical and finance-related support in the following areas:

1. Development of a national Master Plan for LPG in collaboration with MINEE and a steering committee to be established for the purpose. This activity formally concluded in December 2016 but has been extended and revised under the Clean Cooking for Africa Program, with this report as one associated deliverable.
2. Planning and preparation of all necessary investments and interventions of the Master Plan. This activity has been ongoing.
3. Alignment of the Master Plan with the energy-related planning and policy frameworks of key international partners such as the World Bank and UN SEforAll. This activity has been ongoing.
4. Structuring and mobilization of financing (domestic and international, market-rate and concessional) for implementation of the Master Plan investment projects. This activity commenced in May 2017 and has been ongoing.
5. Empowering consumers to adopt and use LPG, in particular through the *Bottled Gas for Better Life* program described in Chapter 18 (Consumer Empowerment) beginning on page 154.

Areas of assistance to MINEE adjunct to the Clean Cooking for Africa Program

1. Guiding and contributing substantially to the Cameroon Sustainable Energy for All Action Agenda and Investment Prospectus with respect to LPG for cooking. This activity has been ongoing.
2. Performing a nationwide safety audit of the LPG filling plants. This was conducted in 2017 with funding support from the African Development Bank.
3. Empowering women entrepreneurs to become successful LPG Distributors. This will commence in 2019 with funding support from the African Development Bank and others.
4. Creating and carrying out a training and certification program for Cameroon's LPG distribution players. This will commence in 2019 with funding support from the African Development Bank.

VI. LPG Demand Potential to 2030

This Part²⁴ provides an evidence base for use by investors, policymakers, industry and researchers to guide the development of LPG infrastructure and distribution systems in Cameroon. It is comprised of two main chapters:

1. Modelling of a base case of LPG consumption, in which “business as usual” is projected into the future; and lower and upper bound scenarios of the demand which could be unlocked by commercially sustainable expansion, in quantity as well as geography, of the national LPG supply chain. The approach taken is to consider the characteristics which have given rise to the demand which was served in 2017 and 2018, and to model how this demand would be reflected across (a) new users brought into the national LPG value chain under Cameroon’s expected LPG policy and regulatory enhancements and expansion investments, and (b) concomitant growth in demand from existing users.
2. Findings from field surveying of Cameroon households in diverse areas with diverse demographics regarding cooking fuels—preferences, economics, and other drivers of and barriers to household LPG adoption in the context of other main fuel alternatives.

The analysis presented in this Part utilizes two main data sources: (1) a multi-region household survey commissioned by GLPGP and conducted by Dalberg Research in June 2018, and (2) a household research survey conducted by the University of Liverpool and Douala General Hospital between April and June 2016 as part of the LPG Adoption in Cameroon Evaluation (LACE-1) study. While nationally representative data sets such as the Demographic and Health Survey (2012) and the NIS data (2014) exist, these data sets were determined to be inadequate for the demand assessment, because they were outdated and had insufficient information on fuel use, availability, and affordability. The GLPGP-Dalberg survey regions and communities were pre-selected to have diverse geographical representation in Francophone regions where future LPG use was deemed at all feasible, in complement to the LACE survey conducted in the Anglophone Southwest region.

As mentioned in the Executive Summary (Part II of this report), the demand modelling predicts that the governmental goal of 58% of the population using LPG as a primary cooking fuel may be out of reach with solely supply-side investments. If the enabling environment enhancements and investments described the national LPG Master Plan and in this report are well and timely undertaken, the analysis predicts that improving LPG availability, by itself, can be expected to have a major impact on both the rate and amount of LPG adoption. The supply-side investments are projected to result in LPG adoption and use—but not necessarily primary use—by 58% of the population. However, additional measures to increase consumer preference for LPG for cooking (compared with wood and charcoal) and to improve affordability of LPG equipment and/or fuel could not only increase the level of consumption, but would be necessary to increase the overall societal benefits from LPG transition. A discussion of potential demand-side measures is presented in the *Cameroon LPG Investment and Implementation* report (Part VIII).

It should be noted that data sources utilized do not contain data sufficient to predict reliably the extent to which such additional measures would increase the rate and extent of adoption. Therefore, only a single

²⁴ The contents of this Part were developed with Dalberg Global Development Advisors under engagement to GLPGP.

primary scenario of increased adoption is presented (together with the business-as-usual case), although certain variations on that scenario, related to fuel-stacking and pricing, are also quantified and described.

12. Demand Assessment

Summary

The assessment presents baseline consumption of LPG in Cameroon in 2017 (the most recent year for which comprehensive statistical data are available), and a forecast of potential demand for LPG as a household fuel in 2020, 2025 and 2030. Forecasts are made reflecting a scenario of increased LPG availability to be achieved through planned and/or potential additional market and regulatory reforms and national infrastructure investment projects.

Data sources

The GLPGP-Dalberg 2018 Cameroon household survey, commissioned by GLPGP for the Clean Cooking for Africa Program, was used for this assessment. Where possible, findings were validated against the findings of the LPG Adoption in Cameroon Evaluation (LACE) Study carried out by the University of Liverpool, the National LPG Master Plan for Cameroon, and various national statistics.

Baseline residential LPG consumption (as household fuel) in 2017-2018

The penetration of LPG has been increasing. In 2018, 30% and 11% of households (across the Littoral, Centre, Adamawa and West regions) reported using LPG as a primary and secondary fuel for cooking, respectively, in the GLPGP-Dalberg survey²⁵, compared to 25% of households reported in 2014 by the Institut National de la Statistique du Cameroun (NIS)²⁶ and 17.5% of primary fuel users reported in the 2011 Cameroon Demographic and Health Survey (DHS)²⁷. Overall, in 2017, LPG was the most commonly used fuel in urban households and firewood was the most commonly used fuel in rural households.

In 2017, Cameroonian households consumed approximately 95,000 MT of LPG, up from 86,463 MT of LPG consumed in 2016. Residential LPG consumption for LPG users varied across urban and rural households, with urban LPG-using households reporting 15.5 kg average annual per capita consumption and rural LPG-using households 12.9 kg in the GLPGP-Dalberg survey sample. Based on the survey, it is estimated that there were 2.4 million 12.5 kg-equivalent LPG cylinders utilized at the household level in 2018 among both primary and secondary LPG users, with an average of 1.2 cylinders per household. This number only represents cylinders possessed by households and does not include other cylinders in circulation. This value is in line with the findings of the National LPG Master Plan, which estimated nearly 3 million 12.5kg cylinders in circulation in 2018.

Forecasted demand for LPG in 2020, 2025, and 2030

LPG demand in 2020, 2025 and 2030 was forecasted by modelling the incremental impact of three drivers of demand: (i) demographic changes, (ii) expanded availability of LPG through increased investment in cylinder availability, infrastructure, and distribution systems across Cameroon, and (iii) changes in underlying preferences for LPG that may result from increased investments in marketing, awareness, and

²⁵ n=1081

²⁶ MINEE (2015)

²⁷ DHS (2012)

safety. Additionally, the effect on consumption of increasing the price of LPG by 300 CFA per 12.5 kge cylinder, to fund a 40% decrease in the up-front cost to industry and consumers of acquiring LPG cylinders, was modelled. These drivers were combined to create the following scenarios:

Main Scenarios

- Scenario 1: Base case scenario, where forecasted consumption is derived by extrapolating historical growth trends for residential LPG consumption. This is also referred to as the business-as-usual case.
- Scenario 2: Market reform and expanded availability scenario, reflecting changes in adoption and consumption due to both planned and potentially additional policy and investment interventions. In the reform and expansion scenario, two sub-scenarios are considered, leading to a range of projected demand:
 - Scenario 2A: Lower-bound expanded LPG availability, incorporating demand growth from demographic changes, as well as the impact of expanded LPG availability to serve latent demand, without changes in average per-user consumption of LPG.
 - Scenario 2B: Upper-bound expanded LPG availability, incorporating the same demand drivers as Scenario 2A (demographic changes and expanded LPG availability), as well as additional changes in preferences that drive growth in the average per-user consumption of LPG²⁸.
- Scenario 3: Market reform and expansion (per scenario 2A) with a fuel price increase, reflecting changes in adoption and consumption per Scenario 2A, adjusted for a potential price increase of 300 CFA (4.6%) per 12.5 kge cylinder refill to 2030 for the purpose of offsetting by 40% the up-front cost to consumer and to industry of new LPG cylinders.

In the base case scenario, which assumes that LPG adoption increases in line with historical trends, it is estimated that residential LPG consumption will grow at an annualized growth rate of 4.4% to 171,339 MT by 2030, with annual per capita LPG use reaching 5 kg and 2.9 million households using LPG. This is consistent with base case estimates previously developed by MINEE.

Under the market reform and expanded availability scenario, the number of households using LPG as primary fuel would grow to 3.8 million households by 2030, representing 59% of all households in 2030. Concurrently, 1.6 million households (24% of all households) presently using LPG as a secondary cooking fuel are projected to transition to using LPG as their primary fuel by 2030.

The annual LPG consumption for household cooking would grow from around 95,000 MT in 2017 to 269,699 MT in 2030 in the lower bound scenario and to 303,194 MT in the upper bound scenario.

²⁸ Because of the lack of reliable fuel-use information in the available datasets, it was not possible to model potential increases in the rate of LPG adoption due specifically to changes in preferences. Therefore, the upper bound case does not project an increase in users over the lower bound case, only an increase in the average consumption of users.

A 300 CFA price increase on the 12.5kg cylinder or cylinder-equivalent (12.5kge), equal to a 4.6% increase in current end-user LPG price, is projected to result in residential consumption of 254,812 MT in 2030 in the lower bound case, a 5.5% decrease. In the upper bound case, a proportional reduction would result in usage of 286,458 MT. This suggests a roughly proportional ratio between price change and consumption change under present and foreseeable demographic conditions. Given the longstanding policy of Government to maintain a stable, subsidized LPG price for purposes of affordability, the risk of underachieving the governmental policy objectives for LPG use due to price change are replaced by the risk of the subsidy amount growing to an unsustainable level for the Government. (See Chapter 21 (Summary of Main Project Risks, Mitigations and Mitigation Sources) beginning on page 200 for a deeper discussion of this topic.)

It is important to note that 29% of non-LPG using households in the sample cited the initial cost of gas stove and cylinder deposit as the main reason that they do not use LPG today. Reducing the up-front cost of the gas stove and cylinder deposit would likely increase LPG demand and consumption. It was beyond the scope of this report to model the potential effect that consumer financial empowerment mechanisms aimed at this barrier may have when implemented at a national scale. (Please see Chapter 18 (Consumer Empowerment) beginning on page 154 for details.)

Conclusion

LPG consumption in Cameroon has been rising steadily over many decades, growing from 21,000 KT per annum in 1995 to 103,000 KT in 2017, driven mainly by urban and peri-urban households switching from firewood for cooking. Household penetration of LPG as the primary cooking fuel has reached 47% of urban/peri-urban households and 6% of rural households, with total penetration (primary plus secondary) of approximately 41%. Projecting the historical growth rate forward, about 46% of households are expected to use LPG for cooking in 2030 under the business-as-usual case. To unlock and serve latent demand, reforms to the Cameroon's implementation of the Branded Cylinder Recirculation Model and additional investments to improve availability and access will be needed. This would include significant investment in additional cylinders, storage, and refill and distribution capacity, particularly in areas with limited LPG infrastructure. This analysis suggests that such reforms and investments could increase LPG uptake by up to an additional 890,000 households (relative to 2017).

This level of penetration is consistent with the Government's policy goal of LPG use by 58% of the population by 2030, if no distinction is made between primary and secondary use of LPG for cooking.

If additional measures are taken to stimulate demand beyond this, such as affordability and consumer empowerment measures and consumer education, the analysis indicates the potential to reach an upper-bound of 60% of all households in Cameroon by 2030. At the upper bound, annual LPG consumption would increase to 303,194 MT in 2030.

Detailed analysis and findings

Using the GLPGP-Dalberg and LACE survey data and the latest publicly available data, the following were estimated:

1. Residential consumption of LPG for household cooking in Cameroon in 2017-2018 across urban and rural households;

2. Potential future demand for LPG in Cameroon in 2020, 2025 and 2030 under a scenario of sufficiency of LPG availability resulting from a systematically expanded LPG sector. This includes additional cylinder availability and an improved refill and distribution system, with no disruption to the refill supply.

The analysis that follows estimates LPG demand in Cameroon between 2018 and 2030 under a number of different conditions. First, an overview of the study and data used for the Cameroon demand assessment is provided. This is followed by an overview of baseline household LPG consumption in Cameroon in 2017-2018. Finally, results from demand projections up to 2030 are presented.

Data sources

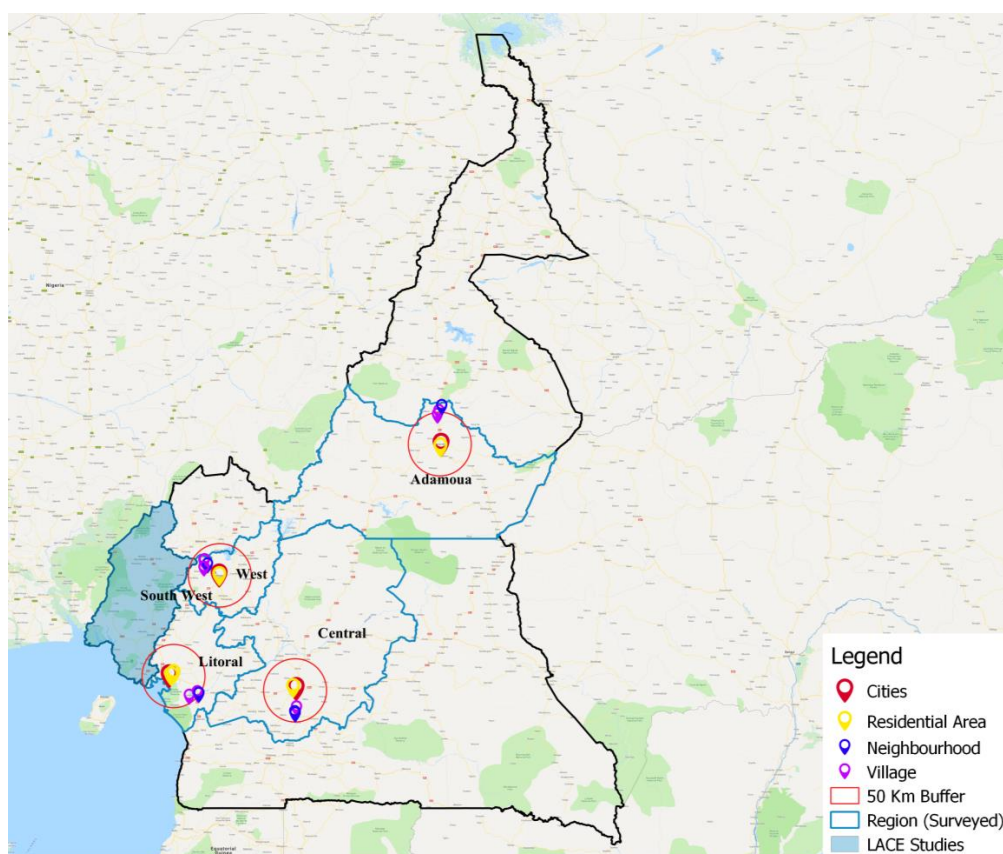
GLPGP-Dalberg survey

As shown in Figure 8, the GLPGP-Dalberg survey was conducted in the Littoral, Centre, West, and Adamawa regions. The survey targeted 1,081 households equally distributed across the four regions. Within the regions, the sample was split equally among urban, peri-urban, and rural areas within a range of 50 km from an urban area. 50 km was both a practical radius for survey logistics and a conservative radius for current and future LPG cylinder distribution from filling plants located in urban areas. The survey details and findings are presented in Annex Chapter 27 beginning on page 281.

The LACE study survey

The LACE survey was conducted in Limbe and Buea peri-urban and rural areas in the Southwest Anglophone region of Cameroon. It targeted 1,500 randomly selected peri-urban and rural households, with a total of 1,577 households (89% peri-urban and 12% rural) (see full methodology and results in Pope et al. 2018). 51% of the sampled households were primary LPG users and 40.5% were primary wood users. Other fuels such as sawdust, kerosene and charcoal were typically being used as secondary fuel.

Figure 8. Map of GLPGP-Dalberg and LACE study regions



Survey methodology

A systematic random sampling approach was used to identify target households in each of the selected villages and neighborhoods. The objective was to obtain insights and comparability on usage, expenditures on different fuels, and other topics of the survey. In the rural areas, villages were selected that were not too remote and were situated around a trading center where fuels would likely be purchased. The survey consisted of a final sample size of 1,081 observations. This included 395 (36.5%) households from urban communities, 339 (31.3%) households from peri-urban communities, and 347 (32.1%) households from rural communities.

For the analysis presented in this report, peri-urban households were re-classified as urban, given the lack of other nationally representative peri-urban data that could be used to estimate demand. Table 8 below shows the breakdown of LPG use in each region sampled, stratified by urban, peri-urban, and rural communities.

73% of households (288 households) in urban areas, 50% of households (171 households) in peri-urban areas, and 38% of households (131 households) in rural areas were found to use LPG. LPG use was similar across the urban communities, with usage ranging from 80% to 88% except for Adamawa, which only had 40% of sample households reporting LPG use. Meanwhile, in peri-urban and rural households, usage varied widely, ranging from 2% to 73%.

Table 8. LPG users and non-users among urban, peri-urban and rural households (GLPGP-Dalberg Survey 2018, N=1,081)

Region	Urban		Peri-urban		Rural	
	LPG users (No, %)	LPG non-users (No, %)	LPG users (No, %)	LPG non-users (No, %)	LPG users (No, %)	LPG non-users (No, %)
Littoral	88 (94%)	6 (6%)	70 (81%)	16 (19%)	73 (85%)	13 (15%)
Centre	80 (88%)	11 (12%)	55 (65%)	29 (35%)	31 (36%)	56 (64%)
West	80 (72%)	31 (28%)	43 (51%)	41 (49%)	25 (28%)	65 (72%)
Adamawa	40 (40%)	59 (60%)	3 (4%)	82 (96%)	2 (2%)	82 (98%)
Total	288	107	171	168	131	216

Note that the sample purposively excluded remote rural households within the sampled regions, because these remote rural areas lack the basic infrastructure necessary to support a commercially sustainable LPG supply chain (e.g., year-round passable roads). According to the DHS 2012, 93% of rural households almost exclusively cooked with gathered biomass. Therefore, the potential for LPG switching among such households was deemed too speculative for them to be included. Rural households with better infrastructure access were included in order to assess the extent to which (i) LPG use and cooking practices factored into household behaviors in the business-as-usual case, and (ii) additional LPG switching or use could occur within this group from improvements in LPG availability, from demographic trends affecting this group (e.g., urbanization and peri-urbanization), and from other measures.

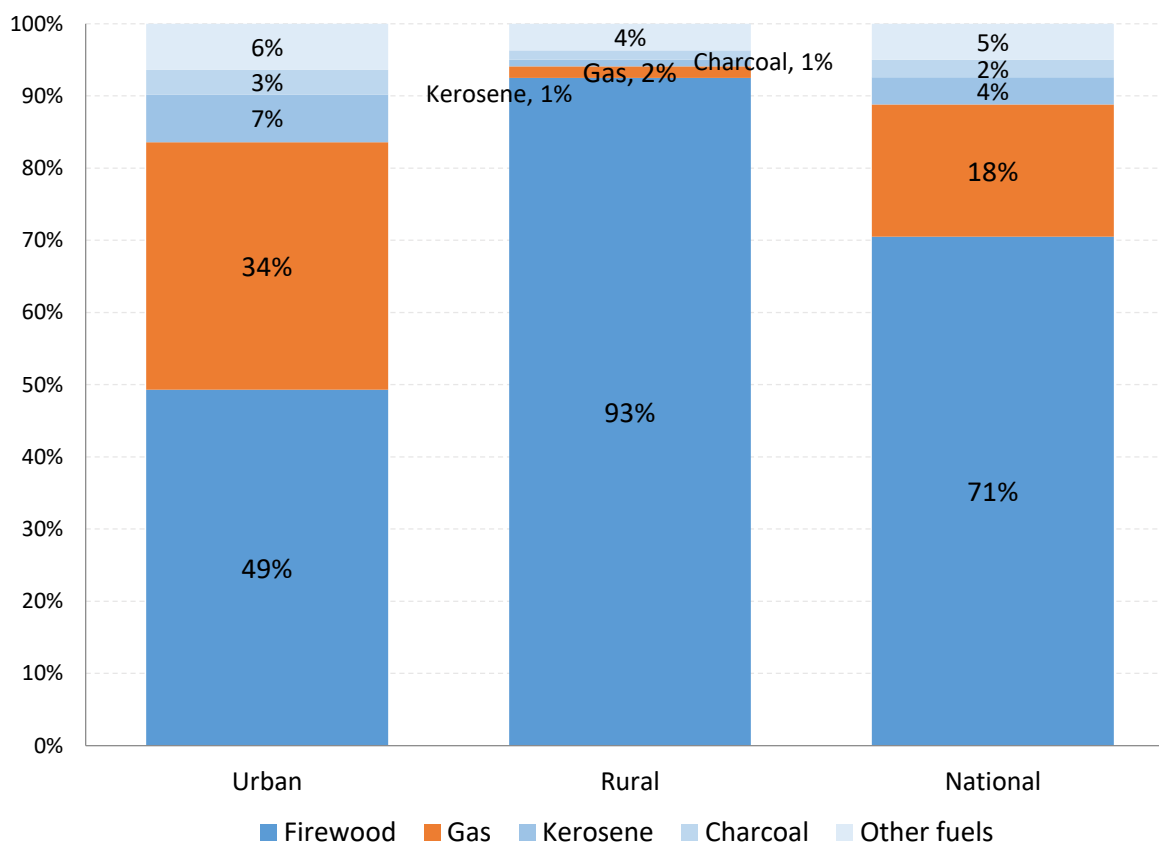
Baseline consumption of LPG as a household cooking fuel in Cameroon

Overview of Cameroon household cooking fuel use

DHS 2012 data (the most recent available of their kind) reveal that firewood was still the dominant primary cooking fuel in both rural and urban areas. However, in urban areas LPG already achieved considerable market share by 2011, with 34% of urban households in the sample reporting using LPG as their primary cooking fuel (see Figure 9). Firewood was overwhelmingly dominant in rural areas, with 93% of households reporting using firewood as their primary cooking fuel. The Ministry of Water and Energy reported that 25% of all households used LPG (any use) in 2014, with 49% of urban households and 5% of rural households using LPG²⁹ as either a primary or secondary cooking fuel.

²⁹ MINEE (2015)

Figure 9. Reported primary cooking fuel use in Cameroonian households in 2011
(% of total households, N=14,214)³⁰

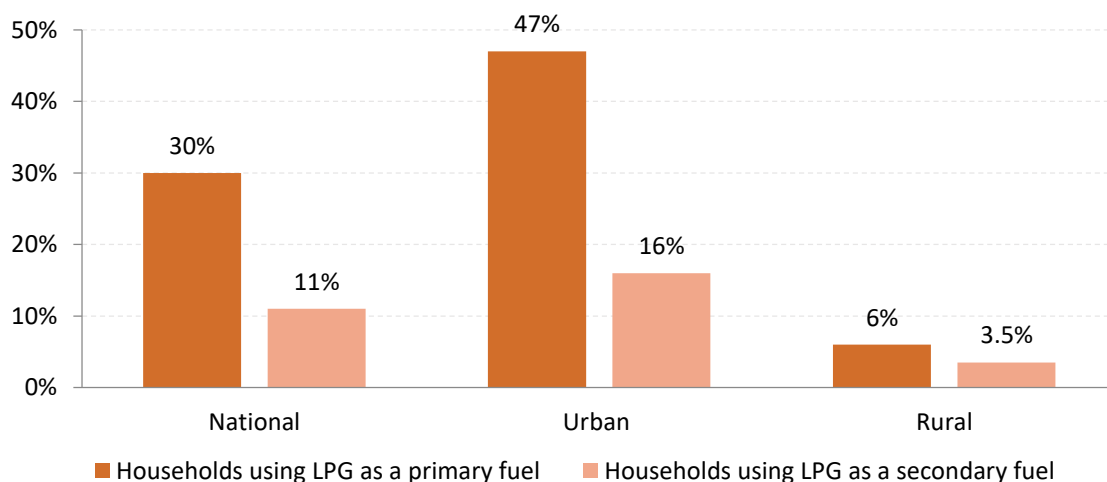


Since 2012, LPG consumption increased considerably, most notably in urban areas. The GLPGP-Dalberg survey shows that in 2018, 47% of urban households and 24% of rural households use LPG as a primary fuel in the sampled regions. Adjusting for population weights, an estimated 47% of urban households use LPG and 6% of rural households nationally use LPG as a primary fuel in 2018. In addition, approximately 11% of national households use LPG alongside their main cooking fuel. These values are consistent with the LACE survey results.

The LACE survey shows that the majority of households (peri-urban) in the Southwest region used either LPG (51%) or wood (41%) as their primary cooking fuel. Very few used kerosene (3%) or charcoal (2%), as their main fuels. Differences were observed between rural and peri-urban households, with rural households consuming less LPG than peri-urban households.

³⁰ Demographic Health Survey (2012). LPG is identified in the survey as “Gas” or “Cooking Gas”.

Figure 10. Reported LPG use as primary and secondary cooking fuel 2018
(% of total households, GLPGP-Dalberg survey, N=1,081)



Baseline residential consumption of LPG in 2017-2018

Cameroon reported a total national LPG consumption of 103,359 MT in 2017, with national annual average per capita consumption for the population of 4 kg per capita. This section estimates the total and per capita baseline consumption of LPG for the residential sector in 2017-2018.

Total residential LPG consumption in 2017-2018

Total and per capita residential consumption of LPG in 2017-2018 were calculated using two approaches: a top-down approach and a bottom-up approach. The top-down approach relied on total national-level LPG consumption data from the Ministry of Energy and Water Resources (MINEE) for 2017. The bottom-up approach relied on the 2018 GLPGP-Dalberg survey data, extrapolated to the general population. In this analysis, a “user” is a member of a household that cooks primarily with LPG.

Top down approach: Assuming that approximately 92%³¹ of total national LPG consumption in 2017 (103,359 MT) was residential, an estimated 95,000 MT of LPG was consumed for residential use in 2017. 25% (1.2 million) of all households in Cameroon used LPG for cooking in 2017. From this, the average annual LPG household consumption for LPG users is calculated at 79 kg and the average LPG consumption per capita by LPG users was 16 kg.

Bottom-up approach: The GLPGP-Dalberg survey data were used to estimate per capita consumption of LPG among primary and secondary LPG users. The LPG consumption at the household level was estimated by multiplying the median cylinder refill rate and the most commonly used cylinder size (12.5 kg).³² Primary LPG users in the survey reported a median cylinder refill rate of 6 times per annum while secondary users reported 4.8 times per annum.

³¹ Estimate based on the assumption that the residential share of the LPG market in Cameroon (comprising 6 kg, 12.5 kg and 15 kg cylinder sizes) has remained stable since 2009 at 92% of total LPG consumption as reported in the ‘Bienvenue au Seminaire de Presentation du Tableau de Bord 2009 du GPL’. MINEE (2009).

³² According the Dalberg Research survey and LACE survey, 98% and 99% of households, respectively, reported using the 12.5 kg cylinder.

The average LPG consumption per capita among LPG users in 2017 was 15.5 kg for urban populations and 12.9 kg for rural populations. Primary LPG users consumed 15 kg per capita and secondary users consumed 12 kg per capita. These results are in line with the LACE survey in the Southwest region, which reported LPG consumption to be 14.7 kg and 12.2 kg for primary and secondary LPG users, respectively.³³

Conclusion: The top-down and bottom-up approaches yield similar values for LPG consumption per capita among LPG users but different total residential consumption estimates. This is explained by the sampling of the GLPGP-Dalberg survey, which purposively looked at areas with good road infrastructure and relatively good LPG access compared to the national average. Relying on the top-down approach, total residential consumption of LPG in 2017 was 95,000 MT, up 10% from 86,000 MT consumed in 2016. The average consumption per LPG user was 16 kg per annum in 2017, while the national per capita LPG consumption for the population as a whole was 4 kg per annum.

Cylinders in circulation

The GLPGP-Dalberg and LACE surveys collected information on the sizes of cylinders used by households (see Table 9). Approximately 97.5% of LPG-using households surveyed in the GLPGP-Dalberg survey reported using a 12.5 kg cylinder, 1.7% of households reported using the 6 kg cylinder, and 1% used other sizes. Similarly, 99% of LPG-using households in the LACE survey reported using the 12.5 kg cylinder. This is consistent with 2007-2014 national cylinder data collected by the Government that consistently show 12.5 kg cylinders being the preferred cylinder size, with almost no market for the smaller 6 kg cylinders.³⁴

The GLPGP-Dalberg survey also collected information on the number of cylinders possessed by households on average. Approximately 81% of LPG-using households reported possessing one cylinder at a time; 19% of households reported possessing two or more cylinders at a time so that they could have a back-up LPG supply at hand. Similarly, 78% of LPG-using households in the LACE survey reported possessing one cylinder and 19% reported possessing two. Extrapolating the GLPGP-Dalberg survey results to the general population, this is equivalent to 2.4 million 12.5 kg-equivalent (kge) cylinders at the household level in 2018. This estimate is consistent with the Cameroon LPG National Master Plan, which estimated that there were 2.275 million 12.5 kge cylinders in circulation in 2015.

Table 9. Numbers of cylinders possessed by households (2018)
(GLPGP-Dalberg survey, N=1,081)

Number of cylinders in each household	Proportion of households		
	Urban	Rural	Total
1 cylinder	82.4%	76.2%	81.0%
2 cylinders	15.2%	23.1%	16.9%
3 cylinders	2.2%	0.8%	1.9%
4 cylinders	0.2%	0.0%	0.2%
Total	100%	100%	100%

³³ Pope et al. (2018)

³⁴ MINEE (2015)

The brands of LPG cylinder most commonly occurring in the sample were SCTM (31%), Camgaz (15%), Total (14%), and Tradex (13%). This ranking and market share are in line with national market share data reported by SCDP, which cites SCTM as 27%, Camgaz as 11%, Total as 13% and TRADEX as 13%³⁵.

Conclusion

Table 10 summarizes key data points related to baseline LPG demand in Cameroon in 2017-2018 as discussed in the preceding sections.

Table 10. Summary of baseline LPG consumption in Cameroon in 2017

Components of baseline LPG consumption	2017
Total residential LPG consumption for household cooking	95,000 MT
National per capita LPG consumption per year	4 kg
Estimated share of households consuming LPG as primary or secondary fuel	41%
As primary fuel	30%
As secondary fuel	11%
Annual LPG consumption per capita per LPG user	14.2 kg
Urban	15.5 kg
Rural	12.9 kg

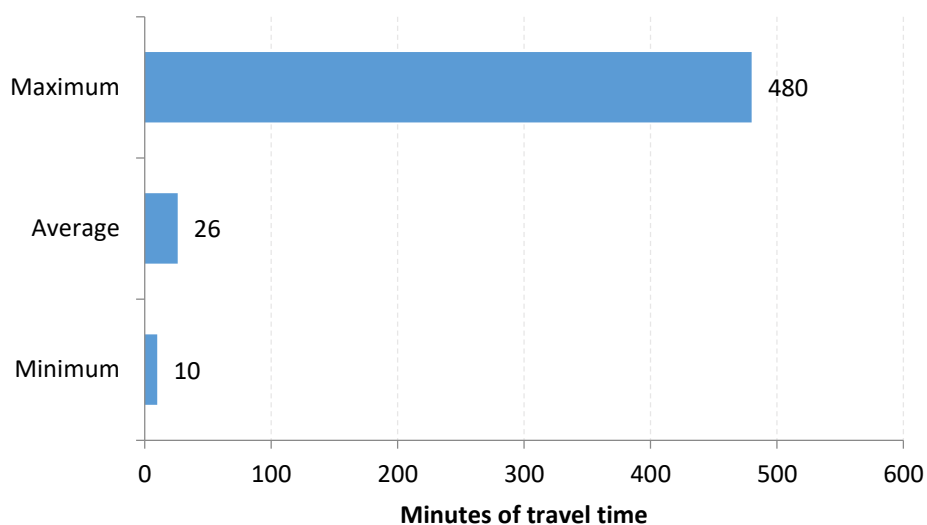
LPG accessibility and availability

LPG accessibility and availability in Cameroon differs by region and location.

LPG users in the GLPGP-Dalberg survey reported taking 26 minutes on average to travel to exchange empty cylinders for filled ones, with a minimum reported time of 10 minutes and maximum reported time of eight hours. 52% of LPG users purchased refills at petrol station and 43% at other retail points, with only 2% using home delivery. The following figure illustrates the range.

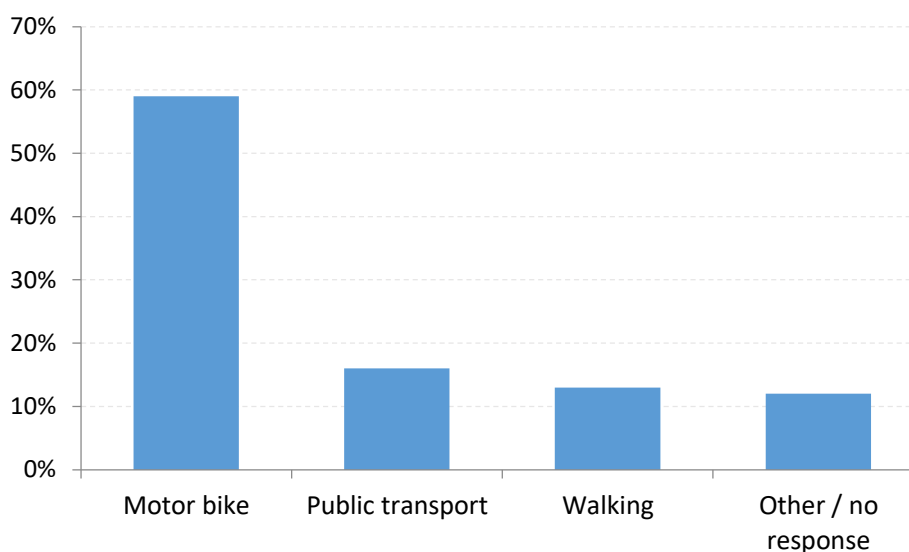
³⁵ SCDP (2015)

Figure 11. Time required for consumers to exchange LPG cylinders (2018)



For those not using home delivery, most used motor bikes (59%) and public transport (16%) to bring the LPG refill home, with 13% walking on foot. Those walking spend an average of 20 minutes to bring the LPG refill home. The following figure illustrates the mix of travel modes.

Figure 12. Mode of travel to exchange LPG cylinder (2018)



These findings reflect the historical basis of Cameroon's LPG distribution system: the sector developed and grew out of the petrol-station-based distribution model of international oil companies. The findings also indicate the potential importance of travel time (and travel cost) as a barrier to LPG adoption among those who (i) lack a vehicle and/or (ii) are not located near to a petrol station or other retail outlet.

User perceptions

The survey collected data from all respondents on their perception of LPG availability, affordability, and usage experiences. 56% of households using LPG thought LPG was easily available, whereas only 24% of non-user households thought LPG was easily available. 67% of households using LPG reported ease of replacing/refilling cylinders, compared to only 31% of non-user households. These findings could imply that

(i) there is more LPG use in areas with better LPG availability, (ii) once a household starts using LPG it develops a more favorable, and/or a more accurate, view of where to purchase refills, or (iii) households who have a positive experience with LPG perceive it to be easily available. The survey did not generate data which allow these factors to be quantified.

The following four figures present the perceptions of availability and ease of cylinder exchange for urban vs. rural users and for LPG users vs. non-users:

Figure 13. Perceptions of LPG availability for households that use LPG: urban vs. rural
(% of total households, GLPGP-Dalberg survey 2018, N=1,081; “no response” answers excluded)

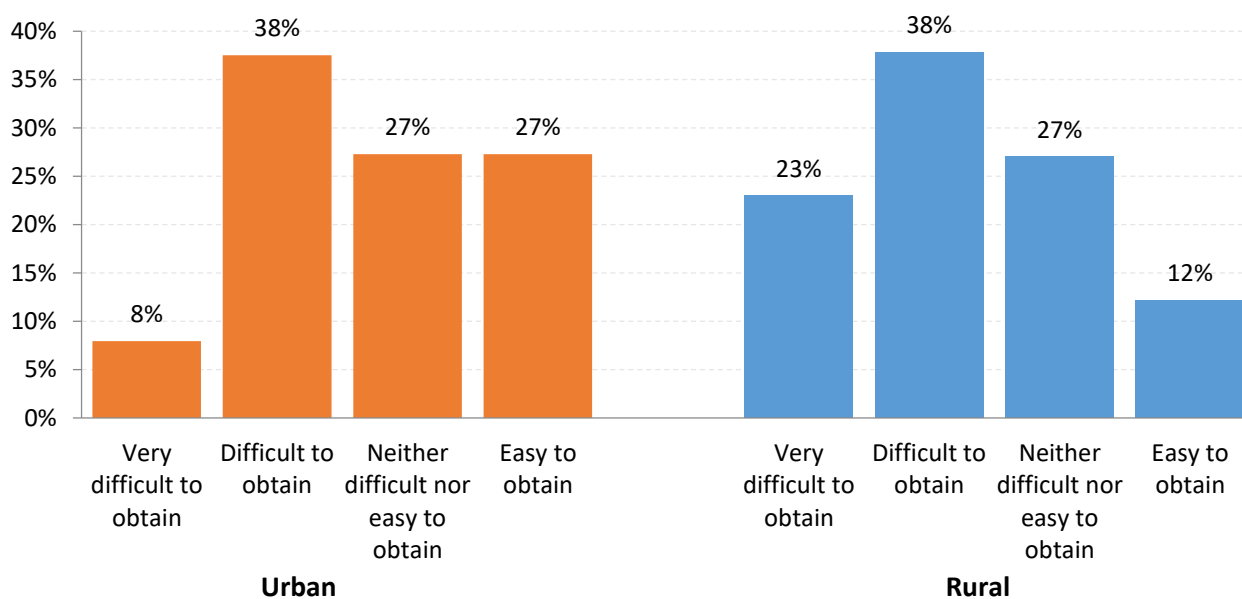


Figure 14. Perceptions of LPG availability for households: LPG users vs. non-users
(% of total households, GLPGP-Dalberg survey 2018, N=1,081; “no response” answers excluded)

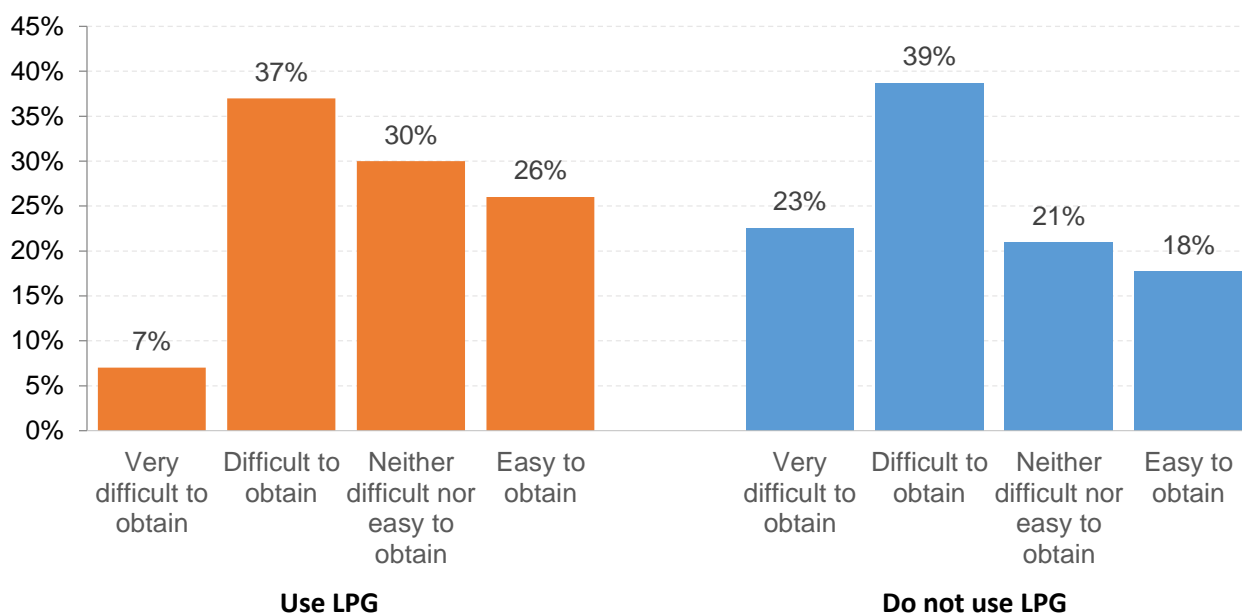


Figure 15. Perceptions of ease of exchanging LPG cylinder: urban vs. rural
(% of total households, GLPGP-Dalberg survey 2018, N=1,081; “no response” answers excluded)

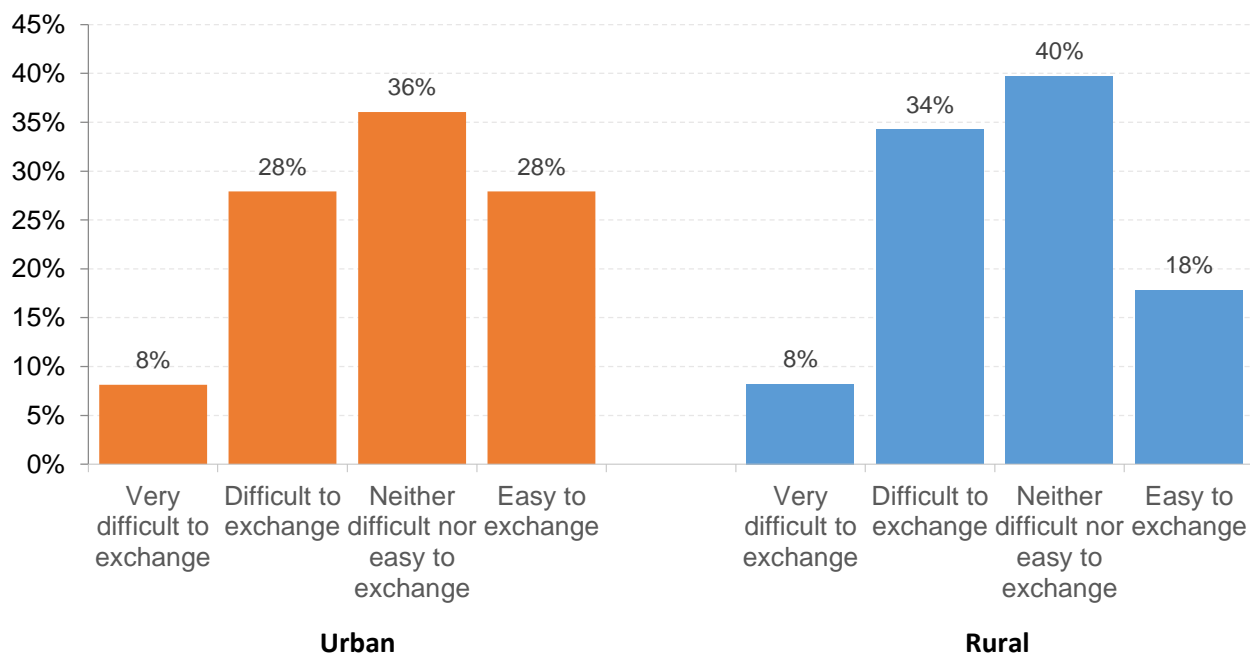
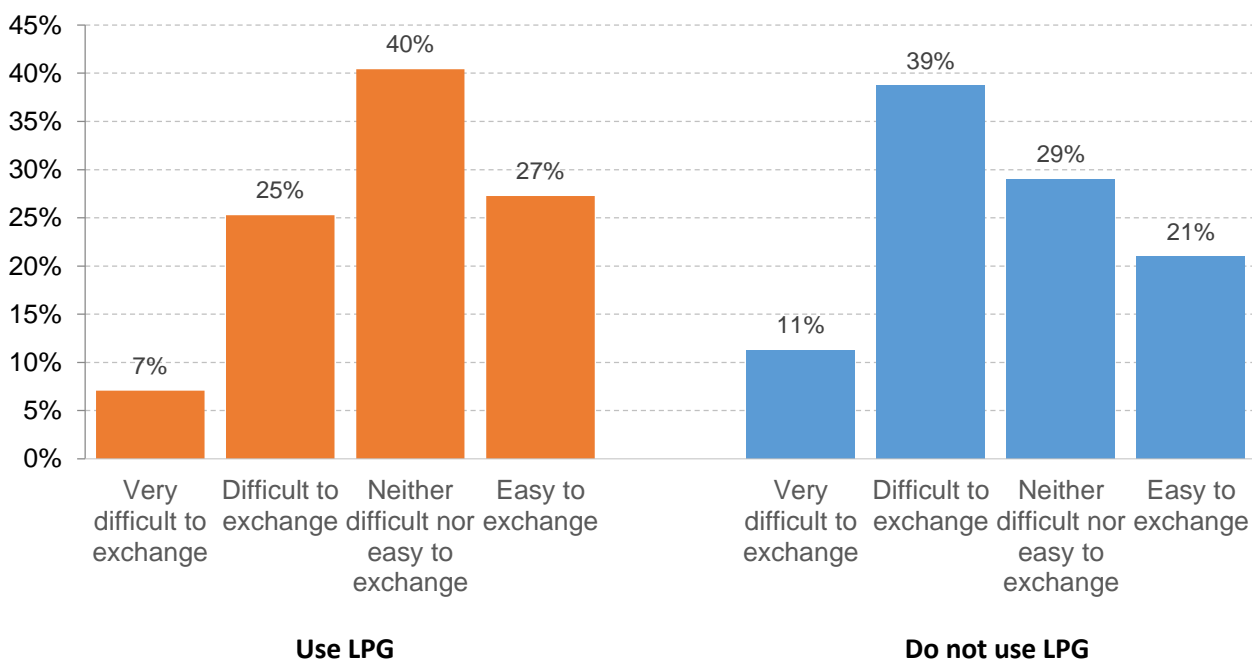


Figure 16. Perceptions of ease of exchanging cylinder: LPG users vs. non-users
(% of total households, GLPGP-Dalberg survey 2018, N=1,081; “no response” answers excluded)



Household Cooking Economics and Prices of Fuels in 2018

Market prices of LPG and other fuels in 2018

The GLPGP-Dalberg survey collected data on costs incurred by households to purchase fuels. These data were used to estimate prices of the most commonly used cooking fuels. The data were compared with additional data collected from retail points in urban and rural markets in the same regions where the household survey was conducted. The market survey sampled 125 fuel and stove retail points in urban areas, 40 in peri-urban areas, and 8 in rural areas in Adamawa, Centre, Littoral and West. Heavy rains hindered retailers from sourcing firewood and charcoal in the peri-urban and rural areas during the data collection period thus the teams were unable to collect as many data points in these areas as in urban areas. Face-to-face interviews with sellers were used to collect current prices of charcoal, firewood, kerosene, and LPG.

The household responses showed a wide range of prices for charcoal and firewood, which fell well outside of the price bands from the market survey, indicating that sometimes households may not have reported price data accurately (see Table 11). As a result, for the price analysis, the collected market price data were used where possible (see Table 12). The market prices for firewood are also high relative to other fuels. This can be attributed to the fact that (i) the market survey was conducted in the rainy season, when firewood is likely to be more expensive, (ii) the market survey has more urban data-points than rural data points, and (iii) firewood tends to be more expensive in urban areas.

Table 11. Summary statistics for fuel prices in the household survey
(CFA, GLPGP-Dalberg Survey 2018, N=1,081)

Fuel	Average price	Std. deviation	Minimum price	Maximum price
LPG (per kg)	536	30	417	760
Kerosene (per litre)	403	78	150	833
Charcoal (per kg)	143	267	1.4	2,500
Firewood (per kg)	85	333	0.03	4,444

Note: 17.8% of charcoal prices estimated from the household survey were less than the minimum price reported in the market data while 4.8% were above the maximum market price; 85.7% of firewood prices estimated in the household survey were below the minimum market price while 4.7% were above the maximum market price.

Table 12. Summary statistics for fuel prices in the market survey
(CFA, GLPGP-Dalberg Market Survey 2018, N=173)

Fuel	Average price	Std. deviation	Minimum price	Maximum price
LPG (per kg)	528	14	520	560
Kerosene (per litre)	438	48	400	550
Charcoal (per kg)	166	66	50	300
Firewood (per kg)	133	43	100	200

Most users reported owning the 12.5kg-sized cylinder. 89% reported paying between 6,500 and 7,000 CFA for refills. Those that used home delivery paid an additional 500 CFA for the service, on average.

51% of non-LPG users reported not knowing the price of a 12.5kg refill. The average reported LPG price in the survey was higher than the subsidized price of 520 CFA per kg, reflecting added distribution costs incurred to transport the cylinders to markets. As expected, the average reported price in urban areas was lower (527 CFA per kg) than in rural areas (543 CFA per kg). There was variation in prices within regions; Littoral had the smallest variation in LPG prices (minimum 520 CFA, maximum 640 CFA), and West had the widest (minimum 480 CFA, maximum 760 CFA).

The data are summarized in the following tables:

Table 13. Average market-survey prices of cooking fuels in urban and rural markets (CFA and Euros,³⁶ GLPGP-Dalberg market survey 2018, N=173)

Fuel	Average urban prices (CFA)	Average rural prices (CFA)	Average urban prices (€)	Average rural prices (€)
LPG (per kg)	CFA 526	CFA 543	€ 0.80	€ 0.83
Kerosene (per litre)	438	425	0.67	0.65
Charcoal (per kg)	153	100	0.23	0.15
Firewood (per kg)	136	100	0.21	0.15

Table 14. Average household- and market-survey fuel prices (Euros³⁶, GLPGP-Dalberg household survey 2018, N=1081, GLPGP-Dalberg market survey, N=173)

Fuel	Household survey (2018)	Market survey (2018)
LPG (per kg)	€ 0.84	€ 0.82
Kerosene (per litre)	0.62	0.68
Charcoal (per kg)	0.22	0.26
Firewood (per kg)	0.13	0.21

Relative cost of cooking a meal using different fuels in 2018

The cost of cooking a standard meal in Cameroon was estimated using average prices from the Cameroon market survey data. The calculation assumed that a standard meal requires 12.15 MJ of energy delivered to the pot for cooking and that an average household cooks a standard meal 2 times a day.³⁷ Global standard net calorific values and regional (African) stove thermal efficiency values were used for the analysis, as outlined in Table 15. Urban and rural market price data from the GLPGP-Dalberg market survey were used to estimate the cost in terms of energy delivered to pot.

³⁶ 1 Euro = 656 CFA (xe.com, September 10, 2018)

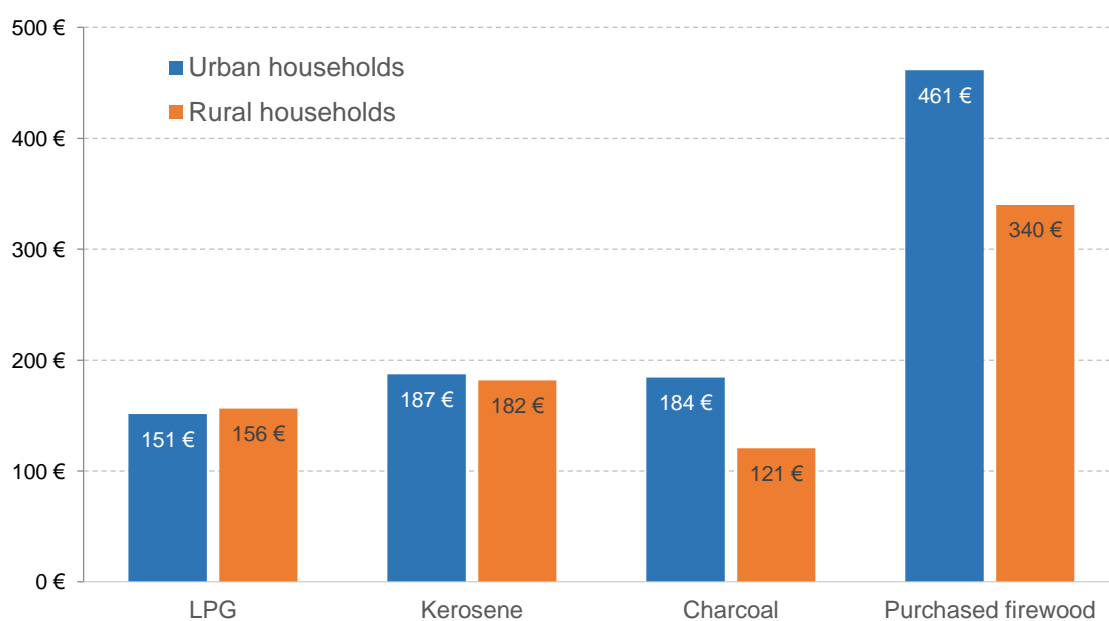
³⁷ This assumption derived from Nerini (2017)

Table 15. Data summary for relative cost of cooking analysis

Fuel	Net calorific value (MJ/kg) ³⁸	Stove thermal efficiencies (%) ^{39,40}	Stove efficiency used for analysis (%)	Avg. urban price per kg (€)	Avg. rural price per kg (€)
LPG	47.3	51%	51%	.80	.83
Kerosene	44.1	46%	46%	.67	.65
Charcoal	29.5	14%-25%	20%	.23	.15
Firewood	15.6	11%-19%	15%	.21	.15

Figure 17 and Figure 18 show the calculated annual costs for households for LPG, kerosene, charcoal and firewood. The former considers the fuel cost and efficiency factors; the latter also includes an amortization of consumer equipment costs over their typical lifetimes.

Figure 17. Average annual cost of cooking per household across different fuels

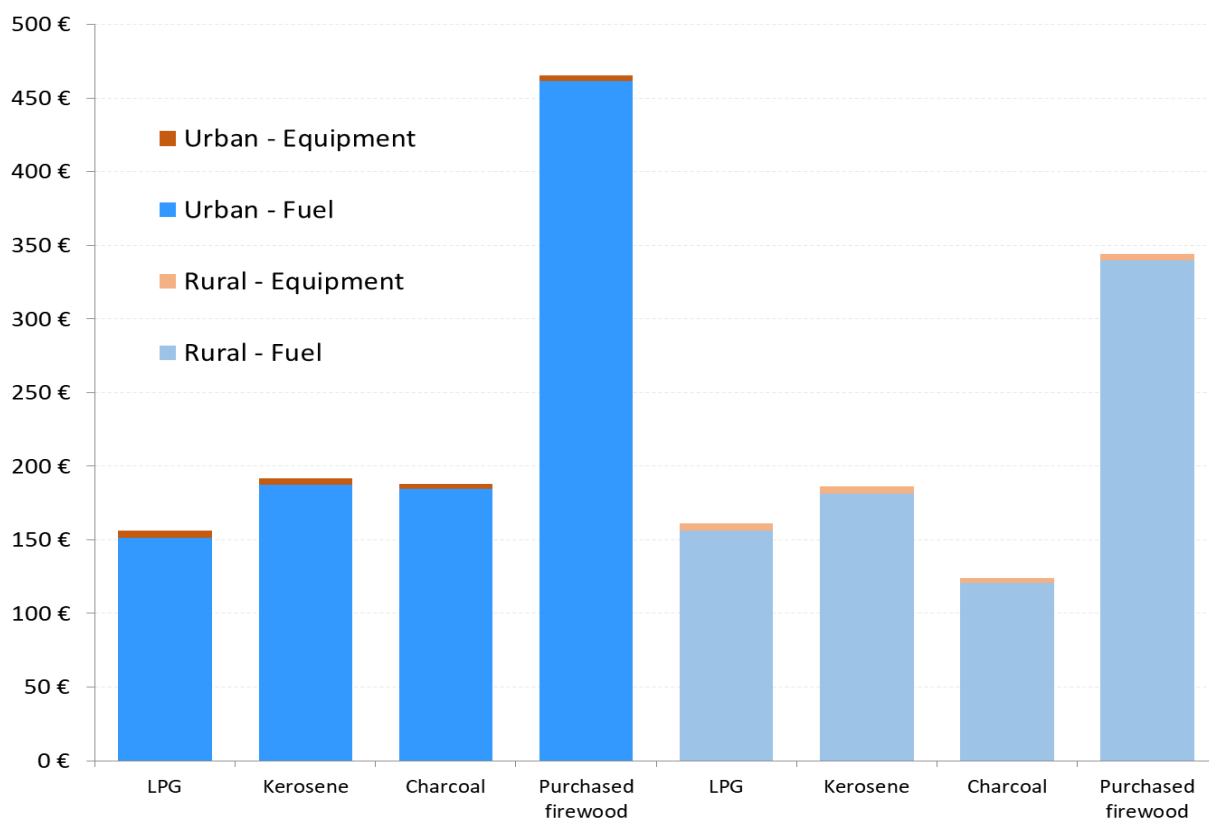


³⁸ IPCC (2006)

³⁹ EPA (2018)

⁴⁰ Shen et al. (2017)

Figure 18. Amortized average cost per day of cooking per household across different fuels (including amortized average cooking-equipment costs)



As shown in the foregoing figure, the cost of the required cooking equipment, spread across its useful life, does not materially change the costs to the consumer of cooking a meal, although it must be noted that the up-front cost to acquire the equipment requires adequate consumer savings, or, in lieu of savings, a mechanism to spread out the cost of the equipment over time. Two such mechanisms (microfinance and pay-as-you-go technology) are discussed in Chapter 18 (Consumer Empowerment) beginning on page 154; a third mechanism (a fuel-based levy that reduces significantly the up-front cylinder acquisition costs to industry and consumers) is discussed in Part VIII beginning on page 117.

Charcoal offers a cost advantage to rural consumers, with estimated annual household spending of € 121 for their cooking needs (€ 10 per month), an average of € 0.33 per day. Purchased firewood, the price of which varies depending on its type and it being dry or wet wood (with the latter being less expensive), is the most expensive fuel, costing the average urban and rural household € 340 and € 461 per year, respectively, or € 0.93 and € 1.26 per day. Other than rural charcoal, LPG is more cost-effective than all purchased alternatives.

Forecasted demand for LPG in 2020, 2025 and 2030

Drivers of and barriers to LPG adoption in Cameroon

75% of rural and 89% of peri-urban non-LPG users in the LACE survey and 83% of non-LPG users in the GLPGP-Dalberg survey stated that they would like to use LPG in the future but are restricted by concerns (whether perceived or real) about LPG safety, affordability and accessibility. These barriers are believed to

result in latent/un-met household demand. Unlocking latent LPG demand will require investments in addressing all three challenges.

While the studies have shown that overall awareness of the benefits of LPG is high, safety concerns persist in both rural and urban households in Cameroon, reducing adoption and use. In the LACE study, 73% of peri-urban and 80% of rural households considered LPG to be dangerous or very dangerous. In the GLPGP-Dalberg survey, 11% of the sample stated that safety concerns were the primary barrier to adopting LPG. Improving the safety profile of the LPG sector is a function of

- Its design and structure (see Chapter 14 (The Value Chain and Recommended Enhancements) beginning on page 104) and, associated with this,
- Sustained investment in cylinder safety and operational safety (see Chapter 10 (Pricing) beginning on page 58 for a discussion of pricing regulations with respect to recovery of cylinder- and safety-related costs).

Affordability of the LPG equipment restricts the adoption of LPG. In the GLPGP-Dalberg survey, 29% of non-LPG using households cited the initial equipment costs (stove and cylinder) as the main reason for not using LPG. In the LACE study, 50% of rural and 55% of peri-urban households cited initial cost of the cylinder and stove as the greatest barrier to LPG adoption.

For poorer households (who are often also more rural households), the cost of the LPG fuel can also be a barrier. 19% of surveyed households reported that the cost of a gas refill is a barrier to LPG uptake. (It was not specified whether this was meant as the transaction size being a barrier, or the cost to cook being perceived, incorrectly in most cases, as a barrier.) 60% of sample households felt that the refill cost was expensive or very expensive. In the LACE study, 82% of rural and 74% of peri-urban households felt that the refill cost was expensive or very expensive.

Limited accessibility due to the long distances and associated travel times to cylinder exchange points also limits LPG adoption in both rural and urban areas. LPG retail outlets are significantly more prevalent in Cameroon in urban areas than rural areas. In the GLPGP-Dalberg survey, 7% of non-users felt that the refills are too far away to be practical to access.

A final barrier is availability of LPG refills when sought. 6% of surveyed households cited disruptions in LPG availability as a critical barrier to LPG adoption.

Despite the demand-side factors, the demand analysis indicates that a significant portion of the population has unmet demand for LPG, which could be served by a systematically expanded LPG market with adequate retail accessibility to filled, safe cylinders and an acceptable level of fuel availability. Additional demand could be stimulated by systematically addressing factors specific to the demand-side, through mechanisms such as microfinance for acquisition of consumer LPG equipment, other cylinder affordability measures, and consumer education programs.

Overall approach to forecasting demand for LPG

This section forecasts household LPG demand in 2020, 2025 and 2030, extrapolating from the GLPGP-Dalberg survey data. Given the above-mentioned LPG adoption barriers, three distinct drivers of demand were modelled:

- i. National demographic changes (e.g. through population growth, urbanization and income growth);
- ii. Expanded availability of LPG through enhancements to Cameroon's implementation of the Branded Cylinder Recirculation Model (BCRM) and corresponding investment in cylinder availability, infrastructure, and distribution systems across Cameroon, with the current, regulated price level continuing; and
- iii. A potential change in the price of LPG refills (in order to reduce up-front cylinder costs through a cost-shifting mechanism).

Anticipated policy changes, as set forth in the Cameroon national LPG Master Plan, are reflected in the potential impact on LPG accessibility and price changes. Given the sample size of the survey, it was not possible to accurately model the impact of improved LPG cylinder affordability, nor of any potential awareness programs or additive marketing efforts.

The incremental contribution of the three drivers of demand were combined to create three scenarios of projected demand:

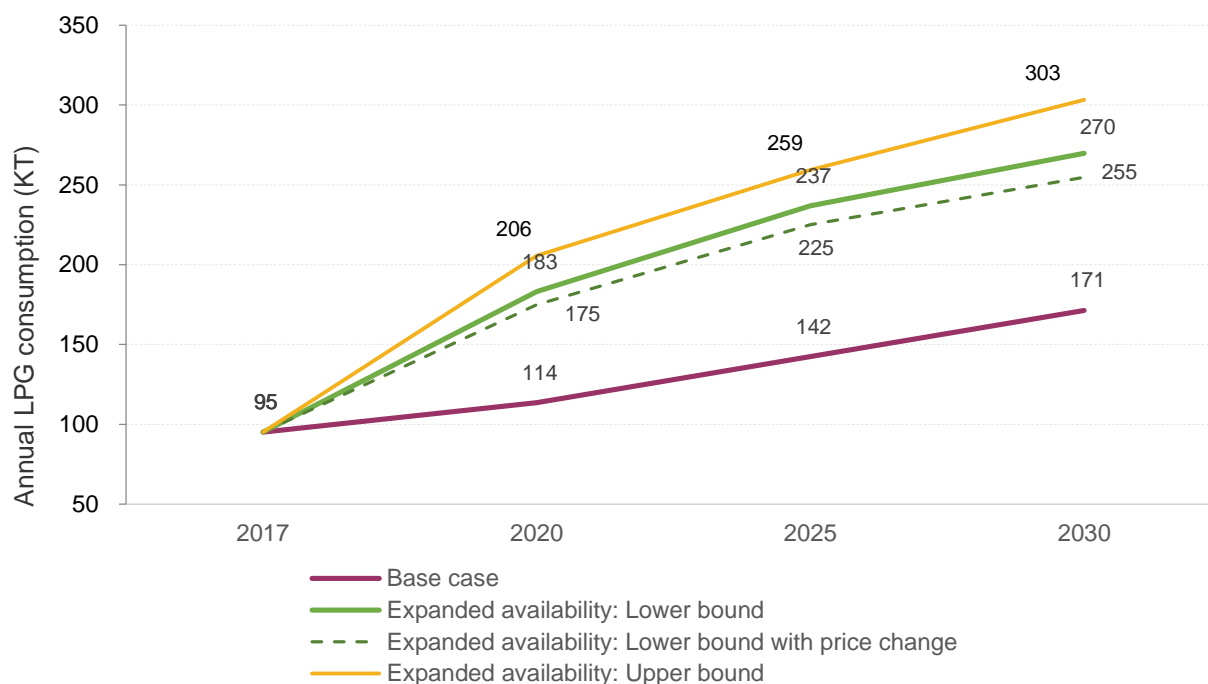
The incremental contributions of the three drivers of demand were combined to create three scenarios of forecasted demand in 2030:

- Base case scenario: LPG demand is projected by extrapolating historical trends of growth in total residential LPG consumption, demographic changes, and improvements in LPG availability and affordability.
- Expanded availability scenario with unchanged LPG pricing: LPG demand is projected starting with extrapolation of historical trends and adding the effects of achieving LPG supply and distribution adequate to serve unmet and latent demand. This scenario has two sub-scenarios:
 - Lower-bound: Per capita LPG consumption per LPG user remains constant at 2017 levels. This is a conservative case, because even demographic/economic trends alone will tend to cause an increase in per-user consumption over a period of 12 years.
 - Upper-bound: Per capita LPG consumption per LPG user grows to 20.3 kg per capita in 2030⁴¹.
- Cylinder acceleration policy scenario, with expanded availability: LPG demand is projected according to the lower-bound case, plus a 4.6% increase in the end-user LPG price (that is, an increase in the cost of refill of a 12.5 kg cylinder by 300 CFA from the current 6,500 CFA price to 6,800 CFA).

The methodology used to derive these three scenarios, as well as detailed results are presented below. A snapshot of overall results is provided in Figure 19.

⁴¹ Given the lack of data on how LPG consumption per LPG user changes over time, the upper bound scenario uses historical LPG consumption to forecast the per capita consumption per LPG user to 2030, with the end-value of 20.3 kg in 2030 derived from a combination of survey findings and usage results of the controlled LPG microfinance programs detailed in this report. It was assumed that LPG users would consume 16.7 kg per capita in 2020, 18.5 kg in 2025 and 20.3 kg in 2030. Based on average energy requirements to cook a meal (Nerini 2017), cooking all meals exclusively with LPG equates to approximately 33 kg/capita of annual LPG use. Thus, 20.3 kg/capita represents not quite 2/3 of the total probable cooking energy, the remainder of which would be supplied by alternative fuels. The 20.3 kg value takes into account that, while LPG is less expensive to cook with than other purchased fuels in almost all settings, many new LPG users through 2030 will come from the portion of the population that presently gathers firewood for free, but nonetheless values the benefits of LPG sufficiently to add LPG to its mix of cooking fuels when LPG becomes available in their vicinity.

Figure 19. Scenarios of forecasted residential LPG demand in Cameroon (2017-2030)



It should be noted that the upper and lower bound scenarios do not differ significantly in the penetration of the population that LPG is projected to achieve. The key difference is the extent to which LPG is actually used by the portion of the population which adopts it.

Scenario 1: Base case demand

The base case scenario was modelled by extrapolating residential LPG consumption according to historical trends in total LPG consumption. The base case scenario includes incremental investments in LPG infrastructure at historical rates, but no large-scale additional investments or changes in policy. The historical growth rate of LPG consumption is estimated based on government-reported residential consumption from 2010 to 2017. Based on these data, the projected residential consumption will grow from 95,000 MT in 2017 to 171,339 MT in 2030. These results are consistent with MINEE projections.

Scenario 2: Detailed methodology and results for LPG demand forecasts unconstrained by limited LPG availability

Overall approach

The methodology employed to forecast future LPG demand considered a number of demand drivers including demographic changes, and scenarios that consider changes in affordability and expanded LPG availability. A range of scenarios were calculated that consider one or more of these drivers, using survey data and general demographic projections to derive future estimates of demand. A propensity score matching approach was used to estimate latent demand for LPG. This matching approach seeks to leverage data on observed characteristics and purchasing behavior of LPG-using households in the market to estimate the potential latent demand that is not being served for similar households who do not currently use LPG because of constraints on the availability of filled LPG cylinders to them. Details regarding this

matching approach, as well as the parameters and demand drivers that shape the various scenarios are presented in this section.

For the availability and price analysis, the households in the GLPGP-Dalberg survey data were divided into two groups:

Group 1: Households that do not currently use LPG

- Group 1A: Households living in a city/region with no or low LPG availability
- Group 1B: Households living in a city/region where LPG is readily available

Group 2: Households that currently use LPG as a primary or secondary fuel

Three different analyses were performed to determine the overall impact of demographic changes, expanded LPG availability, as well as LPG price changes on the level of LPG consumption:

All households

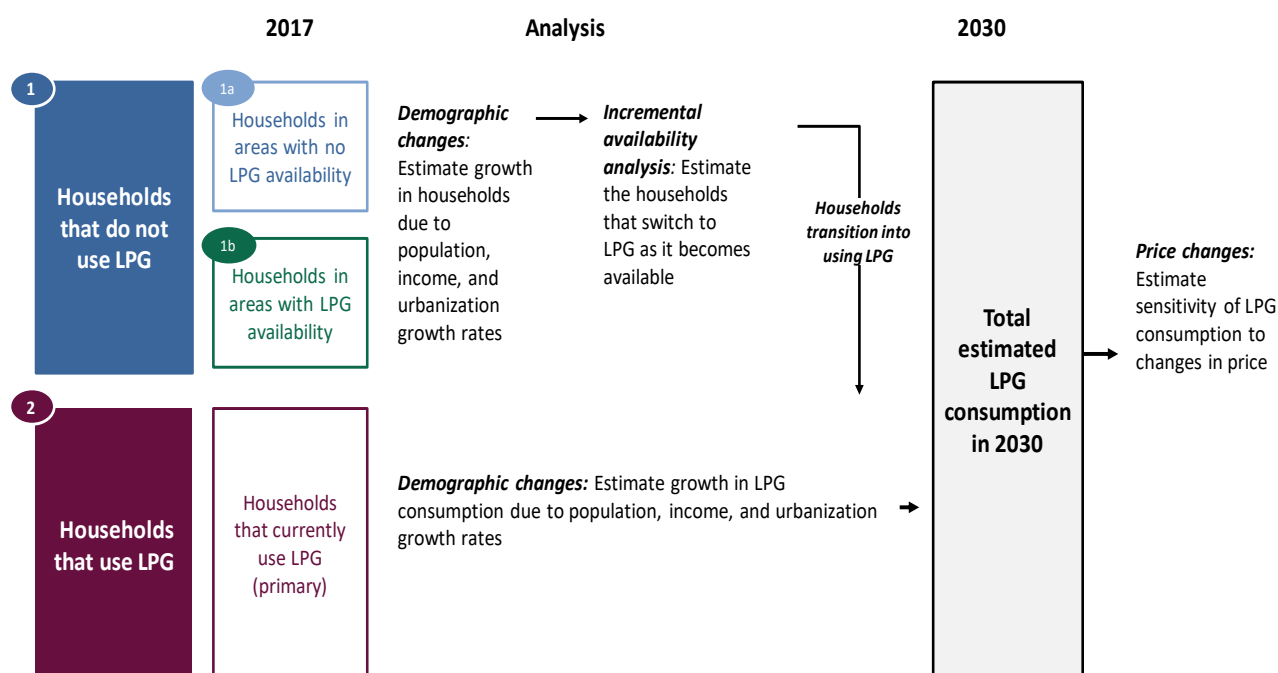
1. Demographic changes: Estimated LPG consumption growth due to population growth, urbanization, and income growth (without considering changes in availability or affordability).

Group 1

2. Group 1A – Expanded LPG availability from market reform and expansion: Estimated latent demand for LPG among current LPG non-users living in areas where LPG is not sufficiently available.
3. Group 1B: This group is not assumed to respond materially to market reform and expansion, above the business-as-usual case, because LPG is already deemed adequately available to them. (This may underestimate future ‘coat-tail’ effects on this group, whereby accelerated adoption and increased use, and associated positive perceptions of LPG, among other groups stimulates more adoption and use in this group through word-of-mouth and other crossover effects. It also underestimates the possible adoption and usage effect of future increased retail outlet density within existing high-availability areas.)

The impact of change in LPG price on overall demand was estimated across Group 1 and Group 2 to establish sensitivity of demand to a specific, recommended increase in price.

Figure 20. LPG demand projection approach



Demographic analysis

Estimate incremental impact of population growth, urbanization, and income growth on residential LPG consumption

The impact of population growth, urbanization and income growth was estimated by applying estimates thereof to the number of households that are currently consuming LPG. The projected number of households consuming LPG was multiplied by the average LPG consumption per LPG-using rural and urban household to estimate increased LPG consumption due to demographic changes.

Table 16. Effect of demographic analysis on LPG consumption to 2030

Key variables	2020	2025	2030
Households consuming LPG	2,119,099	2,479,101	2,902,251
Urban	1,934,694	2,288,221	2,706,932
Rural	184,405	190,879	195,319
Total LPG consumption (assuming per capita consumption per LPG user stays constant over time)			
Total LPG consumed by households (MT)	150,541	176,159	206,275
Urban	137,732	162,900	192,708
Rural	12,809	13,259	13,567

Group 1A – Expanded availability analysis

Estimate incremental impact of expanded LPG availability on LPG demand for households living in areas where LPG is unavailable

To estimate latent demand, LPG-using households (Group 2) were first identified in the sample data. Then, using a tailored propensity score matching approach, households with similar observed characteristics were identified in Group 1A, and matched to the Group 2 households to estimate their latent demand for LPG. As a first step, household characteristics that correlated with LPG usage (among households that currently use LPG) were identified in the data. Then, households with similar characteristics, in areas where LPG is currently not available (and therefore not currently used) were identified. The latent demand for these identified households was estimated assuming that they have similar LPG preferences (e.g., willingness and ability to pay for LPG, preferences for LPG, fuel purchasing habits) given similar observed household characteristics. In effect, this matching approach used the observed consumer behaviour in locations where LPG is available to estimate the consumer behaviour under improved availability in locations where LPG is not currently available. The detailed methodology is provided in the Annexes (Chapter 27 beginning on page 281).

A logit regression on Group 2 was used to identify the household characteristics that predict LPG usage and to estimate a probability of LPG usage per household. This regression considered four independent variables that have been identified in previous literature as predictive of LPG usage: (i) household income, (ii) whether or not a household is in an urban area, (iii) respondent's age, and (iv) respondent's education when the respondent was responsible for making decisions about household fuel use. The coefficients from the regression were then used to estimate the probability that a household of certain characteristics would use LPG. The coefficients from the regression analysis were then used to calculate the probability of a household in Group 1A using LPG, were it available. The households in Group 1A were matched to similar households in Group 2 (current LPG users) to estimate the number of households that would use LPG in Group 1A, were LPG available (i.e. latent demand). An average LPG consumption per capita among LPG users of 15.5 kg and 12.9 kg for urban and rural households, respectively, was used as the proxy for potential consumption for these Group 1A households.

This estimation approach assumes that as LPG infrastructure is expanded, Group 1A would have access to LPG over time. For example, some areas will have greater access to LPG in five years, and others in ten years. As LPG becomes available for Group 1A households, certain households will start using LPG and will move into Group 2, and others would move into group 1B (that is, they would still not use LPG, even if it were available, likely due to other constraints such as affordability and preferences). To model the phased roll-out and the resultant change in LPG consumption, three steps were taken:

- (a) Determine the number of households that fall in Group 1A in 2020, 2025 and 2030, as LPG availability increases in a phased approach across the country:
 - The approach assumed a roll-out path for infrastructure development. This roll-out could be faster or slower, depending on the different scenarios and policy considerations. This roll-out path was modelled based on existing knowledge of how infrastructure development (based on stakeholder interviews) has taken place in Cameroon, as described below.
 - The roll-out plan assumed that infrastructure development: (i) tends to begin in urban areas and move to rural areas; (ii) tends to begin in areas where there is already some infrastructure to build from; and (iii) tends to move from a point of origin outwards.
- (b) Estimate number of households in Group 1A that will start using LPG in 2020, 2025 2030 once LPG becomes available. As each household faces improved LPG infrastructure over time, the propensity

score matching approach determines how many households in Group 1A will transition and begin using LPG.

- (c) Estimate total LPG consumption from households that start using LPG by multiplying the number of households that start using LPG by the average LPG consumption of existing-user households.

Table 17 shows how total consumption of LPG would change based on the foregoing steps:

Table 17. Impact of sufficiency of LPG availability on household LPG demand

	2020	2025	2030
Total number of households consuming LPG due to expanded availability	343,361	688,300	893,835
Total additional LPG consumption from expanded availability (MT)	24,444 MT	48,941 MT	63,424 MT

Price change analysis

Given that the price of LPG is set and subsidized by the government in Cameroon, the government could stimulate demand through price reductions, subject to the government's ability to fund them. This section outlines the impact of price changes on the quantity of LPG consumed for households that are currently consuming LPG. The potential impact of changing prices of LPG relative to other fuels did not result in statistically significant results⁴². Therefore this section derives estimates of changes in demand resulting from changes in LPG price, holding all other fuel prices constant.

The analysis shows that a 1% decrease in price could lead to a 1.2% increase in the quantity of LPG consumed on average by a household. Assuming a 300 CFA price increase for the 12.5kg cylinder refill (4.6% increase in the current price of LPG), LPG consumption under the expanded availability scenario could decrease by 5.5% to 254,812 MT in 2030 compared to consumption under the expanded availability scenario. This price analysis assumes no change in price of other fuels.

It is important to note that customer stickiness may not persist beyond certain price points. According to the GLPGP-Dalberg 2018 survey, 89% of LPG users reported paying between 6,500 and 7,000 CFA for 12.5kg cylinder refills (see Figure 21). (Cameroonian households continue to prefer the 12.5kg cylinder over the 6kg cylinder that is also available in the country.) 72% and 68% of the LPG users in the sample stated that they would continue using LPG if the price of a refill increased by 500 CFA and 1,000 CFA, respectively. This means that if the price of a 12.5kg refill did increase by 1,000 CFA (approximately a 6.5% increase from the current price), at least 68% of current LPG users are likely to continue using LPG. However, only 43% and 54% of urban and rural users, respectively, stated they are willing to pay more than 7,500 CFA for the 12.5kg cylinder refill, up to a certain specified price point as show in Figure 22.

⁴² The impact of changes in price of LPG relative to commonly used fuels for households currently using LPG but that are stacking with other fuels was modelled using the GLPGP-Dalberg survey data. The study used OLS regression analysis to determine the impact of changes in relative price of LPG to price of charcoal, firewood and kerosene. The analysis was run separately for households that use LPG together with charcoal (i.e., fuel stack); those that stack LPG with firewood; and those that stack LPG with kerosene. However, none of the regression results were statistically significant.

69% of LPG users reported satisfaction with their current gas usage while 25% reported wanting to use more LPG. Of the households that wanted to use more LPG, approximately 70% cited refill cost as a barrier to more usage.

Figure 21. Price reported for a 12.5 kg refill by existing LPG users (% of LPG users, GLPGP-Dalberg survey 2018, N=575)

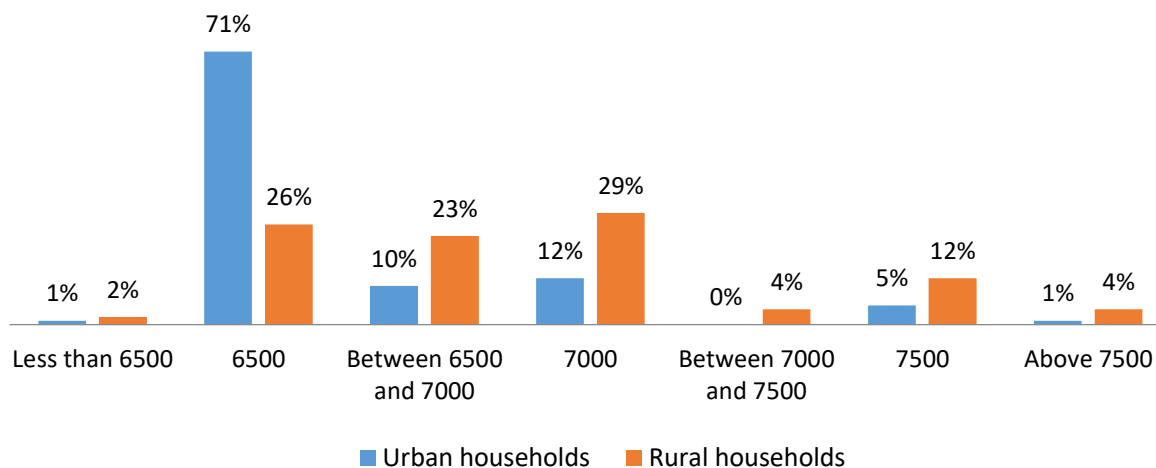
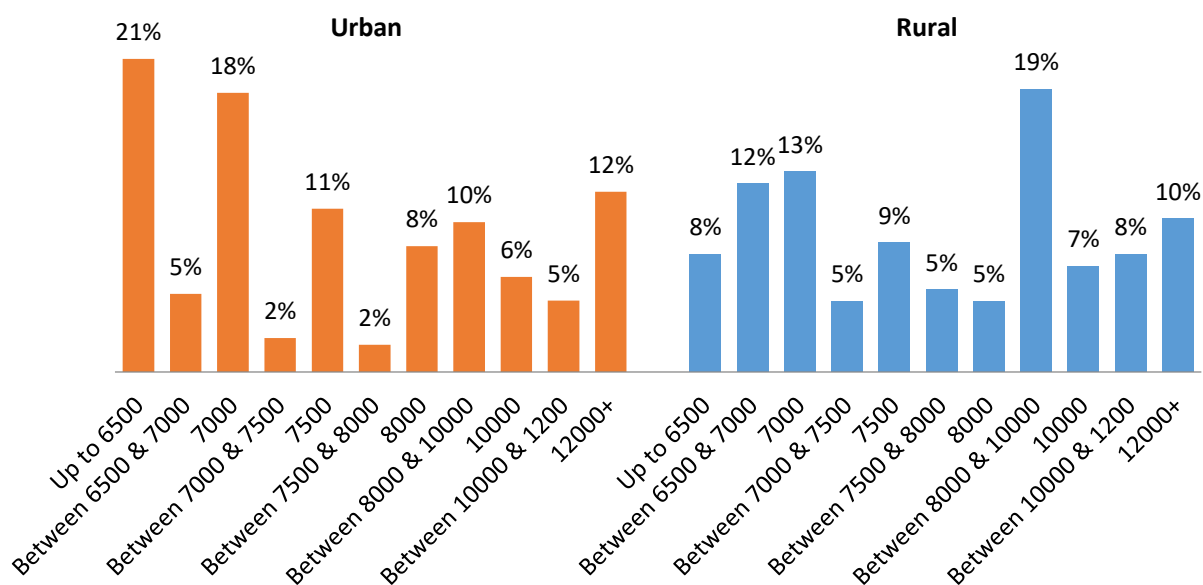
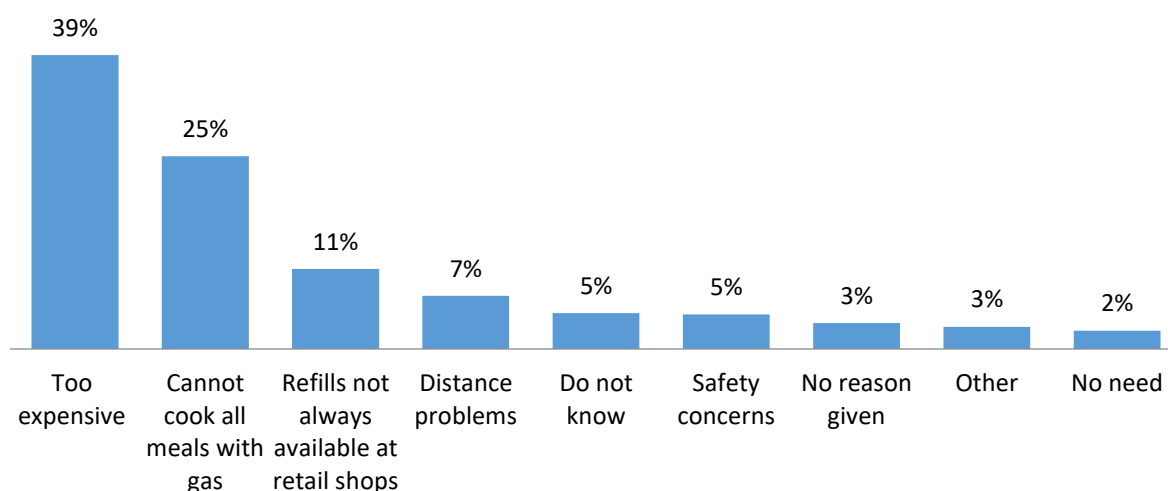


Figure 22. Consumer willingness to pay for a 12.5 kg cylinder refill (% LPG-users, amounts in CFA, GLPGP-Dalberg survey 2018, N=575)



It is noteworthy that the mode in the rural data (8,000-10,000 CFA) is about 1/3 above the market price (6,500 CFA) and 1/4 higher than the most-common rural price (7,000 CFA). Even through willingness-to-pay data are inherently suspect, the interest of rural households to pay (potentially) well above the established market price, even accounting for transportation-cost adjustments to reach rural areas, is indicative of, at a minimum, rural aspiration to access LPG for at least some cooking tasks.

Figure 23. Main obstacles to consumers' using more LPG
(% of existing LPG users, GLPGP-Dalberg survey 2018, N=588)



Note: “Too expensive” and “cannot cook all meals with gas” indicate that fuel-stacking will persist, although rising incomes and increased LPG cooking education, respectively, may eventually mitigate these barriers to increased or exclusive LPG use.

Impact of improving the affordability of LPG equipment

Given the small sample size of the GLPGP-Dalberg survey and that fuel price data were not collected in the LACE survey, it was not possible to estimate the incremental impact on LPG adoption and use from improved affordability of LPG cylinders and stoves. Therefore, the latent demand projected in this report underestimates total potential demand to an unknown degree.

According to the GLPGP-Dalberg survey, 29% of non-LPG using households cited the initial equipment costs (stove and cylinder) as their main reason for not using LPG, followed by 19% of households reporting that the cost of a gas refill is a barrier to LPG adoption. These findings are considerably lower than those of the LACE study, which found that 82% of rural and 74% of peri-urban households deemed the refill cost was expensive or too expensive.

51% of current LPG users reported spending between 15,000 CFA (€ 22.7) and 30,000 CFA (€ 45.7) for the up-front cost of 2 burner or larger gas stove. This represents a significant outlay for most Cameroonian households, given that 56% of households in the sample reported earning a monthly household income of 100,000 CFA (€ 152) or less and 29% of households reported earning a monthly household income of 50,000 CFA (€ 76) or less. Moreover, LPG users on average earn more than non-LPG users; the former have a monthly average income of 132,000 CFA (€ 201) per month, and the latter, 88,000 CFA (€ 134).

Figure 24 and Figure 25 show how affordability of the up-front gas stove and cylinder deposit fee is an important constraint. Improving their affordability would increase LPG uptake. Programs that expand, replicate, or are modelled on, the GLPGP *Bottled Gas for Better Life* microfinance program in Cameroon (see Chapter 18 (Consumer Empowerment) beginning on page 154 for details) could alleviate this constraint and unlock this latent demand.

Affordability of refills is also a key barrier to adoption for some households, as shown in Figure 24. However, it is important to note that 42% of respondents who cited refill cost as a barrier to LPG adoption also reported not knowing how much a 12.5 kg cylinder refill costs, which would imply that improved awareness of the cost of cooking with LPG would also increase uptake for some households.

Figure 24. Main reasons given for not using LPG for cooking
(% of LPG non-users, GLPGP-Dalberg survey 2018, N=347)

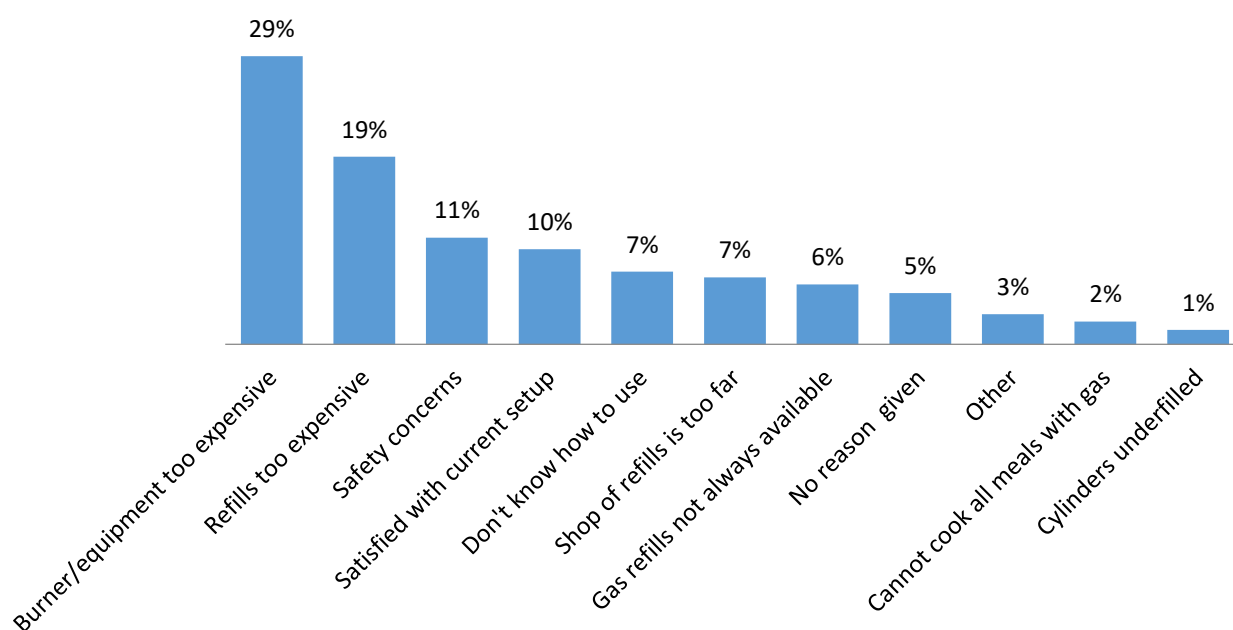
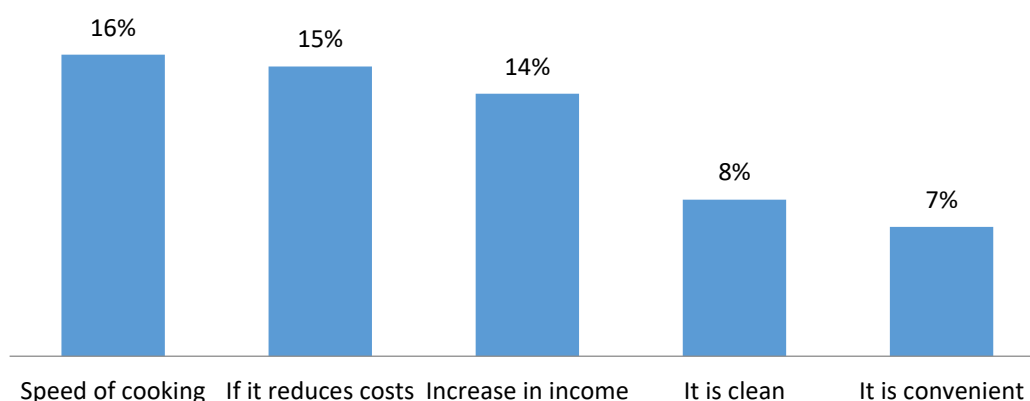


Figure 25. First reason given that would make a LPG non-user start using LPG
(% of LPG non-users, GLPGP-Dalberg survey 2018, N=347)



“Speed of cooking,” “it is clean” and “it is convenient” indicate an existing appreciation that LPG is faster to cook with (including fire preparation time and clean-up time), cleaner to cook with, and more convenient to cook with than other fuels, respectively, and thus these responses may mask another reason that LPG is not exclusively used. “If it reduces costs” indicates a possible lack of consumer education about how to assess the relative cost of cooking with LPG over time compared with other fuels, and this educational gap may be addressed through various educational, communication and awareness measures. “Increase in

income” may capture two ideas: first, that the consumer does not fully understand that LPG is, on average, less costly to cook with over time than other fuels, and second, that the consumer views the up-front cost of LPG equipment, and/or the transaction size of a cylinder refill compared to the transaction sizes for other fuels, as barriers to adoption.

Summary: Forecasted potential LPG demand in 2020, 2025, and 2030

The results of each of the analyses are summarized in Table 18. They show that combining investments in improving LPG availability and investments in marketing have the potential to drive large uptake of LPG in Cameroon.

Table 18. Estimated total LPG demand, by demand driver (2020-2030)

Drivers of demand	Total household LPG consumption			
	2017	2020	2025	2030
Number of households consuming LPG				
Demographic changes (all scenarios)		216,227 new households	391,524 new households	428,655 new households
Expanded LPG and cylinder availability		343,361 new households	324,982 new households	84,879 new households
<i>Cumulative</i>		<i>216,227 new households</i>	<i>688,300 new households</i>	<i>893,835 new households</i>
Total households consuming LPG	2,016,333	2,462,461	3,167,400	3,796,086
Total residential LPG consumption				
Lower Bound scenario	95,000 MT	174,985 MT	225,099 MT	269,699 MT
Upper Bound scenario (assuming LPG consumption per capita per LPG user is 16.7 kg in 2020, 18.5 kg in 2025 and 20.3 kg in 2030)	95,000 MT	205,615 MT	259,378 MT	303,194 MT

These analyses can be combined to form the main demand scenarios, as shown in Figure 26:

Scenario 1: Base case

- Forecasted LPG demand based on historic growth of LPG. Total annual LPG consumption for household cooking is projected to grow to 171,339 MT by 2030 from 2.9 households using LPG as their primary or secondary cooking fuel, resulting in national per capita consumption in 2030 of approximately 5 kg per year.

Scenario 2: Market reform and expansion scenario

- 3.8 million households (approximately 20 million people) consuming LPG in 2030 as a primary or secondary cooking fuel, comprising 3.5 million urban/peri-urban households and 316,000 non-remote rural households.

- Lower bound of residential consumption: 269,699 MT in 2030, or 8.7 kg on a per-capita basis. This assumes no shift in fuel-stacking, on average, and no overall increase in household cooking energy use.
- Upper bound of residential consumption: 303,194 MT in 2030, or 8.9 kg on a per-capita basis. This assumes a gradual increase in per-user consumption of LPG.

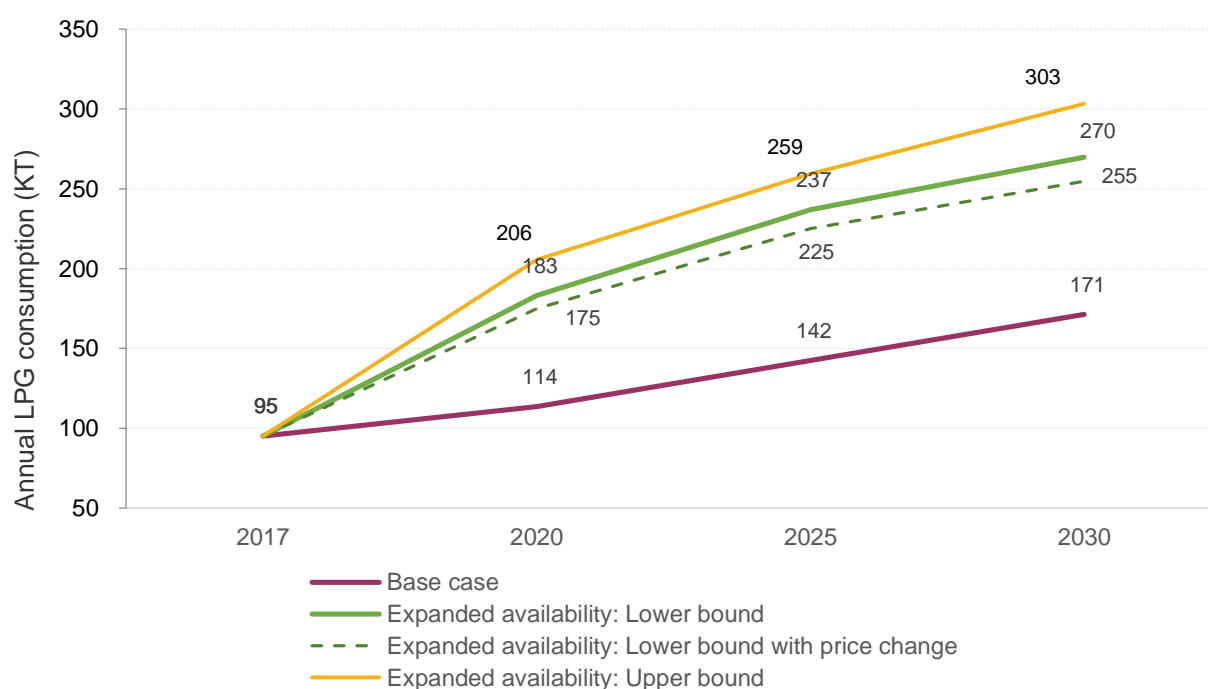
The estimated range for total LPG consumption in 2030 under the scenarios of expanded availability represents a level of consumption that is between 2.8-3.2 times the total consumption in 2017. These scenarios are depicted in Figure 26 below. Note that in both the base case and the lower-bound estimate, the average LPG consumption per capita by LPG users has been kept constant, in the absence of data about the growth rate of consumption by existing LPG users. The total consumption in the base case and lower-bound scenario could be larger if increases in LPG consumption per capita by LPG users occur.

The expanded-availability results could be larger than projected if consumer affordability measures are successfully implemented at scale (for example, microfinance programs for LPG equipment).

Scenario 3: Market reform and expansion scenario with change in LPG price

This scenario projects LPG demand, as modelled in the lower-bound case, in response to a 4.6% increase in LPG price, whose proceeds would be used to offset the up-front cost of cylinders and accelerate their deployment in the early years of market expansion. LPG consumption in this scenario is projected to grow to 254,812 MT by 2030, an approximately 5.5% reduction from the lower bound scenario, indicating a meaningful elasticity of consumption in response to price. However, it was not possible with available data to estimate the number of households that would start to use LPG if the upfront cost of the LPG equipment were made more affordable through this mechanism. Therefore, while per-user consumption would decrease as shown in the figure below, some number of new users, who otherwise would not start using LPG, will do so. Their number was not possible to include in the projection.

Figure 26. Scenarios of forecasted residential LPG demand (2020-2030)



Potential effect of targeting LPG subsidies

The foregoing analysis regarding price sensitivity focuses on the possibility of a reduction in LPG use if end-user LPG prices rise. The reverse effect may also be considered: sustained decrease in the end-user LPG price may proportionately stimulate greater LPG use, especially among lower income groups.

Because the price in Cameroon is regulated, it may be lowered in two ways:

1. The Government may change the national LPG pricing formula to cause the end-user price to be lower. This implies reducing the unit margins, and thus the profitability, of the firms in the supply chain, rendering them less bankable and less capable of investing in growth, managing growth, and maintaining safety. Any price decrease via regulation must therefore consider the extent to which industry profitability can be sustained at an adequate level, whether through major increases in the volume of LPG handled per company, or through improvements in efficiency (such as from economies of scale). Given that adequacy of cashflows in the supply chain is itself a barrier to investment in scaling up the sector, this approach is not recommended.
2. The Government may target the subsidy to the poor, to offset their cost of LPG fuel, while reducing or eliminating the subsidy for the well-off who do not need it.

Targeted subsidies have helped LPG sectors in some LMIC markets serve a portion of the households that otherwise could not afford to use LPG as the primary cooking fuel on a steady basis. In Cameroon, the level of the LPG end-user price is, in part, a political determination. Therefore, removing the subsidy from one group of voters to increase its benefit for another group of voters has an important political dimension. The Master Plan does not contemplate reforms to the subsidy scheme (other than improving its transparency and creating related input-cost benefits, as discussed in Chapter 10 (Pricing) beginning on page 58).

Key issues related to subsidies, the first three of which Cameroon has experienced to some extent in the past, include:

1. As usage grows, the subsidy grows, putting strain on the government's fiscal resources;
2. As usage grows, the government's ability to pay the subsidy timely may suffer, putting financial strain on the intermediary/ies who obtain LPG at an unsubsidized price, sell it onward at the subsidized price, and then are reimbursed the difference by government;
3. The subsidy can have unintended leakages (the subsidy is exploited by those who are not meant to receive it, through subterfuge or other means), which inflates the subsidy amount and dilutes the overall utility of the subsidy; and
4. The subsidy can create market distortions, such price arbitrage between petrol and LPG for vehicular use (which is also a form of leakage, if exploited).

A fifth case, alleged but not provable in Cameroon, is where avoidance of uncontrolled LPG subsidy growth has limited the ability of the market to grow. In this case, the government budgets an annual maximum LPG subsidy amount, and the LPG sector only imports as much volume of LPG as would qualify for the budgeted subsidy. It will be important, therefore, for the Government to set its annual subsidy budgets based on the growth forecasts associated with the national LPG investment program, as it is executed, and with an adequate margin of safety, to ensure that the subsidy budget does not become a growth limiter

year on year. Good coordination among the Government and industry regarding annual LPG volume growth and import cost expectations will allow for continued smooth functioning of the subsidy regime as the market develops. For the long term, as outlined in this report and in the Cameroon LPG Master Plan, the subsidy should be transitioned to a targeted subsidy (to the poor) from a general subsidy, to break the linear relationship between market growth and subsidy growth while making sure that subsidy money that is budgeted helps those—and only those—who are truly in need.

It should be noted that many LMICs, such as India, have a long history of using LPG fuel subsidies as an arm of national development and social policy. Over several decades, India and countries like it have demonstrated that it is possible to fine-tune their LPG subsidy systems to avoid the above-mentioned issues. Should a future Government of Cameroon determine that an LPG subsidy to benefit the poorest is desirable, the Government can apply the targeting learnings from other LMICs to do so in a way that minimizes the foregoing problems.

In view of the Government's present policy against modifying the LPG subsidy, this study does not explore in depth the potential use of, and impact from, a transition from a general subsidy to a targeted subsidy for LPG.

Methodological limitations

The analysis conducted for this demand estimation is impacted by a number of methodological limitations detailed below. It is important to note that these limitations have led to an underestimation of projected LPG demand in 2020, 2025, and 2030, mainly due to:

- i. Representation of remote rural households: The 2018 GLPGP-Dalberg survey sampled rural households located near a trading center, and as a result have a higher level of LPG use than remote rural households with limited access to infrastructure. Given that the sample was missing remote rural households, the study only modelled projected LPG consumption in urban households and non-remote rural households.
- ii. Holding LPG consumption of LPG users constant: The analysis assumed that LPG consumption per capita per LPG user will remain constant between 2018 and 2030. In reality, the amount of LPG consumed by a household could increase over time as fuel stacking declines. Since there was no reliable way to model this effect, the analysis assumed LPG consumption for LPG-using households would remain constant over time. This underestimates the total residential LPG that will be consumed in Cameroon between 2020 and 2030. For this reason, the total potential residential LPG consumption in this analysis is lower than the totals presented in the Master Plan for LPG in Cameroon.
- iii. Infrastructure development: The study assumed a roll-out plan and timing for infrastructure development based on the national LPG Master Plan as accepted and adopted by the Government of Cameroon.
 - The roll-out could change due to changes in government and private sector priorities or lack of investment capital, which would affect the rate and/or number of households switching.
 - Different timing for infrastructure development could result in different numbers of households switching year by year, and different level of LPG consumption year by year.
- iv. Inability to model the impact of LPG affordability: The analysis was able to model the impact of a change in LPG price on consumption, but, due to the small survey sample size, it was not able to

model reliably the impact that programs that would improve LPG cylinder affordability (such as LPG microfinance programs) could have on unlocking additional latent demand.

13. Comparison of Industry Projections and Demand Assessment Projections

Local industry projections of LPG consumption to 2030 align with the demand projections modelled in this report with respect to penetration but not total consumption. This is shown in the following table:

Table 19. Comparison of industry and demand-model projections of consumption

Projection (in 2030)	Local industry	Demand analysis	
		Lower bound	Upper bound
Penetration of population	58%	59%	60%
Total residential consumption	383 KT	270 KT	303 KT
Annual consumption per residential user	25 kg	16.7 kg	20.3 kg
National residential consumption per capita	12.4 kg	8.7 kg	8.9 kg

The industry projection is based on an LPG industry-specific methodology which uses historical per capita consumption values and cylinder rotation rates, together with benchmarks from more-developed markets, to estimate market development potential. These benchmarks, however, did not distinguish between primary and secondary LPG usage and how these would evolve over time, which is the reason why the per user and per capita industry values are not consistently proportional with the demand analysis values. The industry projection is thus a projection of penetration of LPG as the primary cooking fuel—with a correspondingly greater amount of average per-user consumption—whereas the demand assessment presented in this report is a projection of penetration of LPG as either primary or secondary cooking fuel. Although the data did not permit the demand analysis to break out primary vs. secondary LPG use, one may safely assume that the percentage of the population under the demand analysis scenarios using LPG only as the primary cooking fuel is below the 59%-60% shown in the foregoing table.

Each Marketer contributed its projections in confidence upon request from MINEE. It should be noted that some Marketers had very conservative projections, just slightly above the business-as-usual case, while others had very aggressive, even aspirational, projections, based on their ambitions to expand their market shares significantly in a rapidly expanding market.

The industry projections also assumed adequate business financing would be available to each firm as required for it to expand operations to achieve its forecast (i.e., to serve its expanded demand), and that the governmental reforms outlined in the national LPG Master Plan (described in Chapter 14 (The Value Chain and Recommended Enhancements) beginning on page 104) would be implemented over the near and medium terms. The effect of these reforms would be reflected in improved supply chain efficiency and effectiveness that, in turn, improve the cylinder rotation rate, a key variable in the industry's forecasting.

It is important to note that, as indicated in the GLPGP-Dalberg household survey (see Annex Chapter 27), there is considerable consumer "willingness to pay" at prices significantly above present market prices, even in remote rural areas, and even where the actual ability of poorer consumers to pay over time for LPG refills is suspect. This suggests that LPG is often seen as an aspirational purchase by poorer households. (The view of local industry salespersons is generally the same.) LPG adoption for aspirational purposes implies that, initially, a portion of new users will use LPG only in limited ways. Some of these new users will transition over time to using LPG as their primary cooking fuel, based on increased familiarity with LPG, increased preference for the benefits of LPG, improved understanding of its cost savings (where they exist), improved household economics, and other factors. The lower bound demand case includes secondary users but excludes this transition; the upper bound case includes the transition.

VII. LPG Supply Chain Development and Planning

14. The Value Chain and Recommended Enhancements

The generic LPG value chain

The LPG value chain in Cameroon, as in almost every country in the world, comprises six fundamental nodes, as shown in the following figure, implementing with greater or lesser completeness the Branded Cylinder Recirculation Model (BCRM):

Figure 27. Generalized LPG value chain (BCRM)



The nodes, defined by their main functions, are:

1. *Production/Importation.* LPG is sourced from importation and/or as a by-product from the production of natural gas or from petroleum refining. Importation in Sub-Saharan Africa is typically by sea to a terminal, using LPG carriers (ships) at the small end of the size range (and high end of the cost range, per tonne), or overland in tractor-trailers or bobtail trucks (lorries).

Note: In Cameroon, this node is where the governmental LPG subsidy is applied, as described further below.

2. *Bulk Transport and Storage.* The LPG is moved in bulk from its points of importation or production into large-scale storage facilities. Such facilities may be co-located with importation or production facilities, or may be located strategically in other areas.
3. *Investment in, and Marketing, Filling and Safety of, Own-Brand Cylinders.* Cylinders are acquired and deployed into the market at this node, which has corresponding responsibility and liability for cylinder safety and property rights in the cylinders, such that the lifetime cylinder safety responsibility and liability are matched with the lifetime income stream from refills of the cylinders. Branding, universally done using uniquely assigned and registered colors, creates a marketing and asset control advantage for the LPG marketer, ease of accountability when there is a cylinder safety incident, and ease of distinguishing between competitors for the consumer. The cylinder is provided onward through the chain to the consumer through a chain of cash deposits. In global LPG industry terms, the businesses operating at this node are called “Marketers”.
4. *Cylinder Distribution.* Each Marketer develops a network of contracted distributors, who own and/or operate depots and the trucks (lorries) and other vehicles that transport full cylinders to retail points (also called “cylinder exchange points”) from medium to large-scale filling facilities and return empty cylinders to the filling facilities for inspection, maintenance and refill. The generic LPG industry term for these businesses is “Distributor”. Distributors provide the main cylinder logistics function in

coordination with the Marketer. In national LPG markets that sustain high-enough unit margins to support it, the distribution function may also include optional home delivery of filled cylinders and pick-up of empty cylinders by the distributors.

Note: In Cameroon, there is a category of distributor termed “Wholesaler”. A Wholesaler is, in effect, a free agent between multiple Marketers and retail/point of sale networks, which has implications for the risk profile and investment proposition of the sector. This is explained further below.

5. *Retail / Point of Sale.* Also referred to as Cylinder Exchange Points, this node is where the consumer interacts with the LPG cylinder distribution system. A new customer obtains his/her branded cylinder by paying a cylinder deposit plus the purchase price of the LPG it contains. An already-existing LPG customer brings his/her empty cylinder to a nearby retail location to exchange it, for the posted refill price, for a full cylinder of the same brand. The empty cylinder is then “recirculated” to the filling facility of the brand-owning Marketer by the distributor network, giving rise to the term “Cylinder Recirculation Model”. A high density of retail points located conveniently near to the consumers, supported by an adequate volume of cylinders, is critical to ensuring sufficient LPG availability to stimulate and to serve LPG demand.
6. *Consumer.* A first-time user interacts with the retail node to obtain a new, filled cylinder of a given brand, paying an initial cylinder deposit plus the cost of the fuel; an existing user exchanges his/her empty cylinder there for a full one of the same brand, paying for the fuel cost.

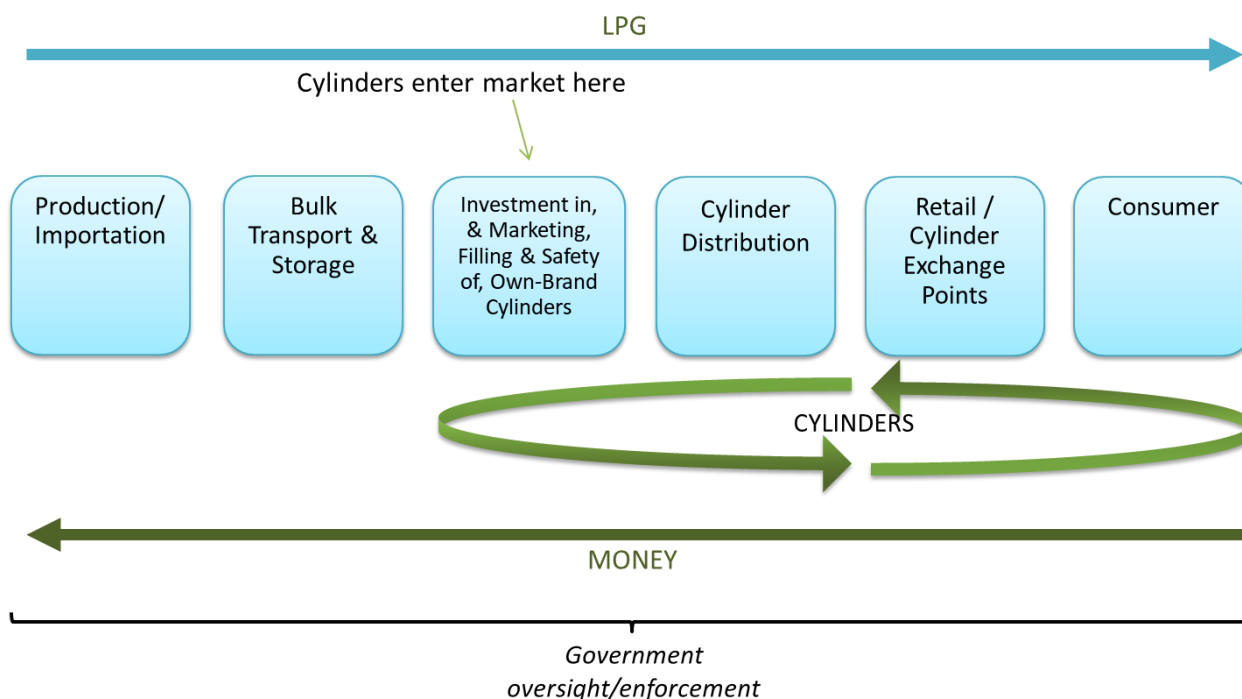
Based on prevailing national policy, regulation, and market design, various nodes may be structured as profit centers or cost centers. Vertical integration (a single company operating across multiple nodes) may or may not be permitted. Competition may be focused on attracting and retaining consumers, and/or in nodes further upstream from the consumer. (Examples of competition within the chain, not focused on attracting and retaining consumers, can consist of competing to acquire and control supply of LPG in bulk, competing for distribution and for retail presence, and interfering – legally or otherwise – with the cylinder inventories and logistics of rivals to influence market shares.)

LMICs with very high levels of LPG penetration and use by their populations, such as India and Morocco, have established the first two or three nodes (looking left to right) on a shared-asset utility model, as cost centers, with either state or common industry ownership thereof. That approach has helped to shift the focus of competition away from the interior of the supply chain to the acquiring and servicing of the consumer in those countries.

There are many potential variations to the value chain structure; nodes may potentially be merged or overlap, in whole or in part. Nevertheless, this basic structure, with good regulatory oversight, has been shown to be sustainably scalable to serve 80%+ of the populations of numerous LMICs, and 95%+ in some, while delivering adequate public safety over time.

The operation of the BCRM value chain, both in general and as applicable to Cameroon at a high level, may be diagrammed more explicitly as follows:

Figure 28. Generalized LPG value chain (BCRM) with operational flows

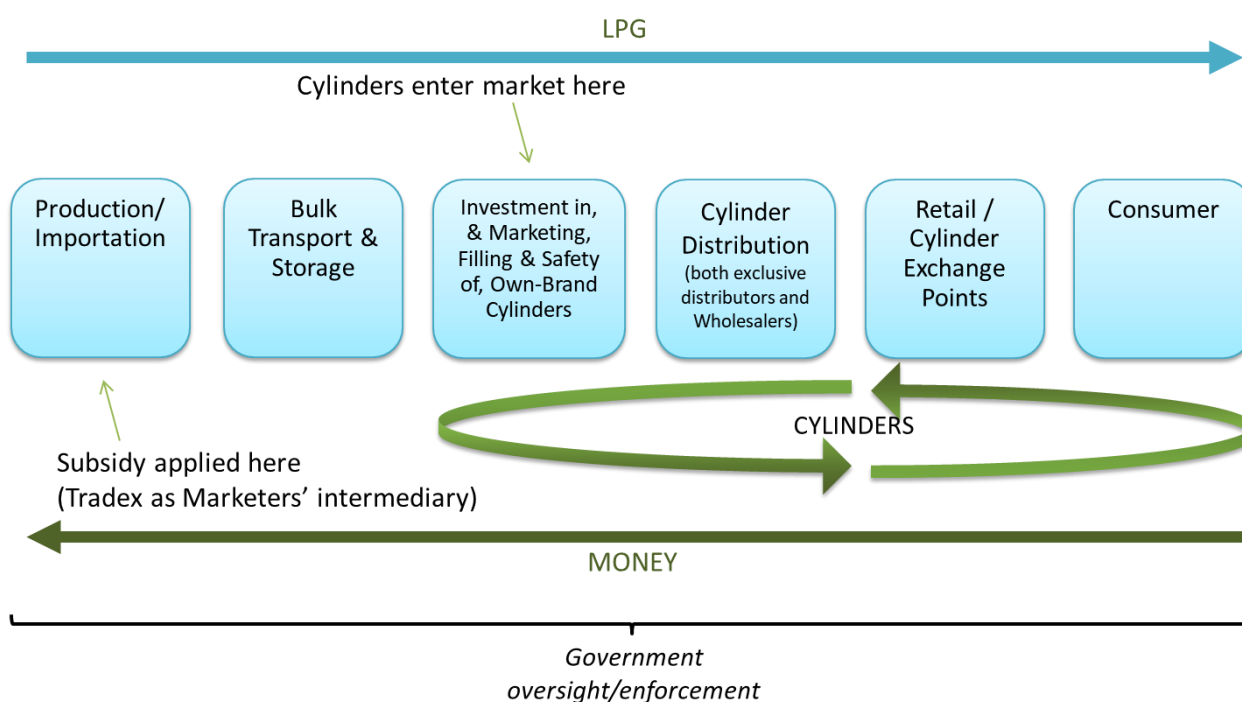


As one moves from production/importation toward the consumer along the chain, the number of players tends to increase, somewhat geometrically. This is the case in Cameroon.

Existing Cameroon LPG value chain

The Cameroon LPG value operates under a moderately strong form of BCRM. A key added element is the introduction of a governmental subsidy on the LPG commodity as it enters the supply chain, via a reimbursement mechanism to Tradex, the national LPG importing company (among its other business functions). This is shown in the following figure:

Figure 29. Cameroon LPG value chain (BCRM)



The nodes of the value chain are:

1. *Production/Importation*. This sourcing node carries forward. As noted above, a governmental subsidy is applied to the LPG as it enters the supply chain. This shields the remainder of the supply chain from margin risk and governmental reimbursement risk as LPG input costs fluctuate while regulated end-user prices remain fixed.
2. *Bulk Transport and Storage Companies*. These companies obtain LPG from sources of importation and/or production and transport it downstream, in bulk, by rail or by tanker truck.
3. *Marketers*. These companies are either licensed sellers of petroleum products generally, which can include LPG, or licensed sellers of LPG only. While they may refill consumers' LPG cylinders themselves through their own facilities, Cameroonian Marketers largely, but not exclusively, outsource the cylinder filling function to SCDP, which operates as a national cylinder filling quasi-utility company. Marketers may, and often do, self-distribute cylinders to the consumer through their own facilities, or through dedicated (brand-exclusive) distributors serving networks of retail points, or through multibrand Wholesalers.
4. *Wholesalers ("Grossiste"), Distributors, and Depot operators ("Dépot Gaz")*.
 - i. *Wholesalers*. Wholesalers are significant participants in this distribution node in the supply chain in Cameroon, unlike in most other LMIC markets, with approximately one-third share of cylinder distribution, measured by fuel volume. Wholesalers operate without contracts, using a standard price list. They have no obligation to return an empty cylinder to its brand-owning Marketers, and no responsibility for the safety of cylinders. Wholesalers are not required to report to Marketers on their sales outlets or their trucks. When a Wholesaler received a Marketer's cylinder, the Marketer loses operational control over brand marketing actions associated with cylinders, the cylinders' safety, and the sales

network. Wholesalers are permitted to, and do, freely collect and keep cylinders from any Marketer and return them to any other Marketer (the branding on the cylinder itself notwithstanding).

- ii. *Distributors.* Distributors in Cameroon are uncommon, unlike in most other LMIC markets. The distributor has a contractual, exclusive right to market a given Marketer's cylinders in its territory. The distributor pays a deposit to the Marketer for cylinder inventory; the Marketer undertakes to pay back the deposit upon return of the (empty) cylinder. The Distributor has its own network of retail outlets, or sells directly to homes. The Distributor represents the Marketer's brand under exclusive conditions prescribed in a distribution agreement. The cylinders are owned by the Marketer, despite being under the Distributor's operational control when away from the Marketer's facilities. The Distributor is prohibited to have cylinders filled by any unauthorized third party (e.g., a competing Marketer, or a pirate marketer), and to collect or keep cylinders belonging to other Marketers. The Distributor has one or more cylinder storage facilities to which the Marketer delivers filled cylinders. Finally, the Distributor owns a fleet of trucks that deliver to retail points under contract with it.
 - iii. *Depot operators and Resellers.* In Cameroon, a *Dépot Gaz* (or Gas Storage Facility) is defined by law and requires a business license. This facility plays a dual role: first, as a Wholesaler or Distributor that stores LPG in cylinders, and second as a retail outlet. This category is under public pressure to be scaled down by Government due to an accumulation of accidents (explosions) in recent years at such facilities. Resellers, conversely, are intermediaries between some Wholesalers and some of their retailers, operating as a shadowy "half node" in the supply chain between the two. Resellers have no legal obligations regarding safety, reporting of activity, licenses, etc.
5. *Retail outlets.* The retail outlet is where consumers exchange their empty cylinders for filled ones. Cameroon has retail outlets that are part of petrol stations, and standalone retail outlets. Retail outlets are served by Marketers (if owned by the Marketer).
 6. *Consumer.* The Cameroonian consumer is the largest single investor, in aggregate, in the assets of the value chain, because the consumer, through a deposit, funds 80% of the cost of the market's inventory of cylinders. (The 80%-of-cost deposit factor is defined by law⁴³.) The consumer puts down a deposit on a cylinder of his/her preferred brand at a nearby retail outlet which carries that brand. (Due to the brand-blurring of retailing by the Wholesalers, retail outlets may offer multiple brands.) When the consumer has used up the LPG, he/she returns to the retail point to exchange the empty cylinder for a full one, paying only for the new LPG on a per-kg basis. In many retail outlets, exchange of same-brand empty cylinder for same-brand filled cylinder is not enforced. The consumer takes the filled cylinder home.

The following table lays out the distribution mix.

⁴³ Governmental Order 011/MINDIC/CSPH of 30 April 2003. The price of a cylinder imported to Douala, plus defined transport cost from Douala to the Marketer facility, is the defined cost basis for the deposit.

Table 20. LPG national retail footprint by channel type (2017)

	Total	Direct channels (single branded)	Indirect channels (multibranded)
Main distribution players in channel	320	35 Distributors	285 Wholesalers
Average annual tonnage per Distributor / Wholesaler		283 MT ⁴⁴	111 MT
Estimated number of retail outlets	4,766	806	3,960
Population per retail outlet	10,309	Low: Douala 3,252	High: Garoua 84,898
% volume handled	100%	67%	33%
Average annual tonnage / retail outlet	23 MT	75 MT	8 MT

The average throughput of the different channel modes shows that the, direct, single-brand channels are far more effective for (i) achieving a critical mass of sales volume for their business entities and (ii) providing much denser coverage of the population.

More than half of residential LPG consumption is served directly by the retail footprints of major Marketers, such as via petrol station networks, without (reported) use of independent distributors.

Overall, these data confirm the need to increase the distribution system footprint significantly in order to serve both current and projected unmet demand. Industry expert stakeholder consultation suggests, and the National LPG Master Plan recommends, a target of 3,000 population per retail outlet, vs. 10,309 today.

Special roles for specific entities

- SCDP (Société Camerounaise des Dépôts Pétroliers) is a 51% state-owned company, responsible for bulk storage of LPG nationwide and for cylinder filling on a public-utility basis, although Marketers are free to perform in-house filling as well.
- Tradex is a 44% state-owned company and a subsidiary of SNH (Société Nationale des Hydrocarbures du Cameroun), the Cameroon state oil company. Tradex is the main petroleum-product importer, exporter and distributor, and is also a leading LPG Marketer. (Tradex is one of the local LPG operating partners in the Cameroon GLPGP/Clean Cooking for Africa LPG microfinance program.)
- CSPH (Caisse de Stabilisation des Prix des Hydrocarbures) is the Hydrocarbon Price Stabilization Fund, which compensates for volatility in the input price of petroleum products into the sector, including LPG. Because pricing is set by regulation below international parity, CSPH effectively implements the national subsidy mechanism. It also implements LPG cross-subsidies such as the transportation equalization tax. CSPH also regulates the distribution subsector, including pricing compliance, and, in cooperation with Tradex, manages tenders for LPG (and other hydrocarbons) for the input quantity not assigned to Sonara.

⁴⁴ Excludes volumes sold directly by Marketers via captive retail outlets.

- SONARA (Societe Nationale de Raffinage SA) is the state oil refinery company. Sonara is allocated a 20% share of the national market for LPG supply, the remainder sourced from abroad through CSPH/Tradex tenders.
- CAMSHIP (Cameroon Shipping Lines) and CAMRAIL (Cameroon Railway Corporation) are the providers of primary domestic maritime and rail transport of LPG. CAMSHIP handles transport of LPG from Sonara in Limbe to SCDP primary storage facilities in Douala. CAMRAIL transports LPG in bulk from SCDP Douala storage facilities to SCDP satellite facilities in Yaounde, Bélabo and Ngaoundéré.

Low fragmentation

The relatively low fragmentation of the supply chain at the Marketer level creates improved bankability, when taken as a whole. This topic is taken up in detail in Part IX (Financing) beginning on page 149.

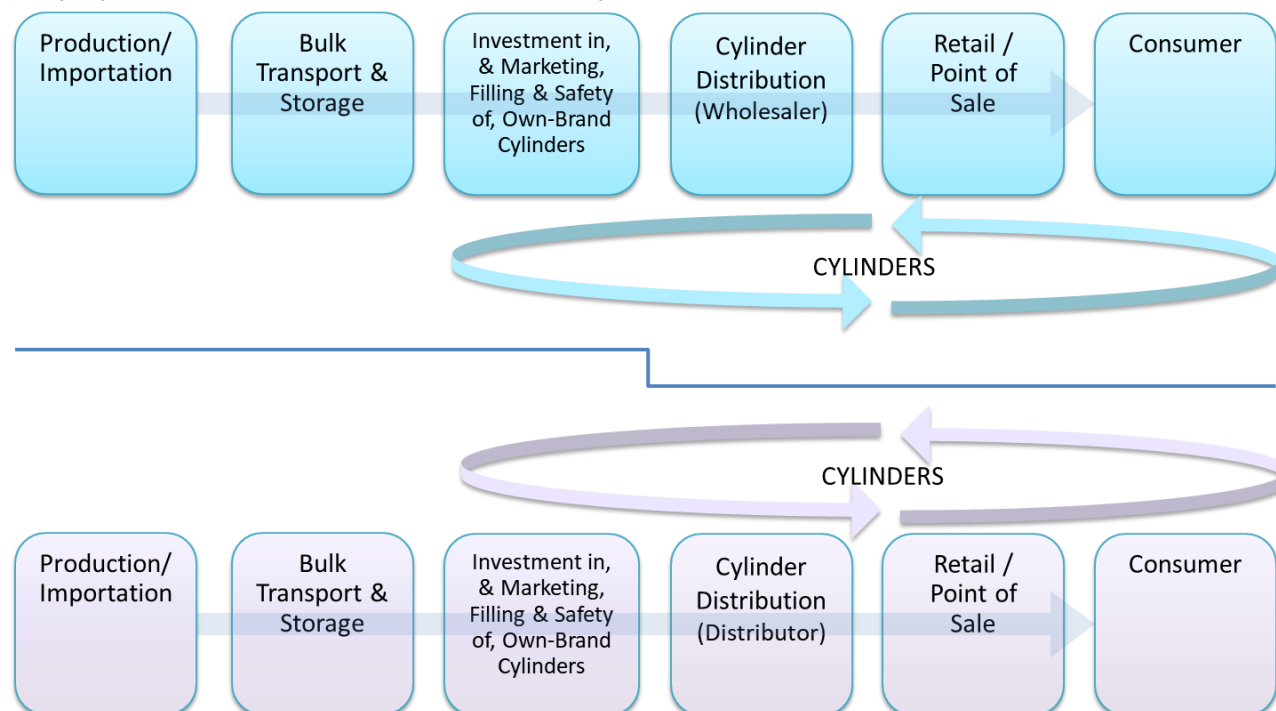
In principle, it also reduces burdens on the regulator, who would otherwise oversee a very large number of companies and proprietorships compared to the level of revenue to the regulator generated by the system. However, because the Wholesaler distribution channel is opaque, with little to no reporting of activity, the regulatory burden is actually quite large. This is evidenced by the very limited efforts of regulators to police the sector downstream of the Marketers, except with respect to Depot operators.

How Wholesalers break the linkage between cylinder investment, branding, profit, and safety accountability

Figure 30 shows the two parallel distribution modalities in Cameroon, constrained for purposes of illustration to two brands (one of blue and one of purple).

Figure 30. Direct and indirect distribution chains in Cameroon

(for purposes of illustration, each assumed initially to offer one brand)

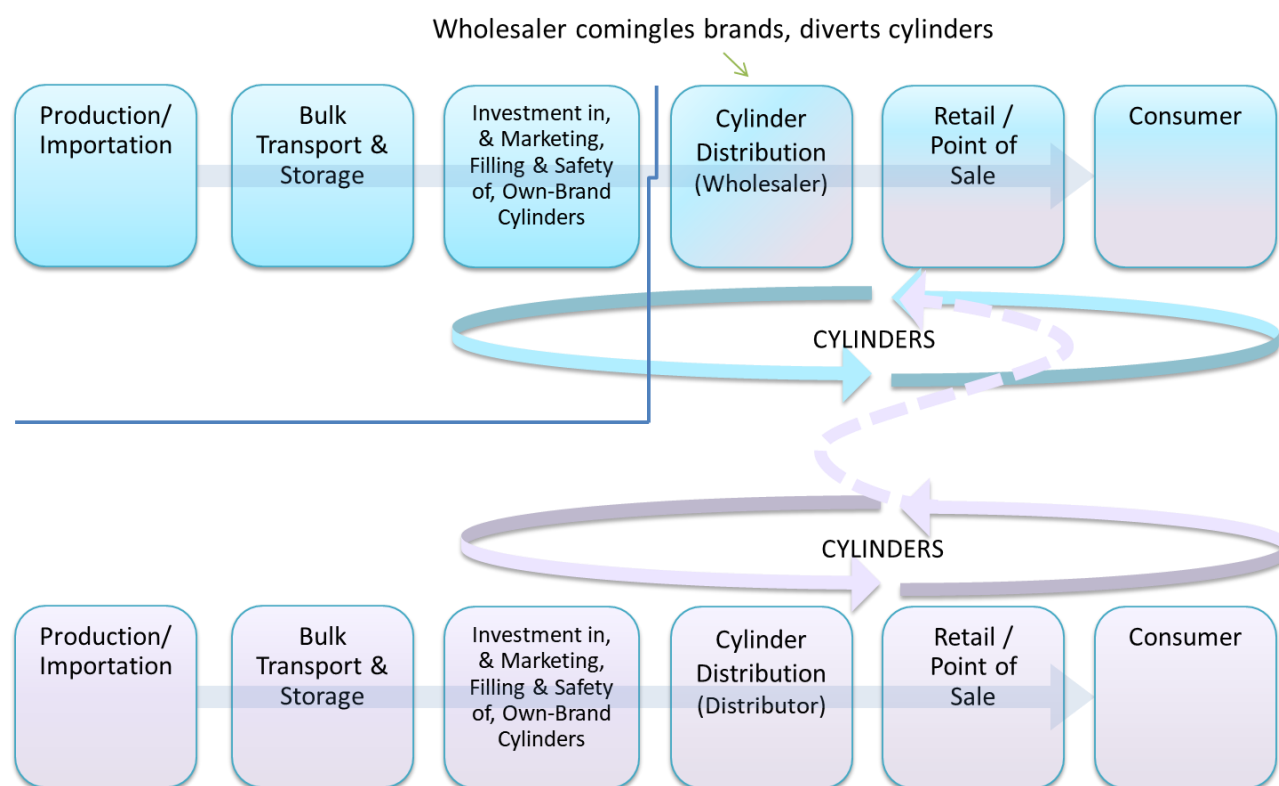


The top (blue) chain shows, for purposes of illustration, a Wholesaler that over time will exercise its freedom to gather and redirect cylinders of any and all brands in the market. The bottom (purple) chain shows the supply chain without any Wholesaler involved.

In this simplified case of two rival LPG brands, each Marketer invests in branded LPG cylinders, deploys them to consumers through its distribution channel, recovers and refills empty cylinders of its own brand through the recirculation mechanism, is assured of receiving the margins from a lifetime of refills associated with the cylinders in which it has invested, and assumes liability for and invests in the safety of its own-brand cylinders.

Figure 31 shows the effect on the chains of the Wholesaler using its freedom to transform the top (blue) chain into a multi-brand distribution chain.

Figure 31. Direct and indirect distribution chains in Cameroon with asset diversion by Wholesaler



In this second illustration, the Wholesaler begins migrating cylinders from the bottom (purple) brand into the distribution channel established by the top (blue) Marketer. Over time, retail points and consumers in the top channel become increasingly multi-brand. Based on where the Wholesaler directs the cylinders over which it gains control, it effectively determines which Marketer will receive customer revenues in the future, regardless of the investment made by the Marketer (i) to acquire its own customers and build out its own distribution system, and (ii) to acquire cylinders, deploy them into the market, and maintain their safety. Because the original Marketer's brand is still physically on the cylinder (blue or purple, in this example), the Marketer remains liable for any safety incident involving that cylinder, regardless of whether the Marketer continues to receive refill income from it. In practice, the Wholesaler moves cylinders within the distribution chain to maximize its own profit, potentially to the detriment of the profit streams of some (or all) Marketers, and of Distributors who operate in the same areas as Wholesalers.

A second business issue for the top (blue) Marketer is that it will lose its visibility into the distribution chain and to the consumer, becoming unable to manage either for lack of information. Effectively, the blue Marketer becomes boxed in by the presence and activities of the Wholesaler.

Over time, the Wholesalers will tend to drive out the Distributors under this scheme, if the Marketers and Government do not adequately resist it.

The breakage between the link connecting cylinder investment, profits and safety also makes it more risky for Marketers to invest, and for financing sources to provide investment capital to them.

With margins already deemed thin by the Marketers under Cameroon's current pricing regime, this situation creates a barrier to scaling up the sector in a way which assures adequate returns to investors and an acceptable level of safety for the public, for those Marketers who rely significantly on Wholesalers.

This situation is avoided by oil companies who co-sell branded LPG through their own petrol stations, bypassing the Wholesalers entirely. However, the national petrol station network is not, and never will be, adequately dense, nor located where all the LPG demand is: it is, and will remain, located and sized according to the need of vehicle drivers to fuel up.

Cameroon supply chain nodes and participants

Production and importation

LPG production comes from Sonara, the national oil refinery, for about 20% of the present national total. Additional LPG is imported via tenders run by CSPH/Tradex. LPG importation is pooled among the Marketers and delegated to Tradex, which conducts the calls for tenders and contracts suppliers. Each Marketer must pay its share up front, via letter of credit.

Importation is primarily from Equatorial Guinea. It is landed at the Bonaberi SCDP terminal. This terminal has a storage capacity of 2,500 tonnes of LPG and a shallow draught for accepting LPG vessels, which limits the maximum vessel size and thus creates a practical floor for the cost of ocean shipping of imported LPG. A floating storage platform paired with a shuttling coastal vessel mitigate this in part. Eventual implementation of a new terminal facility at Kribi, able to store 20,000 tonnes of LPG and receive correspondingly larger LPG vessels, would expand importation capacity, increase the choice of import sources, reduce importation costs, ensure more buffer storage to prevent LPG fuel shortages, and store future LPG produced along with methane (natural gas) from new domestic natural gas field production.

Under the future growth scenarios described in this report, importation is expected to increase significantly its share as a source of supply, because (i) domestic oil refinery output of LPG would not change as a function of LPG consumption, but only to the extent domestic oil refinery output overall is chosen (and funded) to be expanded to serve additional petroleum product demand that may arise, and (ii) the forecasted LPG consumption growth will exceed the anticipated co-production of LPG from natural gas fields.

As discussed in Chapter 21 (Summary of Main Project Risks, Mitigations and Mitigation Sources) beginning on page 200, adequate LPG is expected to be available for importation far beyond 2030. This ignores the additive potential to the surplus of bio-LPG, introduced in commercial quantities at competitive price points by multiple producers during 2018. Should the global LPG surplus end, net importers such as Cameroon must then compete for LPG with sectors such as plastics and chemicals, which choose among feedstocks

including LPG based on price. That sector consumes approximately one third of global LPG production for feedstock use at current price levels. Historically, as LPG prices have risen compared to feedstock alternatives, plastics and chemical producers switch from LPG to other feedstocks. This rebalances global LPG supply and demand across all other consuming sectors. If global LPG prices rise after ten years due to an end to production surpluses, Cameroon can continue to expect adequate availability of imported LPG, albeit at a potentially higher price.

It is expected that the prices of Cameroon's domestically produced LPG will continue to be linked to the region's international LPG reference price. This is both a good business practice and good policy practice for avoiding unintended arbitrages and resulting market distortions. Chapter 10 (Pricing) beginning on page 58 discusses LPG pricing considerations in Cameroon in detail.

Bulk transport and storage

Primary bulk transport of LPG is handled by Camship and Camrail, as described above. The national storage network is managed by SCDP, with bulk road transport handled by company-owned bobtail trucks or through contract with independent petroleum-products trucking firms.

The bulk storage capacity in Cameroon is connected with its filling capacity, as described in the next section.

Filling

The following figure and table set out the national filling and storage capacity as catalogued in the Master Plan:

Figure 32. Filling plants and their capacities (2015)

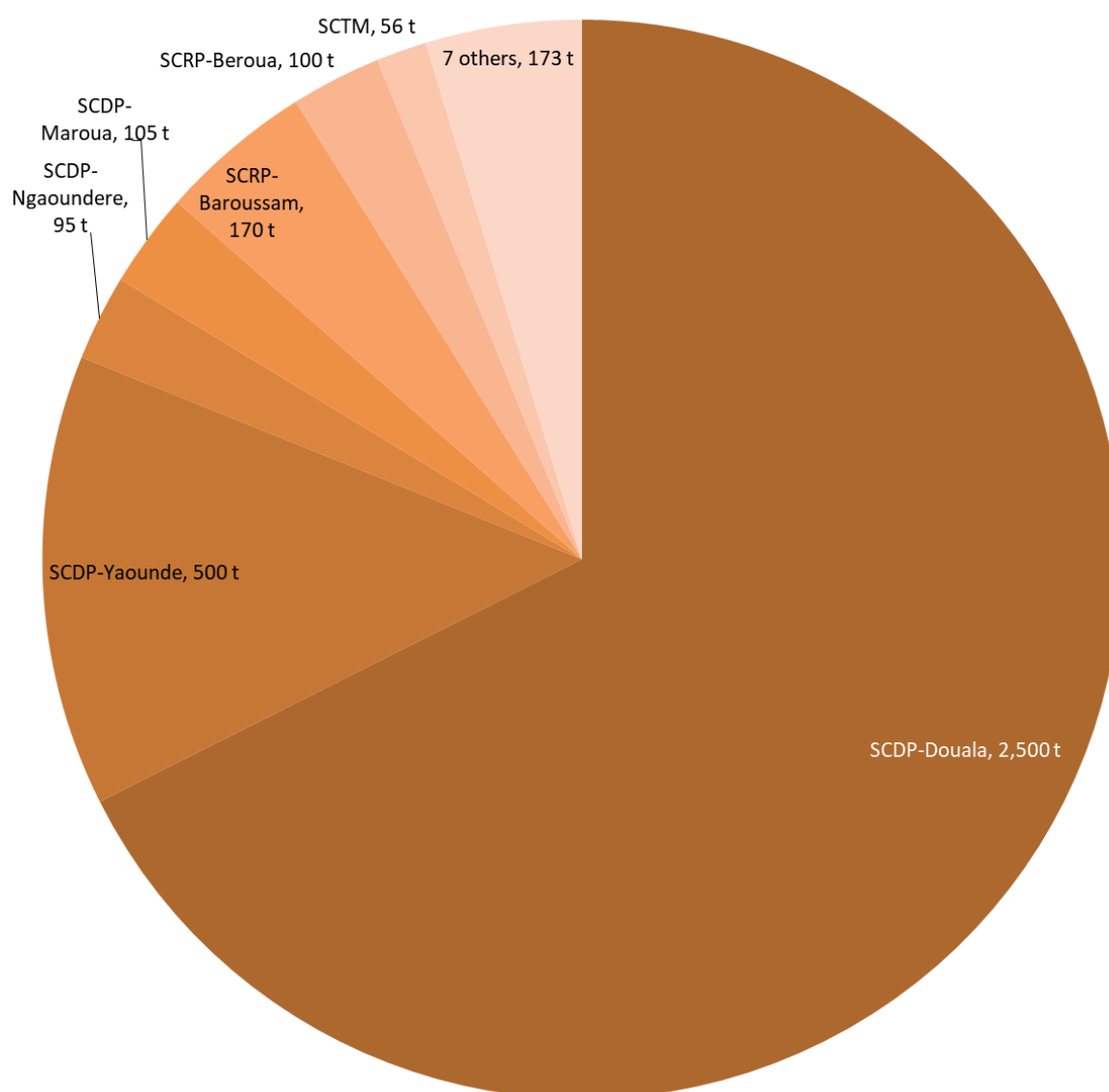


Table 21. Filling plant capacities and capacity shares (2015)

Filling facility	Storage Capacity (MT)	Capacity Share
SCDP-Douala	2,500	67.6%
SCDP-Yaounde	500	13.5%
SCDP-Ngaoundere	95	2.6%
SCDP-Maroua	105	2.8%
SCRP-Baroussam	170	4.6%
SCRP-Beroua	100	2.7%
SCTM	56	1.5%
Others:		
AZA (4 sites)		
GlocalGaz	173	4.7%
Stargas		
Green Oil		
Total	3,699	100.0%

LPG Marketing Companies

Twelve companies were licensed as LPG Marketers as of the end of 2018. Of those, six are multiproduct companies: typically larger, multifuel petroleum distribution companies that pursue a national marketing and retailing strategy with LPG distribution centered on their respective petrol stations. The LPG market leader, however, is a non-petroleum company: Société Camerounaise de Transformation Métallique⁴⁵ (SCTM), a private sector firm with approximately 27% LPG market share.

All twelve had LPG activity in 2018. The most recent entrant, Stargas, moved into LPG in 2015, growing quickly from a small base.

The following figure and table show their market shares for 2017:

Figure 33. LPG Marketers market shares (2018)

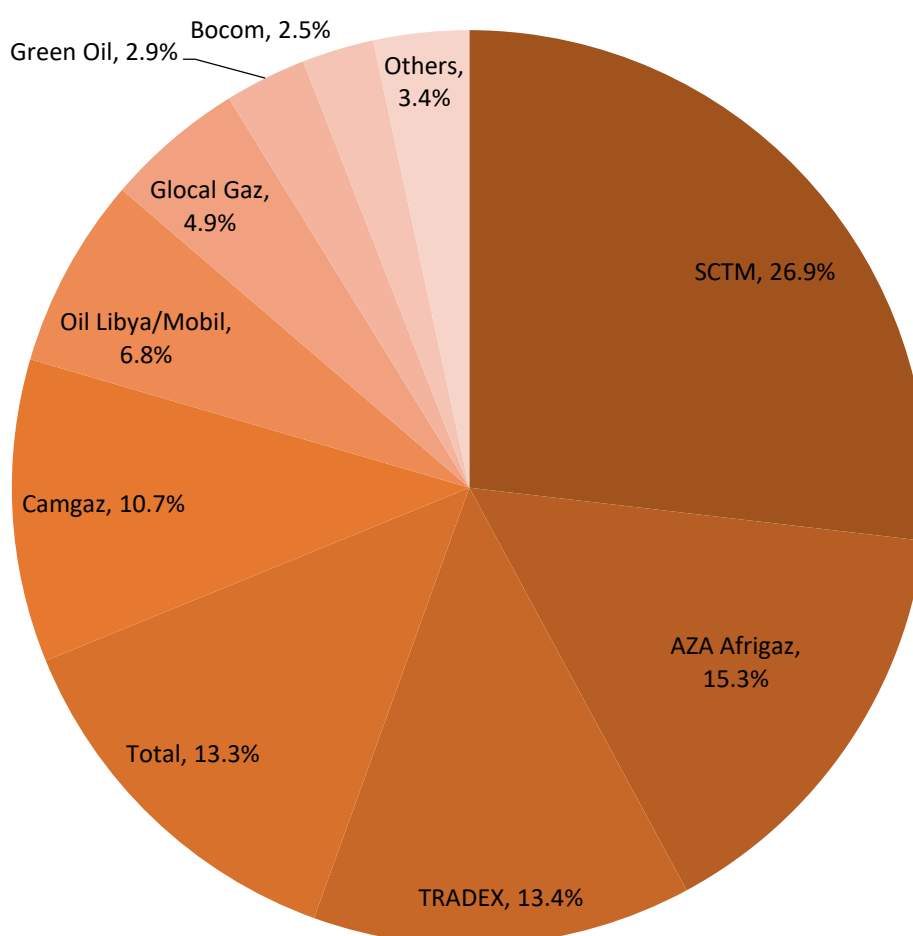


Table 22. LPG Marketers, volumes and market shares (2018)

Company	LPG Sales (MT)	LPG Market Share	Type
SCTM	30,567	26.9%	LPG
AZA Afrigaz	17,383	15.3%	LPG
Tradex	15,245	13.4%	Multifuel
Total	15,159	13.3%	Multifuel

⁴⁵ SCTM was originally established as a national metalworking and LPG cylinder manufacturing company.

Company	LPG Sales (MT)	LPG Market Share	Type
Camgaz	12,179	10.7%	LPG
Oil Libya/Mobil	7,693	6.8%	Multifuel
Glocal Gaz	5,589	4.9%	LPG
Green Oil	3,291	2.9%	Multifuel
Bocom	2,890	2.5%	Multifuel
Infotech	1,744	1.5%	LPG
Stargas	1,209	1.1%	LPG
Corlay	890	0.8%	Multifuel
Total	113,839	100%	Multifuel: 6 LPG: 6

The main difference between the multifuel and LPG-only types of firm is that the multifuel company operates service (petrol) stations that may include LPG among the products offered, and may also have LPG Distributors and Wholesalers, whereas the LPG-only company sells only LPG, which may be direct to the public through its own facilities or through Distributors or Wholesalers, and does not have automotive service stations.

Transportation services

Transportation of LPG in cylinders is carried out by Distributor or Wholesaler vehicles, or under contract by them to third party trucking firms. Distribution (trucking/logistics costs) are omitted as a distinct line item in the national LPG pricing formula. Their costs and margins are thus subsumed into the costs of the Marketers. (See Chapter 10 (Pricing) beginning on page 58 for the margin details.)

Distributors and Wholesalers

As shown in Table 20 on page 109, Cameroon had 35 Distributors managing 806 retail outlets and 285 Wholesalers managing 3,950 retail outlets in 2017, handling in aggregate 283 MT and 111 MT, respectively, of average annual LPG volumes. On average, a single Distributor handles approximately nine times the volume of a given Wholesaler.

The total volume in cylinders handled by the Distributors and Wholesalers in 2017 represented only about 40% of the market, with the remainder being sales by Marketers directly to consumers through their own retail outlets (i.e., petrol stations). The number of petrol stations in Cameroon was estimated at 550 in 2015, of which 100 were owned by 17 oil-and-gas companies not operating in the LPG sector.

Future importation and bulk storage capacity

In addition to the import terminal development planned for Kribi, as mentioned above, there is an eventual requirement to add capacity to the national storage footprint. With a storage capacity of 3,699 MT, including the Bonaberl SCDP terminal and excluding Sonara storage for discharge of its LPG production, the national storage capacity is turned over approximately 30 times per year. At a minimum, the national storage network should have the capacity to store one week of supply, or about 50 turns per year. Thus, by the time the residential market has increased by approximately 2/3, additional storage capacity will be required. The associated investment requirements are described in the next Part of this report.

LPG cylinder distribution in Cameroon



VIII. Critical Path LPG Infrastructure Investment Projects to 2030

This Part describes GLPGP's recommended scenario of expansion and development of the critical LPG infrastructure needed to serve the latent and unmet residential demand estimated in Part VI, and the costs and conditions for the construction thereof, to achieve the national LPG use goal set by the Government. The estimates of costs have been built on the basis of international technical standards. This Part also discusses the financial modalities and expectations for the LPG Marketers under that scenario.

Although the national LPG Master Plan calls for a reduction of the share of distribution handled by Wholesalers, such a shift in the distribution modality is not assumed to occur as a precondition for successful investment into, and implementation of, infrastructure expansion projects. This is, in part, because only one third of the current market volume is touched by Wholesalers, and use of Wholesalers by Marketers is not uniform. Therefore, investment preference can be given, in initial tranches at least, to Marketers that rely minimally, or not at all, on multibrand Wholesalers. Such Marketers will have inherently better control over their mobile cylinder assets, leading to preferential financial, safety, and operational characteristics in contrast with firms that make more extensive use of Wholesalers. However, investing at the full scale required to serve the entirety of forecasted demand will depend on Marketers that do make significant use of Wholesalers reducing that dependence significantly, or on enactment of regulatory reforms which address the present multibrand cylinder freedom permitted to the Wholesalers.

Upon completion of these investment projects in appropriate stages to 2030, Cameroon would have an expanded network of infrastructure and distribution assets with the capacity and capability to address the safety, productivity, and quality needs of refilling of cylinders at the desired scale through 2030 and beyond.

An important consideration is the capability of Marketers to acquire and deploy cylinders at the required pace, given their available cash flow and their ability to obtain and absorb investment capital. This is discussed in the next Part (Financing the Investments) beginning on page 149, and more deeply in the companion *Cameroon LPG Investment and Implementation* report.

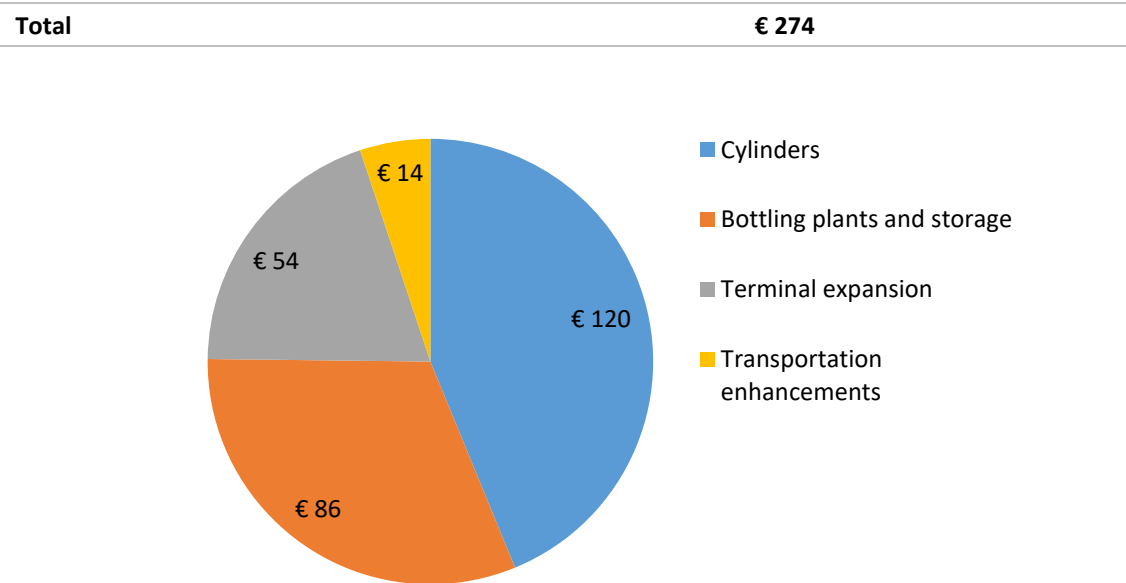
The Marketers must, in turn, plan and carry out business expansion driven by expanded cylinder inventories, wherein they develop deeper and broader retailing footprints (and reduce their use of multibrand Wholesalers, where applicable).

The acquisition of the cylinders themselves, being a procurement task, is also addressed in detail in the next Part. The quantity of cylinders in circulation and their velocity (rotation rate, in industry terms) along the value chain is related to the required capacities of the filling plants.

The total investment requirement is summarized in the following table:

Table 23. Capital investment requirements to 2030 for LPG sector scale-up

Category	Capital Requirement (mm Euro)	Supply Chain Node
Cylinders	€ 120	Marketers
Bottling plants and storage	€ 86	SCDP / Marketers
Terminal expansion	€ 54	SCDP or competitor
Transportation enhancements	€ 14	Distribution (trucking)



As shown in the foregoing chart, cylinders represent the largest single asset type by far, at about 45% of the total, and Marketers—as cylinder owners—the largest single category of entity for deployment of capital.

15. Investments at the Sector Level

This Chapter describes the investments necessary over time to serve the demand projected in Part VI (LPG Demand Potential to 2030) beginning on page 69.

This investment stream has been calibrated in four main ways, and may be recalibrated in future as needed:

1. *Demand.* The hypothetical sector-level investments identified in the Cameroon national LPG Master Plan were developed using confidential growth forecasts provided by the LPG Marketers, which on average assumed a similar number of new users, and a materially higher usage per LPG user, than the upper bound demand assessment set forth in Part VI (LPG Demand Potential to 2030) beginning on page 69. The investment plan outlined in this report utilizes the upper bound demand assessment as a constraint on the scale and pace of investing captured in the Master Plan⁴⁶. The key differences between the lower and upper bounds of the demand forecast are (i) a very slight increase in penetration (59% vs. 60%) and (ii) a material difference in the average usage per user (steady-state from 2017 vs. growth to 20.3 kg/capita in 2030). If such per-user consumption growth does not in fact develop, then future investment tranches would be reduced proportionately.
2. *Financial returns available to investors and lenders.* The financial returns of the investments are consistent with identified requirements of anticipated participants in the capital stack, as described in Part IX (Financing) beginning on page 149.
3. *Normative LPG industry operational and cost-structure ratios.* The operational performance of the supply chain nodes is consistent with LPG industry operating and costing norms for Sub-Saharan Africa LPG markets where BCRM is practiced.
4. *Future growth dynamics.* To the extent the demand estimates prove to be greater than actual demand, the rate of investment can be slowed or halted in any year to rebalance supply, capacity, capacity utilization, and supply-chain growth with actual demand and the actual rate of demand growth. If demand estimates prove to be lower than actual demand, the rate of investment can be accelerated up to the sustainable growth rate limit of the businesses in the supply chain, or can be continued beyond 2030, to catch up to actual demand and, potentially, to the rate of demand growth.

Chapter 16 examines the investment economics and returns at the firm level.

The key metric which ties together all aspects of the financial and operational modelling of the investments, and of the firms, is the number of cylinders required to be in national circulation (i) for the expected usage to be served reliably by the supply chain, and (ii) for the LPG supply chain to generate adequate cashflows to pay for required operations, growth, and the anticipated financial returns required by investors and debt payments required by lenders.

The number of cylinders required is a function of

⁴⁶ It should be noted that the aggressiveness of the industry-sourced growth projections was not across the board; rather, a small number of the Marketers had highly aggressive growth plans and forecasts compared with their competitors, which contributed disproportionately to the overall growth rates reflected in the Master Plan.

1. The number of users;
2. The frequency of refilling of their cylinders;
3. The size of the cylinder; and
4. How and how quickly the cylinders recirculate within the supply chain.

The investments are staged in a series of annual and multi-year steps (based on the asset type) over twelve years, in order to optimize returns, minimize execution risk, and match expansion of supply and distribution to the anticipated growth of demand.

The number of users is projected in Part VI. As elsewhere in this document, a “user” is a member of a household that uses LPG for cooking. Aggregated Cameroon industry data, obtained via survey and interviews, are used to define standard operational parameters for modelling. These are detailed hereafter. Future refill frequency is solved for through analysis of other operational, inventory and usage statistics, and is evolved over time from the industry data, consistent with norms for BCRM in equivalent- and larger-sized LPG markets (measured in usage per capita) in Sub-Saharan Africa. The industry term for this parameter is the cylinder rotation rate, which is a function of multiple drivers that include gross and average consumption level by households, the mix of cylinder sizes, the efficiency of the supply chain including its logistics, the level of diversion (loss, whether temporary or permanent) of cylinders to competitive interventions (legal or illegal) and to mishandling in distribution, the extent of ongoing cylinder maintenance and scrapping required, and other factors. The rotation rate is a key metric for an LPG business to assess and predict the earnings generated by the cylinder inventory it owns or manages. A declining rotation rate in a given geography is a leading indicator of saturation of that geography’s LPG market, all other things being equal, and is a reason to slow or pause further investment.

The main cylinder sizes in Cameroon for households are 6kg and 12.5kg, with 12.5kg overwhelmingly dominant. The current mix has been assumed to continue in this analysis. For purposes of the analysis, cylinders are defined using a measure of kge (kg-equivalent). That is, a 6kg LPG cylinder (for example) is treated as equivalent to 0.48 12.5kge cylinders, or 12/25ths of a 12.5kg cylinder. Where “kg” is used regarding cylinders, it indicates a specific cylinder size; where “kge” (or “kgeq”) is used, it indicates a weighted average of sizes.

The combination of expected (and desired) LPG adoption and consumption rates by households, cylinder rotation rates, associated cylinder inventory requirements, and other factors drives the sizing and costing of the LPG infrastructure that will be required to serve future demand. The sector-level modelling of the needed infrastructure and investments was performed regionally, because (i) the necessary regional data exist, and (ii) regional variations in the key parameters are large enough to be material.

Summary of projected LPG volumes

As discussed in detail in Chapter 10 (Pricing) beginning on page 58 and Part VI (LPG Demand Potential to 2030) beginning on page 69, LPG end-user pricing may be increased slightly by the Government, if it implements fully the recommendations of the Master Plan and the national LPG Investment Committee, in order to spread out the up-front cost of new cylinders over time for the Marketers and to reduce the cylinder deposit amount to consumers, potentially accelerating demand as well. The notional maximum extent of such a price increase is proposed to be € 0.037 per kg, which, if passed on fully to the end-

consumer, is modelled to result in reduction in consumption volume of approximately 5.5% but negligible effect on the percentage of new households adopting LPG (and requiring new cylinders).

A reduction in consumption without a corresponding reduction in the number of users implies a reduction in the refill rate. However, the cylinder inventory requirement does not decline materially, because the refill rate is only one of many factors affecting the national cylinder requirement.

The cylinder requirement is calculated for each region using a 2017 baseline of its residential LPG consumption and cylinders, the population served per existing cylinder, its rate of population growth, the implied cylinder rotation rate, working stock requirements, and cylinder replacement inventory requirements related to the trade-in of existing unbranded cylinders and their replacement with branded cylinders, including governmental and industry expert analysis of the number of existing cylinders which can be refurbished and the number which can be scrapped, and the expected level of average consumption per LPG user in 2030 (20.3kg) from the demand projections.

These elements are shown in the following set of tables:

Table 24. LPG consumption by region (2015)

Region	Population ⁴⁷ (millions)	LPG residential usage/capita	Population per cylinder	LPG residential consumption	
				Volume (MT)	As %
Extreme-Nord (Maroua)	3.9	0.5	54	2,078 t	2.3%
Nord (Garoua)	2.3	0.6	52	1,432 t	1.6%
Adamaoua	1,1	2.3	13	2,624 t	2.9%
Centre (Yaounde)	4.0	8.1	5	32,490 t	35.8%
Sud (Kribi)	0.8	2.4	18	1,899 t	2.1%
Est (Bertoua)	0.9	1.5	29	1,312 t	1.4%
Littoral (Douala)	3.2	12.3	3	39,945 t	44.1%
Sud Ouest (Kumba)	1.6	1.3	30	2,063 t	2.3%
Nord Ouest (Bamenda)	2.0	1.2	33	2,394 t	2.6%
Ouest (Bafoussam)	2.0	2.2	18	4,405 t	4.9%
Total	21.9	4.1	10	90,641 t	100.0%

Applying the region by region penetration projections from Part VI, the following regional breakdown of future regional consumption results for residential cylinders:

Table 25. Estimated cylinder filling volumes and penetration by region in 2015 and 2030

Region	LPG volume in cylinders (KT, 2015)	LPG volume in cylinders (KT, 2030)	Population (mm, 2030)	LPG residential usage/capita (kg, 2030)
Extreme-Nord (Maroua)	2.1	28.0	5.9	4.7
Nord (Garoua)	1.4	16.8	3.5	4.8
Adamaoua	2.6	11.1	1.7	6.5
Centre (Yaounde)	32.5	66.5	6.0	11.0

⁴⁷ GLPGP industry survey (2016)

Region	LPG volume in cylinders (KT, 2015)	LPG volume in cylinders (KT, 2030)	Population (mm, 2030)	LPG residential usage/capita (kg, 2030)
Sud (Kribi)	1.9	10.0	1.2	8.4
Est (Bertoua)	1.3	11.2	1.4	8.2
Littoral (Douala)	39.9	82.5	4.9	16.8
Sud Ouest (Kumba)	2.1	24.1	2.4	10.2
Nord Ouest (Bamenda)	2.4	26.2	3.1	8.5
Ouest (Bafoussam)	4.4	26.6	3.0	8.7
Total	91 KT	303 KT	33.1	9.1 kg

This projection reflects an average level of LPG use by an LPG user through 2030 of 20.3kg per year, as discussed in Part VI (LPG Demand Potential to 2030). The standard industry metric of 9.1kg/capita of annual nationwide consumption projected for 2030 begins to approach the levels of already better-developed LPG markets in Sub-Saharan Africa, such as Senegal and Cote d'Ivoire, which were well above 10kg/capita in 2018.

It is possible that more than 58% of the population will cook with LPG, or that users will expand their LPG use to more than 20.3 kg per year (the upper bound estimate for 2030), on average. New users may ramp up their LPG use as they gain familiarity with the use of LPG to cook an increasing portion of their meals. Others may immediately cook exclusively with LPG, far exceeding the average consumption level. The theorized maximum usage level of an average Cameroon household that uses LPG for cooking, as discussed in Part VI, is 33 kg per year, if LPG is used exclusively for cooking all meals every day. By comparison, a user in the upper bound scenario is projected to use 20.3 kg of LPG per year, implying mixed use of LPG and other cooking fuels, on average. A "user" means a member of a household that cooks with LPG.

For purposes of this Part, incremental investment in LPG infrastructure through 2030 will result in the capacity for slightly under 60% of the population to have LPG access, via a cylinder in the home, and to use LPG at or above the present average level among existing users in the country.

The GLPGP industry survey of the Cameroon LPG marketing companies calculated a weighted average cylinder rotation rate of 3.19, projected by the companies to grow moderately to a weighted average of 3.36 in 2030.

The foregoing data, in combination, predict incremental cylinder inventory requirements:

Table 26. New cylinders required to 2030, nationally and by region
(000s of total new 12.5kg units⁴⁸ in circulation, shown in alternate years)

Region	2019	2020	2022	2024	2026	2028	2030
Extreme-Nord (Maroua)	96	131	217	321	422	511	608
Nord (Garoua)	59	80	131	194	254	307	365
Adamaoua	102	121	159	195	218	229	241
Centre (Yaounde)	880	1,015	1,259	1,452	1,522	1,486	1,439
Sud (Kribi)	67	81	114	148	176	195	216
Est (Bertoua)	42	56	90	131	170	204	242

⁴⁸ Cameroon industry forecasts for new residential cylinders included solely the 12.5kg cylinder size, due to the negligible level of consumer adoption of the other sizes permitted by regulation.

Region	2019	2020	2022	2024	2026	2028	2030
Littoral (Douala)	1,113	1,282	1,588	1,825	1,906	1,854	1,787
Sud Ouest (Kumba)	88	118	192	281	367	441	522
Nord Ouest (Bamenda)	82	114	193	291	388	474	568
Ouest (Bafoussam)	132	168	252	347	433	501	576
Total 12.5kge	2,660	3,165	4,194	5,185	5,857	6,203	6,564

These required cylinder inventories, rotation rates, and total LPG refill volume in each region over time are the key determinants of the required capacities of the filling plants over time.

Filling plant and storage capacities

Filling plants may be grouped into SCDP facilities and the in-house facilities of other LPG Marketers. These may be subdivided into expansion of existing facilities and construction of new facilities. Where existing facilities are in place, the investment plan presented builds up from the 2017 volume and capacity, ramping up capacity in stages to achieve the storage and throughput requirements for the facility's anticipated share of the total national LPG cylinder refilling volume, region by region and entity by entity. (SCDP provided its own forecast of the aggregate future volumes it would serve from Cameroon's LPG Marketers, taken together.)

In regions without existing facilities, it was assumed that operations from a new facility would commence during 2020, after which it would be expended, as necessary, in steps as its throughput requirements increase to serve the demand associated with that facility.

A Cameroon filling plant audit was conducted by the GLPGP/Clean Cooking for Africa engineering and construction experts in 2018 to review operations, potential improvements, and estimate near term, medium term, and long-term investments costs consistent with the Master Plan (as recalibrated to the demand projections described in this report).

The SCDP share of national filling was projected to be approximately 79% of the total in 2030, with the remainder to be provided by the independent, in-house filling facilities of individual LPG Marketers.

Total required bottling capacity was projected to be approximately 380 KT per year in 2030 nationwide, with one shift of operations (labor) depending on the region to serve the projected consumption (upper-bound scenario). This nameplate capacity allows for 20% of flexibility to cover all peak needs throughout the year.

Overall filling and storage investments

The following two tables show the filling and storage capacity requirements by region:

Table 27. Filling plant capacity growth requirements by region to 2030 (KT)

Region	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Extreme-Nord (Maroua)	10		4		5				3	
Nord (Garoua)	7	2		3			3		2	
Adamaoua (Ngaoundere)	4	2			1					
Centre (Yaounde)	39									
Sud (Kribi)	7				2				2	2

Region	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Est (Bertoua)		3			1		2		3	
Littoral (Douala)	43									
Sud Ouest (Kumba)	10		3		4			4		
Nord Ouest (Bamenda)	11		4		4			4		6
Ouest (Bafoussam)	10			5				4		
Total	139	7	11	8	17	0	5	12	10	8

Table 28. Filling plant storage growth requirements by region to 2030 (MT)

Region	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Extreme-Nord (Maroua)		90		60		75				15	
Nord (Garoua)		105	30		45			45			
Adamaoua (Ngaoundere)		25	30			15					
Centre (Yaounde)	570	474									
Sud (Kribi)			7,500			6,000					
Est (Bertoua)								30		45	
Littoral (Douala)											
Sud Ouest (Kumba)		140		45		60			60		
Nord Ouest (Bamenda)		168		60		60			60		90
Ouest (Bafoussam)		70			75				60		
Total	570	1,072	7,560	165	120	6,210	0	75	180	60	90

The total incremental filling facility investment requirement for these capacities is estimated as follows:

Table 29. Filling facility investment requirements to 2030 (€ millions)

Category	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Storage capacity	2.6	4.9	34.8	0.8	0.6	28.6		0.3	0.8	0.3	0.4
Filling capacity		6.6	0.3	0.5	0.4	0.8		0.2	0.6	0.5	0.4
Cylinder maintenance units		0.5	0.5	0.5		0.3				0.3	

The investment cost through 2029 (with no further investment required in 2030) is € 74 million for expanded storage, € 10 million for added filling equipment (carousels, etc.), and € 2 million for added cylinder maintenance equipment, totaling € 86 million.

SCDP investments

Even though SCDP is projected to own and operate 79% of the total capacity of the sector, due to economies of scale and other factors, the SCDP share of the investment requirement was costed at just € 40 million, or 47% of the total of € 86 million. (Additional investments to improve safety and infrastructural flexibility were identified at € 10.7 million.) This includes the following specific elements:

- Increased LPG storage and pipeline capacity at the Bonaberi facility, comprising three new spherical units of 1,300 tonnes each and a new 8" pipeline for unloading LPG vessels. This could also delay the time by which a new terminal at Kribi would be required to come on line.
- Expansion of the Yaounde facility to the level of 40 KT per year, which will entail a separate assessment of its integration with the Yaounde hydrocarbon depot.

- Consistent utilization of filling carousels, palletizers, on-line scales and cylinder running stock.

The SCDP investments are grouped into five main phases, as shown in the following table:

Table 30. SCDP filling investment requirements summary
(€ millions)

Category	Investment Amount
Security and safety enhancements*	0.7
“Quick win” improvements (very rapid financial payback)*	10.0
Near-term scale-up (through 2021)	23.2
Medium-term scale-up (2022-2025)	14.1
Long-term scale-up (after 2025)	3.5
Total	51.5

* These items increase safety and improve operations but do not increase capacity per se

Capacity would increase in the following steps:

Table 31. SCDP filling capacity and storage build-out steps (KT)

Year	Capacity	Storage
2019	60	3.0
2020	170	9.5
2024	255	13.0
2028	315	14.0

National technical committee under SCDP

A new national technical committee, led by SCDP, is expected to be created during 2019 to perform the detailed engineering studies (including detailed descriptions of equipment, calculations, and all necessary drawings) and the estimation of the final investment cost of filling and storage expansion capacities to 2030. The technical committee would also specify or define the relevant safety and construction standards. The 2018 GLPGP audit of SCDP facilities is to provide a starting point for the technical committee’s work.

Ship and rail transportation

The capacities of Camrail and Camship for bulk transport of LPG are deemed adequate and expandable for the forecast period, and therefore have not been addressed in this report.

Road transportation

To serve the expanded network of filling plants and storage, additional road tanker capacity will be required. Approximately 20 tankers were active in 2015 to serve filling plants, per SCDP data.

The number required to support the added infrastructure will be 15 additional in 2019, 10 additional in 2020, and from 1-5 more in each additional year to keep pace with increasing refilling volumes, for a total of 39 additional vehicles as of 2030. Preliminary procurement data indicate an estimated acquisition cost of € 13.5 million, in aggregate.

Cost of cylinder distribution vehicles

The cost of additional cylinder delivery trucks is deemed recovered by delivery SMEs through the marketing margin of the existing national price build-up formula, and the recommended distribution-specific margin of the recommended formula described in Chapter 10 (Pricing) beginning on page 58. A detailed analysis of delivery truck fleet expansion was beyond the scope of this report.

Import terminal capacities

The Kribi deepwater port, originally constructed by China Harbour Engineering Corporation, already handles petroleum product importing and exporting for Cameroon. Its petroleum-handling capability is planned to be expanded, in part in connection with the development of natural gas production in the country. The LPG Master Plan calls for constructing a new oil, gas and LPG terminal facility at Kribi. This LPG capacity has been costed on a preliminary basis at € 54 million. SCDP awarded a contract for the project to Blaze Energy of Canada in 2015, subject to financing to be obtained by Blaze Energy. As of this writing, the project has not yet moved forward. (Meanwhile, natural gas is being handled at Kribi through a floating storage system deployed and operated by Perenco and SNH, which has adequate capacity to handle the upper bound-projected LPG volume through 2024.)

LPG cylinder investment

It is estimated that the number of cylinders in circulation by 2030 will need to increase by 4.3 million of 12.5kge, in order to serve the anticipated number of new users and demand. This number includes all cylinders in use, in stock, sitting idle, located with consumers, at distribution points, at the filling plants, in transition (recirculation) in trucks, and in transition for maintenance.

Depending on the final procurement process chosen to be used for these cylinders, the provisional estimate of the required investment in cylinders is €120 million through 2030.

Total investment

Set forth below are the components of the total investment for filling, storage, cylinders, transport, and import terminal of € 274 million, or about € 8.3 per capita in 2030.

The following table provides a summary of the investment:

Table 32. Summary of investment to 2030, by asset type

Asset type	Amount (€ mm)	Per capita (2030)
Filling plant and storage: expansion and new facilities	86 €	2.6 €/capita
Additional cylinders	120 €	3.6 €/capita
Terminal expansion	54 €	1.6 €/capita
Transportation	14 €	0.4 €/capita
Total⁴⁹	274 €	8.3 €/capita

⁴⁹ Amount does not add exactly due to rounding.

The investment cost to develop LPG for clean cooking in Cameroon comes to under € 9/capita to reach just under 60% penetration of the population by 2030.

One may extrapolate this figure to about € 20/capita for a 100% penetration rate, taking into account the diseconomies of scale from serving the most remote areas of the country.

Measured on a per-household basis, the € 8.3/capita value is approximately € 70 per LPG-using household in 2030 and € 40 per household for all households. Adding the cost of a typical basic Cameroon LPG stove and associated accessories (€ 37), the cost per household comes to approximately € 77 (€ 107 for only LPG-using households). This value is consistent with infrastructure and equipment costs experienced by other LMICs executing major LPG scale-up programs.

Investment in LPG infrastructure (cylinders and bottling plants and bulk depots) can last up to 50 years, if the BCRM is well enforced, and if its safety rules and maintenance requirements are observed.

Overview of investment project assumptions and methodology

The assumptions and methodology are based on the demand analysis presented in Part VI and on what the Government of Cameroon and its state sector and private sector LPG companies have indicated to GLPGP, as described in detail in Chapter 14 and as set forth in the Cameroon LPG Master Plan.

The LPG companies provided information under the direction of MINEE on a confidential basis, for use in aggregate without attribution or reference to any specific company. The exception was SCDP, which permitted evaluation and auditing of its national filling and storage infrastructure and operations.

The LPG companies indicated an interest in financing solutions for increasing their cylinder investment, but were not willing, on a preliminary basis, to make commitments to specific cylinder investment volumes (as called for in the Master Plan and as indicated that they could achieve with appropriate financing). They were also not willing to have detailed discussions about procurements or financing of procurements without a demonstrated and specific financing package on offer from a credible source.

A technical assumption is that the current, nearly exclusive use of butane for Cameroon's LPG would continue. Butane-rated equipment (storage, cylinders, etc.) can generally withstand a certain level of propane content, but too much propane creates safety risks due to its significantly higher vapor pressure. Propane-rated infrastructure would be more costly, due to its need to handle higher-pressure gas, but the ability to handle a higher level of propane in the LPG mix could reduce the average cost of the gas. It was beyond the scope of this report to evaluate the potential for changing the fuel specification in regulation and standards, and in the infrastructure costing, to account for such a change.

The methodological approach used was to estimate the projected filling volume per filling region from 2017 to 2030, described earlier in this Chapter, and introduce appropriately sized plants or plant-expansions in multiple phases.

The steps were:

1. Utilize the demand data and projections described in Part VI, allocated among the regions based on historical usage patterns and cross-checked with the 2017 and 2018 sales of every LPG marketer for residential use and combined with relevant parameters regarding the cylinders' operating cycle

(supply-chain velocity and bufferage), to project the cylinder inventory requirements and the refill volumes for each region over time;

2. Scale these as necessary for alignment with the demand forecast upper bound case, in order to ensure adequate capacity to serve the projected demand without creating shortages;
3. Project the step-wise capacity required of the sector through 2030 in adequate anticipation of consumption year by year, while maintaining reasonable stability in the year-over-year pace of investment in order to help the sector to absorb and deploy capital and to grow with minimum risk of operational and financial disruption or discontinuity;
4. Calculate the filling and storage capacity required in each region to serve the consumption in its region over time, concluding with overall 59% adoption and use by 2030 in accordance with the demand forecast⁵⁰;
5. Separate out the SCDP facilities for separate assessment and costing, because SCDP, due to its unique position as a quasi-utility in LPG storage and filling, has a different infrastructure starting position and different economies of scale from the remainder of the LPG sector.

By calculating the annual filling volumes, the required capacity of the plants' main elements (scales, storage, etc.) can be defined according to industry norms, taking into account good operational practices and adequate capacity buffer to absorb peaks of consumption.

Then, the equipment and facilities of each facility are specified and the cost of construction estimated (land cost not included).

Note: This report does not consider the future of the non-residential LPG segments, such as LPG as a vehicle fuel.

Assumptions

The number of circulating cylinders (also called the "cylinder park")

The official number of existing cylinders in circulation in Cameroon is not available, but was obtained for 2015 (deemed old enough to be of low competitive risk) through a MINEE-mandated survey carried out by GLPGP, and extrapolated for 2018 based on overall LPG market growth from 2015-2018. A cylinder in circulation is any cylinder, in use or idle at home, in the plant, shop, or warehouse, or on a truck.

Cylinder park technical and physical condition

It was assumed, absent information to the contrary, that the cylinder inventory is in adequate safety condition, with a normal 20-year or longer life, indicating an approximately 5% annual need to scrap cylinders that are no longer safe, maintainable and recertifiable.

⁵⁰ As discussed previously, the pace and scale of investment would, in practice, be adjusted in each year or each multiyear phase (based on the type of asset), based on whether demand rises faster or slower than projected.

Calculation of operating projections per region

Population

While projections could be made based on either households or persons (users) of LPG, for purposes of calculating capacities and investment requirements, population has been used. That is because consumption of LPG for cooking is linked to the number of meals cooked, which varies not with households (each region having its own average household size), but with the number of persons across the using households. Cylinders themselves, conversely, are linked to the count of households (or, more properly, to the number of “kitchens”, in that the concept of a household, from a cooking standpoint, might involve more than one family group at a time, with shared cooking duties).

Projection of LPG consumption to 2030

It has been assumed that the LPG consumption progression rate varies between the southern regions and the northern regions and that LPG consumption will progress more quickly going north, starting from a proportionately smaller base, compared to the south, where LPG has already achieved high penetration in the regions around Douala and Yaounde.

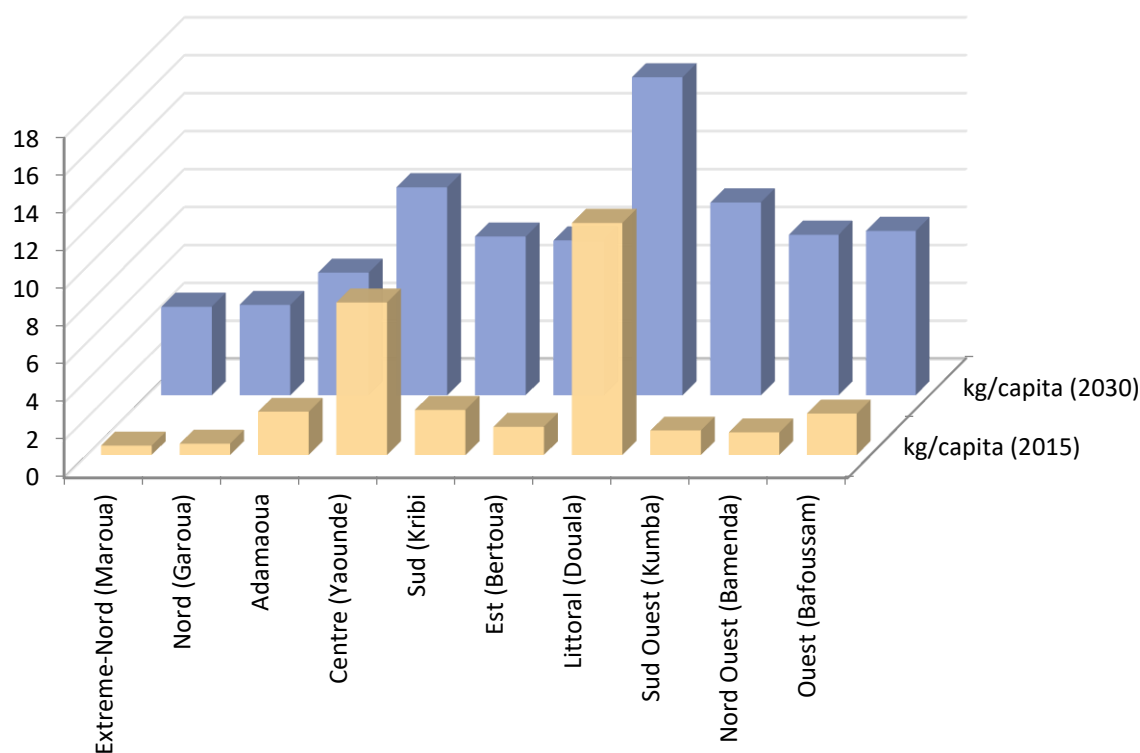
LPG annual volume growth was annualized in three stages, the first from 2019-2020 (as the first new infrastructure is deployed), then 2021-2025 to the inflection point in the demand projections, as market saturation starts to take effect, and finally 2026-2030. A linear interpolation was used for purpose of ramping up the investments. (This is different from the recommended staging of the financing for the infrastructure to serve the volume, which is based on linkages among relevant projects, construction lead times, and other factors.)

The penetration rate and consumption level per region were determined by applying the region-by-region growth projections for each from the Master Plan to the 2018 starting values. The consumption rate ramps, as in the upper bound demand scenario, to 20.3 kg per capita per user, to give the projected LPG volume per region over time.

The projected usage and volume data are summarized in Table 25 on page 122.

The following figure shows the consumption per capita per region that the investments in supply chain capacity will track, as a proxy for penetration of each region (and a rough proxy for regional volume):

Figure 34. Projection of consumption by region to 2030 for investment sizing



Note: Linearity of the projected consumption, done for investment purposes, (i) anticipates projected demand growth per the demand studies, ensuring adequate supply is in place adequately in advance of demand to be served, and (ii) serves to minimize the potential for volatility in the requirement to absorb and deploy capital by the supply chain for expansion.

Analysis of LPG supply infrastructure turns

LPG production capacity

It is assumed that Sonara cannot arbitrarily increase domestic LPG production, because that production is a by-product of its oil refining chemistry. Therefore, all growth in production is assumed to occur through importation, and Sonara's share of the LPG supply will fall from 20% today to around 7% by 2030.

The filling and storage capacity described in this Part have regional annual turns of between 14 (Far North) and 35 (Douala), with a capacity-weighted average of 25, which is consistent with having two weeks' LPG surplus in the system at any given time. The turn ratios necessarily fluctuate moderately year by year, as a given facility serves consumption that grows steadily in-between capacity upgrades. With the exception of Douala, the turns are substantially lower in 2030 than they were in 2015, at which time shortages were frequent. Douala is projected to have a 1.5 week buffer capacity on average (noting that its expansion is sized to have a further 20% buffer to deal with peak demand periods). However, as seen in the figure above, Douala's LPG service growth will be modest on a percentage basis compared to the growth in the rest of the country. Douala is the least shortage-prone facility, being the hub of the SCDP storage network.

If the overall storage ratio were to be optimized to 36 from 25, the storage capacity could accommodate a total supply volume of more than 500,000 MT/year.

Projected filling capacity and number of bottling plants

The filling capacity requirement is defined by the peak consumption in a year, increased by a safety factor. The peak of consumption is related to the seasonality.

The filling capacity has been calculated conservatively at 120% of the annual consumption target.

The following table shows the theoretical need of bottling in the different regions.

Table 33. Theoretical maximum bottling capacity required to 2030 (MT)

Region	2018a	2020e	2022e	2024e	2026e	2028e	2030e
Extreme-Nord (Maroua)	2.6	8.5	11.7	15.4	19.3	23.5	28.0
Nord (Garoua)	1.8	5.2	7.1	9.3	11.6	14.1	16.8
Adamaoua	3.3	7.9	8.6	9.3	10.0	10.6	11.1
Centre (Yaounde)	40.5	66.0	68.2	69.6	69.6	68.4	66.5
Sud (Kribi)	2.4	5.3	6.2	7.1	8.0	9.0	10.0
Est (Bertoua)	1.6	3.6	4.9	6.3	7.8	9.4	11.2
Littoral (Douala)	49.8	83.5	86.0	87.4	87.2	85.3	82.5
Sud Ouest (Kumba)	2.6	7.7	10.4	13.4	16.8	20.3	24.1
Nord Ouest (Bamenda)	3.0	7.4	10.5	14.0	17.8	21.8	26.2
Ouest (Bafoussam)	5.5	10.9	13.6	16.6	19.8	23.1	26.6
Total	113	206	227	248	268	285	303

Bulk transportation

In the LPG supply chain, the *mass primary transport*, filling, and cylinder primary transport must satisfy an economic transportation optimization.

The positioning of the filling plant must be as close as possible to the sales area, as large as possible to minimize bottling costs, yet cannot be in an urban area due to safety concerns.

The mass primary transport must be favored over the cylinder primary transport, because the former transports only the product while the latter transports the product and the weight of the cylinder steel (the weight of the steel of the cylinder is approximately equal to the weight of the LPG it contains when full).

Definition of terms used in the adjacent paragraphs:

- **Mass primary transport:** semi-trailer transport of the liquid product
- **Cylinder primary transport:** transport of large quantities of bottles (8-900 bottles) from the filling center to the warehouse.

As a general rule, it is more economical and professional to have filling capacity above 20 KT/year, to minimize the per-unit bottling cost and ensure a higher safety level and refilling quality.

When the consumption of a region is less than 20K T/year, it was assumed to have a cylinder depot supplied by the filling plant of a neighboring region, as shown in the table above. This rule must be weighed against the cost of cylinder secondary transport. For example, it the East and South regions could be served from Yaounde (Central region) during the first several years, and it may be optimal for those two regions to share a common filling and storage facility for the long term.

It is recommended that the rollout of filling plants (new and expanded), as much as possible, be based on economic criteria, rather than on administrative sequencing. This will ensure that the highest probability new LPG users, in the most numbers, with the strongest underlying business fundamentals for industry, are served first.

Projection of storage capacity of filling plants

The LPG storage capacity of a filling plant is calculated to address the risks of supply disruptions during the primary bulk transportation of LPG to the plant. The primary transportation can be by bulk road tankers (BRT), pipeline or train. The time necessary for a truck, for example, to transport LPG to the filling plant without difficulties corresponds with the distance of the plant from the depot where the truck loads the LPG, taking into account the queueing of the truck, the change of driver, any labor working hours constraints, the break time for the driver, traffic speed, the quality of the road, etc.

If the plant is located within 50km distance, one or two daily round trips can easily be managed, and the storage capacity can be reduced accordingly, because the risk of trucks being delayed is very low. The proximity of the plant with a terminal does not require excess storage capacity (which is expensive). The factor used to summarize this is the “tank rotation rate per year”; that is, how many times the storage facility is refilled in a year.

The following tank rotation rates are recommended to calculate the size of the storage capacity:

- “24” (i.e. 24 fillings in a year, or a filling every two weeks) for a very distant plant in order to have more storage capacity, reduce any risk of supply disruption and avoid any scarcity situation due to the long transportation time;
- “36” for plants less than one day’s transport from the source of the product, and
- “52” for any plant located near the import terminals and/or refineries where the product is located.

The following tank rotation rates were calculated with respect to the final storage capacity of each region’s filling plants in 2030:

Table 34. Estimated tank rotation rates for each region in 2030

Region	Rotation Rate
Extreme-Nord (Maroua)	14
Nord (Garoua)	15
Adamaoua	16
Centre (Yaounde)	17
Sud (Kribi)	Special*
Est (Bertoua)	19
Littoral (Douala)	35
Sud Ouest (Kumba)	16
Nord Ouest (Bamenda)	19
Ouest (Bafoussam)	16

* Note: Kribi import terminal storage would also serve the Kribi regional filling plant. Because the terminal would have national-scale storage, the rotation rate on that storage relative to the regional filling volume of the associate plant is not a useful calculation, being dominated by the national-scale storage.

The foregoing schedule of rotation rates takes the following into account:

- It will not be possible to change the storage capacity every year or two;
- The size of tanks—especially spherical tanks—are more or less standardized, the typical sizes being 250 MT, 500 MT, 1000 MT, and 2000 MT.
- For bullet tanks, there is no standard size, but the overall diameter is more or less standardized: 2.5m, 3m, and 3.5m. These diameters are imposed by transport convenience. The ratio length of a bullet/diameter is more or less observed; around 10. For economic reasons, it is useful to multiply the number of bullets. Four bullets of 50 T are far cheaper than one of 200 T.
- Financially, a spherical tank is cheaper than a multiple bullet of the same size. A 250 MT spherical tank is less costly than 300 MT of bullets. For operational reasons, the 10-year inspection of a sphere requires a stoppage for more than one month; thus, it is wise not to have only one sphere or bullet.

Figure 35. Examples of spherical and bullet LPG storage



The following table summarizes the recommended rules for tank sizing and type:

Table 35. Mapping of storage capacity to tank type and size

Desired storage	Bullet type	Spherical type
300 T	6x50 T	
400 T	8x50 T	
500 T	10x50 T	1x 500 T
1000 T		1x 1 000 MT
1500 T		1x 1000 MT+ 1x500 MT
2000 T		2x 1000 MT

Strategic reserve storage capacity

The consumption of LPG for cooking in 2030 in line with the national policy goal will be approximately 303 KT per year, or 25 KT per month. Existing LPG storage capacity (3.7 KT MT) plus new storage at filling plants of about 16 KT, for a total of about 19.7 KT, will store approximately 24 days' consumption of LPG at the 2030 volume.

Any storage capacity above 30 days will result in an unneeded increase in the asset intensity of the supply chain, and would therefore result in an increase of the cost for the supply chain and/or an increase in the price to the end-user. In the event additional temporary storage capacity is needed, such as for transitions, a floating storage can easily be added on a temporary basis.

Primary transport capacity

There are about 20 Bulk Road Tankers (BRTs) in Cameroon owned or under contract to SCDP. A further 54 are projected to be needed through 2030 to serve the expanded network of filling facilities, based on one BRT of 24 MT average capacity transporting 4,100 MT per year, with 3-4 trips per week.

Number of cylinders

The projected number of cylinders required year by year is presented in Table 26 on page 123, starting from the number of existing cylinders (net of cylinders to be scrapped) in 2017.

The usual methodology used in the LPG industry is based on the average cylinder rotation rate (the average annual number of refills per cylinder), which include all the cylinders in the country. It directly affects the financial return on the cylinder investment. The rotation rate is applied to one size-equivalent: for Cameroon, this is 12.5kg (the dominant size). It is necessary to convert all the other sizes to 12.5kg equivalent for purposes of the calculation.

To be conservative in the modelling, very modest growth in the rotation rate was permitted year over year in each region, even though the rotation rate usually increases significantly with major additions of cylinders into a market. It is likely that the rotation rate will improve significantly in Cameroon due to the proposed, massive investment in new cylinders, by making the distribution process more productive and allowing the distributors' truck drivers to be more efficient in collecting empty cylinders. If the rotation rate were to improve from 2.9 to 3.6, the number of cylinders required for investment would be reduced by about 3 million.

Calculation of the annual quantities of cylinders to be acquired

The total number of additional cylinders (about 4.6 million of 12.5kge) to be invested should be seen as a flow of annual investments rather than a one-time investment. In the present case, the annual flow of investment is about 500,000 cylinders per year during the peak of the first investment phase (2020-2022), then declining to under 200,000 per year in the final phase (2026-2030).

Table 36. Projected 12.5kge cylinder quantities required to 2030
(000; in two-year increments)

	2019-20	2021-22	2023-24	2025-26	2027-28	2029-30
New 12.5 kge cylinders	890	1,029	991	672	346	361

The total number of 12.5kge to be invested will be 4.3 million.

The investment calculation has been made on the basis of the following assumptions for the procurement of new cylinders:

- Import parity (CIF), import taxes and import audit service are not included;
- The specifications of the cylinder are basic-level ones, and could be improved;
- The valve (e.g., clip-on) is included and mounted;
- A preliminary procurement process by GLPGP obtained a best commercial cylinder quote price at the required specification of € 28 per cylinder, when aggregating the total quantities for the entire market by year.

The total investment for all the cylinders to 2030 is therefore € 120.1 million.

Investment in cylinders is an annual process, adjusted according to market trends. This investment plan can self-adjust the pace of the investment, based on actual consumption and the actual level of increase of the rotation rate, either for proper balancing of assets with consumption, or to improve the return on investment through improved asset utilization with scale. The pace of investment may be accelerated if consumption is greater than forecast, up to the sustainable growth rate of the firm, and decelerated if the market starts to saturate (that is, the demand for new cylinders stabilizes with respect to demographic trends).

An important driver and metric is the cylinder rotation rate in a given area, which increases as the distribution network becomes more efficient and productive, ensuring no cylinders remain idle, no scarcity or problems of refill supply, and no (or minimal) illegal cross-filling or diversion of cylinders by competitors. (Diversion of cylinders will be much less likely to occur upon phase-out of the multibrand Wholesaler distribution model.) When the rotation rate eventually stabilizes or declines in an area absent any other major factors, it indicates saturation of the market area at its then-current level of consumption.

Assumptions regarding the number of cylinders in the working stock

The cylinder counts include working stock. To insure a fluid and efficient cylinder filling process and good availability of cylinders in the distribution network for the end-user, the theoretical cylinder working stock in terms of maximum daily consumption, taking seasonality into account, is as follows:

- Pallets:
 - In the filling plant: 1.5
 - On the trucks (cylinder primary transport): 1
 - In the warehouse or cylinder regional depot: 2
 - On the trucks (secondary transport): 1
- Cages:
 - In the distribution network: 4

Overall, the working stock represents 9.5 days of consumption.

These figures assume that the equipment (filling plant and trucks) are optimally used.

If not, a minimum stock is required (for example, an 800-cylinder truck will need a stock minimum of 800 cylinders).

16. Investments at the Firm Level

This Chapter examines the economics of the sector-level investments at the firm level.

SCDP, a state-controlled enterprise, would lead on carrying out necessary filling, storage and terminal investments (potentially with foreign partners) as detailed in the preceding Chapter. Importantly, SCDP would not be in position to make the most critical investment of all: in new, branded cylinders that the Marketers would deploy to consumers.

Therefore, the relevant supply chain node for this Chapter's analysis is the LPG Marketer.

Details on the scale, scope, geography, and phases of corresponding SCDP bottling plant investments are set forth in the *Cameroon LPG Investment and Implementation* report.

It should be noted that some Marketers in Cameroon, for purposes of operational control or geographic coverage, choose to perform some or all of their cylinder filling in-house. The financial effect on the LPG Marketer of insourcing vs. outsourcing of its bottling activities is presented later in the Chapter.

Methodology

In the ideal case, multiple firms would volunteer financial information and business plans showing how they would grow their businesses, and this body of information would then drive a bottom-up investment scenario. In Cameroon, while firms disclosed volume projections to 2030 on a confidential basis, obtaining detailed financial projections firm by firm was not possible, because (i) businesses were, in general, unwilling to share proprietary internal business information, except to a recognized financing source interested to discuss a transaction; (ii) businesses were also, in general, concerned about violating applicable competition law by disclosing internal financial or operating data that could eventually be viewed by the public; (iii) for entrepreneurial firms in marketing, retailing and distribution, standardized financial statements often did not exist; and (iv) for oil and gas companies, LPG financial data typically were aggregated with data about non-LPG operations, and not practical to extract.

In the absence of volunteered financial and business planning information from a critical mass of individual firms, the alternative was chosen to construct a pro-forma model of firms and investments at the key supply chain node.

This choice involved making certain assumptions about unit margins, potential costs of capital (i.e., financial return requirements), and key operating parameters affecting the cash flow generation potential and growth rate capacity of a typical firm. Details behind the key assumptions are described in Chapter 10 (Pricing) beginning on page 58 and Chapter 19 (Investment Plan Overview) beginning on page 175.

Where possible, the pro forma case has been benchmarked against information provided under conditions of confidentiality, or through public non-binding disclosures and announcements, by representative firms. The pro forma cases are in line with such benchmarks.

These additional firm categories were not modelled, for the following reasons:

- *SCDP facilities.* As a quasi-public entity, SCDP is expected to carry out necessary expansion of facilities utilizing funding sources accessible to the state. The Cameroon LPG Investment and

Implementation report lays out the SCDP investments required to keep pace with the expansion of national LPG consumption and the national cylinder park. (To the extent that assistance in obtaining external financing is desired by SCDP in future, an appropriate analysis and modelling of the transaction and an arranging of funding sources may be performed then.)

- *Bulk Road Vehicles and cylinder trucks.* Vehicles are easily obtainable, together with financing, by the oil and gas companies for their multiproduct fleets, or by specialty trucking firms, using their existing balance sheets and cashflow capacity. Truck service to carry cylinders is not growth-constrained, and access to vehicle financing is not a barrier to capacity growth.
- *Production and importation.* No expansion of domestic production from Sonara is assumed, and new LPG import terminal capacity at Kribi is part of a separate, government-initiated project for overall petroleum product importation facilities⁵¹.
- *Retail (cylinder exchange) points.* The anticipated main source of new retailing facilities is existing shops already offering non-LPG products to the public. To the extent outside financing of cylinder inventory is required at this level, it would be accomplished through small-scale entrepreneurial lending from domestic lending sources, with creditworthiness determined by those lenders, and/or through credit that OMCs/LPGMCs choose to extend. The lack of standardized financial and accounting reports at this level of the supply chain, together with the challenge of diligencing thousands of individual retail-point owners, does not make large-scale financing feasible.

As noted in Part XII (Recommendations for Further Technical Assistance and Research), it could be a subject of useful future study to examine these additional nodes in more detail.

The following examination of prospective firm-level economics is based on a representative model of a marketer with a 10% market share, investing in cylinders at the rate necessary to match the growth of the LPG sector as presented earlier in this Part of this report.

Despite the restrictions and limitations affecting the gathering and evaluation of firm-level data, partial information was obtained on a confidential, voluntary basis and was used for benchmarking the pro-forma model. These data were in line with the models.

The model excludes the use of an LPG volume-based capital recovery levy fund to support the cylinder investment. If implemented in Cameroon, this levy would shift a notional 40% of the capital cost of all new cylinders to this fund. The fund would pay for the shifted 40% through an increase of € 0.037 per kg of LPG in the national pricing formula over twelve years, expiring in 2030. Use of an LPG capital recovery levy is currently being studied by relevant ministries of the Government. This approach is discussed in detail in Chapter 19 (Investment Plan Overview) beginning on page 175.

The model includes a sensitivity analysis to revenue per tonne and to the percentage of equity vs. debt utilized for the required investment in new assets.

⁵¹ Floating facilities for LPG storage are projected to be adequate to handle expansion of LPG imports during the first two of the three SCDP expansion phases to 2030 as set forth in the *Cameroon LPG Investment and Implementation* report. These facilities would handle expansion of LPG imports during the period the new LPG terminal project is completed. The LPG terminal project would be necessary to complete in time for the third SCDP expansion phase.

The Marketer is assumed to outsource its bottling to SCDP, the national filling utility, which can perform this function at a lower average cost and without the Marketer having to invest in bottling plants. A sensitivity scenario is also presented for a variant of the Marketer where the bottling function is performed in house, up to 100%. These two cases, 100% outsourced and 100% in-house bottling, define the extreme ends of the Marketer investment scenarios. (In practice, Cameroon's LPG Marketers often use a hybrid approach for reasons including greater control over their cylinders, geographic coverage, opportunities for transport optimization, and other economic and strategic reasons).

Finally, the pro-forma capital structure and costs of capital (debt and equity) used for modelling capitalization and financial returns are based on the outcomes of detailed discussions with the major Cameroon banks and other financial sector institutions, and with DFIs that are active in other sectors in Cameroon, regarding relevant transaction benchmarks and applicable lending and investment policies and limitations.

LPG Marketer financial model

This pro-forma LPG Marketer is modelled on the basis of a 10% market share by volume, including investment in 10% of the national cylinder requirement in each year. It is thus a composite (at 1/10th scale) of the LPG marketers active in Cameroon (considering only their LPG lines of businesses), whose 2018 market shares range from 1% to 27%, with an average share of 8.3%.

For purposes of this analysis, the existing price build-up formula Revenue is made from the permitted unit margin under the national price formula for filling of cylinders. In this case, the unit margin under both the existing and recommended new price build-up formulas is € 210.5 per tonne⁵².

The baseline modelling is performed for a Marketer which opts to outsource its filling function to SCDP. This is financially desirable for a Marketer to do wherever practical, because SCDP provides a low filling cost per tonne, as well as a lower capital expenditure per tonne of capacity, due to its economies of scale. Nonetheless, some Marketers choose to bottle in-house, or to split their bottling between their own facilities and SCDP, in order to maintain higher control over their cylinder assets and the filling and safety operations, or to enter a geographic service area that is outside of the practical SCDP footprint⁵³.

Assumptions

The following are the main financial and operating assumptions:

Item	Value
Market share of the firm	10%
Cost of cylinder (12.5kge)	28 €
Cylinder deposit (as % of cost) ⁵⁴	80%

⁵² Under the existing formula, this is an exact amount. Under the new formula, it is broken out into the following components: stock-loss recovery (€ 5.2), cylinder depreciation (€19.8), cylinder maintenance (€35.4), marketer margin (€ 110.1), and an increase to the distributor/ retailer margin to cover formally the distribution cost (a net increase of approximately €40).

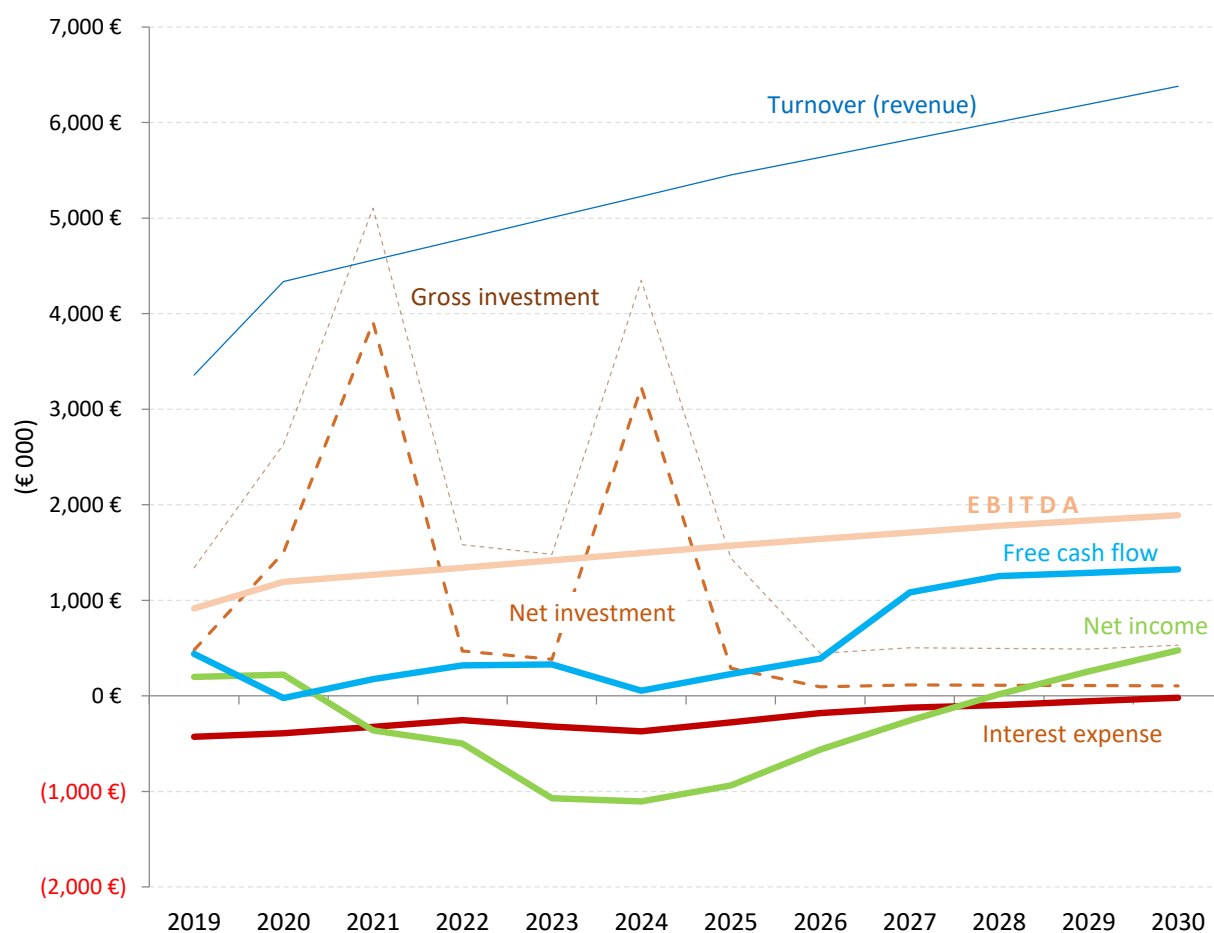
⁵³ An industry rule of thumb is that a given filling plant can serve an area within a roughly 100 km radius with workable economics. This radius can be significantly larger or smaller based on the efficiency of the cylinder transportation, which is largely a function of the quality and capacity of the road networks radiating outward from the plant.

⁵⁴ The cylinder deposit, paid by the end-consumer, is capped by law at 80% of the cost of the cylinder to the Marketer.

Net cylinder cost to marketer	20%
Margin per tonne (includes cylinder-related margin)	210.5 €/t
Annual rate of margin increase	0%
Cost of outsourced filling to SCDP	€ 24.6/t
Share of filling handled by SCDP	100%
Company income tax rate	20%
Tranches of capital increase (loans and equity)	3
Blended cost of debt	8.93%
Loan tenors	3-7 years
Minimum required rate of return to equity	20%
Capitalization:	
Non-concessional debt (at 10%)	35%
Concessional debt (at 8%)	40%
Equity	25%

These parameters result in the following financial characteristics and performance of the firm over time:

Figure 36. Marketer with cylinder investment and SCDP outsourcing: financial performance



The selected metrics are as follows:

Gross investment	Value at purchase/construction of invested assets
Net investment⁵⁵	Gross investment less cylinder deposits received via the distribution network
Turnover (revenue)	Tonnage x margin/tonne
EBITDA	Turnover less operating costs
Net income	EBITDA less depreciation ⁵⁶ , interest expense and taxes
Free cash flow	Net income adjusted for non-cash charges

The following table sets forth the financial performance data of the firm over the projection period.

⁵⁵ The effect of the proposed capital recovery levy to offset the cylinder acquisition costs borne by the firm would reduce the net investment amount by an additional 40%. The effect of the proposed levy has not been included in this analysis.

⁵⁶ Note: The model assumes that the gross investment amount is useable for purposes of determining depreciation. Such treatment would be subject to the approval of the actual firm's accounting and tax advisors and the relevant tax authorities.

Table 37. LPG Marketer with cylinder investment and SCDP outsourcing: pro-forma financial data
(values in 000s except as noted)

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	TOTALS
Cylinders Acquired and Deployed	38	50	53	50	49	50	51	16	17	17	17	19	429
Price of Cylinder	28	28	28	28	28	28	28	28	28	28	28	28	
Gross Capital Cost of Cylinders	1,077 €	1,413 €	1,490 €	1,391 €	1,374 €	1,401 €	1,441 €	440 €	485 €	482 €	479 €	531 €	12,005 €
Cylinder Deposits Received	861 €	1,130 €	1,192 €	1,113 €	1,099 €	1,121 €	1,153 €	352 €	388 €	386 €	384 €	425 €	9,604 €
Net Cylinder Cost	215 €	283 €	298 €	278 €	275 €	280 €	288 €	88 €	97 €	96 €	96 €	106 €	2,401 €
Tonnage	16 t	21 t	22 t	23 t	24 t	25 t	26 t	27 t	28 t	29 t	29 t	30 t	298 t
Marketer Margin/Tonne	210.5 €	210.5 €	210.5 €	210.5 €	210.5 €	210.5 €	210.5 €	210.5 €	210.5 €	210.5 €	210.5 €	210.5 €	2,526 €
Total Marketer Margin	3,357 €	4,336 €	4,559 €	4,783 €	5,006 €	5,229 €	5,452 €	5,637 €	5,822 €	6,008 €	6,193 €	6,378 €	62,761 €
TUNROVER (REVENUES)	3,357 €	4,336 €	4,559 €	4,783 €	5,006 €	5,229 €	5,452 €	5,637 €	5,822 €	6,008 €	6,193 €	6,378 €	62,761 €
% Filling by SCDP	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
SCDP Filling Fee	392 €	507 €	533 €	559 €	585 €	611 €	637 €	659 €	680 €	702 €	724 €	745 €	
Bulk Transport Costs	526 €	680 €	715 €	750 €	785 €	820 €	855 €	884 €	913 €	942 €	971 €	1,000 €	
Distribution Costs	640 €	826 €	869 €	911 €	954 €	996 €	1,039 €	1,074 €	1,109 €	1,144 €	1,180 €	1,215 €	
General OPEX	718 €	916 €	951 €	985 €	1,017 €	1,049 €	1,079 €	1,101 €	1,122 €	1,142 €	1,177 €	1,212 €	
Total OPEX	2,554 €	3,293 €	3,456 €	3,618 €	3,780 €	3,769 €	3,922 €	4,046 €	4,171 €	4,294 €	4,427 €	4,559 €	52,151 €
EBITDA	517 €	679 €	726 €	774 €	823 €	874 €	925 €	972 €	1,019 €	1,067 €	1,100 €	1,133 €	10,610 €
Less Depreciation	(215 €)	(498 €)	(796 €)	(1,074 €)	(1,349 €)	(1,409 €)	(1,414 €)	(1,204 €)	(1,023 €)	(845 €)	(666 €)	(484 €)	(10,976 €)
OPERATING INCOME (EBIT)	301 €	181 €	(70 €)	(300 €)	(526 €)	(535 €)	(489 €)	(232 €)	(4 €)	223 €	435 €	650 €	(366 €)
Interest Expense	72 €	63 €	45 €	27 €	40 €	55 €	39 €	23 €	21 €	22 €	13 €	4 €	425 €
OPERATING PROFIT BEFORE TAXES	229 €	118 €	(115 €)	(327 €)	(566 €)	(589 €)	(528 €)	(256 €)	(25 €)	201 €	421 €	645 €	(791 €)
Income Tax	(46 €)	(24 €)	0 €	0 €	0 €	0 €	0 €	0 €	0 €	(40 €)	(84 €)	(129 €)	(323 €)
Tax Holiday	no	no	no	no	no	no	no	no	no	no	no	no	
NET INCOME (NI)	184 €	94 €	(115 €)	(327 €)	(566 €)	(589 €)	(528 €)	(256 €)	(25 €)	161 €	337 €	516 €	(1,114 €)

Capital infusions are structured into three tranches, as follows:

<i>(in 000s)</i>	Tranche 1	Tranche 2	Tranche 3
Cylinders	2019	2023	2027
Debt	376 €	326 €	138 €
Concessional Debt	430 €	373 €	158 €
<i>Debt amortization in years</i>	<i>2-5</i>	<i>6-9</i>	<i>10-12</i>
Equity	269 €	233 €	99 €
Total	1,074 €	931 €	396 €

Note: Because it is possible that all the steps set forth in this report (dated December 2018) to be taken in 2019 and the immediate following years may not be accomplished on such a timely basis, and that this might jeopardize the achievement of the projected LPG penetration rate and usage volumes for household cooking by 2030, it would be worthwhile for the reader to consider the 2019-2030 target years of activity to be Years 1-12.

The following table shows debt service, EBITDA coverage of debt service, and free cash flows, and calculations of notional terminal value in 2030 and the corresponding IRR for equity:

Table 38. LPG Marketer with cylinder investment: debt coverage, FCF, and equity IRR

Total Debt Service

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	TOTALS
Total Principal	806 €	0 €	0 €	0 €	698 €	0 €	0 €	0 €	297 €	0 €	0 €	0 €	1,801 €
Total Interest	72 €	63 €	45 €	27 €	40 €	55 €	39 €	23 €	21 €	22 €	13 €	4 €	425 €
Total Debt Service	878 €	63 €	45 €	27 €	739 €	55 €	39 €	23 €	318 €	22 €	13 €	4 €	2,226 €
EBITDA	517 €	679 €	726 €	774 €	823 €	874 €	925 €	972 €	1,019 €	1,067 €	1,100 €	1,133 €	10,610 €
EBITDA Coverage of Debt Service	0.59x	10.78x	16.1x	28.7x	1.1x	16.0x	23.7x	41.5x	3.2x	48.0x	82.5x	255.4x	
EBITDA After Debt Service	(361 €)	616 €	681 €	747 €	85 €	819 €	886 €	948 €	701 €	1,045 €	1,087 €	1,129 €	8,384 €
Taxes	(46 €)	(24 €)	0 €	0 €	0 €	0 €	0 €	0 €	0 €	(40 €)	(84 €)	(129 €)	(323 €)
Cashflow After Debt Service & Taxes	(407 €)	592 €	681 €	747 €	85 €	819 €	886 €	948 €	701 €	1,005 €	1,003 €	1,000 €	8,061 €
Exit Multiple	5.0x												
Terminal Value FCF												5,666 €	5,666 €
Total Cash Flow	(402 €)	592 €	681 €	747 €	85 €	819 €	886 €	948 €	701 €	1,005 €	1,003 €	6,666 €	13,732 €

Calculation of Operating Cash Flow

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	TOTALS
Net Income	184 €	94 €	(115 €)	(327 €)	(566 €)	(589 €)	(528 €)	(256 €)	(25 €)	161 €	337 €	516 €	(1,114 €)
+ Depreciation & Amort	215 €	498 €	796 €	1,074 €	1,349 €	1,409 €	1,414 €	1,204 €	1,023 €	845 €	666 €	484 €	10,976 €
+ Non Cash Charges	0 €	0 €	0 €	0 €	0 €	0 €	0 €	0 €	0 €	0 €	0 €	0 €	0 €
Free Cash Flow From Operations	399 €	592 €	681 €	747 €	783 €	819 €	886 €	948 €	998 €	1,005 €	1,003 €	1,000 €	9,862 €
- Principal Debt Repayments		201 €	201 €	201 €	201 €	175 €	175 €	175 €	175 €	99 €	99 €	99 €	1,801 €
Cash Flow After Debt Payments (FCF)	399 €	391 €	479 €	546 €	582 €	645 €	712 €	774 €	823 €	906 €	904 €	901 €	8,061 €
										Tax Adjusted EBITDA		907 €	
										Terminal Multiple		5.0x	
										Terminal Value		4,533 €	
- Equity Fundings	269 €				233 €					99 €			600 €
Net FCF to Equity (Net of Investment)	130 €	391 €	479 €	546 €	349 €	645 €	712 €	774 €	823 €	807 €	904 €	5,434 €	11,994 €
Total Equity Fundings	(600 €)												(1,736 €)
IRR to all Equity Classes	60%												

The equity IRR, based on the notional capital stack, is a very healthy 60%, including a terminal value of approximately € 4.5 million in 2030.

There is adequate capacity to withstand future changes to the unit margins, whether to contribute to cylinder discounting levy, to adapt to some future rationalization of the national price structure, or for any other reason, as shown in in Table 39:

Table 39. LPG Marketer with cylinder investment: IRR sensitivity

IRR to all Equity Capital	
	60%
Revenue/t	17%
190.00 €/t	38%
210.50 €/t	60%
220.00 €/t	79%
230.00 €/t	100%

IRR to all Equity Capital		Equity as % of Capitalization		
Revenue/t	60%	20%	25%	50%
190.00 €/t	19%	17%	11%	
200.00 €/t	42%	38%	26%	
210.50 €/t	66%	60%	40%	
220.00 €/t	89%	79%	53%	
230.00 €/t	19%	17%	11%	

Impact of cylinder-discounting levy on LPG Marketer IRR

Further sensitivity analysis indicates that, if the capital structure is kept the same, and the margin to the Marketer is reduced by € 37/tonne as a mechanism for entirely funding a cylinder discounting scheme that further reduces the up-front capital cost of cylinders by 40%, the IRR to equity becomes negative and EBITDA is not adequate to cover debt service. Therefore, the cylinder-discounting levy, if implemented, would need to be funded through an increase in the national pricing structure, as outlined in Chapter 10 (Pricing) beginning on page 58.

LPG Marketer with investment in in-house bottling capability

As an alternative to utilizing the bottling capability of SCDP on an outsourced basis, a Marketer may opt to perform bottling in-house, by investing in its own filling plant facilities. The foregoing models, adjusted for this, reflect the following assumptions:

Item	Value
Market share of the firm	10%
Cost of cylinder (12.5kge)	28 €
Cylinder deposit (as % of cost)	80%
Net cylinder cost to marketer	20%
Margin per tonne (includes cylinder-related margin)	210.5 €/t

Annual rate of margin increase	0%
Share of filling handled by SCDP	0%
Cost of bottling operations per tonne	35 €
Company income tax rate	20%
Tranches of capital increase (loans and equity)	3
Blended cost of debt	8.93%
Loan tenors	3-7 years
Minimum required rate of return to equity	20%
Capitalization:	
Non-concessional debt (at 10%)	35%
Concessional debt (at 8%)	40%
Equity	25%

Capital infusions are structured into three tranches, as before. The first two tranches are concurrent for cylinders and plant expansion. The third tranche is for cylinders only:

<i>(in 000s)</i>	Tranche 1	Tranche 2	Tranche 3
Cylinders	2019	2023	2027
Debt	376 €	326 €	138 €
Concessional Debt	430 €	373 €	158 €
<i>Debt amortization in years</i>	2-5	6-9	10-12
Equity	269 €	233 €	99 €
Total	1,074 €	931 €	396 €
Plant	2019	2023	
Debt	1,850 €	1,072 €	
Concessional Debt	2,115 €	1,225 €	
<i>Debt amortization in years</i>	2-8	6-12	
Equity	1,322 €	766 €	
Total	5,278 €	3,064 €	

While EBITDA is adequate to cover debt service, the resulting returns to equity are no longer adequate to incentivize non-concessional sources of equity or quasi-equity capital, with the IRR to equity at just 12%. This is shown, adjusted for various margin levels and degrees of financial leverage, in Table 40:

Table 40. LPG Marketer with cylinder investment and in-house bottling: IRR sensitivity

IRR to all Equity Capital	
	12%
Revenue/t	1%
190.00 €/t	7%
210.50 €/t	12%
220.00 €/t	16%
230.00 €/t	20%

		IRR to all Equity Capital			
		Equity as % of Capitalization			
		12%	20%	25%	50%
Revenue/t	190.00 €/t		2%	1%	-3%
	200.00 €/t		8%	7%	2%
	210.50 €/t		14%	12%	6%
	220.00 €/t		18%	16%	9%
	230.00 €/t		23%	20%	12%

Nonetheless, some marketers do perform in-house filling, in whole or in part. That choice is made for strategic reasons: to maximize control over cylinder assets, to support a geographic strategy that extends outside the effective SCDP geographic coverage area, or to prepare for significant expansion which can deliver economies of scale in bottling, which are reflected in the SCDP bottling costs charged to Marketers (on a utility basis) but are not possible for a Marketer to match until its volumes become much larger⁵⁷. GlocalGaz, for example, performs its filling entirely in-house in Limbe, from which it serves the Southwest region on a local basis rather than using SCDP's Douala facility approximately 80 km distant. GlocalGaz also claims a marketing advantage from refilling cylinders more accurately: according to the company, its consumers report that its more rigorous and fair-to-the-consumer refilling standard means that their LPG cylinders last up to a week longer than rival brands, with the same level of cooking.

LPG Marketers with hybrid filling strategies

For comparison, a Marketer was modelled with 50% of its bottling done in-house, and 50% outsourced to SCDP. The Marketer thus invests only half as much in new bottling capacity to 2030 as the foregoing case. The resulting IRR to equity is 33%, with sensitivities as shown below:

Table 41. LPG Marketer with cylinder investment and hybrid bottling: IRR sensitivity

		IRR to all Equity Capital	
			33%
Revenue/t	190.00 €/t		18%
	200.00 €/t		26%
	210.50 €/t		33%
	220.00 €/t		39%
	230.00 €/t		45%

		IRR to all Equity Capital			
		Equity % of Capitalization			
		33%	20%	25%	50%
Revenue/t	190.00 €/t		21%	18%	11%
	200.00 €/t		29%	26%	16%
	210.50 €/t		37%	33%	21%
	220.00 €/t		44%	39%	25%
	230.00 €/t		52%	45%	29%

⁵⁷ A Marketer can also reduce average filling costs by cutting corners, and some in Cameroon do, as per a recent national filling plant audit. This is a further motivation for bottling to remain primarily the responsibility of a (well-run) national utility.

IX. Financing the Investments

17. Financial and Investment Environment

Cameroon has experienced stable economic growth over much of the past decade and has been steadily diversifying its economy, with services and agriculture representing 49% and 23% of GDP in 2017. Real GDP growth averaged 4.2% between 2002 and 2008, after which economic performance was negatively affected by the global economic and financial crisis, which led to disruptions in mining and energy investments and falling global demand and prices for many of the country's main exports (particularly in oil, timber and rubber). As a result, GDP growth decreased from 3.5% in 2008 to 2.2% in 2009. Economic activity picked up in 2010 and 2011 with GDP growth of 3.4% and 4.1%, respectively; between 2012-2018, GDP growth averaged 4.7%.

Cameroon's 2018 GDP is estimated at US \$39 billion, which is 42% of the 6 members of the Economic and Monetary Community of Central Africa (CEMAC). Cameroon's financial system is the largest in the CEMAC, accounting for about half of regional financial assets.

Political and economic outlook⁵⁸

- The most pressing threat to political stability is the context of renewed violence in Cameroon's restive Anglophone regions, as violent confrontations between the authorities and separatist groups continue.
- Security and humanitarian conditions in northern regions will probably deteriorate further in the medium term as attacks from Boko Haram, the Nigeria-based jihadi group, continue.
- Economic policy is expected to continue its focus on diversifying the economy away from oil. Government attempts to achieve further fiscal consolidation are expected, however, to be hindered in the near term by high security-related spending pressures.
- Real GDP growth will average 4.5% in to 2022, as natural gas production from a new liquefied natural gas (LNG) offshore terminal will partly offset a decline in oil production. Infrastructure projects, agriculture and services will also support growth.
- Despite occasional spikes related to poor weather or insecurity, and slightly higher global oil and food prices, inflationary pressure will remain contained, allowing inflation to fluctuate around an average of 1.4% a year to 2022.
- The current-account deficit is expected to widen gradually to 3.3% of GDP in 2020, on the back of higher import spending related to the 2019 Africa Cup of Nations and the development of the LNG sector, before gradually narrowing to 2.8% of GDP in 2022.

⁵⁸ Source: Economist Intelligence Unit (2018)

Economic growth⁵⁹

Real GDP growth is forecast to increase to 4.2% for 2018 from an estimated 3.7% in 2017, owing to the start of production at a new natural gas terminal at Kribi port (which is expected to produce 2.4m tonnes/year of liquefied natural gas—LNG—over the medium term). Strong performance of agribusiness and manufacturing industries will also support growth. Agricultural output should increase in the medium term as various development projects aimed at boosting productivity begin to show results. Nonetheless, structural issues—such as a lack of land rights and poor access to credit—mean that agriculture will be the slowest growing sector for much of the forecast period. The timber subsector will remain buoyant, helped by public efforts to stimulate local wood processing.

GDP growth is forecast to increase further to 4.6% in 2019 on the back of sustained investment in the LNG sector and for the 2019 Africa Cup of Nations football tournament, before declining to 4% in 2020, as lower global growth will have an impact on overall investment in the country. The economy will then expand gradually to 4.8% in 2022 as some large infrastructure projects (such as the Lom Pangar power station, and bridges and highways) become operational.

Despite the authorities' efforts to improve the business environment, progress is expected to be slow, and private-sector growth to be hindered, by tighter global financial conditions, a high level of state interference, an oversized administration and widespread corruption. Risks to this forecast are predominantly to the downside; delays in the public investment program could derail the growth trend, and adverse weather would cut agricultural production. In addition to the costs of Boko Haram's insurgency in the Far North, a continued spread of insecurity in the English-speaking Northwest and Southwest regions (which account for over half of the country's GDP) could affect the country's wider economic performance negatively.

Table 42. Cameroon key economic indicators 2017a-2022e

Indicator	2017a	2018e	2019e	2020e	2021e	2022e
Real GDP growth (%)	3.7	4.2	4.6	4.0	4.7	4.8
Consumer price inflation (avg.; %)	0.6	1.4	1.2	1.0	1.6	2.0
Government balance (% of GDP)	-4.0	-4.5	-3.8	-3.0	-2.9	-2.8
Current-account balance (US\$ mm)	957	1,072	1,289	1,522	1,44,	1,514
Current-account balance (% of GDP)	-2.6	-2.6	-3.0	-3.3	-2.9	-2.8
External debt (year-end; US\$ bn)	9.4	11.2	13.0	14.5	16.1	17.9
Money market rate (avg.; %)	3.0	3.5	3.5	3.5	3.5	3.5
Exchange rate CFA:Euro (fixed)	655.96	655.96	655.96	655.96	655.96	655.06
Exchange rate CFA:US\$ (avg.)	582.1	537.7	546.6	542.1	541.0	530.1
Growth rates (%)						
Private consumption	3.6	4.3	4.6	3.8	4.8	4.8
Government consumption	5.0	5.6	3.2	3.4	3.7	3.7
Gross fixed investment	5.2	5.0	5.4	5.0	5.5	5.5
Exports of goods & services	3.0	4.5	5.2	5.0	5.6	6.0
Imports of goods & services	5.0	6.4	5.0	4.8	6.0	6.0
Domestic demand	4.2	4.7	4.6	4.1	4.9	4.9
Agriculture	3.9	3.6	3.8	3.6	3.8	4.0
Industry	3.3	4.5	4.5	3.8	4.4	4.5

⁵⁹ Source: Economist Intelligence Unit (2018)

Indicator	2017a	2018e	2019e	2020e	2021e	2022e
Services	3.8	4.0	4.6	4.4	4.9	4.9

Fiscal policy; IMF role⁶⁰

An ongoing IMF policy and financial package agreed in mid-2017 will continue to focus on supporting fiscal reforms, enhancing public financial and debt management, and improving the resilience of the financial sector. The IMF completed its first review of Cameroon's US\$ 666 million three-year extended credit facility at end-2017, and praised the authorities' commitment to fiscal consolidation, which contributed to improving the country's fiscal and external position in 2017. However, in the near term, policy achievements are likely to fall short of the IMF's ambitions as growing sociopolitical pressure in the Anglophone regions, as well as security and humanitarian concerns in the Far North, weigh on the government's finances while also discouraging private investors. The diversification of the formal economy is likely to be hindered by a challenging business environment and the existence of a large informal economy. The increase of non-concessional external debt beyond the IMF program targets also remains a concern. However, the IMF is expected to remain engaged even if the reforms are slow-moving and fall short of the program's targets, given the security and political challenges that the country is facing, as well as Cameroon's role in leading regional efforts to preserve the integrity of the Communauté économique et monétaire de l'Afrique centrale (CEMAC) monetary union.

Inflation⁶¹

Inflation is expected to remain in check through 2022, in part owing to Cameroon's membership of the CFA Franc Zone, which helps to anchor prices, and a fairly tight monetary policy, which will dampen demand-side inflationary pressures. Inflation is expected to remain under the 3% CEMAC convergence criteria over the forecast period. Global commodity prices will increase slightly, but the government will maintain its policy of heavily regulating consumer prices, which will help to keep inflation down. Average inflation is forecasted to increase to 1.4% in 2018, from 0.6% in 2017, in line with rising food prices, before retreating gradually to 1% in 2020 as global commodity prices dip. Inflation is then expected to edge up to 1.8% on average in 2021-22 as both domestic demand and global fuel prices (to the extent passed on to consumers and business) pick up.

Exchange rates⁶²

The CFA franc is pegged to the Euro at CFA 655.96 : € 1 and therefore fluctuates in line with Euro : dollar movements. The Euro is forecast to depreciate slightly in 2019, as monetary tightening in the US reaches its peak, before a cyclical economic downturn in the US weakens the dollar in 2020. Moves by the ECB to unwind its accommodative monetary policy, coupled with steady growth in the Euro region and structural support from the current-account surplus, will drive an appreciation of the Euro against the dollar in 2021-22. Tracking these dynamics, the CFA franc is forecast to hit CFA 546.6 : US\$ 1 in 2019 and then strengthen

⁶⁰ Source: Economist Intelligence Unit (2018)

⁶¹ Ibid.

⁶² Ibid.

to 530.1 in 2022. A risk is that rising anti-colonialist sentiment in West Africa has reignited the debate about the merits of maintaining the CFA franc's peg to the Euro.

Financial sector overview

The financial sector, characterized by excess liquidity, heavy concentration of loan and deposit activity and a low level of financial innovation is largely dominated by foreign banks. Non-bank financial institutions play a minor role, with the public insurance and pension systems in difficulties, and the publicly owned postal bank and real estate finance institution both struggling with insolvency. Problems in the legal enforcement of guarantees and the land tenure system also hamper the utilization of real estate as collateral, further constraining the expansion of the financial sector.

Due to the integration of Cameroon with the CEMAC region, regional laws govern most of the country's financial system. This often renders legal procedures cumbersome. Accounting requirements are not yet fully in line with International Financial Reporting Standards (IFRS). However, authorities have recently stated intentions to reform the country's banking and financial sectors in efforts to deepen financial intermediation and intend to finalize the implementation of a central credit registry, introduce new financial instruments targeted towards SMEs, and set up a judicial court to handle commercial matters and improve the enforcement of contracts.

While CEMAC countries jointly launched a common regional stock exchange in 2008, Cameroon has also set up its own stock market, the Douala Stock Exchange (DSE or DSX). However, market infrastructure development, in support of the expansion of capital markets, lags behind issuing plans. Regional auction mechanisms and dealer-type systems in support of both the primary and secondary market are not yet fully in place. Moreover, a cash and debt management framework is not yet established at the Treasury, which hampers budget financing through government-issued debt securities.

The DSX is owned 64% by commercial banks, 23% by four state entities, and 13% by six insurance companies, with outstanding capital of CFA 1.8 billion (€ 2.74 million). The stock market capitalization reached CFA 149.3 billion (€ 227 million) as of August 2018, with only three companies active. Bond market capitalization was just CFA 272.5 million (€ 414,700) as of August 2018.

The insurance sector as a whole is small relative to the country's economy. Nonlife companies dominate the industry. Major nonlife companies include AXA and Channas. For the life sector, the leading companies are Beneficial Life and SNAC. A regional body, Conférence Internationale des Marchés d'Assurances (CIMA), established in 1992, acts as regulator and supervisor and has played a major role in Cameroon's insurance sector since its inception.

Cameroon financial sector capacity for LPG infrastructure and business financing

The Cameroon financial sector, despite being the largest financial center of CEMAC, is too small, with too limiting a set of investment and lending conditions, to be able to finance the full national LPG investment requirement at the level described in this report, although it can in principle participate meaningfully in the initial tranche.

It is also highly risk averse (or, put another way, very costly in its desired terms) with respect to financing for the LPG sector. As a particularly concrete example, GLPGP/Clean Cooking for Africa financing experts consulted with the leading banks in Cameroon about indicative terms for standby letters of credit (LOCs) for

use in procurement of LPG cylinders; the banks sought an asset ratio of 3:2 (that is, for every Euro or franc of an LOC for an LPG company, the bank required 1.5 Euros or francs on deposit), an impossibility for Cameroon's LPG companies.

The Cameroon financial sector is, however, interested to co-fund justified projects up to its allowed limits.

Cameroon financial sector capability for consumer LPG financing

14.8% of Cameroonian adults have an account at a formal financial institution, compared to 11.6% across the CEMAC region and 24.2% across Sub-Saharan Africa, according to the IMF. 34.6% of the Cameroon adult population (above the age of 15) has access to a bank account, and only 7% of Cameroonian adults make use of MFIs.

Therefore, financial inclusion measures with respect to LPG have three prospective challenges: (i) creating access to banking (of any type) among consumers, (ii) creating LPG loan products that can be scaled up to large populations, and (iii) ensuring adequate repayment levels by consumers for such loans (whether by tightly credit screening them or executing efficiently and effectively on loan collections or both). GLPGP/Clean Cooking for Africa Program pilot projects regarding the second and third of these challenges are described in the next Chapter.

Key financial sector metrics

The following table summarizes key metrics of the Cameroon financial sector, as of 2016.

Table 43. Cameroon financial sector assets overview (2016)⁶³

Financial Sector Category	XAF (billion)	US \$ (million)	% of GDP	No. institutions
Commercial banks	5,308	9,215	26.9%	14
Insurers	553	959	2.8%	26
Pension funds	455	788	2.3%	1
Mortgage institutions	316	548	1.6%	1
Postal savings institutions	158	274	0.8%	1
Total	6,790	11,784	34.4%	

⁶³ Sources: Government of Cameroon, BEAC, IMF, GLPGP analysis

18. Consumer Empowerment

LPG use as a primary cooking fuel has made significant inroads into the population in the last decade, especially in urban areas (see Chapter 12 and ISLE Table 1). According to the demand modelling described in this report, 40%⁶⁴ of the addressable LPG market as of 2030 is presently unserved today, but could adopt LPG by 2030 if good, reliable, nearby access to, and availability of, safe LPG cylinders and refills were provided. To accelerate adoption within that unserved 40% who are modelled to be addressable through supply-side initiatives, and to expand the market beyond them (but still within zones of logistical feasibility), demand-side measures will be needed.

One of the major consumer barriers for switching from firewood use to LPG use for cooking is the relatively high up-front cost to obtain LPG equipment. This is in particular a challenge for rural users, who on average are poorer than urban users. These upfront costs are dominated by two items: the cylinder deposit (about € 22) and the stove (which can range from under € 5 for a simple cylinder-top ring burner to above € 35 for a high-end multi-burner stove, with € 15-20 a more typical range). There are various instruments which could lower these barriers and thereby help consumers afford switching to LPG more easily.

As highlighted in Chapters 10 and 16, the cylinder deposit cost can be lowered considerably by introducing an LPG fuel-based levy that would be used to fund a large portion of the up-front cost of cylinders at the expense of slightly higher fuel cost, which, presumably, would be much easier on balance for consumers to tolerate.

To help consumers pay for these up-front costs, a microfinance program was piloted.

Microfinance program

In each partner country of the Clean Cooking for Africa Program, the Global LPG Partnership has engaged with local partners to design and, where possible, launch and complete a pilot program in LPG microfinance. In most Sub-Saharan African countries, microfinance for LPG is a first-of-its-kind effort for both the LPG sector and the microfinance and banking sectors.

The purpose of these microfinance programs is to determine whether LPG demand and consumption can be unlocked and sustained on a commercial basis through replicable, profitable microloans which help consumers who cannot afford the full up-front cost of the equipment required to become an LPG user at one go, or who may have seasonally variable incomes that make it difficult to do so except at particular times of year.

These programs are collectively called “Bottled Gas for Better Life”. They support microfinance lending operations, including provision of loan capital, to facilitate equipment purchase (double burner stove, cylinder and accessories) by lower income households, to help them adopt LPG for clean cooking. Training of, and support to, local microfinance institutions, and education for new LPG consumers, are also provided.

The first instance was launched in 2017 in Southwest Cameroon.

⁶⁴ Calculated as (58% of households with projected 2030 adoption less 34% of 2017 adoption, divided by 58%).

The following table summarizes the status of these programs across the three active Clean Cooking for Africa partner countries as of this writing:

Table 44. Summary of LPG microfinance program status by country

	Cameroon			Kenya	Ghana
	Phase I	Phase IA	Phase II	Phase I	Phase I
Households	150 (target reached)	50 (target reached)	680 (target), 484 registered as of this writing	150 (target), 63 registered at time of this writing	150 (target)
Location	One community in South West Cameroon	One community in South West Cameroon	10 communities across Centre, Littoral, South West, North West, West regions	One community in Nyandarua County	One community in Brong Ahafo Region
Project period	March - October 2017	November 2017 - May 2018	April 2018 – March 2019 ⁶⁵	August 2018 - April 2019	TBD
Status	Complete	Complete	In progress	In progress	Not yet started

Overview of Cameroon microfinance sector

Cameroonian microfinance falls under the aegis of the Banque des Etats de l’Afrique Centrale (BEAC), the central bank of the CEMAC (Central African Economic and Monetary Community)⁶⁶ region, of which Cameroon is part. Microfinance in Cameroon, therefore, operates in a complex regulatory structure with regional institutions working in tandem with national governments and financial sectors. In addition to the BEAC, the Commission Bancaire de l’Afrique Centrale (COBAC) acts as the primary regulator of the banking and financial sectors in these Central African countries.

According to COBAC regulations, microfinance institutions (MFIs) in the CEMAC region are divided into three categories on the basis of whether the institution is engaged in savings activities, credit distribution/loan activities, or both⁶⁷. Category 1 refers to cooperatives or solidarity groups that offer savings products. Category 2 refers to entities that may have the status of commercial companies and offer both savings and credit facilities. Category 3 MFIs provide only credit facilities to the public.

Cameroonian financial inclusion remains relatively underdeveloped. As mentioned in the prior Chapter, according to International Monetary Fund data⁶⁸, 14.8% of Cameroonian adults have an account at a formal financial institution, compared to 11.6% across the CEMAC region and 24.2% across Sub-Saharan Africa. 34.6% of the Cameroon adult population (above the age of 15) has access to a bank account⁶⁹ and only 7%

⁶⁵ Final data gathering, analysis and reporting by independent evaluators to occur during Q2 2019.

⁶⁶ CEMAC, created in 1994, consists of six member states in Central Africa: Cameroon, Gabon, Equatorial Guinea, the Republic of Congo, Chad and the Central African Republic.

⁶⁷ See www.beac.int/index.php/supervision-bancaire/reglementation-de-la-microfinance

⁶⁸ IMF Working Paper: Financial Inclusion and Development in the CEMAC (2015)

⁶⁹ See www.microfinancegateway.org/country/cameroon

of Cameroonian adults make use of MFIs⁷⁰. It is a regulatory requirement in Cameroon that a borrower establish an account with the MFI if none previously existed.

Prominent microfinance networks in Cameroon include the Cameroon Cooperative Credit Union League (CamCCUL) and the National Association of Microfinance Institutions of Cameroon (ANEMCAM), which operate as umbrella institutions for member MFIs. However, lack of adequate MFI infrastructure, understaffing of the COBAC oversight function, and a lack of systematically enforced regulation have led to instances of failure to meet prudential requirements, bankruptcies, and high rates of loan delinquency among some Cameroon MFIs. Limited expertise and limited capability and capacity to maintain accurate data on MFI loans and loan performance further compounds regulatory difficulties.⁷¹ For example, no data are available on the average or range of prevailing microloan interest rates for consumers.

In June 2018, Cameroon's Ministry of Finance announced the launch of the Centrale des Risques de Etablissements de Microfinance (CREMF), an organization tasked with maintaining centralized data on MFI customers' creditworthiness to address microloan delinquency rates as high as 23%, as reported by the National Credit Council.⁷² Accordingly, the LPG microfinance program design, described further below, required a goal and mechanisms to assure, if possible, a stable and low delinquency rate, in order that the program could justify eventual expansion on a commercial basis.

Considering the underdeveloped nature of the Cameroon microfinance sector overall, the GLPGP/Clean Cooking for Africa LPG microfinance programs, being the first of their kind in the country, represent a major step towards establishing a commercially scalable microfinance framework for clean household energy access.

Program designs and results

The Cameroon LPG microfinance programs were developed and implemented in three phases, referred to as Phase I (150 households), Phase IA (50 households), and Phase II (484 households participating as of this writing, and currently ongoing). Phases I and IA did not charge interest to consumers and were intended to serve as proofs of concept. Phase II was an expansion into new geographies with additional MFI and LPG industry partners and charged market rates of interest, as agreed among the partners. The objective of Phase II is to demonstrate resilience and replicability of the program geographically and among a broader group of local operational partners, and to demonstrate the potential for commercial viability.

The following table summarizes the main parameters of the loans in each phase:

Table 45. Summary of microloan parameters by program phase
(amounts in XAF except where indicated)

Item	Phase I	Phase IA	Phase II
12.5 kg LPG cylinder	18,500	18,500	18,500
Cost of gas: initial fill (12.5 kg)	6,500	6,500	6,500

⁷⁰ FinScope Cameroon (2018). Consumer Survey Highlights: Cameroon 2017. FinMark Trust.

⁷¹ Microcapital (2018, July 3). *Government of Cameroon Launches Centrale des Risques de Etablissements de Microfinance (CREMF) in Collaboration with Microfinance Institution Networks CamCCUL, ANEM-CAM to address Delinquency Rate of 23%*.

⁷² Ibid.

Double burner gas stove	20,000	20,000	18,000
Regulator	3,500	3,500	3,500
Gas hose	1,500	1,500	1,500
Total	50,000	50,000	48,000
Loan term	6 months	6 months	6 months
Interest rate	0%	0%	1.25% / month
Repayment amount (including interest)	50,000	50,000	51,600
Security deposit	7,500	8,333	11,600

Phase I design

The Phase I program was the first-ever LPG microlending program in Cameroon. It was carried out during 2017 in Batoke, a coastal village in Southwest Cameroon. GLPGP's local implementing partners included LPG marketer Glocalgaz and MFI Mutuelle Financière des Femmes Africaines (MUFFA). Borrowers self-selected and were not screened for credit risk, and loans were provided interest-free for program piloting purposes. Because LPG microfinancing was a completely new line of business in Cameroon, the MFI partner, MUFFA, required GLPGP to provide the loan capital to be on-lent to consumers. GLPGP also handled most field operations during Phase I, such as community sensitization and loan repayment collection.

Baseline and follow-up surveys were performed before and after the program, respectively, to characterize the Batoke households.

The breakdown of costs to participants (in XAF) is shown in Table Table 45 above. A total of 150 households made initial security deposits of 7,500 XAF (US\$ 13.50⁷³), followed by six equal monthly principal payments.

The University of Liverpool, UK, undertook to perform an independent evaluation of Phase I as part of the LPG Adoption in Cameroon Evaluation (LACE) studies. The evaluation focused on the effectiveness of the loan scheme in driving LPG adoption as well as the resulting health benefits. It included Household Air Pollution (HAP) measurements performed in a set of beneficiary households before and after their adoption of LPG. 110 beneficiaries completed household surveys prior to receiving the LPG equipment, and again after the 6-month loan period. Additional surveys were completed by 1,000 randomly selected households in both beneficiary and control communities (Botoland village). Measurements of fine particulate matter (PM_{2.5}) in kitchens and inhaled by primary cooks were measured in 35 beneficiary households over 48-hour periods. Qualitative in-depth interviews were conducted with a subset of beneficiary and control households.

Phase I results

Key outcomes included:

- 94% of loan capital repaid;

⁷³ Dollars are used as the comparison currency for this Chapter, rather than Euros, because the underwriting and guarantees of loans and loan performance undertaken by GLPGP were transacted in dollars.

- 89% of households repaid their loans in full, although 41% reported difficulty making timely repayments;
- Average LPG usage by the participating households over the loan period was at an annualized rate between 19.0 and 23.4 kg/capita⁷⁴, significantly above the average annual usage level of LPG users of 12.9-15.5 kg/capita observed in the GLPGP-Dalberg household survey (see Annex Chapter 27 (Household Survey and Findings) beginning on page 281 for details).
- Significant reductions in HAP personal exposure;
- Reductions in self-reported health symptoms and burns in both women and children;
- Stimulation of LPG adoption throughout the community, beyond the microloan recipient group; and
- Replication of the program by neighboring communities, acting on their own.

The program became well known in the vicinity of Batoke through word of mouth and coverage by the local media (television and press). Several nearby communities replicated the program on their own. Glocalgaz, the Phase I LPG marketing company partner, promptly initiated a similar program on its own to benefit plantation workers in Southwest Cameroon.

Key survey findings are as follows:

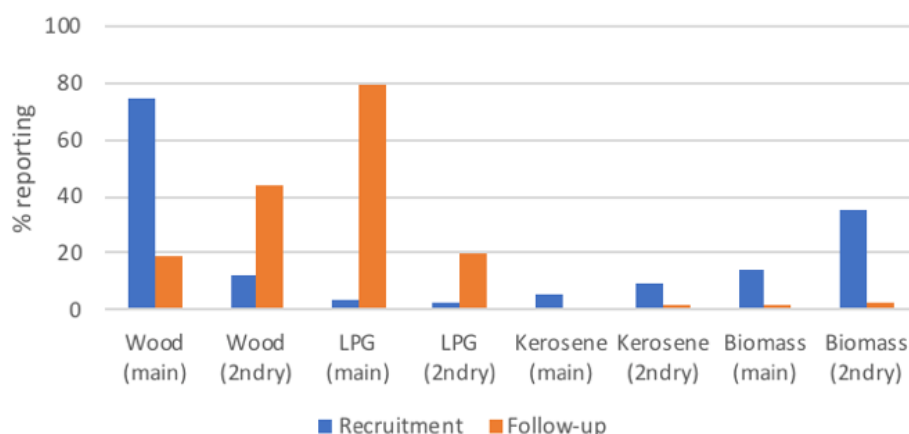
- The beneficiary sample covered a range of socio-economic status, with 24% earning below the national monthly average household income of 50,000 XAF (US\$ 90). 38% owned their own property; 45% rented their homes.
- Households reporting difficulty in making timely repayments cited the following main reasons (n=56 out of 110; 41.2%):

Reason for delay	Number	Percent
Health (own or child)	16	28.6
Work problems	12	21.4
Financial problems	9	16.1
Travel	9	16.1
Family problems	4	7.1
Bereavement	3	5.4
Other	3	5.4

- Amongst program participants, cooking fuels used shifted from wood (75%) and other biomass (15%) before the loan period to LPG (79%) after the loan period. No household used LPG exclusively. By comparison, negligible fuel use changes occurred in a control community where the microloan was not offered. The following Figure shows this shift from the baseline survey to the follow-up survey:

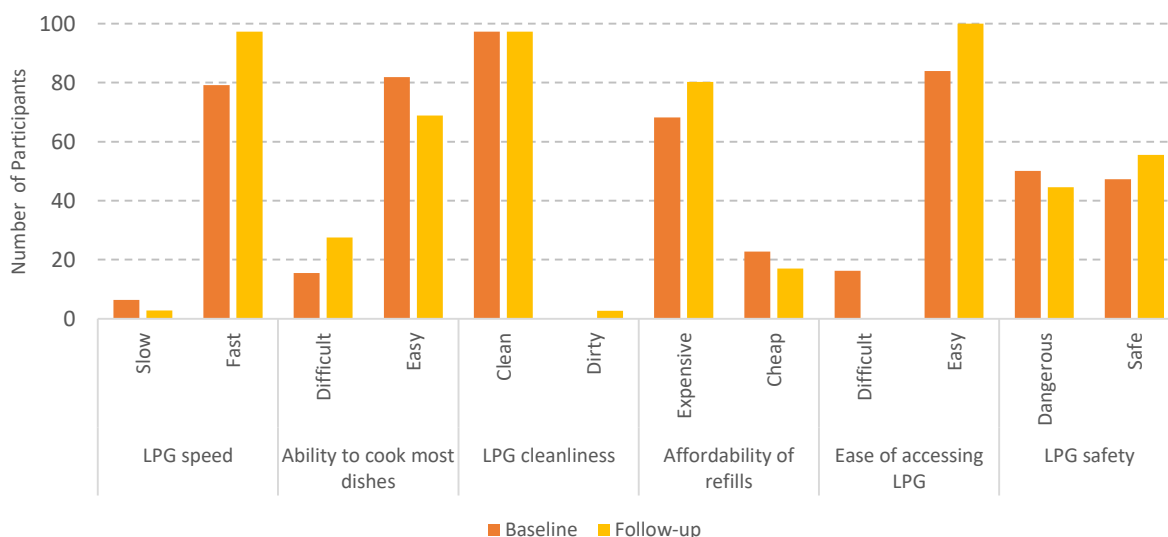
⁷⁴ Methodologies: For the lower bound, number of cylinder refills purchased during loan period, excluding the initial fill, multiplied by 12.5(kg) ÷ loan period (in months) x 12. This is an underestimate, because consumers will have consumed some or all of their final refill as of the end of the loan period. For the upper bound, number of cylinder refills purchased during loan period, including the initial fill, multiplied by 12.5(kg) ÷ loan period (in months) x 12. This is an overestimate, because not all customers would have fully consumed their entire final cylinder refill as of the end of the loan period. 19.0-23.4kg/capita represent use of LPG for a majority of cooking tasks, but not exclusive use. Assuming 12.15 MJ of cooking energy required for meal preparation, exclusive use of LPG for all cooking tasks in Cameroon equates to approximately 33 kg/capita.

Figure 37. Household fuel usage before and following microloans – Phase I



- Levels of PM_{2.5}, the particulates responsible for most of the disease burden due to HAP, fell significantly. Exposure in primary cooks once using LPG was recorded at below the World Health Organisation's (WHO) indoor air pollution interim target I (WHO-IT1 of 35 ug/m³), confirming LPG's health-protective role.
- Significant reductions in headaches (from 46% to 9%), eye problems (from 66% to 8%), cook burns (from 25% to 3%) and child burns (from 9% to 0%) were also observed after families adopted LPG through the microloan program.
- Changes in perceptions of LPG over the course of the loan period are shown in Figure 38. These findings indicate that future instances of the program must address education on how best to cook of local dishes using LPG, as well as the relative affordability of LPG measured in weeks or months.

Figure 38. Changes in perceptions of LPG among borrowers



Key findings from 20 face-to-face qualitative interviews conducted with loan recipients include the following:

- Most interviewees reported using their gas stoves every day, some up to three times a day.
- Interviewees reported preferring cooking with their gas stove (to a three-stone fire) due to gas having a faster cooking speed, being cleaner, and being easier to use.

- Both loan recipients and non-recipients found gas cheaper than purchased firewood, measured according to the time the fuel lasted.
- Interviewees reported planning to continue using LPG after their loans were repaid.
- Most non-borrowers reported that if they had taken a loan, they would have been able to pay it back on time.

Phase IA design

Following Phase I in Batoke, an additional 50 households in Buea, Southwest Cameroon, were offered equivalent loans to the Phase I loans to cover the costs of a double-burner gas stove, a filled 12.5kg LPG cylinder, a regulator and a hose. The purpose of Phase IA was to examine repayment rates with the borrowers selected and screened for credit suitability by the local MFI partner. (In Phase I, the loan recipients were not screened.)

Loans were made in November 2017 and repaid by May 2018. Households made initial security deposits of 8,333 XAF (US\$ 15), followed by six equal monthly payments.

No baseline and follow-up household surveys were conducted with these 50 households.

Phase IA results

Key outcomes included:

- As of the end of the loan period, 94.9% of the loan capital was repaid. 43 out of the 50 households (86%) completed repayments on time (see Figure 39, with 38 (76%) of the total households completing repayments in fewer than six months (Figure 40). Violent civil disorder broke out in the Southwest region of Cameroon towards the end of the loan period,⁷⁵ preventing the remaining seven households from completing their repayments. The unrest also delayed loan collections from some households. Therefore, it is probable that the total repayment would have exceeded 94.9% but for the outbreak of civil disorder.
- Average LPG usage by the participating households over the loan period was at an annualized rate 21.2 kg (the midpoint of the annualizing calculation range of 19.0 to 23.4 kg/capita⁷⁶), significantly above the average annual usage level of LPG users of 15.5 kg for urban populations and 12.9 kg for rural populations reported in the GLPGP-Dalberg Cameroon household survey (see Annex Chapter 27 (Household Survey and Findings) beginning on page 281 for details).
- 50% of households had an annualized LPG consumption of 20 kg/capita or more (see Figure 41).
- Households sampled that consumed the most LPG had a smaller household size (average of 4). It can be inferred that the households consuming more LPG used it for all or most of their cooking needs, while those consuming less LPG intermixed LPG cooking with their use of preexisting cooking fuels (i.e., fuel stacking).

⁷⁵ See www.theguardian.com/global-development/2018/may/30/cameroon-killings-escalate-anglophone-crisis

⁷⁶ Methodologies: For the lower bound, number of cylinder refills purchased during loan period, excluding the initial fill, multiplied by 12.5(kg) ÷ loan period (in months) x 12. This is an underestimate, because consumers will have consumed some or all of their final refill as of the end of the loan period. For the upper bound, number of cylinder refills purchased during loan period, including the initial fill, multiplied by 12.5(kg) ÷ loan period (in months) x 12. This is an overestimate, because not all customers would have fully consumed their entire final cylinder refill as of the end of the loan period.

- Households purchased an average of 4.3 cylinder refills (12.5 kg each) over the loan period, in addition to the initial fill, with almost 50% of households having purchased either 5 or 6 refills during the loan period.
- Of note is that some households continued purchasing refills in the months in which they missed loan repayments. Six out of the seven households that did not re-pay the full loan amount had an average annual LPG consumption of 20 kg per capita or more. This suggests that the households were unable to manage making both loan repayments and LPG refill purchases, and prioritized the LPG refill.

Figure 39. Frequency of loan repayment levels – Phase IA
(n=50)

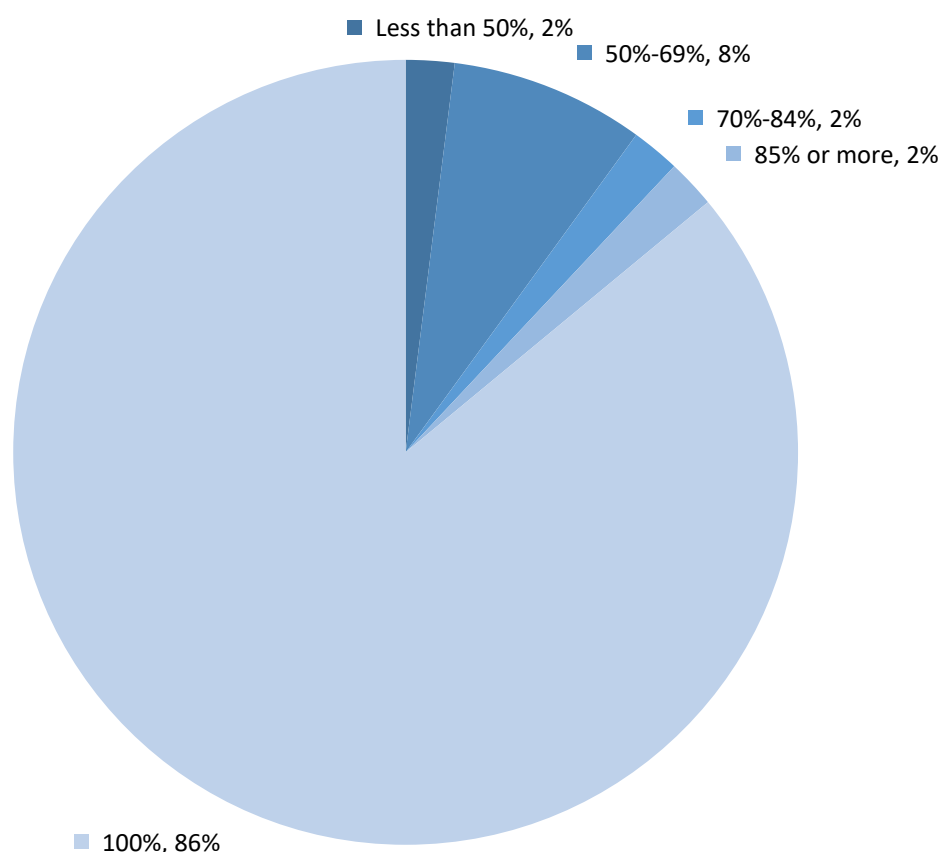
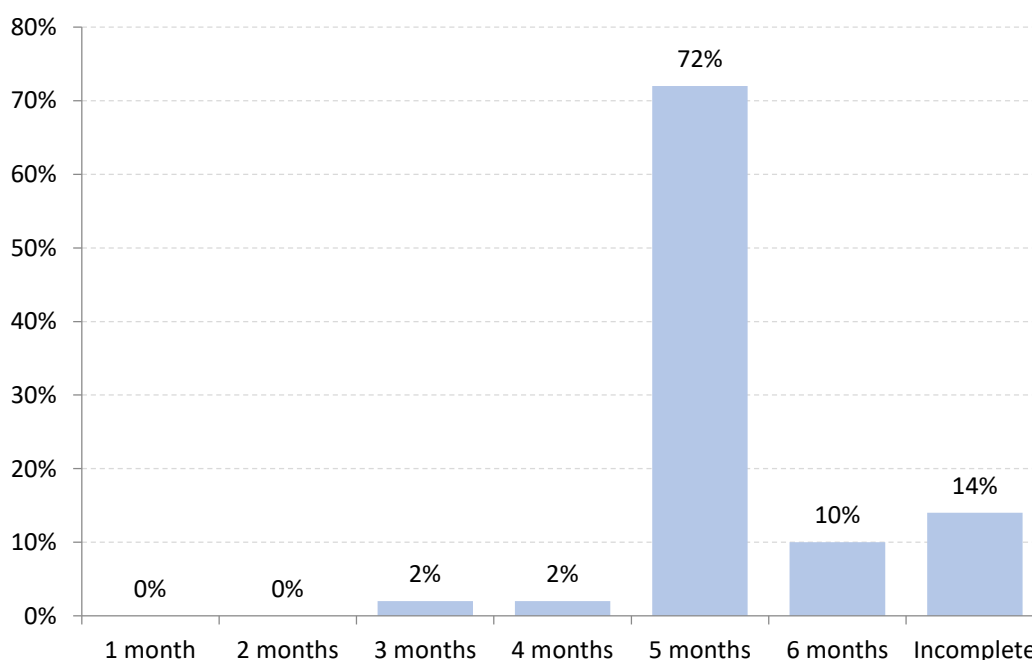
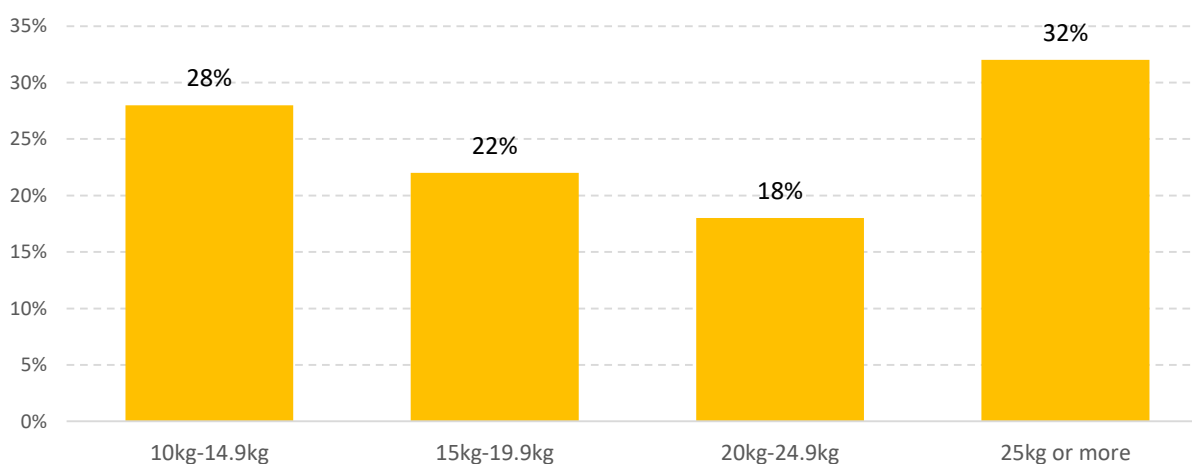


Figure 40. Frequency of loan repayment times – Phase IA
(n=50)



Note: Civil disorder in the Southwest region interfered with the final payments of the “Incomplete” borrowers.

Figure 41. Microloan households’ annualized per capita LPG consumption – Phase IA
(n=50)



Phase II design

A second expansion program in multiple communities across five regions was launched in March 2018 (see Figure 42). This involved an expanded group of program partners and took a geographically phased approach, rolling out community by community across urban, peri-urban and rural areas (see Table 46). Community sensitization and participant registration commenced in April 2018.

The objective of Phase II was to assess whether the microloan program, when expanded into additional geographies with additional local operating partners and charging market rates of interest, would continue

to deliver results that could motivate and justify widespread commercialization of LPG microlending in Cameroon.

The local implementing partners in Phase II were LPG Marketer companies Glocalgaz (also in Phase I/IA) and Tradex and MFIs MUFFA (also in Phase I/IA) and MC2. The MFI partners continued to require GLPGP to provide capital to be on-loaned to consumers⁷⁷.

Tradex, the largest LPG Marketer in Cameroon, approached GLPGP to participate in the microloan program after hearing about the successful pilot (Phases I and IA) in the Southwest region.

In Phase II, the MFIs became responsible for all field operations, including assessing the creditworthiness of interested households (at their option), with community sensitization becoming a shared task. Different from the earlier phases, the MFIs charged interest to the consumers at a rate of 1.25% per month. In principle, this rate of interest would generate adequate profit to the MFIs to justify LPG microloans as an ongoing line of business, if repayment rates were to remain at similar levels to those of Phases I and IA.

The communities were jointly chosen to be nationally representative, subject to being within the practical operational geographies of the partner MFIs and of the partner LPG Marketers. Urban, periurban and rural communities were included.

Figure 42. Map of communities of Phase II microloan program



⁷⁷ Funding of the Phase II loan capital was provided in part by the OPEC Fund for International Development via grant to GLPGP.

Table 46. Communities, local partners and scale targets for Phase II microloan program

Region	Community	Type	MFI	LPG marketing Company	Initial HH target	Revised target ⁷⁸	Households registered ⁷⁹
Littoral	Douala Bonaberi	Urban	MUFFA	GLOCALGAZ	50	50	34
	Douala Village	Urban	MUFFA	GLOCALGAZ	50	50	25
	Njombe	Peri-urban	MC2	GLOCALGAZ	100	100	64
	Loum	Mixed	MC2	GLOCALGAZ	0	50	30
Southwest	Tiko	Peri-urban	MUFFA	GLOCALGAZ	50	0	0
	Buea	Peri-urban	MUFFA	GLOCALGAZ	50	10	8
	Muyuka	Peri-urban	MC2	GLOCALGAZ	100	30	20
Northwest	Njinikom	Rural	MC2	TRADEX	100	0	0
	Bafia	Rural	MC2	TRADEX	125	125	39
Centre	Briquetrie-Yaounde	Urban	MUFFA	TRADEX	50	85	100
West	Bandjoun	Rural	MC2	TRADEX	125	125	58
	Bafoussam	Urban	MUFFA	TRADEX	0	55	106
Total					800	680	484

Site visits and LPG user and safety training were organized by GLPGP in collaboration with the local MFI branches.

Phase II preliminary results

Through December 2018, 484 households were registered and received their equipment. This registration level represents 72% of the 680 households registration target. The primary reasons for the below-target registration level as of December 2018 were (i) Anglophone-Francophone conflict erupting around certain of the communities, requiring the program to relocate from there to, and restart in, alternate communities, (ii) a high level of credit rejection by the initial MFI partner, resulting in bringing in a second MFI partner with a less restrictive credit policy later during the program rollout, and (iii) delays in equipment delivery in some communities to the first wave of registered consumers which reduced willingness of consumers in subsequent waves to register until it was proven that equipment was actually in stock.

104 households re-paid the loan fully within three repayment cycles or less.

The operational territory served by LPG marketer GlocalGaz, which was the first territory for the rollout, covers 290 households. The operational territory served by LPG marketer Tradex covers 390 households.

A number of existing LPG users, particularly in urban and peri-urban communities where LPG



Equipment distribution in Douala, April 2018

⁷⁸ Targets were revised after civil disorder arose and delayed program rollout in Anglophone regions of Cameroon.

⁷⁹ As of December 2018. Almost all of these households received their LPG equipment.

was already available to some extent, wanted the microloan in order to get new or better equipment. Program partners had agreed to limit the number of existing LPG users to about 30% of all loan recipients, since the main goal was to catalyze LPG adoption by non-users. Therefore, many existing LPG users who sought microloans were denied access to them.

As of December 2018:

- 81% of total loan capital had been repaid;
- 226 borrowers (46%) completed their repayments, of which 104 (21%) did so within three months; and
- 59 households paid for the LPG kits in full, up front, bypassing the loan.

Phase II will conclude during Q2 2019, and final gathering of data and analysis of the data will conclude during Q3 2019.

Phase II baseline survey findings

Baseline survey data collection for Phase II was completed in December 2018. The survey utilized a 10-minute questionnaire adapted from the survey used by the University of Liverpool in its Phase I evaluation. Baseline surveys were administered by MFI staff prior to participants' receiving their new LPG equipment.

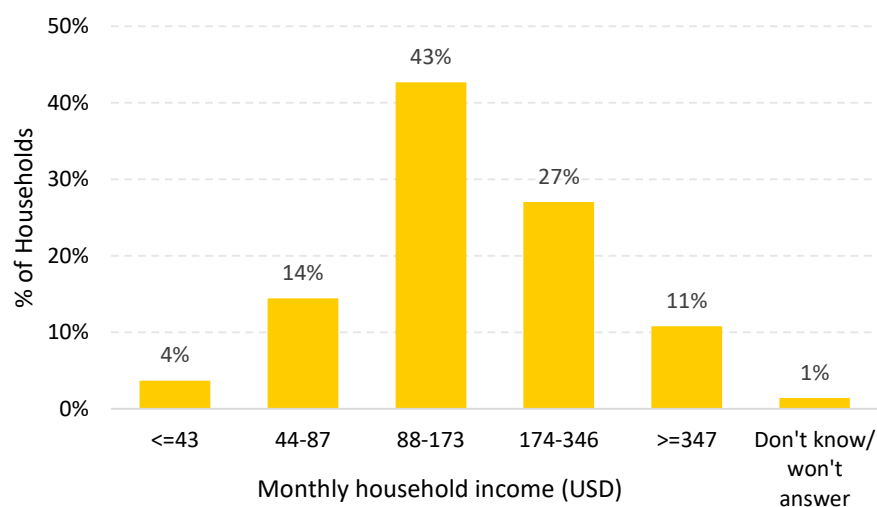
(As such surveys are not part of the MFIs' usual business operations, GLPGP paid a nominal fee of 1,000 XAF (US\$ 1.80) to the MFIs for each completed survey to cover the MFIs' surveying costs.)

As of December 2018, preliminary results were available from 493 households (74%) that had registered earlier for the loans, representing all the communities except for Njinikom (rural), Loum (rural/peri-urban) and Tiko (peri-urban), where program rollout was still pending. These results are summarized below:

- 46% of participants surveyed (n=227) lived in urban areas, 23% (n=113) in peri-urban areas and 31% (n=153) in rural areas.
- The most common occupations of those registering for the loan were business employees (41%) (e.g., workers in a shop), public sector employees (e.g., doctors, teachers) (15%), shop owners (12%) and day laborers (11%).
- Households from all income strata registered for loans, with a mode of 43% falling in the monthly household income range of XAF 51,000-100,000 (US\$ 88 - US\$ 173) (Figure 43), equivalent to about US\$ 2.93-US\$ 5.77 per capita per day. Cameroon's average per capita income in 2017 was US\$ 3.96 per day⁸⁰. Data were not possible to obtain as of this writing to determine how much of the moderate skewing of registrations toward above-average incomes, as shown in the Figure, was due to self-selection by applicants, by the geographic targeting of the program (driven by the MFIs within GLPGP-defined criteria for diversity and the service areas of the LPG operating partners), or due to the effects of MFI credit screening. (All registrants were, or were required to become, members of the respective MFI credit networks.)

⁸⁰ World Bank: data.worldbank.org/country/cameroon

Figure 43. Phase II microloan program household income histogram (n=492)



- 57% of participants reported having taken a loan before.
- Wood was the primary cooking fuel used (50% of participants, n=245), followed by preexisting use of LPG (22%, n=107), charcoal (12%, n=60), kerosene (8%, n=41) and sawdust (8%, n=37) (see Figure 44).
- Wood was the most common primary fuel used, by 73% (n=111) of participants living in rural areas, by 54% peri-urban (n=61), and by 32% urban (n=73).
- 78% of participants (n=386) paid for their primary fuels, including for wood (37%, n=143) (see Figure 45). Among those that did not pay for their primary fuels (22%, n=107), 77 lived in rural areas, 28 in peri-urban areas, and 2 in urban areas.

Figure 44. Microloan Phase II survey - primary cooking fuel used (prior to receipt of LPG equipment, n=493)

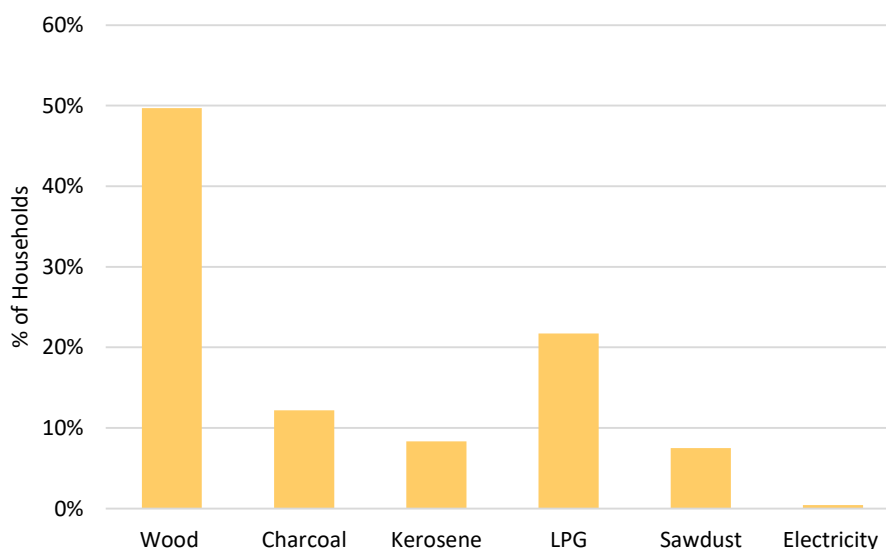
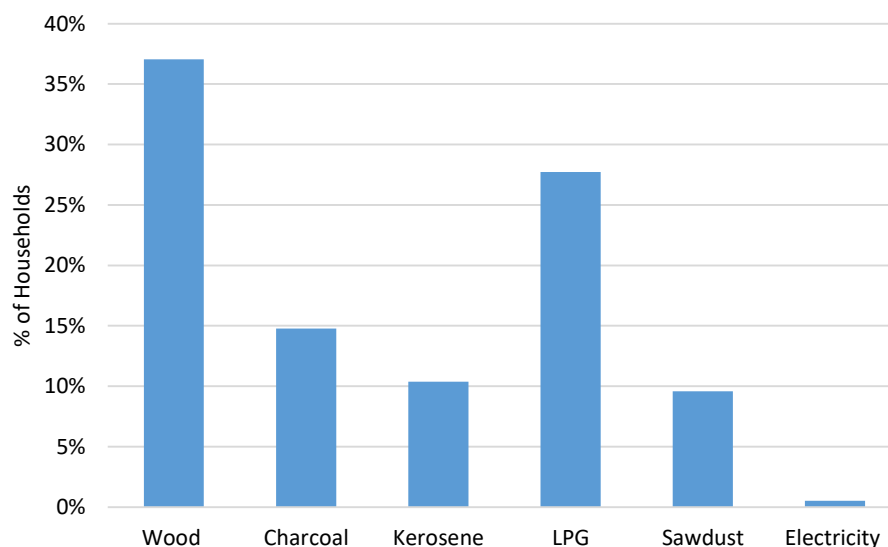
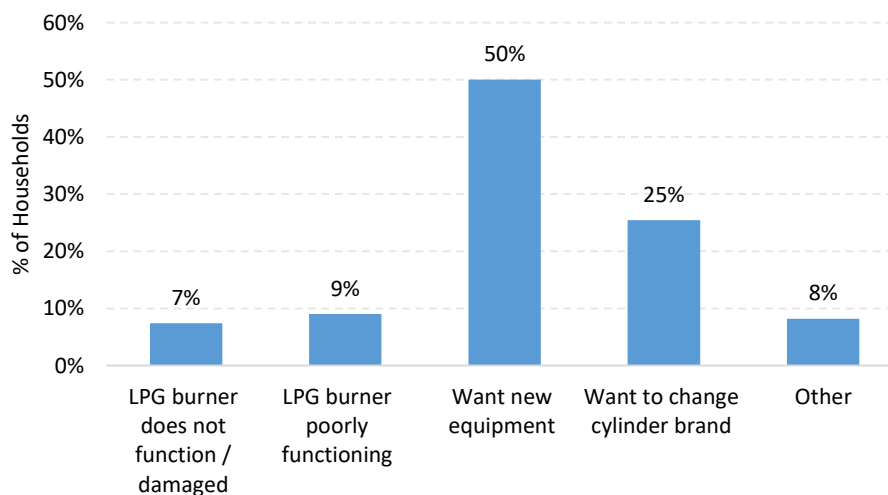


Figure 45. Microloan Phase II survey - primary cooking fuel paid for (prior to receipt of LPG equipment, n=386)



- Existing LPG users who requested the loan did so primarily because they wanted new LPG equipment through the loan (50%, n=61), 25% (n=31) because they wanted to change cylinder brands and 16% (n=20) because of a poorly or non-functioning burner (Figure 46).

Figure 46. Existing LPG users' reasons for requesting a microloan (n=122)



- Of the 122 current LPG users, 54% (n=66) lived in urban areas, 23% (n=28) in peri-urban areas and 23% (n=28) in rural areas.
- At baseline, participants whose primary cooking fuel was wood (50% of all participants) reported spending an average of 3.2 hours cooking all meals in a typical day – including lighting a fire. Those whose primary fuel was LPG (22% of participants) spent an average of 2.7 hours cooking all meals daily.

Monitoring and evaluation

Since 2016, GLPGP has been partnering with the Department of Public Health and Policy at the University of Liverpool, UK and Douala General Hospital, Cameroon, which are jointly studying enabling factors to support large-scale population shifts from traditional, polluting fuel use to LPG use for cooking. This includes testing initiatives designed to help households make the switch, especially in poorer, peri-urban and rural communities. As part of the LACE studies, the researchers conducted an independent evaluation of Phase I of the microfinance program, carrying out household surveys with participants before and after they received their LPG equipment and performing HAP exposure measurements (kitchen emission concentrations and personal exposure in primary cooks). During both the baseline survey and a six-month follow-up survey, they also surveyed an additional 500 households in the pilot community and 500 households in a nearby control village. Data from non-participants were compared with those who received the microloan. Key findings from these evaluations are presented in the *Phase I results* section in this Chapter, beginning on page 157.

Issues and lessons from the Cameroonian microloan programs

Achieving the planned targets in Phase II in accordance with the original, desired timeline proved challenging. In Phase II, the program partners cover multiple regions and credit screening was added to the loan origination process. Some interested households were disqualified, for example, because they had been in default on other loans. Others were not provided with a loan because the number of existing LPG users had exceeded the cap set by program partners.

The main challenge for the expansion program was (and is) the civil disturbances, some violent, in certain Anglophone areas of Cameroon. This and other key factors are outlined in the sections below.

Civil unrest

Civil unrest erupted in the two Anglophone regions of Cameroon in March 2018, creating a challenging security situation. This delayed completion of Phase IA repayments. As a result, the MFI partner units working in Njinikom, Muyuka, and Buea (covering Tiko and Muea communities) were unable to operate for a period of time. In Muyuka, some households that had been approved for the loan were unable to collect their LPG equipment. GLPGP therefore decided to reassign some prospective loans from these affected areas to other areas served by other MFI units, including two new units, MUFFA Bafoussam (West Region) and MC2 Loum (Littoral Region).

This required training and orientation for the new units' personnel. Consumer sensitization, registration and equipment delivery commenced in Bafoussam in August 2018 and in Loum in September 2018. To compensate in part for the time- and labor-intensity to bring the new operating units and staff into the program, GLPGP also re-assigned 35 prospective loans to Briquetrie-Yaounde, increasing the registration target in that community accordingly. Table 46 (page 164) shows the updated targets for each community alongside the original target. (Initial registration targets have already been exceeded in Bafoussam and Briquetrie-Yaounde as of this writing.)

The security situation also made it difficult for households in other regions to be provided with LPG equipment on a timely basis. In some cases, businesses, including the MFIs, remained closed for three business days per week. This was especially challenging for GlocalGaz in arranging timely transport of LPG equipment from its main operational hub in the Southwest region to other regions.

Selection of microfinance institution

Approximately two calendar quarters were required to be spent in discussions with a number of prospective MFI partners before a successful partnership was conceived with MUFFA. It then required two more calendar quarters to negotiate an MOU with MUFFA (and the LPG Marketer partner) defining the cooperation and the program details and to obtain formal approvals from MUFFA's board of directors and from its supervisory (host) bank.

This process was shortened by about one calendar quarter with MC2 for Phase II, in part because MC2 was able to reference the prior experience of MUFFA, as it was not taking the risk of being the sole 'lead' MFI in an unproven project.

A characteristic of many of the Cameroon MFIs interviewed for potential partnership is that they are as much or more social service organizations, with their services funded by third parties, as they are lending organizations, with their on-lending funded by host banks or other outside capital sources (such as GLPGP, in the case of these LPG microfinance pilot programs).

Selection of MFI partners with an adequate focus on lending, operating in the needed geographic area, and with the potential and desire to create a profitable line of business through LPG equipment lending (rather than being a conduit for grant funds to be loaned to households for other purposes), was and remains a critical element of program success, particular during these initial ramp-up phases (I, IA, II), when there are no data or benchmarks or peer experiences to reassure the MFIs that their activities will be impactful for the communities they serve and will be financially worthwhile for them and for their capital sources.

Selection of LPG Marketer

Selection of the LPG commercial partner for Phase I and IA, GlocalGaz, was much more direct and simple than selection of the MFI, because of past familiarity among the GlocalGaz senior management of the work of GLPGP in Cameroon, and past experience offering installment payment programs to attract new LPG consumers. As a smaller player (approximately 5% market share) with a footprint concentrated in one main region (Southwest), GlocalGaz gave ample management attention and support to the microloan program at all levels. For Phase II, Tradex, the dominant player in Cameroon's LPG sector, voluntarily approached GLPGP to participate. However, partly in consequence of its size, many extra months were required for Tradex to conclude discussions of, and gain the required approval for, the project MOU. Both GlocalGaz and Tradex have met their obligations as project partners. Of the two, the rate of rollout by Tradex has been less uniform than by GlocalGaz, apart from the effects of the civil unrest that affected all of the program partners.

It is noteworthy, and encouraging, that GlocalGaz eventually established its own lending/installment payment program for plantation workers in the Southwest region after observing the results of the GLPGP/Clean Cooking for Africa microloan program. (The details of its parallel program are proprietary to GlocalGaz. It is not known whether the parallel GlocalGaz initiative represents a loss-leader to the company or generates immediate or prompt incremental contribution margin.) That LPG companies might choose to offer consumer credit for a complete consumer LPG kit after observing MFIs succeed in doing so was an unanticipated co-benefit of the program. It represents a second potential route for consumer financial empowerment to adopt and use LPG, alongside the MFI-oriented route. Tradex, conversely, did not choose to develop its own, internal consumer credit program.

Education and sensitization

The pilot projects in Cameroon as well as Kenya have shown that sensitization activities are crucial in influencing adoption of LPG among communities of non-users. Non-LPG users are far more likely to adopt LPG if they are aware of the benefits of LPG, of how to cook local dishes using LPG, and of the health hazards of continuing to cook with charcoal, firewood and kerosene. As a point of comparison, researchers in India recently found that LPG usage and willingness to pay were higher among women who received information about the health benefits of LPG compared to traditional fuels, compared to women who only gained access to LPG without receiving the health information.

Education focused on household economic decision-making is also important. In Cameroon, a woman who was interviewed after a Bottled Gas for Better Life sensitization event stated: “I can use a [12.5kg] bottle of gas for one month and a half. I will not regret it, because if I calculate the charcoal or the firewood [I'd use], it will be more expensive than the gas I'm using.” LPG usage per capita among this group of microfinance participants who attended sensitization events was high, suggesting sustained and near-exclusive use of LPG for cooking. 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.

Endorsements from consumers and village leaders in Cameroon resulted in neighboring villages expressing interest in adopting LPG through the microloan program.

In Phase I of *Bottled Gas for Better Life*, support from the Chief of Batoke village, a strong advocate for the program, proved instrumental in encouraging families to register for the microloan. In Phase II, engagement of local leaders was initially done in some communities through the local MC2 or MUFFA units. Observing that registration numbers increased directly with intensified sensitization efforts, additional funds were allocated for the GLPGP Cameroon team to travel to each community to recruit local leaders as “LPG champions” ahead of the public awareness raising events. GLPGP also worked with the village Chiefs to recruit the local town criers to spread awareness about the program.

As the program expands in each Clean Cooking for Africa country, GLPGP and its partners will be better able to employ such “word-of-mouth” publicity, engaging new LPG users as ambassadors to increase adoption in their own and neighboring communities.

In addition, GLPGP's *Bottled Gas for Better Life* education, participant sensitization and launch events have been well covered by local media. This helps spread word about the microfinance program, including in areas as yet unserved by the program, and – through GLPGP's own outreach efforts and, potentially, those of complementary groups working on SDG7, including Sustainable Energy for All – into other Sub-Saharan African countries as well.

Need to prevent temporary localized LPG shortages

In April 2018, equipment delivery was delayed by about two weeks in MUFFA Bonaberi when Globalgaz experienced a temporary LPG shortage in its operations. This slowed down the momentum the MFI had created for registration. Moving forward, GLPGP will continue to emphasize to the partner LPG marketers, as stated in the governing project MOUs, that LPG supply shortages must not occur, with adequate reserves of LPG maintained to prevent service interruptions of reasonable durations (e.g., up to two weeks).

Data collection on LPG refills

As part of data collection, LPG refills purchased by loan recipients must be tracked to assess: (i) the level of sustained, ongoing LPG usage, and (ii) recipients' ability to afford refills while also making timely loan repayments. In Phase I, mandatory refill cards were handed out for people to bring to their retail shop to get a mark, but people often forgot to bring their cards with them. The GLPGP team were able to record refill purchases in such cases by asking loan recipients about their refills each time they made a monthly loan payment and through follow-up phone calls.

In Phase II, the collection of refill data was intended to be handled by MFI staff, given the much larger number of participants to be tracked. MFI staff in some of the communities reported difficulty obtaining such data, explaining that loan recipients complained about excessive questioning whilst making their loan repayments. The option of tracking refill data by obtaining sales records directly from local LPG retailers was explored, but such records would be comingled with the records of refill purchases from households not part of the *Bottled Gas for Better Life* program. It was concluded that there is no practical way to track such refills short of a digital payment mechanism that can automate the data collection. It was ultimately decided amongst the Phase II program partners that a question about number and frequency of LPG refill purchases is to be included in the concluding survey administered to all loan recipients.

Expansion potential

Where it has been launched, Bottled Gas for Better Life has garnered interest not only from households but also from small businesses in the food services sector. A future phase of the program may involve business microloans for the purchase of LPG for commercial use. Loans to small and medium enterprises (SMEs) should constitute a lower risk lending activity to MFIs than household lending, since the LPG is used for an income-generating purpose, and many small business owners in Cameroon, Kenya, and Ghana already belong to organized credit and savings groups.

Street food vendors could be one target group – a sector dominated by women. They are particularly vulnerable since they are exposed for long hours daily to hazardous cooking smoke from firewood or charcoal, both professionally and presumably at home as well (a double health burden). Moreover, their cooking often mirrors what happens at the household level. The food vendors' embracing of LPG for cooking would be a catalyst to greater acceptance of LPG for household cooking.

There is also an opportunity to expand the program through creating synergies with other energy services. GLPGP has received extensive interest from companies in the off-grid solar energy sector to collaborate on delivering LPG for cooking and solar home systems as a bundle to customers, either via microfinancing schemes and digital repayments, or potentially using nascent pay-as-you-go technologies.

Additional funding sources for program expansion and underwriting

As the program expands over time, it is hoped that MFIs will become more comfortable with the concept and commercial viability of LPG microfinancing. The eventual goal is that the MFIs will be able to fully fund the loans on their own, and guarantees from GLPGP (or any other third-party guarantor) to eliminate risk on delinquent loans will not be needed.

However, in addition to loan funds, funding is required for each rollout of *Bottled Gas for Better Life* for:

- Staff to manage the project, including the initial outreach to government and to potential partners to recruit them into the program, and to oversee program rollout. Eventually it is hoped that MFIs and LPG marketers will undertake this type of partnership directly, but our experience is that having an external catalyst at this early stage helps tremendously in coordination and management of challenges.
- Printing of publicity collateral and educational materials on LPG use and safety.
- Sensitization and awareness-raising events, such as cooking demonstrations, and additional publicity efforts such as door-to-door canvassing in peri-urban and rural communities. In Cameroon for example, this cost around US\$ 1,000 (including staff travel and collateral printing) for each community where eventually about 50-100 loan registrations would be obtained.
- Transportation, assembly and storage of equipment, prior to distribution to participants. Some of the MFI partner units in Cameroon were unwilling to store LPG equipment in their offices due to security or insurance concerns. This meant that any equipment uncollected by participants on the designated delivery date had to be transported back to suppliers' facilities, or incur extra costs for local storage.
- Hiring temporary staff to conduct baseline and end surveys for participants (M&E) as these are not business-as-usual operations for MFIs.

In current iterations of the program, the above activities have been funded by GLPGP using supplemental funding from a combination of donors apart from EU/KfW. It is envisioned that once proof of concept for LPG microfinancing is established, MFIs will be able to take on all or most of these costs (which should benefit from economies of scale with larger numbers of loans). Sensitization efforts could also be funded by a development finance institution, other donor, or supplemental project funding from other mechanisms (e.g., carbon credits)⁸¹.

Pay-as-you-go technologies

Pay-as-you-go technologies have been successful in off-grid lighting and electrification at shrinking significantly the size of individual purchase transactions for the consumption of energy. This has made off-grid electricity more affordable, on the dimension of transaction size, for households who find it difficult to accumulate the savings necessary to make a larger, single purchase, such as to own solar PV home equipment outright.

In LPG markets with unregulated end-user pricing and a strong mobile payments and wireless data services environment, such as in urban East Africa, new and established LPG distribution companies have begun experimenting with business models and technologies to apply the pay-as-you-go approach to LPG cylinder refills.

Their business premise is that by making the size of individual purchase transactions much smaller (and therefore much more frequent), many poor consumers who otherwise would not adopt and use LPG due to the size of purchase transactions can be persuaded to do so.

Initial pilot programs in the hundreds of users are being carried out by several companies in East Africa.

⁸¹ See the *Cameroon LPG Investment and Implementation* report for a description and discussion of such a program.

The latest generation of such systems for LPG employ wirelessly Internet-connected “smart valves” with embedded meters and controls which allow users to prepay for small quantities of LPG that are then released by the smart valve until the prepayment amount is used up. This is similar in practice to buying mobile phone minutes on a prepaid basis and then using them.

The cost of such valves is in the range of € 30 to € 50, which potentially doubles the asset intensity (*i.e.*, the CapEx) of an LPG distribution business which utilizes them. Unless and until those costs decline sharply, pay-as-you-go LPG companies may face significant challenges in generating adequate profits and financial returns compared to traditional LPG marketing and distribution companies serving the same markets, or may have to price significantly higher (per kg on average) to recover their added technology cost, thus reducing the size of the market they can serve. In Cameroon, with its regulated pricing structure and predefined margin limits for Marketers, commercial viability for pay-as-you-go LPG companies, except where largely or entirely grant-funded, is unlikely for the foreseeable future.

To recover the added cost of the smart valve over a reasonable time period, there are two main approaches, both of which are being used in the East African example companies:

- i. Charge the customer more, in some way. This can be through a subscription fee charged in addition to the cost of the LPG consumed, or through a surcharge to the LPG fuel cost, or both. This is more practical to do in an LPG market with unregulated pricing than in a market, such as Cameroon’s, that has regulated or semi-regulated LPG pricing.
- ii. Extract some level of operational savings by using the telemetry and usage data from the smart valves/meters to improve customer service and to optimize logistics. In practice, such operational savings have not risen to a level at which, by themselves, they cost-justify the pay-as-you-go technology.

A third approach, chosen by one East African pay-as-you-go LPG provider, is to forego profits; that is, to attempt to be price-competitive (per kg) with conventional LPG providers and accept a much reduced level of profits and a much reduced return on investment. This approach necessarily forces the company to seek grants and/or highly concessional capital in order to expand.

Profit-seeking pay-as-you-go LPG companies are making two strategic bets. It is too early, as of this writing, to judge whether the bets will prove sound, leading to meaningful scale of adoption and use and to commercial success for at least some competitors. These bets are that:

- i. A consumer who starts out as a pay-as-you-go customer of a given company will remain a customer of that company over the long term. That is, will pay-as-you-go technology serve as an on-ramp to the national LPG system for new users, who eventually transition to the traditional part of the LPG system (where the price per kg of LPG is often lower, but the transaction size is larger), or will they, mostly, remain pay-as-you-go customers for life? For companies that seek to create business value from LPG service, this bet may be hedged by operating a parallel LPG business on the traditional pay-as-you-refill model, so that customers who transition from pay-as-you-go can remain brand loyal. For companies that seek to create business value from selling the pay-as-you-go technology to other LPG companies, the result from this bet will determine whether their market is a narrow, niche market requiring a continual churn of the newest LPG users to survive, or whether it can expand to a meaningful share of the total residential LPG market, country by country.

- ii. The cost to acquire, deploy and use the pay-as-you-go technologies applicable to LPG will fall rapidly and significantly with time, increased scale, and growth in smart valve production volumes.

As of this writing, no pay-as-you-go LPG pilot program has been launched in Cameroon. Any such program which does launch in future would necessarily need to experiment with pricing and business models to find an optimal value proposition whose price points and elements are sufficiently attractive to a critical mass of unserved Cameroonian consumers, sufficiently attractive to the LPG company and its investors, and in compliance with government pricing requirements and related regulations.

19. Investment Plan Overview

Given that there is substantial unmet demand in Cameroon for LPG, the key issue that causes LPG sector scale-up to be slower than it could be (and is desired to be) by all relevant stakeholders—despite a reasonably good LPG ecosystem—is that self-financing by Cameroonian LPG businesses for major expansion of the national cylinder inventory has been generally unfeasible due to cashflows limited by the margins allowed by law and regulation, and due to external financing being prohibitively difficult to obtain, considering both the cost of capital and the terms available for acquiring the capital.

This is something of a self-fulfilling worldview among Cameroon's LPG stakeholders: failure to act to expand the sector aggressively in any one part of the supply chain for such reasons is, in turn, a valid reason for those operating at other parts of the chain not to act, either.

While a virtuous cycle of coordinated expansion projects is projected to expand LPG use significantly within the population over the next twelve years, expanding the LPG value chain to its maximum potential requires both a supply-side and a demand-side approach.

Stimulating additional LPG demand

To develop demand beyond what can be unlocked through investments that increase access and availability, additional measures should be undertaken, which could include the following:

- Fiscal or financial mechanism to discount new cylinders, as discussed hereafter
- Targeting of subsidies, to increase their effect for the segment of the population in actual need
- Financial empowerment of consumers, such as through LPG microfinance programs
- Consumer education and sensitization programs to stimulate demand by addressing consumer concerns, ignorance, misperceptions and misunderstandings about LPG and its benefits

These measures—and in particular, major expansion of LPG microfinance—are described and discussed in the *Cameroon LPG Investment and Implementation* report.

Governmental action is important

Government and its fiscal policies have an important role to play as well. Once the LPG sector does grow significantly, the cost to the Government of the LPG fuel subsidy, as presently configured, may become an equal or more important issue affecting the continuation of rapid growth. Moreover, desired regulatory and pricing reforms that are in the Government's control can improve the bankability, riskiness, safety, and efficiency of the sector, as well as the affordability of LPG equipment for consumers. While policy-related actions by Government are not essential for the first stage of market expansion to succeed, they will be important to the success of follow-on stages. The sooner that Government can implement the recommendations applicable to it in this report, and in the Cameroon LPG Master Plan, the sooner the benefits for sustainable growth (related to subsidy reform), bankability, riskiness, efficiency, safety, and efficiency of the sector can benefit consumers, industry, and investors.

Critical path of supply-side financing

Based on the research and analysis of the Clean Cooking for Africa/GLPGP financial expert team (as set forth more fully in the companion *Cameroon LPG Investment and Implementation* report) recommends the following steps be taken by the Government and its advisors⁸²:

1. Confirm the Government's support for the proposed, or some amended version of the, national LPG investment plan (Investment Plan), including confirmation by MINEE and MINFI;
2. Structure the potential lenders and their financing need
3. Select the appropriate funding structure(s) to optimize access to Funders at the most attractive overall terms for the Government, and for designated private sector champions;
4. Identify the leading Funders which can "crowd in" others;
5. Ensure the domestic execution parties have the cash flow absorption, deployment and generation capacities to support the proposed financing structures and to perform their roles;
6. Strengthen the "bankability" of the financing with sufficiently strong backstops, such as levies, guarantees and risk mitigation tools; and
7. Secure operational approval from relevant ministers and agencies as to the structuring and financing path chosen.

No set of Funders can ultimately be chosen until an LPG Investment Plan has been approved by the Government, and the specific recipients of the associated funding (that is, public sector or private sector companies or consortia for each major project or expansion of an existing business) identified and qualified.

The detailed investment and financing plan is documented in the companion *Cameroon LPG Investment and Implementation* report. In this report, this Part summarizes key elements of the companion report.

Financing and investment tranches

The recommended investments have been structured into three tranches which take into account potential growth in consumption, corresponding expansion of assets and business operations to serve that consumption, projected financial performance of the modalities, and expectations of a representative mix of prospective financing sources, based on conversations and interviews held.

The following table, reproduced from the *Cameroon LPG Investment and Implementation* report, summarizes the tranches:

⁸² Which may continue to include GLPGP

Table 47. Overall target capitalization of LPG investment projects - 2019 to 2030
(€ 000)

Tranche:	-1- 2019-2022	-2- 2023-2026	-3- 2027-2030	Totals
Total Cylinders	53,709 €	46,563 €	19,780 €	120,052 €
SCDP Bottling Plants & Storage	24,847 €	15,448 €	231 €	40,526 €
Non-SCDP Bottling Plants & Storage	28,019 €	17,420 €	261 €	45,700 €
Terminal Expansion	20,000 €	34,000 €	0 €	54,000 €
Transportation Enhancements	3,818 €	5,091 €	5,091 €	14,000 €
Gross Capital Investment	130,393 €	118,523 €	25,362 €	274,278 €
<i>Max. Potential Funding from Cylinder Deposits</i>	42,967 €	37,250 €	15,824 €	96,042 €
Potential Net Capital Investment (Floor)	87,426 €	81,272 €	9,538 €	178,237 €

Each tranche could be considered a standalone portfolio of linked projects. Tranche one represents the least risk, because it involves a measured expansion of the current LPG value chain, tapping into significant unmet demand (quantified in Chapter 12) without assuming any growth in per-user consumption, which is the main, material differentiator between the lower and upper bounds of the demand projection.

During tranches two and three, certain risks may become more important, and the level of these risks should be reassessed at the time. These include (i) the capacity of Government to continue to support fully the LPG subsidy as it grows, or the willingness of Government to reform the subsidy so that it no longer grows linearly with consumption but still provides appropriate support to the poor; (ii) the completion, ideally by 2024, of the terminal expansion project⁸³, and (iii) the level of consumption growth per LPG user vs. historical levels. With results known from the tranche one projects and activities, financing sources can make wiser funding decisions about the second, and then third, tranche, each of which might be resized or shifted in time to accommodate the evolving LPG environment and increased operational and financial knowledge about it.

In case consumption growth turns out to be closer to the lower bound of the demand projections than the upper bound, programs to stimulate additional demand and consumption may be implemented, instead of shrinking or delaying the supply-side investments. Certain examples, such as consumer LPG microfinance, are discussed later in this report, and additional examples and recommendations are presented in the *Cameroon LPG Investment and Implementation* report.

Summary of assets requiring financing

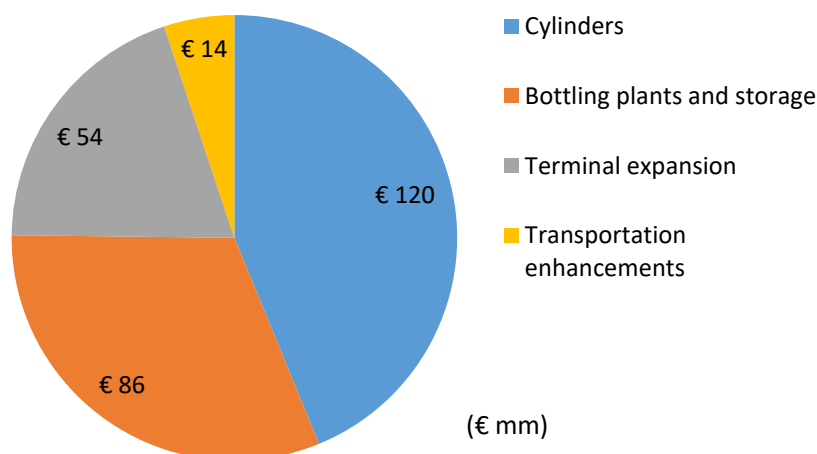
The overall investment requirements would cover 4.3 million additional LPG cylinders of 12.5kg equivalence, expansion of existing filling plants and construction of new plants with appropriate storage capacity, and development of the planned new LPG import facility at Kribi.

⁸³ This project represents a potential exception to the way the tranches have been organized. The terminal project should be completed by 2024 but requires three years to build and put into operation, with three phases of investment required (one per year). This project should be financed fully, even though, on the investment timeline, the use of and need for funding straddle tranches one and two. Therefore, it may be effective either (i) to carve out financing needed for the terminal project into a standalone structure, or (ii) to pre-arrange the needed financing commitments for the terminal during tranche one, so that the project is certain to be completed during the tranche two period, even if there are delays in mobilizing and deploying the rest of the tranche two capital for the other tranche two projects.

The GLPGP Clean Cooking for Africa expert team, working with Cameroon governmental ministries and agencies, LPG industry participants, and financial sector entities, identified the following € 274 million of capital expenditures over the 2019-30 period to help achieve such LPG penetration.

Table 48. Capital investment requirements to 2030 for LPG sector scale-up

Category	Capital Requirement (mm Euro)	Supply Chain Node
Cylinders	€ 120	Marketers
Bottling plants and storage	€ 86	SCDP / Marketers
Terminal expansion	€ 54	SCDP or competitor
Transportation enhancements	€ 14	Distribution (trucking)
Total	€ 274	



Gross asset values vs. net funding needs for cylinders

It should be noted that Marketers benefit from consumers paying a deposit for use of the cylinder. In Cameroon, Marketers may borrow internally against the cylinder deposits obtained from their end-customers. Under law, the cylinder deposit amount in Cameroon is set to 80% of the cost of the cylinder to its Marketer. The Marketer must treat these funds on its books as a liability of the Marketer to the depositor. The funds provided by the customer are to be returned to the customer when s/he cancels service and returns the cylinder to the Marketer. The internal reuse of these deposit funds makes the consumer, in effect, a major financing source for Marketers. As presented in the Table 47 above, this effect causes the net amount needed by Marketers for financing of new cylinders to be closer to 20% of the capital cost of the cylinders than 100%. The actual percentage will depend on the rate of cylinder inventory growth year over year, deposit liability reserve levels, cylinder losses and scrap rates, and other factors, and is not possible to determine in advance.

In this report, the sector-level investment focus (Chapter 15) has been on the total asset values for investment, and the firm-level focus (Chapter 16) on the net financing need of individual modalities.

Program strategy

The strategic objectives of the overall program are

1. To unlock, and to serve, the latent demand for LPG throughout the country, by utilizing appropriate financing structures, sources, and tools to enable qualified Cameroon LPG companies and projects to be built or expanded all along the supply chain in synchrony; and
2. To reduce or eliminate barriers that limit the ability of demand and consumption of LPG to develop and that limit the ability of the supply chain to serve the demand safely and efficiently.

The former objective depends on the investments set forth in this Part, while the latter depends on a combination of reforms to the enabling environment (Part V) and measures that encourage additional LPG adoption and use (Chapter 18, the cylinder discounting levy discussed below, and, beyond these, the program of supplemental activities described in Part VIII of the *Cameroon LPG Investment and Implementation* report).

SCDP

Because state-owned SCDP and/or SNH and other entities are main owners of certain portions of the major LPG infrastructure assets (in particular, the Kribi terminal project and a portion of the filling plants and national storage network), they may have access to sovereign or sovereign-backed funding apart from the approaches described in this report. SCDP, in particular, has suggested that it may seek financing from the Government for its recommended investments, provided the corresponding investments along the supply chain are financed and made as well. If that turns out to be a workable modality for that portion of the financing, it can be split from, or partially co-funded with, the remaining cylinder, filling, storage and transport investments.

This report assumes, however, that such state-owned enterprises will seek some or all of the required financing from non-governmental sources, in view of the need of the Government to be cautious about uses of its balance sheet (discussed more fully in Chapter 17 beginning on page 149). While it was within the scope of this report to discuss the non-terminal assets and projects in some detail, it was beyond the report scope to address in detail the Kribi terminal project and its economics, other than to identify key timing requirements and its overall funding need.

Filling plants (SCDP and Marketers)

The filling plants involve short-term, medium-term and long-term cost components, and the main investments would be clustered in 2020-2021 and in 2024.

For geographic areas where SCDP has adequate geographic storage, filling and depot coverage, its economics as a centralized LPG utility are economically and strategically advantageous to Marketers, and as such, Marketers are recommended to, and are expected to, utilize SCDP services as much as practical. The national filling share of SCDP is projected to remain around 80% to 2030 on this basis.

Nonetheless, a number of Marketers will continue to make filling plant and storage investments on their own to perform in-house filling, either to maintain strategic independence from SCDP with regard to this critical part of the LPG supply chain functionality, and/or to operate more cost-efficiently and time-

efficiently in geographic areas where SCDP has limited or no practical presence, taking into account incremental transportation, critical geographic density of activities, and other costs and cost factors.

Cylinders (Marketers)

The cylinders would be funded in three four-year tranches spread over the 2019-2030 period, with interest only the first year and equal principal repayments in the remaining years of each tranche. Repayment periods would range from 3-7 years, based on the tranche.

Capital recovery and cylinder affordability mechanism

An important element for accelerating growth and improving bankability in the proposed Investment Plan, in addition to reducing significantly the up-front cost to the consumer to obtain a first LPG cylinder, is the establishment of a notionally 12-year LPG levy in the LPG price structure, such that the price structure can reduce the initial cost of cylinders to the supply chain. This reduction, if employed, is in effect a subsidy that covers a portion of the capital cost of the key, high-risk asset—cylinders—thereby improving the risk profile of the cylinder investment for the Marketers and their investors and lenders, increasing substantially the rate at which cylinders can be acquired and deployed without generating negative cashflow, and as a corollary benefit, decreasing proportionately the size of the deposit required of consumers to acquire a new LPG cylinder.

This mechanism, which (if paid by the consumer) would increase LPG pricing by approximately 4.6% on average until 2030, might increase consumer adoption on balance, but quantification of that effect was not feasible to calculate with the data available. The countervailing reduction in LPG consumption (but not in the rate of adoption) from such a price increase would be approximately of 5.5%, based on the price sensitivity analysis from Part VI.

The LPG levy, if adopted as proposed and as discussed to date with the Government, would result in a reduction in the capital cost paid by the LPG Marketers for cylinders of approximately 40%. This 40% savings would have a ripple effect throughout the supply chain, potentially reducing in proportion the working capital need of the distribution and retailing network and the one-time deposit amount to be paid by consumers for access to their LPG cylinder service under BCRM.

The levy, when combined with an SPV or other similar financing vehicle for pooling of national cylinder acquisition and management, has several purposes:

1. To partially shift the risk associated with cylinder investment from the Marketers to the LPG market as a whole (that is, recovery of capital is partially shifted to the levy, a state-administered mechanism associated with the total volume of LPG consumed in the country, and not to any one private counterparty);

2. To increase (by approximately the same 40%) the rate at which the entire supply chain, starting with the Marketers⁸⁴, can acquire and deploy cylinders without reducing their free cashflows to unsustainably low levels, or to zero or below;
3. To provide a layer of improved diligence, transparency, and accountability for cylinder assets to the Funders, in view of many private-sector LPG businesses having non-standard or incomplete accounting (of their LPG operations, where multiproduct), insufficiently strong balance sheets, inadequate credit capacity (such as for obtaining letters of credit affordably), and so on;
4. To increase the focus of the LPG sector on customer acquisition and customer service by reducing the need to focus on cylinder acquisition and financing.

Importantly, the structures proposed in this report to back these expenditures benefit from: transparency, liquidity, and potential pricing and returns requirements of Funders as well as regulatory bodies that control local institutions such as banks, pensions, and insurance companies. This set of benefits should make successful funding more likely.

Recommended cylinder acquisition process under a cylinder aggregation SPV

A number of structuring options are presented later in this Chapter for investment into the various modalities within the Investment Plan. The first of these options, a special purpose vehicle (SPV) specifically oriented to cylinders, is presented here.

Which vehicles and structures would ultimately be used to fund the various investments and tranches can be determined only after detailed discussion and negotiation of specific transactions with Funders.

SPV-Cylinders (SPV-C)

A SPV-Cylinders (SPV-C) would purchase cylinders by pooling all the procurements under a BOT framework, using different contracts signed among the SPV-C, the Marketers, and the Funders. It would be necessary to secure from each Marketer its commitment to the SPV-C to put up its share of the funding based on its existing share, or expected share of the increase, in cylinders.

SPV-C would conduct a global procurement based on agreed-upon specifications (see below). The cylinder purchases are expected to be in three tranches of approximately four years each, with the subsequent one activated based on the successful completion of the sales of the prior one. In the contract, each Marketer would address its participation in the program, including the necessary details of commitments and obligations (the maintenance and replacement of the cylinders, the conditions of the BOT, and the safety and distribution of cylinders).

In advance of the order, each Marketer would be expected to provide two financial amounts:

- i. A rolling indicative purchase order for that tranche, setting out the number of cylinders it expects to order over that period; and

⁸⁴ Each node of the supply chain downstream of the Marketers, as cylinder investors, obtains its cylinder inventory from the node above on deposit, which consumes working capital. The deposit amounts would decrease by 40% in a cascade down the chain, ultimately reducing the deposit paid by the consumer for an individual new cylinder.

- ii. A commitment letter to buy a specified number of cylinders for that year if a manufacturer's offered price in the public auction is at or below the Marketer's specified price.

If the specified price is met, the Marketer must then prepay the order. If the price to the Marketer includes a levy-backed discount, the Marketer is prepaying its 60% of the cylinder cost, and final asset transfer would occur after the levy mechanism pays the SPV-C the remaining 40%. If there is no material discount (other than from pooling of purchases), the Marketer bypasses the BOT approach to take immediate title to the cylinders. This helps avoid a requirement of asking the Marketer or Bottler to post a standby letter of credit to ensure payment performance. Manufacturers could then start to build the cylinders against that confirmed, and paid for, order.

"Rolling" means that at the end of each 12-month period, each Marketer or Bottler needs to present a new indicative order. Given the size of the orders, it is expected that at least two manufacturers will be contracted to provide cylinders, to avoid the risk that a single provider has production problems which could hamper the growth and development of the Cameroonian cylinder market.

For cylinders subject to BOT, ownership of the cylinders would preferably remain with the SPV-C until the Funders were repaid, as a strong form of security against the invested/loaned capital. This also ensures that the SPV can reallocate money and cylinders over time as Marketers perform, or do not perform. A secondary effect is a level of *de facto* consolidation, pooling risk across the sector while enforcing operational discipline and mandating adequate reporting and accountability from all participants to a standard level of completeness and quality. (In practice, the point at which ownership would transfer would be a subject of negotiation among the Funders, SPV, and the Marketers as a class). Once the Funders are fully repaid, the SPV-C can sell the individual assets for the residual values remaining in their expected operation life, less what was originally paid up-front by the Marketers, by customers' deposits, and (if in force) by the cylinder discounting levy.

Either way, the cylinders remain the responsibility of each Marketer through the BOT contract between the SPV-C and these parties, which includes undertakings: (i) that the responsibility and the obligation of the Marketers is to ensure the cylinder remains under the control of its distribution network, (ii) to not resell or transfer the ownership rights of the cylinders, (iii) to transfer the use of the cylinders thru the refundable deposit scheme, (iv) to refill the cylinders complying with the applicable norms, and (v) to maintain and repair the cylinders (including the valves) as per the applicable norms to guarantee the safety of the cylinder over its useful life.

Harmonized specifications

While respecting each Marketer's registered color and brand, it is recommended to establish a harmonized set of specifications for the cylinders, based on the Cameroon norm, and to allow each Marketer to choose its preferred size(s) of cylinder (12.5kg, 6kg, etc.) Any order not 12.5kg in size and different from the harmonized specifications may result in different pricing for those cylinders.

Non-cylinder asset ownership

The filling plants, storage, terminal and transportation are recommended to be built and procured through a public tender process and under a "build, own, transfer" (BOT) framework, noting that different ownership structures might be necessary with respect to state-owned projects (SCDP, Kribi terminal), as

previously mentioned. Ownership should remain with the relevant aggregating entity (as discussed below), and not transfer to an ultimate end-owner until the cost of that part of the financing has been fully repaid.

Operational responsibility for the asset will flow from such entities by contract to the responsible local parties. Once the Funders are fully repaid, the relevant SPV can sell the individual assets for the residual value remaining in the assets' expected operational life.

Summary of financial structuring and arranging approach

To fund these investment projects, it is recommended to create up to four types of financing vehicles: two special purpose vehicles (SPVs), Non-Bank Financial Institutions (NBFIs), or Investment Funds (Funds). One, an SPV-Cylinders, has already been mentioned. The choice of which one or ones to create would be based on the requirements and preferences of the Funders, who will take into account the relative efficiency in the deployment of their capital, structuring- and vehicle-specific risks applicable to them, and the rules (internal or external) that they must follow regarding the use of such vehicles.

A potential financing role for the Clean Cooking for Africa Program/GLPGP could be to provide the expert resources to act as technical advisor to the SPV managerial companies, the NBFI and/or the Funds, to help establish objective outside management and oversight of comfort to both large foreign and some domestic institutional (debt and equity) providers (Funders), as well as risk mitigation sources.

The recommended approach for mobilizing funding, guarantees, and risk mitigation options is initially to focus on sizable sources, as "leaders," in building the capital and risk mitigation layers and "crowd in" other Funders. This entails engaging both Cameroonian and non-Cameroonian sources. Ideally the approach will enable GLPGP-related entities in the target markets to mobilize funding to build out the LPG supply chains, and use commercial and concessional capital (Blended Capital) to yield, in hard currency, an overall target debt interest rate of around 8% and a target equity internal rate of return (IRR) of around 20%. These rates are consistent with what capital providers to top-ranked investments are currently realizing in target Sub-Saharan African markets.

Main structuring options

The four options discussed below are the likeliest alternatives on an initial basis, based on the fact that the NPA and Task Force deliberation and decision-making process regarding the investment projects and enabling environment are not yet concluded. The options will be refined based upon further local LPG constituent and Funder discussions. While they are not the only options, they represent the most attractive identified to date based on extensive consultations.

The four options all entail prioritizing the blending of local capital with international capital. They differ in that the Investment Funds approach (Option 4) will most likely not attract considerable local funding, because institutional investors' stated preferences regarding liquidity would be difficult or impossible to meet via a longer-horizon fund. The following four options are prioritized as follows. They match funding structures with appropriate Funders and risk mitigation sources:

- 1) "SPV-C (Cameroon)" Listed.** For example, a cylinder-focused SPV for Cameroon. For cylinder investment, a dedicated LPG fuel levy could be created and used to cover the portion (notionally 40%) of the capital costs of cylinders borne by the SPV. The SPV would be funded by investors, would acquire cylinders, would resell them at a 40% discount to Marketers, and would recover that

40% from the levy over time. This involves active outside oversight, such as through an escrow agent and specialist⁸⁵, and transparent involvement of capital expenditures entities. DFI and other guarantors, such as the Africa Guarantee Fund, could be brought in to support the Investment Plan through, or alongside, the SPV-C. The SPV-C approach allows for aggregated investment in, oversight of, and monetization from, cylinder assets, while allowing for direct investment or co-investment into more conventional (non-mobile) assets and modalities, such as storage facilities and cylinder filling plants.

- 2) **LPG (Vertical) SPVs-listed or Non-listed.** For example, an LPG sector SPV for Cameroon. The SPV would fund the underlying modalities' growth. As with all the structures, this option would depend on the creation/enhancement of the "bankability" of the underlying entities to be funded and de-risked. This also involves active outside oversight, such as through an escrow agent and specialist, and transparent involvement of capital expenditures entities. A sector SPV would provide the greatest flexibility with respect to structures, types of capital to be invested, and monetization options. The level of official market based oversight, such as through the Cameroon Securities and Exchange Commission (SEC) if this SPV were listed, will also impact the level of appeal such a structure will have to Funders. A sector SPV could subsume the role and function of the cylinder-focused SPV-C.
- 3) **LPG Non-Bank Financial Institution (NBFI).** Create a new NBFI entity which could finance specific LPG developments (and also could be listed). This option would be appropriate as a backup to the above two SPV approaches, if a critical mass of Funders cannot be assembled to capitalize an SPV structure. The NBFI would be limited to lending activities (no equity investment) and would be subject to specific regulations and requirements that GLPGP has researched and discussed for potential partnering with existing local financial institution leaders such as Afriland First Bank, which is an existing banker to nine of the 12 Cameroon LPG marketing companies. AfDB, CDC, DBSA, DEG, FMO, IFC, Norfund, OPIC, Proparco (which has expressed its interest for such time as the right funding candidates are put forward) and Swedfund are prospective NBFI Funders. These institutions are active in financial institutions/innovations and also infrastructure plays. In addition, along with EIB, many of these institutions were recently part of the announced € 1.2 billion Nachtigal Hydro Power Company financing (Nachtigal Financing).
- 4) **Investment Funds (LPG infrastructure Development Fund (LID) and LPG First Costs Fund (FCF)).** Clean Cooking for Africa/GLPGP could create two multicountry LPG-specific Investment Funds with an appropriate and qualified fund operating partner (a DFI or a regional investment or merchant bank with relevant experience) for LPG sector investment in Clean Cooking for Africa countries, such as Cameroon, where large-scale LPG investment is deemed feasible. These Funds would act as aggregators and managers of DFI and other institutional capital from major Funders. The LID Fund would be for the capital expenditures and growth capital along the LPG supply chain. The concessional-rate FCF Fund would be for the related SME working capital and consumer and small business microfinance needs. Because of the FCF Fund's mandate to facilitate accessible and affordable finance for SMEs and consumers, it may be an earlier candidate to design and partner with a local financial institution, such as Afriland First Bank or BICEC (Banque Internationale du Cameroun pour l'Epargne et le Cr dit), which have asset management activities.

⁸⁵ Such as Clean Cooking for Africa/GLPGP

The case of the DFI/local bank Nachtigal Financing is instructive because it demonstrates that, despite being capital-constrained, larger locally-operating banks such as Societe Generale Cameroun and Standard Chartered Bank Cameroon can step into the financing equation alongside major international Funders (concessional and commercial) to create a blended finance mix of significant scale. The major foreign and domestic Funders and providers of other structural supports like guarantee mechanisms include: African Development Bank, Africa Finance Corporation, Agence Francaise de Developpement, Attijariwafa SCB Cameroon, BICEC, CDC Group, DEG, EIB, PIDG company - the Emerging Africa Infrastructure, FMO, International Finance Corporation, OFID, Proparco, Société Générale Cameroun, Standard Chartered Bank Cameroon.

As previously noted, funding for state-owned projects (SCDP assets, Kribi terminal) might be sought by the relevant entity from the Government, in whole or in part, which could affect Funders' preferences for choosing among the above-mentioned vehicles, as well as which Funders participate. The state has not specified a definite preference for how new state-owned assets would be financed as of this writing. Accordingly, the approach taken in this report, for sake of not omitting a key asset that requires financing, is that these vehicles would include financing (or at least co-financing) for these assets.

Main advantages of these four options

- a) They are potentially appealing to the Government because MINFI, as well as the Central Bank of Central African States (BEAC, Banque des États de l'Afrique Centrale), desire to encourage more domestic and foreign institutional investment into Cameroon's infrastructure and critical social and business sector development.
- b) They will also appeal to DFIs and IFIs who are trying to promote capital flows into Cameroon and emerging markets through innovative financial instruments. AfDB, CDC, FMO, OPIC, and the IFC are active examples of groups to be approached to back these instruments in some capacity. This can be through investment in the SPVs, on-lending or funding the NBFIs or parent company, investing as limited partners in an Investment Fund (debt or equity funds), or providing guarantees. These groups have indicated their potential interest once the specifics are established behind how such vehicles might be structured and operated.
- c) They can attract a wide range of local and CEMAC institutional investors such as pension funds, mutual funds, insurance companies, private investment houses and foreign investors.
- d) The precedents for documentation and structuring have been established and accepted for SPV and corporate related securities issuance and shelf registrations of debt and equity, bonds, etc. This means that the primary targets among local market institutional investors and foreign investors are familiar with the concepts involved.

Benchmarks for funding the investment plan

Descriptions of relevant benchmarks for mobilizing foreign capital to meet the requirements of large capital initiatives in Cameroon are presented in the *Cameroon LPG Investment and Implementation report*.

20. Potential Funding Sources

Important drivers in choosing among alternatives for financing the investments

Important requisites for choosing financing approaches and sources include:

1. Cameroon's targeted LPG-related funding needs all along the value chain (from importation to consumer) should be well defined.
2. The entities or modalities in the LPG value chain which are willing and able to take on the ultimate repayment responsibilities should be able to demonstrate "bankability". (This implies that not all market participants will initially participate in the funding solution; of those that do not, some will work toward participating later, some will stay out and presumably be at a competitive disadvantage, and some may contemplate mergers or being acquired.)
3. The debt and equity (or other instruments) should reflect the blended capital that is most efficient, to achieve the costs and structural terms most suited for the Investment Plan.
4. The risk and return needs (financial, liability management, etc.) of the Funders have to be factored into the instruments for best success potential to be able to close with the Funders.
5. Attracting the participation of meaningful internal sources is a means to "crowd in" external funding sources by providing a vote of confidence).
6. Operational cashflow predictability and managerial, operational and financial transparency should be well-established to encourage faster responses from Funders.
7. There should be built-in risk mitigation: Escrow accounts, liquidity, governance by outside parties (trustee agents such as banks and industry auditors) to monitor economic flows.
8. Respected, professional, and sector-experienced management for the funding vehicles is necessary.

If possible, an "official request" by the Government will facilitate responses from DFI, IFI, and MDB Funders when sound, detailed business plans for the projects and business expansions are in place. The Government is currently active with international Funders, so fund arrangers (which may involve the Clean Cooking for Africa Program/GLPGP) should engage with MINFI and the national agencies designated to attract national investments, to align interests and strategize on approaching the larger foreign sources of capital and guarantees.

Addressing Funder requirements for LPG financing

1. In building the specific capitalization mix from blended finance sources, one must be aware of the particular characteristics of the targeted Funders, and take these into consideration. These include but are not limited to:
 - a) Funders' Own Liability and Fiduciary Requirements: Requirements for repaying or meeting their funds sources' repayment requirements. Pensions and insurance companies need to match the weekly, monthly or other payment requirements of their clientele.

- b) Other Competing Investment Opportunities: The range of structures and the risk-adjusted returns being offered is considerable.

The opportunity cost of taking on an LPG-related investment versus other investments available must be addressed. LPG-related investments are competing for domestic funds against government securities and also other high-quality fixed income instruments.

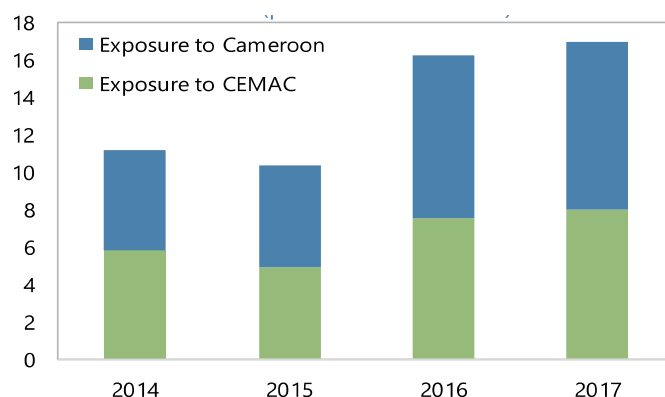
2. For the proposed and recommended LPG structures to be attractive, the funding vehicles must at a minimum be able to attract investors with the correct blend of risk-adjusted prices, equity comparable returns (meaning high and predictable cash flow), credit comfort (if debt or debt-like), and maturities at least as attractive as those of comparable opportunities.
3. For the portion of the Cameroon LPG sector development funded by such entities, the four options are appropriately suited to take advantage of the structural expectations and realities in Cameroon's capital markets.
4. GLPGP determined from its face-to-face discussions and market research with leading Cameroonian investment groups and banks that:
 - There is a preference for debt or fixed income-linked investment securities over equities (for reasons of predictability of returns, transparency, and current income);
 - The local institutional investors seek high levels of asset coverage. For example, Afriland First Bank stated a requirement of 1.5X coverage of assets for any letter of credit provided. Thus, for example, € 120 million of cylinder investment would require € 180 million of acceptable assets as collateral, if purchased *en masse*.
 - Therefore, sourcing of equity and quasi-equity, and of debt on terms supportable by the Cameroon LPG modalities on average, will require significant participation from international Funders able to tolerate and/or mitigate the risks represented by the equity component of the investments and the higher risk asset types, such as cylinders.

Identification of prospective funding sources

To focus efforts efficiently on targeting the largest and most accommodative mix of blended capital from pivotal funding groups (Development Finance Institutions (DFIs), International Financial Institutions (IFIs), and Multilateral Development Banks (MDBs)) as leads, coupled with risk mitigation, the Clean Cooking for Africa/GLPGP team conducted face-to-face discussions and phone calls, and researched comparable activities of the targeted organizations.

In Cameroon, there is a relatively limited depth of capital and investment/funding flexibility by the existing financial sector capital sources (banks, investment funds, pensions, insurance companies and others). Banks are also strained by debt exposure to state-owned enterprises (SOE) and typically limit their funding to larger, more established businesses that can maintain high cash balances at the banks: trade-related accounts that can serve as collateral, or hard assets. The chart below from the latest IMF report on Cameroon (IMF 2018) demonstrates that Cameroon's banks are investing heavily in the Central African countries beyond Cameroon. This results in limited capital available and deployed to local businesses.

Figure 47. Cameroon banks' sovereign exposure, 2014-2017



Because of the limitations of the domestic Cameroon business funding markets, it is anticipated that the majority of the funding for the investments described in the preceding Chapters will be led by foreign capital sources of debt and equity and then supplemented by local banks and potentially other local institutional investors (e.g., from the sole pension fund in Cameroon). Efficient funding efforts should therefore focus on targeting the largest and most accommodative larger-scale mix of blended capital from funding groups such as development finance institutions (DFIs), international financial institutions (IFIs) and multilateral development banks (MDBs) as leads, coupled with risk mitigation.

The Clean Cooking for Africa/GLPGP financing experts conducted face-to-face discussions and calls with, and researched comparable activities of, an array of prospective financing sources inside and outside Cameroon. Funding must be customized to meet the requirements of these sources, and may come from privately placed arrangements. The equity and debt markets for public capital-raising are thin on the Douala Stock Exchange, as mentioned above, so utilizing larger regional listed capital approaches may be preferable, or listing an SPV on selected Central or West African stock exchanges using the services of pan-African banks such as Ecobank, UBA, Standard Charter or Stanbic. These banks have expressed interest in assisting in this capacity.

It is noteworthy that international MDBs, such as the IBRD, IDA, AfDB, AsDB, EBRD and IADB, committed almost \$84 billion in 2014. European DFIs, such as BIO, CDC, COFIDES, DEG, FINNFUND, FMO, IFU, Norfund, OeEB, PROPARCO, SBI, Sifern, SIMEST, SOFID, and SWEDFUND committed \$6.8 billion in 2015, and OPIC a further \$4.4 billion. IFIs contributed additional funds. This indicates that funding and Funders are available if the targeted recipient and project are right.

Currency

An advantage for financing Cameroonian projects is that the purchase contracts of assets sold by non-Cameroonian firms into Cameroon could be denominated in Euros, because there is a fixed currency link between the Euro and the CFA.

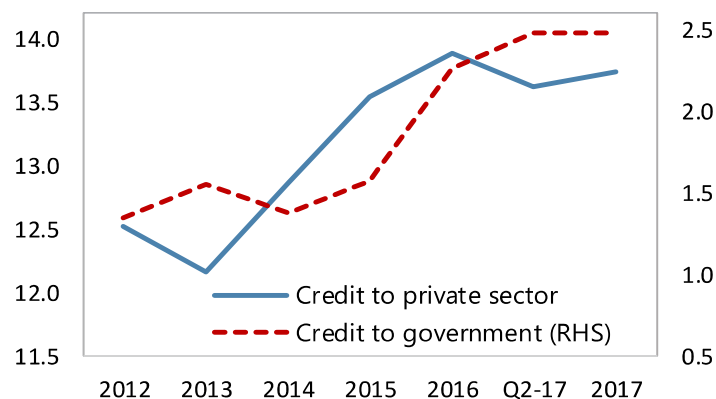
Internal Funders: Analysis of Cameroonian Sources of Funding

The Government has internal funding demands and budgetary constraints that limit its ability to support LPG Master Plan without raising outside capital from bonds or other sources. Major SOEs like Sonora are placing budgetary strain on local banks and the Government budget, according to the IMF. The IMF reports

that “...about two-thirds of arrears are tax arrears, which generate revenue gaps for the government”. Banks control close to US \$9.2 billion in assets⁸⁶, indicating availability of capital, but large exposures to non-performing loans (NPLs) from SOEs like CAMTEL, CAMWATER, and CDE limit internal funding capacity to lend to a wider range of private or PPP projects, such as the LPG initiatives described in this report.

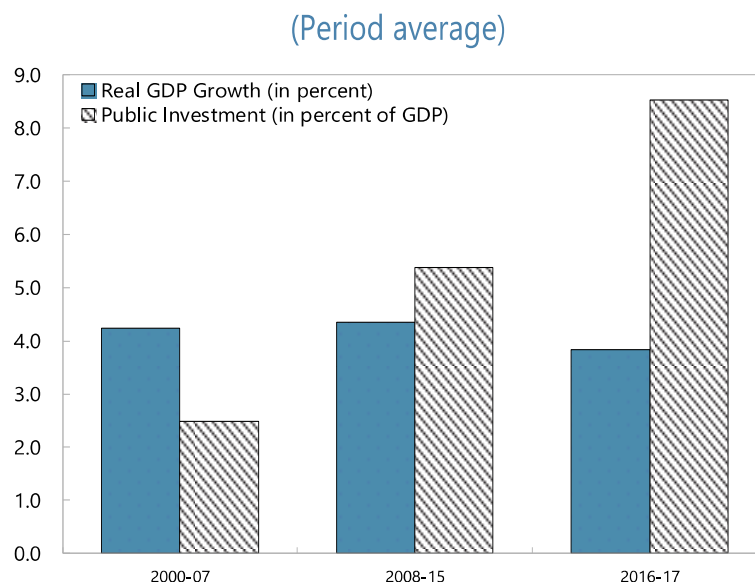
The chart below shows how private credit, primarily from local banks and bond markets, is the largest source of funding in Cameroon. Such sources are tied up in Government financing activities, as indicated by the chart. This leads to a “crowding-out effect”, which then requires foreign funds to be drawn into the mix.

Figure 48. Credit to the Government and private sector in Cameroon, 2012-2017⁸⁷



The following two figures indicate, under a positive interpretation, a role for the Government in mobilizing or attracting foreign capital for investment and GDP growth, including for the LPG sector.

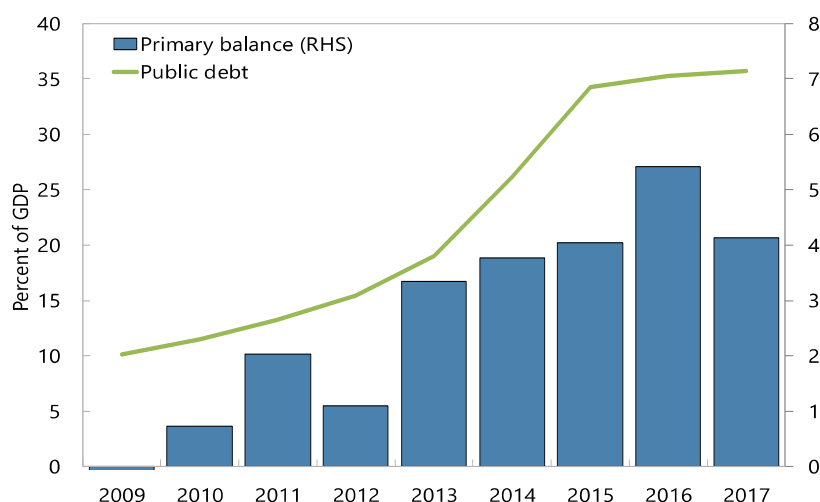
Figure 49. Economic growth and public investment 2000-07, 2008-15, 2016-17⁸⁸



⁸⁶ IMF Country Report No. 18/256 (August 2018)

⁸⁷ Sources: BEAC, COBAC, IMF calculations

⁸⁸ Sources: Government of Cameroon, IMF calculations (2018)

Figure 50. Public debt and primary balance, 2009-2017⁸⁹

Under a negative interpretation, public investments outpace GDP growth, with the government accumulating public deficits. If the source of such borrowing is local financial institutions, and if these are meaningful tax arrears, it suggests the possibility of a misuse of resources.

The Doula Stock Exchange has only three listed companies. By comparison, Kenya and Ghana have much more active publicly-listed equity and debt exchanges; while not extremely liquid, numerous private companies have listed on the Kenyan and Ghanaian exchanges, and they have attracted both domestic institutional pensions, mutual funds, and insurance companies as investors. Cameroon's much shallower public listing market implies taking creative approaches to structures that can attract CEMAC regional and international investors to fund a Cameroonian SPV. This would most likely occur through either a private placement or a regional listing (eventually) of an SPV in the CEMAC regional public markets (debt or equity).

Although the bulk of the capital for the Investment Plan is expected to come from foreign capital, it is desirable also to attract some Cameroonian banks, pensions, mutual funds, insurance companies and specialized investment funds, as supplemental domestic investor targets, even though the locally active commercial banks have expressed a strong preference for fixed-income investments and for very high asset coverage. Politically, it may be advantageous (noting the risk of misuse of resources mentioned above) for local financial sector participation as well. International investment banks and specialized institutions (such as development banks)—thus represent a first prospective lead source of funding. Second are private/public/parastatal specialized infrastructure and sector funds, institutions like pensions, mutual funds, insurance companies, and private debt and equity firms.

Hurdle rates of return among local banks

To understand the hurdle rates of returns expected by local banks, key operational performance points are worth noting in designing the necessary structures:

⁸⁹ Ibid.

- i. The banks' overall Return on Assets (ROA) was 0.7% in 2017. Although this is slightly better than the 0.6% for CEMAC region banks, it is low for banks globally (Ghanaian banks produced an average 2.8% ROA in 2017, for example).
- ii. In Cameroon, Return on Equity (ROE) for the banks on average is 14%. By comparison, ROE was 19.7% for the 34 Ghanaian banks surveyed by PwC in its *PwC 2018 Ghana Banking Survey*.
- iii. Specific to the pricing of bank loans in the capital structure presented in this report, the targeted 8.93% interest payment and 20% IRR equity returns should satisfy these ROA and ROE benchmarks, since the hard currency interest rate and equity return targets are higher than what banks are realizing.

Identification and qualification of Funders

To ascertain the capacity of banks to meet the LPG Investment Plan needs, GLPGP established dialogues with leaders such as Afriland First Bank, Ecobank, and Stanbic. With these Funders, assets and collateral are, in some cases, as important as cash flows, requiring business and transaction structuring to satisfy those interests. This could benefit from guarantees from DFIs or other groups working with DFIs like GuarantCo. In Cameroon, private sector banks and DFIs have worked together funding entities in partnerships including the utilization of guarantees.

Local institutional capital from banks, pensions, insurance, mutual funds and specialized funds, using SPVs to ring-fence the borrowers' assets and cash flows for honoring repayment and returns to Funders, are all prospective financing participants. These identified Cameroonian institutions are active in debt and debt-linked investments such as Government and CEMAC sovereign securities. Importantly, the LPG funding needs in Cameroon are over a 12-year period, allowing the Funders to phase in their funding over time. This means that local Funders may be able to roll over their exposures once a prior lending tranche is repaid. Additionally, some Cameroonian-sourced Funders may then be in a position to put more money into follow-on tranches, if satisfied with the performance of their initial exposures. A pension fund or insurance company might buy a tranche of 4-year exposure, and have it repaid over that period. A DFI or IFI with a much longer time horizon (5 to 12 years) could take straight private debt and hold for a longer period. With this kind of capital stacking and layering over time, it is anticipated to be feasible to mobilize the required € 274 million internationally and locally into properly-structured SPVs in Cameroon.

As noted, outside of local banks the internal sources of institutional investment capital in Cameroon are not as deep as other sub-Saharan African countries. As such, the full funding of the recommended LPG investments for Cameroon will also depend heavily on mobilizing non-Cameroon based capital sources.

As shown in Table 43 on page 153, the relevant institutional funding and investment landscape in Cameroon is comprised mainly of 14 commercial banks, 1 pension fund, 26 insurance companies, 1 postal savings institution, and an extremely small stock exchange (3 listed companies). Together their assets are about US \$12 billion.

Typically pensions, insurance companies, and mutual funds are long-term fixed income seeking investors. This demand feeds countries' bond markets and other fixed income investments that back infrastructure and other national spending initiatives. For perspective, Cameroon has only one pension fund as compared to 33 in Ghana, excluding the state owned pension fund SSNIT, the largest financial entity in Ghana. According to the World Bank, pensions in 2016 accounted for 12.75% and 4.06% of GDP in Kenya and

Ghana, respectively, compared to 2.3% in Cameroon. Cameroon's pension fund, The National Social Security Fund (CNPS), has about US \$800 million in assets and insurance companies in Cameroon have another US \$1 billion in assets, all of which are regulated in allowed investments, particularly with regard to the private sector. This limits the scope of local investable funds within Cameroon. In Cameroon, the commercial banks, with US \$9.2 billion in assets, are therefore the most likely, and largest, local source of funding for LPG initiatives.

External Funding Sources: Non-Cameroonian Sources of Funding

With regard to external sources of funding, DFIs, IFIs, MDBs, private debt/equity, and regional and international bond markets have all been active recently in funding Cameroon. As previously described, the IFC and EIB syndicated and led the Nachtigal Financing, which is a current reference around options for Cameroonian-focused funding for LPG may be developed, by targeting similar blended finance syndicate Funding sources.

To do this effectively, the LPG projects must demonstrate the capacities to meet these Funders' requirements. A number of prospective Funders have expressed interest in exposure to the LPG sector in Central Africa, under suitable conditions. DFIs and IFIs will typically price their debt at spreads to their cost of funds such as Libor, Euribor, or US Treasuries. Hybrid institutions such as MDBs (AfDB for example) may have members who provide funding at a range of costs to support certain international impact and development initiatives. For DFIs and IFIs, their pricing spreads may range from 200 basis points (bps) to 600 bps. This varies based on capital markets conditions as well, and can be lower for some DFIs. These same groups have an acceptable range for loan maturities, repayment approaches (amortizing or bullet maturity), moratoriums on the commencement of repayment of interest and principal, etc. In terms of maturities and timing of funding and exposures for LPG in Cameroon, there is alignment with the maturity tolerances of DFIs and IFIs in the range of 5 to 15 years. These are highlighted in the next figure:

Table 49. Capitalization stacking and maturities of DFIs and IFIs

CAPITALIZATION STACKING DFIs/IFIs	Typically Up to					Terms	
	Grants	Debt	Equity	Benchmark Pricing/Int. Spread	Applicable Term (yrs)	Grace	Prds
AfDB	yes	\$50 - \$100	yes		15 to 20 years		yes
BOAD			yes				
DFID: CDC (Infra, health and ed, financial inst. some priorities)	yes	\$20 - \$100	yes	Cap Mkts	5 to 10 yrs		yes
DEG		\$50 - \$100	yes				
EIB	yes	\$50 - \$100	yes	Cap Mkts	5 to 10 yrs		yes
ECOWAS Bank		\$50 - \$100					
FinnFund	yes	\$10 to \$50	yes				
US EXIM (Guarantees and trade facilitation)							
IDA (Credit/grants & guarantees to Govt directly for Infra Proj)	yes				5 to 10 yrs		yes
IDA (Private Sector Window: debt/eq/grants/gtees: to Govt or Proj)	yes			Libor/Eurbor	5 to 10 yrs		yes
IDA (Scale up Facility & Transitional Support Rates: Fixed Rate)	yes	\$50 - \$100		Libor/Eurbor +120/+125	15 -18 (terms)		yes
IDA 17 (Scale up Facility: Fixed Spread)	yes	\$50 - \$100		Libor/Eurbor +120/+125	24 (terms)		yes
IDA 18 (Scale up Facility SUF: Fixed Spread)	yes	\$50 - \$100		Libor/Eurbor +120/+125	to 35 (ARMM 20)		yes
IBRD (Inv Proj Fin "IFP") or IBRD Loans (Fixed Spread)	yes	\$50 - \$100		Libor/Eurbor +120/+105	15 -18 (terms)		tbd
IBRD (Inv Proj Fin "IFP") or IBRD Loans (Variable Spread)	yes	\$50 - \$100		Libor/Eurbor +86/+86bps	15 -18 (terms)		tbd
IBRD (Development Policy Financing "DPP")	yes	\$50 - \$100		6 Mo Lib	min 200bps	5 to 10 yrs	3-5 yrs
IBRD (Trust Funds FIFs: GEF, Climate Inv Funds) (to Govt or Proj)	yes	\$50 - \$100		Cap Mkts		5 to 10 yrs	tbd
IBRD (Proj Prep Facility) (to Govt or Proj)	yes	\$50 - \$100		Cap Mkts		5 to 10 yrs	tbd
IFC (Debt, equity, convertible loans etc, guarantees)		\$50 - \$100	yes	Cap Mkts		7 to 12 yrs	
Dutch Govt Fund: Infrastructure Dev Fund	yes	up to \$50 /tranche	yes	Cap Mkts			
FMO		\$5 dev; \$75		tbd			
FMO; CFM; USAID Climate Investor One							
Nordic Development Fund Grants financing for climate related)	yes	up to \$50 /per deal	yes				
Norfund		\$10 to \$50	30% expected			up to 15 yrs	yes
OeEB (sponsors should be 30%)(own Global Climate Fund)	yes	\$50 - \$100					
OPEC Dev Fund							
OPIC		up to \$100 / tranche	through inv funds	UST+200	200 - 600bp;	5 to 20 yrs can be 30yr	yes
Proparco		\$10 to \$50/ per deal	yes				
Swedfund		\$10 to \$50/ per deal	yes				
USAID	yes/DCA	\$10 to \$50/ per deal					

Succinctly put, there is a considerable amount of capital for LPG-related entities (SPVs or otherwise) to engage with outside of Cameroon, provided projects and structures are prepared and positioned properly. The following information shows the depth of activities and the capacity of some leading prospective Funders, based on the most recent available data:

1. MDB commitments in 2014 (includes exposures through: grants, loans, guarantees, technical assistance etc.)
IBRD (US \$22.2 billion)
IDA (US \$18.6 billion)
AfDB (US \$7.1 billion)
Asian DB (US \$13.5 billion)
European BRD (US \$8.9 billion)
Inter-American DB (\$13.5 billion)
2. IFC commitments in 2015
US \$18 billion for a total portfolio of \$84 billion

The information in the following table indicates how DFIs are active in areas that overlap with the targeted initiatives. This makes them candidates to be lead Funders and risk mitigation providers for selected initiatives. Related sectors and aspects, such as SMEs, Financial Institutions/Innovations, and Infrastructure could be part of the appeal to DFIs. In addition to the areas described in the table, additional options may exist and should be explored with respect to Energy and Forestry, the latter in view of the importance of the Cameroon LPG initiative to reduce pressure on forests from extensive cooking with non-renewable woodfuels. For example, if an SPVs, an NBF, or a pair of Investment Funds were created to fund the build-out of the LPG sector and related SMEs/MSMEs, participation may appeal to DFIs because those are areas they target. AfDB, CDC, DEG, FMO, IFC, Norfund, OPIC, and Swedfund are already active in Cameroon, with prospective alignments among their funding windows.

Table 50. Focus areas of selected prospective DFI Funders⁹⁰

DFI	Sector	Region	Instrument	Staff Size	Ownership Structure	Tied to National Interests
OPIC	I, F, A, SME	G	L, G, I	230	Owned by U.S. government	U.S. interest required
BIO	F, SME, I	A, A-P, LA, MENA	E, Q-E, L	44	Owned by Belgian government	Untied
CDC	F, I, S	A, SA	E, Q-E, L, G	158	Owned by UK government	Untied
COFIDES	I, A, M, SME, S	G, LA	E, Q-E, L	72	Owned by Spanish government (54%), Spanish banks (45%), and CAF (1%)	Spanish interest required
DEG	A, F, I, M, SME	G	E, Q-E, L	491	Owned by KfW, the German development bank	United
FINNFUND	F, I, A	G	E, Q-E, L	54	Owned by Finnish government (93%), Finnvera, and Confederation of Finnish Industries	Finnish interest required
FMO	F, I, A	G	E, Q-E, L, G	372	Owned by Dutch government (51%) and commercial banks, trade unions, and others (49%)	Untied
IFU	I, F, A	G	E, Q-E, L, G	56	Owned by Danish government	Danish interest required
Norfund	I, F, A	A, LA, A-P	E, Q-E, L, G	45	Owned by Norwegian government	Untied
OeEB	F, I, A	G	E, Q-E, L, G	40	Owned by Oesterreichische Kontrollbank AG, the Austrian export credit agency	Untied
PROPARCO	F, I, A, S	G	E, Q-E, L	168	Majority owned by AFD (64%), the French development agency	Untied
SBI	S, A, I	A-P, LA, LA, A	E, Q-E, L	6	Owned by Belgian government (63%) and private financial institutions	Belgian interest required
Sifem	F	G	E, Q-E, L	17	Owned by Swiss government	Untied
SIMEST	S, I, A	G	E-, Q-E, L	163	Owned by CDP, the Italian national promotional bank	Italian interest required
SOFID	I, S, A	A, LA, MENA	L, G	12	Owned by Portuguese government (60%) and four Portuguese banks	Portuguese interest required
SWEDFUND	F, I, A	G	E, Q-E, L, G	33	Owned by Swedish government	Untied

Relevant sector codes:

- **SME:** Small and Medium Enterprise
- **F:** Financial Institutions/Innovations
- **I:** Infrastructure

One further prospective funding avenue is through the IFC and its active syndication process, with respect to the private sector elements of the Investment Plan. The IFC can provide direct project-related funding, debt, convertible securities, equity, and investment fund capital, typically originated directly by the funded entity and funded accordingly (which could be the SPV-C, if correspondingly structured). The IFC also provides risk mitigation products.

Operationally, the IFC active syndication process brings in additional qualified funding partners. Its syndicate is a capital and resource-intensive club of IFIs and DFIs. A Master Cooperation Agreement (MCA)

⁹⁰ Source: GLPGP interviews

among IFC and several, or even dozens, of DFI and IFI partners brings together the members' respective capital markets teams. This process was more deeply institutionalized in October 2009, when the IFC created, along with DEG, FMO, and PROPARCO, an MCA syndication format for syndicated and parallel loans, with 30 participating members. The MCA details how the IFIs and DFIs will work, in a pre-arranged, standardized manner, to co-finance projects where the IFC is the mandated lead arranger.

This is accomplished through the IFC Parallel Loans Program. The IFC acts the lead arranger for loans, and can also act as administrative agent. In such a situation, MCA participants (DFIs, IFIs, et al.) benefit from the IFC using its syndication platform, deal-structuring team, origination expertise, due diligence, loan documentation and closing for its own exposures and those of its fellow Parallel Loan syndication members. (IFC, for LPG purposes, could partner with an expert group in LPG, such as the Clean Cooking for Africa/GLPGP group, to supplement IFC in-house expertise, which is not LPG-specific.) This approach could create blended funding-related efficiencies in terms of scale of funding (larger pools raised), time (close more investors/Funders faster), and costs of funding. In the case of the MCA, many of the target institutions for potential participation in LPG financing in Cameroon are already signatories.

Environmental/carbon finance

The potential carbon-market value from implementing what is described in this report is potentially €3-4 million per year, as discussed in Part X (Environmental, Health, Social and Economic Impact Potential) beginning on page 210. However, monetizing that value as an additional financing source faces a significant practical challenge, for which no solution can presently be envisioned. The challenge is that the ownership of the carbon-credit value is attached to the consumers' use of LPG for cooking, through displacement of higher carbon-emitting fuels and technologies. This implies monetizing the carbon value from millions of individual points of use, through an acceptable, practical, and cost-efficient means of measuring and auditing the net carbon benefit from each. The monetized carbon value would also have to be transferrable not to the end-user, but to the service providers along the LPG supply chain which make the investments to be co-funded through that carbon value.

The CDM does not allow carbon credits for fossil fuels (since these are defined as non-renewable), and therefore LPG is not eligible for carbon credits under CDM, despite the fact that overall the impact on climate forcing is similar to or less than even the best biomass stoves when all emissions are considered. Recent evaluation studies of CDM-approved, more efficient biomass stoves also demonstrate that there is a substantial risk that these interventions fail to realize the expected fuelwood and associated-carbon reductions under real-life conditions because of technology performance, fuel stacking (the ICS is used together with the traditional stove instead of replacing it) and/or because of extra cooking tasks performed due to previously suppressed demand. In addition, some improved stoves (including rocket and natural draft stoves) have been shown to emit more BC and PM_{2.5} emissions than traditional biomass stoves and open fires.

Gold Standard offers a possible path forward if the issue of end-user scale can be solved, as Gold Standard includes the Kyoto Protocol gases and Black Carbon (BC), although it still does not include CO, SO₂, OC and NMHC.

A number of small-sized LPG projects have been funded through the Gold Standard carbon credit mechanism. One example is the 9,000-stove Darfur Low Smoke Stoves Project implemented by Practical Action and CarbonClear Ltd., which began stove dissemination in 2010. Each LPG stove in that project

avoids about 4.6 tons of CO₂ equivalent a year compared to traditional and improved mud wood stoves (15-20% efficiencies) and to traditional and improved metal charcoal stoves (20-25% efficiencies).⁹¹

Should a practical mechanism arise for monetizing the carbon-credit value created by millions of added users of LPG, and for deploying that value toward the financing of the supply chain expansion that makes the carbon-credit value possible, it could lower both the cost of capital for the expansion and potentially the cost that consumers incur to become new LPG users.

In parallel, climate finance mechanisms like the Green Climate Fund or the NAMA Facility (grants up to € 20 million) could potentially be usable to support an LPG microfinance project accompanying supply-side funding. Because these mechanisms do not have an LPG-microfinance history, such potential would need to be explored as part of fully elaborating and finalizing the Investment Plan.

Specific roles for DFIs to increase impact and reduce risk

DFIs are well-positioned to help facilitate the national LPG build-out described in this report and the companion *Cameroon LPG Implementation and Investment* report. Through their mandates, experienced teams, and range of tools, they can have a powerful effect on the success of LPG ecosystems and the projects and companies within them. Useful and effective DFI tools include grants, technical assistance, direct or indirect (through investment funds) funding, debt/equity/hybrid funding, guarantees, risk mitigation structures, insurance, syndication with other DFIs and IFIs, SPVs, IFC-led MCA/parallel loans, and political advocacy and influence including linkages (in which governmental undertakings regarding LPG are linked as performance requirements to a larger, broader portfolio of financing and financial cooperation).

The DFIs' critical anchor role as catalyst Funder and accommodative capital provider can be essential for moving the large quantum of capital needed for the country's investments.

DFIs can undertake some of the following key roles:

1. Provide large and diversified capital investment of their own;
2. Catalyze and crowd-in outside non-concessional, more risk-adverse co-funding;
3. Lower the cost of capital for various projects (where it makes sense to do so);
4. Introduce first-loss-protection for other investors (for example, Swedfund with SIDA taking a 50% first loss);
5. Provide risk mitigation tools, such as guarantees (range of DFIs, MIGA) and private bond 144A placement insurance (OPIC);
6. Provide hedging tools to help mitigate LPG price volatility and address currency risk;
7. Use financial influence in the country overall to ensure governmental performance of obligations;

⁹¹ Carbon Clear (2016): *The Gold Standard: Project Design Document for Gold Standard Voluntary Offset projects - Darfur Efficient Cook-Stove Project*. See mer.markit.com/br-reg/public/project.jsp?project_id=103000000002416.

8. Provide technical assistance funding to help the government and the sector develop capacity to suppress black market activities;
9. Provide technical assistance to educate and create awareness of LPG benefits among consumers;
10. Underwrite a country's initial LPG microfinance program on a concessional basis to demonstrate to local financial firms that microfinance can be a legitimate commercial activity for them;
11. Help secure international LPG supply on more favorable terms, through bringing their balance sheets to bear (e.g., AfDB offering letters of credit with concessional terms for use by marketer-bottlers to acquire cylinders *en masse*);
12. Become a Funder to listed or non-local stock exchange listed SPVs and/or provide protections for other investors/Funders; and
13. Support further work by the Clean Cooking for Africa expert team.

The financial modelling of the investment parameters, economic performance, and financial returns of the key firm-level investments described in Chapter 16 (Investments at the Firm Level), which begins on page 138, includes co-funding with concessional debt for approximately 40% of the capital stack of the projects sector-wide, both to ensure rates of return to equity investors are possible without risking over-leverage, and to moderate the cost of debt in order to reduce the debt service burden on the LPG sector's firms as they consume capital and defer full profitability for the sake of growth.

The thesis for the DFI role is that DFIs have interest in the large health, environmental, social and development impact that scaling up clean cooking can have on the target countries' populations. To achieve the desired impacts as efficiently as possible, DFIs welcome sizable, scalable, bankable funding opportunities. Although the global LPG sector is over 100 years old, and LPG-for-impact has been the subject of study by UNDP, WHO, and other organizations for many years, it is only recently—such as through the efforts of the Clean Cooking for Africa program—that opportunities for LPG investment and lending at scale are being identified, prepared, and structured for addition to the global flow of projects suitable for DFI support. It is therefore recommended that DFIs include consideration of financial support to LPG initiatives where LPG investment and lending opportunities are demonstrated to be feasible—such as in Cameroon, with BCRM well-implemented.

A description of a DFI-directed program of investment and technical assistance measures is provided in the companion *Cameroon LPG Investment and Implementation* report.

Development of LPG-specific investment funds

A second key role for DFIs is in contributing to indirect investment into such LPG opportunities, by participating in the establishment and funding of an LPG-specific impact-investing fund. Such a fund would aggregate and deploy LPG-focused global capital, including DFI capital, to high-impact, high-need LMICs for prudent and justified LPG expansions and utilize the particular, deep domain expertise of the Clean Cooking for Africa/GLPGP expert team in so doing. GLPGP and KfW have collaborated to design two such funds for future implementation, which could potentially be operationalized for Cameroon. These funds are the LPG Infrastructure and Distribution (LID) Fund, designed to target LPG supply chain infrastructure as outlined in this report, and the First Costs Financing (FCF) Fund, designed to underwrite microlending at scale to consumers for financing the up-front equipment costs necessary to switch to LPG from charcoal and wood

fuel. The first FCF fund and LID fund, at anywhere from € 100 million to € 300 million overall, could be conduits through which interested DFIs could align capital for LPG impact-investing at scale with proven, impartial, dedicated LPG expertise. DFIs can potentially provide General Partnership operating launch capital, as well as provide anchor Limited Partner funding commitments. This can then facilitate additional funding sources joining the fund(s) alongside the DFI sponsors.

21. Summary of Main Project Risks, Mitigations and Mitigation Sources

Main risks and mitigations

Risks may be grouped into several categories, which include:

- Country risks (regulatory, political, other)
- Industry
- Economic
- Consumer demand
- Execution
- Financing / Fund structure and operation
- Investment process

Country risks

Regulatory Risks. The regulatory landscape in Cameroon applicable to LPG, for financing, and overall, is an important consideration. The regulatory scorecard presented in Part V, Chapter 6 (beginning on page 46) is a useful assessment tool regarding the supportiveness of the LPG regulatory environment and gaps to be diligenced and hedged against. As part of investing, legal stabilization clauses will be sought in contracts with Government. Risk mitigation products may also be utilized where justifiable, as described later in this chapter.

Specific regulatory risks include:

1. Failure to reform the multibrand Wholesaler category of distributor, as recommended in the national LPG Master Plan, if the influence of Wholesalers were to increase (via increased distribution market share) over time. This can be mitigated by directing growth capital to those LPG companies whose strategies, operations and distribution networks do not include, or bypass, such Wholesalers, and by requiring compliance as a condition of the financing.
2. Failure to enforce safety requirements adequately for cylinders and cylinder handling. Historically, the Government has been adequate but not optimal in this task, and with a larger LPG sector--particularly one with growth in the more remote regions of the country—the task will become more challenging. This can be mitigated by a program of mandatory, regular safety audits of filling plants, primary transportation, and a sampling of the cylinder inventories and cylinder holding facilities of distributors and retailers. Funding for such a program could be a component of technical assistance provided by the development system; this is discussed in more detail in the *Cameroon LPG Investment and*

Implementation report⁹². Additionally, industry self-auditing as well as undertakings by each modality to follow core safety practices and procedures may be mandated, as a condition of the financing of new cylinders.

3. **Weak enforcement.** A constant risk throughout most Sub-Saharan African LPG markets is weak enforcement of otherwise good regulation. There can be many reasons for enforcement to become lax, ranging from inadequacy of governmental capacity/resources to corruption. Mitigation can occur in three main ways: (i) cooperation and sharing of regulatory cost burdens between government and industry, out of industry self-interest, as has recently occurred in countries such as Kenya; (ii) changes to LPG companies' operational and distribution models to increase control over cylinder assets and their safety as they recirculate; and (iii) mobilization of increased political will to address the inadequacy within the relevant regulatory agencies. Increasing political will, while perhaps the slowest form of mitigation, becomes increasingly easy to do as LPG becomes important to more and more voter-consumers, particularly if LPG safety declines in consequence of lax regulatory enforcement and increased short-cutting of needed safety spending and processes by some industry players.

Additionally, diligence would be undertaken regarding the regulatory frameworks for business rights protection (including anti-counterfeiting), investment, and/or microlending being adequate. Use of qualified locally-familiar counsel and accountancies will facilitate such diligence.

Investing Environment Risks. Cameroon has an overall favorable and improving investment environment, as described earlier in this Part of the report. Country risk premiums may also be priced into the overall cost of blended capital, based on the blend and the needs of the Funder sources.

Nationalization/Expropriation Risks. Standard project and other insurance would be obtained where appropriate through bodies such as OPIC and MIGA; additional sources and products are noted later in this chapter.

Government Nonperformance/Default on Contractual Obligations. As a possible partner in certain levels of the LPG infrastructure and distribution chain, the Government may be contractually committed to funding or other obligations related to projects and consumer access. If the Government were to default, this could have numerous politically sensitive impacts on the general voting public, once they are increasingly tied into the expanded LPG market. Performance guarantees by Government and other key partners and counterparties should be provided for project completion and operational finance commitments as conditions precedent to investment.

Subsidy Risks. Risks associated with the LPG subsidy in Cameroon are of the following types:

1. The Government is unable for budgetary reasons to increase the size of the subsidy to keep pace with LPG consumption (despite the countervailing taxes in the LPG price formula), or to deal with an unanticipated and long-lasting price shock in the international LPG markets, creating insolvency and performance risk in CSPH as the subsidy administrator and funds-manager.

⁹² It is noteworthy that the African Development Bank has provided funding to GLPGP to carry out in 2019 under governmental mandate a first national LPG filling plant safety audit in Cameroon for this purpose.

2. Conversely, subsidized consumption grows far faster than projected, and faster than new LPG infrastructure can be funded and deployed, creating LPG shortages while raising the subsidy burden on government. Overshooting consumption projections could occur because of subsidy leakages as LPG becomes widely available—for example, LPG begins to be used as a primary automotive fuel (as happened in Ghana) or for the heating of swimming pools by the wealthy (as happened in India before its LPG subsidies were targeted to the poor).
3. The Government, in responding to fiscal pressure from subsidy growth, seeks to restrict LPG consumption growth and/or LPG imports (creating shortages) in order to limit the size of the subsidy.
4. The Government, in responding to fiscal pressure from subsidy growth, cuts the amount of the subsidy per tonne, increasing the end-user price (and thus putting downward pressure on demand growth) and/or cutting margins for the LPG supply chain (thus putting financial pressure on the supply chain participants and limiting their ability to invest in growth and in safety).

In all of these cases, beyond the use of risk management products (in particular, those associated with governmental performance), Government should actively plan each year, on a multi-year basis, its anticipated subsidy volumes and cost in context of expected LPG market growth and achievement of national policy goals and milestones for LPG. As part of contingency planning, Government, working with LPG stakeholders, should also develop a transition plan to be able to shift the subsidy from a general subsidy to one that is directly targeted at the poor, who most need it, as other LMICs with large LPG penetration rates, such as India and Brazil, have very successfully done.

If the Government decides to institute a targeted LPG subsidy aimed at the poor, the Clean Cooking for Africa/GLPGP advisory team can provide best practice knowledge and guidance to establish the new subsidy in a way which is minimally distortive to the market and minimizes the risk of the subsidy growing beyond the Government's capacity to honor it as LPG volume grows in the target population.

Pricing and Levy Risks. The LPG investments presented in this report are potentially viable under Cameroon's existing regulated LPG pricing and margin structure, with or without any form of cylinder discounting or other capital recovery levy added. If such a levy is instituted, it would accelerate the rate at which cylinders can be acquired and deployed by LPG Marketers to serve the projected unmet demand, and the rate of LPG adoption by consumers (due to the significantly lowered deposit cost for a residential cylinder, which the levy mechanism achieves). The key risk with respect to both pricing and any levy is the risk of a future adverse change. If viable investments are made based on current expectations about the pricing formula and its long term stability, and the pricing formula is changed in future in a way that materially reduces demand or margins, the investments may become unviable after the fact. If viable incremental investments are made, whose increased size and/or pace depend on the levy, and the levy in future is reduced or terminated prematurely, the incremental investments may become unviable after the fact. Guarantees by Government should be sought with respect to stability of the price formula and permissible adjustments to the formula over time, as conditions precedent to investment. Additionally, if the Government determines that it will institute a levy, guarantees should be sought about its longevity and its minimum and maximum permitted effects on prices and, if applicable, on margins.

Political Risks. Sufficient political and business support are integral to scaling up LPG. To reduce political risk, both local official and private sector partners must have a material stake in the success of the local projects. Political support can be developed by project sponsors and Funders, and through linkages by DFIs (for example) to other lending activities in the country. Regarding a shift in future political/policy for LPG investments, various third party insurance products can be considered.

Industry risk

LPG Supply, Demand, and Price Movements. As a global commodity, LPG may be subject to price movements based on supply and demand dynamics outside of the internal market conditions of the country. This could impact the availability of product in target markets, if prices rise too high. In Cameroon, margins are fixed by regulation, which eliminates margin risk; the remaining market risk is to volume. (This is normal in commodity dependent businesses.) The projects' cost basis, through blended capital sources, will lower overall break-even margin points for infrastructure assets and companies. In addition, underlying companies and projects will be expected to implement appropriate contingency planning in their operations such as hedging of inputs, including LPG supply. Long term supply contracts with diverse sources and buffer storage will serve as mitigants to these disequilibria. MIGA and USAID offer programs to insure commodity price risks and these may also be employed, where justifiable. To the extent that production of natural gas at Kribi will generate any LPG as a co-product, this LPG should be used as a hedge and buffer against any volatility in the international LPG market.

Consultancy IHS Markit has forecast that global LPG supply will be in surplus for approximately another 10 years, creating relative price stability during the expected investment horizon. See Annex Chapter 34 (Note Regarding Long-Term LPG Pricing and Availability) beginning on page 317 for further discussion.

Additionally, commercial quantities of price-competitive bio-LPG have been introduced into the global market in 2018; by 2030, such quantities could become a significant hedge against potential LPG supply or price volatility.

Lastly, entering into long-term, price-capped contracts for LPG supply hedges further against LPG volume and price risk.

Energy Alternatives. Price differentials could create a risk regarding substitute fuels at the end of the value chain. Given the level of development of other fuel products, it is expected that the risk of substitution is limited, except among the poorest. While that creates a corresponding risk with respect to impacts connected with that population, the likely effect on investment results is expected to be small, based on the modelling performed and presented in this report. In addition, once businesses and consumers have invested in LPG equipment and adapted to them operationally and behaviorally, respectively, a switching barrier (whether economic or psychological or both) is created for abandoning LPG use. That is, LPG use is somewhat sticky, once begun.

Bankability of Certain LPG Companies. Some LPG companies, upon due diligence, may be deemed unbankable. This can be mitigated in several ways:

1. Technical assistance (TA) measures, which could be funded by international development resources, can strengthen management capability, business planning, transparency and reliability of reporting, and operational effectiveness. (See the companion Cameroon LPG

Investment and Implementation report for a discussion of applicable TA measures and their costs.)

2. If instituted, a cylinder discounting levy, such as presented in this report, would significantly improve LPG companies' bankability where the key issue is adequate cashflow to cover debt service and generate sufficient returns to equity investors.
3. Investing via a special purpose vehicle, or similar, that aggregates multiple capital recipients and provides an active oversight role, can help to mitigate the bankability risk of the weaker players by (i) pooling risk across both strong and weaker players, (ii) creating a de facto form of consolidation among the players, and (iii) allocating or reallocating capital to maximize impact sector-wide and minimize risk sector-wide.
4. Unbankable companies can be excluded from the investment program until they improve enough to become bankable. Access to significant expansion capital on favorable terms by competing, bankable companies should motivate those which do not qualify to make improvements, and to take advantage of TA resources which may become available.
5. Informally, unbankable companies can also be encouraged to merge with stronger, bankable companies on mutually acceptable terms.

It should be noted that it is not necessary for every LPG company to maintain its present market share in order for the investment program to be carried out to its full extent and for all addressable demand to be served.

If the combined growth capability of the bankable firms receiving investment capital turns out to be below the scale and pace of investment described in this report, then the scale and/or the pace of the investments would necessarily be adapted to their actual capability.

Microfinance scalability risks. Microfinance may prove to be important to unlocking an additional level of LPG demand, particularly among lower-income households that can afford LPG refills but not the up front costs of the LPG equipment. Scaling up LPG microfinance on a commercial basis requires that LPG microloans continue to demonstrate acceptable repayment characteristics to the participating lenders, as well as create long-lasting LPG customers for the participating LPG operating companies. Sensitization and education of prospective borrowers is also important, but beyond the scope of activities and availability of resources of most MFIs. Ongoing TA resources to support sensitization activities would address that gap. (See the *Cameroon LPG Investment and Implementation* report for details.) As microlending scales up, the average credit quality of consumers who have not yet taken LPG loans may also decline, due to the "low hanging fruit" being plucked in the beginning. That in turn would lead to a higher percentage of credit rejections (and higher average costs to originate each loan), or to worse loan performance, or both. If that occurs, further expansion of LPG microlending may slow or stop. Providing concessional capital and/or guarantees in the loan underwriting mix has proved important in MFIs undertaking LPG lending, and a bespoke funding vehicle for providing concessional capital or guarantees, such as the First Costs Fund described in the preceding Chapter, could help to address this.

If microfinance of consumer LPG equipment does not scale readily or widely, then the overall level of demand that can be served will likely be smaller (closer to the lower bound demand projections in this report), and the investment program's scale may need to be adapted accordingly.

Economic risks

Interest Rate and Inflation Risks. Currency, interest rates, and inflation changes may impact LPG affordability and also the repayment performance of the LPG projects. Interest rate hedging and other approaches can be utilized to insulate from adversely expanding spreads. Inflation should be priced into contracts as appropriate, so as not to erode SPV/Fund performance. Cameroon has experienced very modest price inflation in recent years. Currency hedging will be employed under both project level and SPV/Fund level risk management policies, as needed.

Currency and Exchange Rate Risks. The income received by the investment vehicle(s) will typically be denominated in the local currency of the project companies; however, the books and assets, capital contributions, and distributions will be conducted in U.S. Dollars or Euros, as appropriate. As long as the CFA is pegged to the Euro, currency risk remains relatively small, with U.S. Dollar/Euro exchange rate risk affecting only the portion of investments or purchases which are dollar-denominated. Dollar-Euro currency hedging and derivative products may be employed to mitigate these risks for both investors and operating companies.

Consumer-related risk

Lack of Demand. The amount of projected demand may not come into fruition for a variety of reasons, including lack of awareness by consumers, relative affordability of LPG equipment and fuel, and accessibility. These potential issues (except for cost of fuel) can be mitigated by the work that Clean Cooking for Africa/GLPGP will continue to do in Cameroon (subject to availability of resources), including working to create awareness of LPG benefits among consumers. Additionally, the investments are staged over time, and can be accelerated or delayed/reduced based on leading indicators (including those specified in this report) signaling additional pent-up demand or early saturation of the market. To the extent Government wishes to ensure maximal residential LPG demand for policy reasons, it should consider targeting and deepening its LPG subsidy specifically to lower income households, to create greater fuel affordability for that segment.

The separate risk of price changes is discussed in the *Industry risk* section above.

Consumer Repayment Risks (re: Microfinance Loans). Credit risk in large part will depend on both the selection of on-lending partners and consumer repayment behavior. The analysis of the extension of credit will include diligence of the MFIs and their underlying approaches to customer selection, credit policies, and the target market segments. As a practical matter, consumers will not want to be cut off from LPG once they are using LPG for cooking and have acquired the appliances for cooking and heating with LPG. Nevertheless, as a backstop, the use of blended capital that may be required to underwrite or guarantee or partially guarantee MFI lending will lower the costs of lending, and first loss arrangements with DFIs or other impact investors can protect the performance of the underlying lending portfolio.

New MFI lending for LPG adoption will be piloted in carefully expanding phases, applying lessons from each preceding phase to reduce the risks of later phases.

Ultimately, the aim of the Clean Cooking for Africa program is for LPG microlending to transition to an entirely local platform of partners with underwriting from one or more of them for the group's activities, thereby creating the option for early exit and monetization of microlending activities.

Execution risks

Execution Risks. Investment projects must be required to have competent, experienced management. The funding vehicles (e.g., SPVs) must do the same⁹³. Local partners that will be required, or are desired, where they are competent and experienced will help address local execution risks at the operational and local co-investment level. Ultimately, a sound governance system with international-standard financial reporting at all levels will be among the most important tools for identifying execution risks and responding quickly and appropriately to eliminate or reduce them.

LPG Distribution Execution Risk. The inability to reach the ultimate end users of LPG will be a gating decision point regarding whether to invest in a particular geographic target area. This will also limit the success of the investment vehicles but will protect from over-stretching to serve untenable markets.

Counterfeiting and Issues Around Safety. Local LPG industry and the management of the investment vehicle(s) must address these issues to the extent they may arise. Good implementation of the BCRM model (as described in this report) will substantially derisk this issue. Part of the solution may also come from integrating fragmented operators in the distribution chain vertically and horizontally, offering shared benefits from economic scale and market power.

Risks of the Multibrand Wholesaler Distribution Model. See above under *Regulatory risks*.

Complexity of Coordination of Multiple Investment Projects. The quantity of parallel projects may introduce complexity which could cause delays, overruns in project preparations costs, and execution challenges in excess of projects taken individually. This is particularly the case with respect to the majority of filling being outsourced by Marketers to SCDP, such that individual Marketer business expansions are linked to the expansion of capacity as well as geography of SCDP facilities. There can be no assurance that the management of project and operating companies can successfully manage and coordinate this complexity. Conversely, the fact that the projects are all linked through a master investment plan means that no one project will receive and deploy a quantum of growth capital without strong assurance that the linked projects in the supply chain receive proportional, and well-timed, quanta of growth capital, so that all projects are mutually reinforcing.

SPV/Fund/NBFI structural and operational risks and mitigants

No Operating History. These vehicle(s) are likely to be recently-formed entities, with no operating history. This may be mitigated by the operating experience and expertise of the Clean Cooking for Africa/GLPGP team, by experienced LPG operating managers on the ground, and by relevant in-country and international project partners.

Liquidity of Investment. The investments will be illiquid for a period of time, as with all private equity and long term debt investments. The investors will be provided with distributions as appropriate and feasible. If a critical mass of investments (or a special purpose vehicle) can be securitized, it would allow that set of investments to be packaged into an exchange listing (as discussed earlier in this Part of the report) or a potential acquisition. To the extent possible, the investment project agreements will include terms that give options for forced monetizations or exit pathways under appropriate conditions.

⁹³ The Clean Cooking for Africa/GLPGP LPG expert team may play such a role in the latter.

Long Term Investment. An investment in the vehicles is a medium- to long-term investment; for debt, notionally as long as seven years. For equity, potentially longer, unless there is an agreed or forced monetization trigger occurring earlier. There may therefore be a significant length of time between the initial investment and the return of investment or realization of gains, if any. “Patient capital” will therefore have a role to play in the capital stack. This is mitigated, however, by the structuring of the investments into multiple tranches spread across the 12-year investment horizon.

Restrictions on Transfer and Withdrawal. There may be no market for the investment securities, absent an exchange listing. In addition, investments in the SPVs/Funds/NBFIs may not be transferable or withdrawable in the usual course of business.

Asset Valuations. Valuations of the LPG assets will be determined by the management of the investment vehicles working with outside valuation experts. The valuations will be based on audited financial information to the extent possible, complemented by best-practice valuation methods and metrics used in the LPG sector globally.

Investment process-related risks

Finding Investments. The ability to prepare projects and execute the investment strategy in reasonable time frame given possible regulatory and other issues will be a major focus. Continuing diligence will permit walking away from projects which cease to offer the return and risk profile meeting investor requirements before significant amounts of capital have been deployed in them.

Ability to Realize Cash Returns and Exits. As with all investment vehicles, continued listings of the vehicles on liquid exchanges, as well as underlying assets, plus trade sales and dividends, are not certain in time or amount. The strategy of listing or shelf registration can mitigate these risks.

Country Development Risk. Part of the feasibility assessment in this report involved consideration of favorable national developmental trends such as: attractive demographics; rising per capita income; credit reach; urbanization; legal and political stability; progressive governmental policies for healthcare, environment and development; growing foreign investment; development of infrastructure (in particular, road networks), etc.

Environmental Hazards (Other Than LPG Accidents). The investments and projects will be implemented following ADR and other best practices and global regulatory standards. In addition, the funds and projects will take appropriate insurance policies against hazardous accidents and occurrences.

Wrong Investment Thesis. If the findings of, and conclusions from, this report and its companion *Cameroon LPG investment and Implementation* report are wrong, it will result in overinvestment in infrastructure, but there are nonetheless choices available to address this. For example, a) to run at lower capacity or b) to run at normal capacity but resell surplus LPG acquired into other markets (e.g., to regional traders, or to regional petrochemical producers) at a discount. Also, most LPG infrastructure can be scaled up in steps, rather than built all at once. Management and advisors must continue to conduct detailed studies in advance of major capital deployments to be maximally confident that the investment thesis is correct.

Risk mitigation sources for investors

DFIs, MDBs, IFIs, private companies and others provide the risk mitigation tools profiled below.

Risk mitigation tools include guarantees, insurance, and other credit enhancements that are often used in combination with impact or related funding to strengthen the creditworthiness of a funding recipient.

Many providers of capital also provide risk mitigation tools which offer potential efficiency in lining up the right combinations of blended funding and risk mitigation for many products and services.

The following figure⁹⁴ provides several examples as points of reference:

Figure 51. Large providers of risk mitigation products, by category



One example of a good source of potential capital and risk products is the U.S. Overseas Private Investment Corporation (OPIC). Its risk/insurance products include enhancing Funders' investment positions by guaranteeing 144A bond placements which can be quite large and attract global pensions, insurance and other investors. This could be used by LPG-related vehicles to issue securities to international investors. This is because the 144A bond insurance essentially converts LPG-related risks into a U.S. Government-mitigated risk. This could also lower the costs of issuance to the backed entity.

IFC and AfDB are investors in, and also offer directly, numerous insurance and risk mitigation products. They are also on the top-tier of potential Funders for the Finance team to approach.

Trade guarantee facilities can be used for the importation of cylinders and other vertical needs.

African-oriented cross-owned institutional financing, credit, and risk mitigation sources should also be leveraged. This could cover trade finance, working capital, capital investment, risk insurance (including re-insurance), and hedging. This cross-ownership is likely to enhance the strategic appeal to various partners, due to their joint focus on doing business in Africa. Examples GLPGP is exploring include the Africa Trade

⁹⁴ Self-reported institutional data analyzed by GLPGP.

Insurance Agency (ATI), into which AfDB has invested, and the European Investment Bank, which has expressed initial interest.

Given that GLPGP and AfDB have established a working relationship through AfDB's grants window for LPG micro-finance, and are exploring larger funding for 2019 and thereafter, AfDB could be a logical partner for risk solutions as well. AfDB and ATI would be logical first partners to approach in terms of larger risk mitigation tools for Cameroon.

A two-tiered approach could be used, by accessing AfDB's various risk mitigation tools such as trade guarantees, insurance, and credit enhancements – either directly from AfDB or from proxies. Following one AfDB investment into ATI, a statement from the then Director of Private Sector and Microfinance at AfDB noted that "ATI uses innovative risk mitigation instruments to catalyze private sector financing into a range of critical sectors from core infrastructure to trade finance." This could be useful for Cameroon's LPG investments. Other active groups like Sweden's SIDA partner with USAID, IFC, DFIs and others to actively guarantee risks in development areas that complement Sweden's international development agenda. GLPGP will approach SIDA as appropriate.

Another target might be the heavily DFI-backed AFC (although Cameroon itself is not a present shareholder member). This entitles member countries to risk and funding support from AFC, and issuing capital via AFC's enhanced credit rating if appropriate projects are brought forward. AFC is owned by numerous groups including very active DFIs such as AfDB, KfW, DEG, FMO, and PROPARCO. This could be a logical grouping to approach.

In addition, FMO and OeEB have been involved with LPG related activities (FMO in Bangladesh – invested; OeEB in Albania – commissioned studies). OeEB, while smaller among the European DFIs, is quite active across debt, equity, quasi-equity, and grants. In addition, like AfDB, FMO and other DFIs, it could be approached to provide credit lines for an NBFi.

X. Environmental, Health, Social and Economic Impact Potential

This Part⁹⁵ provides an evidence base and estimation for use by investors, policymakers, industry and researchers to guide the development of LPG infrastructure and distribution systems in Cameroon.

Introduction: impact scenarios

The assessment utilizes the demand forecast scenarios presented in Part VI together with the investment scenario of Part VIII to calculate the potential social, environmental and development impacts through 2030 from each scenario compared to the “business as usual” projection of LPG adoption and use from Part VI.

All of the scenario models take into account that improved biomass cookstoves (ICS) will seek to compete with LPG.

The scenarios are:

- Scenario 1: Base case, where forecasted consumption was derived by extrapolating historical growth trends for residential LPG consumption without market reforms and associated acceleration and scale-up of investment. Total annual LPG consumption for household cooking is projected to grow to 171,339 MT by 2030, with a national per capita consumption of 5.5 kg per year.
- Scenario 2: Market reform and expansion scenario, reflecting policy and investment interventions as described in this report. In this scenario, the LPG use population expands to 3.8 million households (59% of all households) in 2030⁹⁶. This scenario comprises two sub-scenarios, leading to a range of projected impacts:
 - Scenario 2A: Lower-bound with sufficiency of availability, incorporating demand growth from demographic changes, as well as the impact of expanded LPG availability to serve latent demand without shortages. Total annual LPG consumption for household cooking is projected to grow to 269,699 MT by 2030. This represents a national per capita LPG consumption of 8.1 kg per year.
 - Scenario 2B: Upper-bound with sufficiency of availability, incorporating the same demand drivers as Scenario 2A (demographic changes and expanded LPG availability) and modelling the effect of shifts in cooking preferences that cause more average LPG consumption per

⁹⁵ The contents of this Part were developed with Dalberg Global Development Advisors under engagement to GLPGP.

⁹⁶ An OLS regression was used to determine the impact of changes in the relative price of LPG vs. the prices of charcoal, firewood and kerosene. This analysis showed that the relative price of LPG to the prices of the other fuels (charcoal, firewood, kerosene) has no statistically significant correlation to the quantity of LPG consumed by a household. It is probable that this statistically insignificant result is caused by limitations in the self-reporting of price data by households in surveys, and a limited sample size of users who concurrently purchase multiple types of fuel. Given the limitations of the data (in particular the large standard deviations in the pricing data), it was not feasible to estimate reliably the impact of changes in relative fuel prices on the level of LPG consumed. Given that LPG prices in Cameroon are stabilized via government fiscal intervention, and that this policy is expected to continue indefinitely, the impact of price changes on LPG consumption would be driven by changes in the cost of charcoal, firewood or kerosene, rather than changes to the price of LPG.

user. Total annual LPG consumption for household cooking is projected to grow to 303,194 MT by 2030. This represents a national per capita LPG consumption of 9.1 kg per year.

Data sources

This impact assessment relies on two main sources of data for projecting future LPG adoption and use: (i) a survey commissioned by GLPGP and conducted by Dalberg Research in June 2018 (referred to as the GLPGP-Dalberg survey) and (ii) a household research survey conducted by the University of Liverpool between April and September 2017 as part of the LPG Adoption in Cameroon Evaluation (LACE studies). Although nationally representative data sets such as the Demographic and Health Survey (2012) and the NIS data (2014) exist, these data sets were not well suited for the assessment, being outdated and having meaningful data limitations regarding fuel use and fuel availability and affordability.

These data, alongside the demand scenarios, were used to analyze and model the environmental, health, gender, and macroeconomic impact from serving the potential demand for household cooking in Cameroon to 2030, taking into account the primary cooking fuel(s) previously used by new LPG users.

Each cooking fuel has its own characteristics in daily use with respect to health, environment, gender and economic impacts.

It is important to note that the impact assessment presented in this report is calculated for scenarios where LPG is made sufficiently available to serve the projected demand, relative to the base case projections. This approach helps estimate the incremental impact of the investment to be made to cause LPG to be fully available to Cameroon households that desire it over time, and are located in an area of Cameroon where LPG is feasible to be provided and used⁹⁷.

Environmental impacts

Cameroon has the second highest deforestation rate in the Congo Basin, losing approximately 220,000 hectares of forests annually. Although 48% (22.5 million hectares) of Cameroon is covered in forest, Cameroon has lost 4.4 million hectares of its forests (18.1% of its total forests) between 1990 and 2010.⁹⁸ The impact of households changing their primary fuel from charcoal and firewood to LPG can have many positive impacts on the environment and climate. For this analysis, the environmental impacts from increased LPG use and corresponding decreased charcoal and firewood use was calculated as follows:

- **Averted deforestation:** 35 to 54 million trees saved annually relative to base case projections in 2030 and over 300 million trees saved between 2020 and 2030.
- **Carbon dioxide equivalent (CO₂eq) emissions⁹⁹ averted:** 5.0 to 5.6 million MT of CO₂eq emissions reduced annually in 2030 and over 40 million MT of CO₂eq emissions averted cumulatively between 2020 and 2030.

⁹⁷ For example, areas without good road access, or where most cooking fuel use is and will be from gathered wood, were not deemed to develop new LPG demand.

⁹⁸ FAO (2015)

⁹⁹ CO₂eq emissions include carbon dioxide equivalent emissions from carbon dioxide, methane, and nitrous oxide. These were calculated using IPCC conform standards. Further details are provided in the Annex.

- **Black Carbon equivalent (BCeq) emissions¹⁰⁰ averted:** 5.5 to 8.0 million MT of BCeq emissions averted annually in 2030 and over 46 million MT of BCeq emissions averted cumulatively between 2020 and 2030.
- **The economic value of averted CO₂eq emissions in terms of carbon financing:** € 45 – € 147 million cumulatively between 2020 and 2030, using the 2018 prevailing price of carbon.

Health impacts

Quantitative impacts

Transitioning from charcoal and firewood to LPG can have significant health impacts due to reduced exposure to household air pollution (HAP) from burning solid fuels to meet household energy needs. HAP is causally related to ischemic heart disease, stroke, chronic obstructive pulmonary disease, lung cancer in adults, and acute lower respiratory infection in children (based on Global Burden of Disease (GBD) data)¹⁰¹, plus several other conditions not included in GBD estimates (e.g. blindness in women). All these diseases can result in premature death or a disability. For this study, the health impacts from increased LPG use (and decreased charcoal and firewood use) were estimated by calculating (1) deaths averted, and (2) Disability-Adjusted Life Years (DALYs)¹⁰² saved due to reduced exposure to HAP from respirable fine particulate matter (PM_{2.5}).¹⁰³ Impacts on both adults and children were estimated.

Overall, relative to base case projections, 18,985 deaths could be averted cumulatively between 2020 and 2030 due to increased LPG usage under conditions of expanded availability and increased consumption. In addition, 926,484 DALYs could be saved relative to base case projections. This could result in a total economic value of labour of working age adults (from deaths averted and DALYs saved) of € 208 million, relative to base case projections. It is important to note that using indoor PM_{2.5} concentrations will overestimate health benefits of LPG. While outdoor cooking would result in lower exposure to PM_{2.5}, due to increased ventilation, this analysis uses indoor PM_{2.5} exposure concentrations in the absence of reliable data on outdoor exposure.

Gender impacts

Qualitative impacts

Globally, it is estimated that women spend an average of 4.5 hours a day on unpaid work, more than double the amount of time spent by men.¹⁰⁴ Reducing the number of hours per day women spend on unpaid work could have numerous financial and social benefits including allowing women to find more paid work (including both farming activities and other income-generating labor which would vary by setting),

¹⁰⁰ BCeq emissions includes black carbon equivalent emissions from black carbon, organic carbon, carbon monoxide, and total non-methane organic compounds. Further details are provided in section 2.3.

¹⁰¹ IMHE (2016)

¹⁰² The disability-adjusted life year (DALY) is a measure of the overall disease burden, expressed as the number of years lost due to ill-health, disability, or premature death.

¹⁰³ PM_{2.5} refers to Particulate Matter, 2.5 micrometers or less. These are air pollutants with a diameter of 2.5 micrometers or less, small enough to invade even the smallest airways and produce respiratory and cardiovascular illness.

¹⁰⁴ Gates, Melinda (2016)

pursue education and/or have more leisure time.¹⁰⁵ LPG may offer a time savings compared to charcoal and firewood (and other collected biomass), as it provides storage of LPG in cylinders within the home, and saves cooking and cleaning time.¹⁰⁶ In this analysis, the main gender impacts of transitioning to LPG resulted from time saved from not having to acquire fuel daily as households transition from firewood and charcoal to LPG, and secondarily from time saved from cooking faster with LPG (through better and instant-on heat delivery to pots), fire preparation time, and cleaning (for example, because pots are not blackened by LPG).

Cooking with LPG will result in an estimated total time saving of 38 minutes per person per day for former charcoal households, 34 minutes per person per day for former firewood households, and 24 minutes per person per day for former kerosene households. In a developed country, saving 38 minutes from a daily work commute, for example, would be deemed a very significant source of value. Its significance is less clear in the context of cooking in Cameroon. The value of this time as perceived by those who spend it was not evaluated as part of the survey scope, nor assessed in available datasets or studies. (It is, however, one of the benefits that users consider, at least qualitatively, when choosing to use LPG in place of another type of fuel.) The time savings for households that collect firewood and purchase charcoal are much smaller—10.2 and 4.4 minutes per person per day, respectively, from switching to LPG.

If the total saved time were possible to convert to gainful employment paid at the minimum wage, the combined time savings from fuel collection and cooking efficiencies could result in an annual economic value of € 52 million a year, relative to the base case. This is necessarily a hypothetical estimation, and further research would be required to assess the extent to which time savings translate into value as perceived by individuals and as measured by society.

While jobs will be created in the LPG sector, including for women, women are likely to experience reduced employment and income opportunities in the informal charcoal sector as charcoal use for cooking is displaced by LPG use. These effects may be significant, but were excluded from this analysis due to lack of available data on employment in the charcoal sector.

Consumer household expenditure impacts

Quantitative impacts

Stove and fuel affordability are potential constraints to LPG initial adoption and sustained use, given income and liquidity levels of Cameroonian households.¹⁰⁷ Yet, LPG could save households costs in the long run, because LPG is more cost-efficient at delivering heat to pots than charcoal, kerosene and firewood in Cameroon.

In 2018, households in Cameroon spent € 2.2 billion on residential cooking fuel (7.6% of GDP)¹⁰⁸. Under conditions of expanded availability and increased consumption of LPG, the annual cost savings to consumers could exceed € 780 million in 2030, relative to the base case scenario. For the households

¹⁰⁵ Oxfam International (2017)

¹⁰⁶ Brooks N. et al. (2016); Nautiyal S. (2013)

¹⁰⁷ Maxwell et al. (2018); Asante et al. (2018)

¹⁰⁸ This was calculated using the total number of households, primary fuel use per household, the average consumption per household, and the average cost of each fuel, to obtain the total spent in 2018.

switching to LPG, this equates to an annual per household cost savings of € 26 for former kerosene households and € 22 for former charcoal households.

The absolute savings are greater for urban households due to the higher price of charcoal and firewood in urban (and peri-urban) areas relative to rural areas. For households switching from purchased firewood, the annual cost savings are even greater. However, an estimate of the total saved among consumers switching from purchased firewood to LPG could not be reliably made due to limitations in the underlying data.

Macroeconomic impacts

Quantitative impacts

Increasing LPG usage within the country could affect the (1) tax revenue and (2) trade balance for the country's economy, as well as the (3) total number of jobs across various fuel value chains. Cameroon's LPG supply is imported in part, and LPG is taxed, and these are expected to continue in a reformed LPG market.

LPG, charcoal and firewood are all subject to tax in Cameroon. The total of LPG taxes (VAT on elements of the price build-up plus the stabilization tax) is approximately 14%, and firewood and charcoal are subject to VAT of 19%. Assuming that the taxes on these fuels remain unchanged over time, an increase in LPG consumption, combined with a decline in purchased firewood and charcoal consumption, will impact national tax revenue. The 80% of LPG supply to Cameroon which is imported is also subsidized¹⁰⁹; increased importation will increase the subsidy burden on Government, in addition to affecting the trade balance. There is no import tax on LPG and firewood and charcoal are not imported, so increasing or decreasing LPG imports will have no net impact on tax revenue.

For purposes of this analysis, production capacity of LPG, the pricing and price-formula of LPG, and the subsidy on LPG were assumed to be constant at 2018 values. Given the lack of price data on other fuels, the macroeconomic impact of change in firewood, kerosene and charcoal consumption was not possible to model; the results presented here should be interpreted accordingly.

Increased LPG usage could decrease national tax revenue on an annual basis by € 150 to 220 million in 2030, relative to base case projections. This equates to a cumulative decrease in national tax revenue of € 1.25 to 2.0 billion between 2020 and 2030, relative to base case projections. (This calculation assumes effective tax collection within the charcoal and purchased firewood sectors, which may overstate the potential tax decrease due to the informality of those sectors.)

The subsidy cost could increase by CFA 36 to 48 billion per year in 2030, should sales price and import price stay constant at 2018 levels.

The national trade deficit in 2030 could enlarge by € 130 to 175 million relative to the base case.

Across the LPG value chain, an estimated 4,300 jobs existed in 2016. Serving the projected increased LPG consumption could create between 17,976 and 24,097 net new direct jobs in the LPG value chain by 2030, relative to base case projections, predominantly in LPG distribution and retail operations. It is important to

¹⁰⁹ The LPG subsidy amount fluctuates based on variations in the market price of imported LPG. For this analysis, an average subsidy amount equal to 367 CFA/kg has been assumed.

note that a wide uptake of LPG will result in job losses in the charcoal and firewood value chains, particularly in the informal sector. It was not possible to estimate such losses from available data.

Unquantified and under-quantified impacts

Increasing the volume of LPG in the country will create additional formal economic activity (e.g., growth of LPG businesses, staff of bulk depots, staff of filling plants, and transporters) which could positively affect the tax revenue from corporate tax in the country. This effect was not captured/modelled in the analysis, because of the lack of data on the corporate tax of different levels of the LPG value chain.

The health analysis was restricted to the five GBD health outcomes while acknowledging that there is good quality and emerging evidence of other health outcomes associated with HAP (e.g. cataracts, adverse pregnancy outcomes, TB, etc.) and burns, which have not been included in this analysis.

Conclusion

The results summarized above demonstrate that successful scaling up LPG use has meaningful positive impacts on four of five socio-economic impacts assessed: environment, health, gender and consumer household expenditure.

22. Detailed Impact Analysis and Findings

Impacts modelled, data used, and overall approach

This assessment estimated five different impacts of increased LPG adoption and use for household cooking under the lower-bound and upper-bound adoption scenarios described above relative to base case projections scenario:

- **Environment and climate impacts** – the averted deforestation, carbon dioxide equivalent emissions (considering carbon dioxide, methane, and nitrous oxide), black carbon equivalent emissions (considering black carbon, organic carbon, carbon monoxide, and total non-methane organic compounds), and the economic value of averted CO₂eq and BCeq emissions in terms of carbon financing.
- **Health impact** – the averted negative health impacts due decreased burning of firewood and charcoal and resultant household air pollution (HAP). This includes the number of deaths averted, the disability-adjusted life years (DALYs) saved, and the potential economic value that these individuals can now realize from the five main GBD outcomes.
- **Gender impacts** – the time that could be saved by women and other family members by no longer needing to buy firewood and charcoal daily for household cooking, and time saved from faster cooking with LPG. Some of these effects are quantifiable, some not. Health impacts as mentioned above will be particularly important for women. Increases in employment of women in the expanded LPG sector, particularly in LPG retail, but loss of women's jobs in the information charcoal and firewood sectors.
- **Consumer household expenditure impacts** – the cost savings/increase for the household due to increased LPG adoption and reduced usage of other fuels.
- **Macro-economic impacts** – the impact of increased LPG adoption on Cameroon's tax base and trade balance, as well as the total job creation within the LPG value chain and job losses in the charcoal and firewood value chains.

The assessment excluded certain potential mechanisms for impact, due to the lack of reliable data:

- Under environmental impacts, the assessment does not consider cooling effects.
- The health analysis is restricted to the five GBD health outcomes, while noting that there is good quality and emerging evidence of other health outcomes associated with HAP (e.g. cataracts in women, stillbirth and low birth weight, tuberculosis etc.) as well as burns in adults and children.
- Under macro-economic analysis, the assessment does not account for the job losses that may take place in the charcoal and firewood value chains as LPG adoption increases and charcoal and firewood consumption decrease.

In consequence, the total positive impacts of transitioning to LPG may be underestimated.

Data used and overall approach

This report uses the GLPGP-Dalberg survey and the LACE survey as the basis of forecasting. It must be noted that the GLPGP-Dalberg survey sample purposively excluded remote rural households in the sampled regions because they lack the basic infrastructure necessary to support an LPG supply chain (e.g., year-round passable roads), and because it was known that households in those settings rely almost exclusively on collected biomass as their cooking fuel. This choice is set against a backdrop of rapid urbanization in the country. The rationale for selecting rural households with better infrastructure access was to understand whether such access had an impact on fuel use and cooking practices in order to model demand for LPG more precisely.

In order to measure the impact from transition to LPG under the evaluated scenarios, it is important to consider which fuel households would switch from, and how much LPG they would potentially consume in future. Given the nature of the demand data obtained, a number of common assumptions were required to be made across the analyses:

- **Fuel transition:** In 2018, there were 4.9 million households in Cameroon, and they used four main fuels for cooking: charcoal, firewood, kerosene and LPG. 71% of all Cameroonian households used firewood as a primary fuel in 2011¹¹⁰. Given that only 5% of households reported using another fuel for cooking¹¹¹, only households using firewood, charcoal, kerosene, and LPG were considered. It was assumed that as LPG becomes more widely available over time, households will begin using LPG as a primary fuel and will gradually phase out the use of charcoal and firewood. The remaining charcoal, kerosene and firewood households were projected from estimates of population growth over the specified time-period.
- **Fuel consumption:** In the absence of data which enable accurate projection of how fuel consumption among LPG users could change over time, the analysis assumes that the average firewood, charcoal, kerosene and LPG consumption, derived from the GLPGP-Dalberg survey, would remain constant for urban/peri-urban and rural households between 2018 and 2030. With the exception of the increased consumption scenario, the analysis assumes that when transitioning from other fuels to LPG, consumers' LPG consumption is equivalent to the average LPG consumption in their segment.¹¹² No other potential impacts on household consumption were analyzed.

It should be noted that the impact assessment presented in this report is calculated for scenarios where LPG is sufficiently available (lower and upper bound) to serve LPG demand in the areas potentially

¹¹⁰ DHS (2012)

¹¹¹ Ibid.

¹¹² Average annual consumptions per household were obtained from the GLPGP-Dalberg survey. It was observed that the average annual household consumption for LPG was 71 kg nationally, 71.3 kg in urban areas, and 69.7 kg in rural areas. For kerosene, charcoal, and firewood, the limited data points made the rural consumption averages unreliable. For these fuels, national estimates were used: 17.9 kg (in litre-equivalents) for kerosene, 542 kg for charcoal, and 3,045.4 kg for firewood. In the increased consumption scenario an adjustment is made to account for fuel stacking (with increased LPG) by decreasing the average consumption of non-LPG fuels, taking into account variations in average stove fuel efficiency and calorific values.

accessible to LPG, relative to projected base case projections. This approach helps estimate the incremental impact of the investment to make LPG fully accessible to relevant Cameroonian households over time.

Environment and climate impacts

The impact of households changing their primary fuel from charcoal and firewood to LPG can have many positive impacts on the environment and climate. For the purpose of this analysis, the environmental impacts from increased LPG use (and decreased charcoal and firewood use) were estimated by calculating (1) averted deforestation; (2) carbon dioxide equivalent (CO₂eq) emissions¹¹³ averted; (3) Black Carbon equivalent (BCeq) emissions¹¹⁴ averted; and (4) the potential economic value of averted CO₂eq and BCeq emissions in terms of carbon financing.

The potential utilization of this carbon financing is addressed in the companion *Cameroon LPG Investment and Implementation* report.

Table 51. Summary of environment and climate impacts from increased primary LPG consumption relative to base case scenario in 2030

Annual impact	2030	
	Lower-bound scenario	Upper-bound scenario
Averted annual deforestation	35 million trees saved annually	54 million trees saved annually
Reduction in annual CO ₂ eq emissions	5 million MT reduction in CO ₂ eq emissions annually	7 million MT reduction in CO ₂ eq emissions annually
Reduction in annual BCeq emissions	5.6 million MT reduction in BCeq emissions annually	8 million MT reduction in BCeq emissions annually
Economic value of annual averted CO ₂ eq emissions	€ 5.5 million annually	€ 20.3 million annually
Cumulative impact	2020 - 2030	
	Lower-bound scenario	Upper-bound scenario
Averted cumulative deforestation	296 million trees saved	472 million trees saved
Cumulative reduction in CO ₂ eq emissions	10.7 million MT reduction in CO ₂ eq emissions	34.8 million MT reduction in CO ₂ eq emissions
Cumulative reduction in annual BCeq emissions	41.6 million MT reduction in BCeq emissions	68.0 million MT reduction in BCeq emissions
Cumulative economic value of averted CO ₂ eq emissions	€ 45 million	€ 147 million

¹¹³ CO₂eq emissions includes carbon dioxide equivalent emissions from carbon dioxide, methane, and nitrous oxide.

¹¹⁴ BCeq emissions includes black carbon equivalent emissions from black carbon, organic carbon, carbon monoxide, and total non-methane organic compounds.

Averted deforestation

Cameroon has the second-highest deforestation rate in the Congo Basin, losing approximately 220,000 hectares of forest annually. Cameroon lost 4.4 million hectares of forests (18.1% of its total forests) between 1990 and 2010.¹¹⁵ As of 2011, 71% of all Cameroonian households still relied on firewood as a primary cooking fuel.¹¹⁶

A transition to LPG has the potential to significantly reduce the pace of forest degradation and deforestation in Cameroon. To calculate the potential averted deforestation from increased LPG uptake, the study estimated the total number of trees saved due to reduced firewood and charcoal use through displacement by LPG use. The number of trees used in each scenario was calculated from current firewood¹¹⁷ and charcoal consumption,¹¹⁸ the proportion of this consumption that is produced unsustainably (using the forest non-renewability factor – a measure of how sustainably fuel is sourced from the forest¹¹⁹), and the typical usable mass of a tree.¹²⁰ The approach assumes that the same mix of wood type is used nationally and does not change over time.

Using this approach, it is estimated that 98 million trees were used for household cooking in Cameroon in 2017-2018. As shown in the following figure, In 2030, 50 million trees could be saved per year under the expanded LPG availability scenario, compared to base case projections. Between 2020 and 2030, this amounts to as much as a cumulative 472 million trees saved (upper-bound case), relative to base case projections.

¹¹⁵ FAO (2015)

¹¹⁶ DHS (2012)

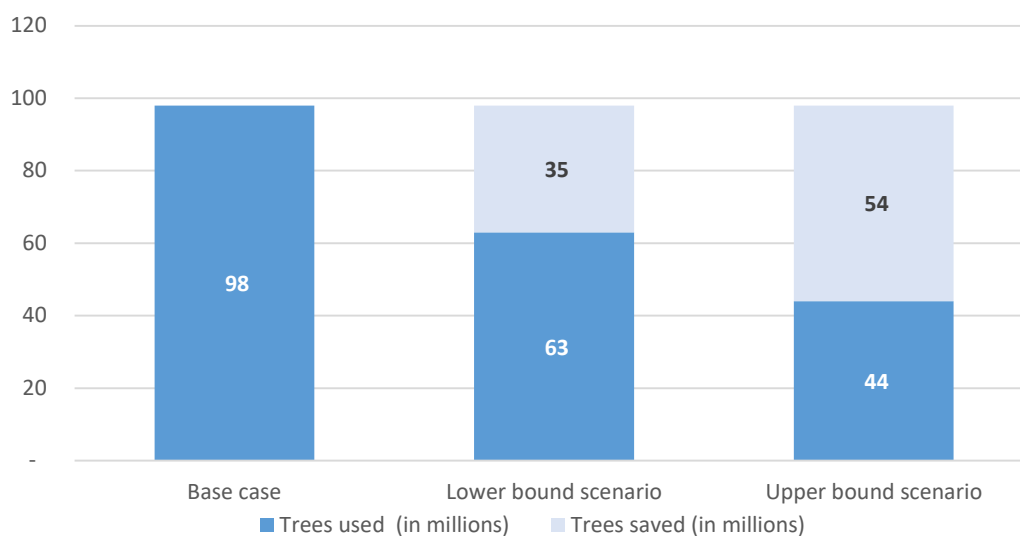
¹¹⁷ For firewood, this is calculated by using the average firewood use of 1200 kg per household using firewood Source: GLPGP-Dalberg survey (2018).

¹¹⁸ For charcoal, this was calculated by using the average charcoal use of 542 kg per household using charcoal from the GLPGP-Dalberg Survey. This household charcoal use was converted to equivalent wood consumption, using a ratio of 7 from Mjumita (2016). This is a global approximation that is commonly used in literature.

¹¹⁹ Cameroon has *de minimis* forest planning, measured by area, resulting in almost all wood that is taken from forests being non-renewable (this can be applied to both charcoal and firewood). Source: www.timbertradeportal.com/countries/cameroon.

¹²⁰ The global average value is 100 kg which is most commonly used in the literature. Source: Penn State University (2016).

Figure 52. The number of trees used and trees saved per year under base case, lower bound and upper bound adoption scenarios in 2030



Averted carbon emissions

In 2014, Cameroon emitted 197 million metric tonnes of total carbon dioxide equivalent emissions (CO₂eq).¹²¹ Cameroon's greenhouse gas emissions profile is dominated by emissions from land-use change and forestry (55% of total emissions) and industrial processes (30% of total).¹²² Only 5% of emissions are due to energy.¹²³ One contributor to land use change and fuel combustion is the widespread use of biomass as a cooking fuel. The transition from charcoal and firewood to LPG for cooking will decrease total and per capita carbon emissions through two avenues: carbon emissions from fuel production changes and from fuel use changes.

The total CO₂eq emissions from fuel use was calculated using the Gold Standard TPDDTEC Guidelines.¹²⁴ This methodology estimates total CO₂eq emissions by calculating the carbon dioxide equivalent emissions of three particles – carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O) – and applying global warming potential (GWP) conversion factors.¹²⁵

The CO₂eq emissions for different fuel use were calculated by multiplying household level fuel consumption by the net calorific value of the fuel and average stove efficiencies using global averages obtained from literature.¹²⁶ This results in the energy use per fuel (MJd), which was multiplied by the CO₂eq emissions factor (in g/MJd) to obtain the total CO₂eq emissions (in grams), which was then converted to metric tonnes. This methodology was used to calculate CO₂eq emissions for the base case projections scenario and the expanded LPG availability scenario. The CO₂eq tonnage differential was calculated by subtracting the

¹²¹ Climate Watch (2014)

¹²² Ibid.

¹²³ Ibid.

¹²⁴ Gold Standard Methodology (2017)

¹²⁵ CO₂ emissions rate was multiplied by the applicable non-renewability factor, CH₄ and N₂O emissions rate were multiplied by the global warming potential 100 factors (25 for CH₄ and 298 for N₂O).

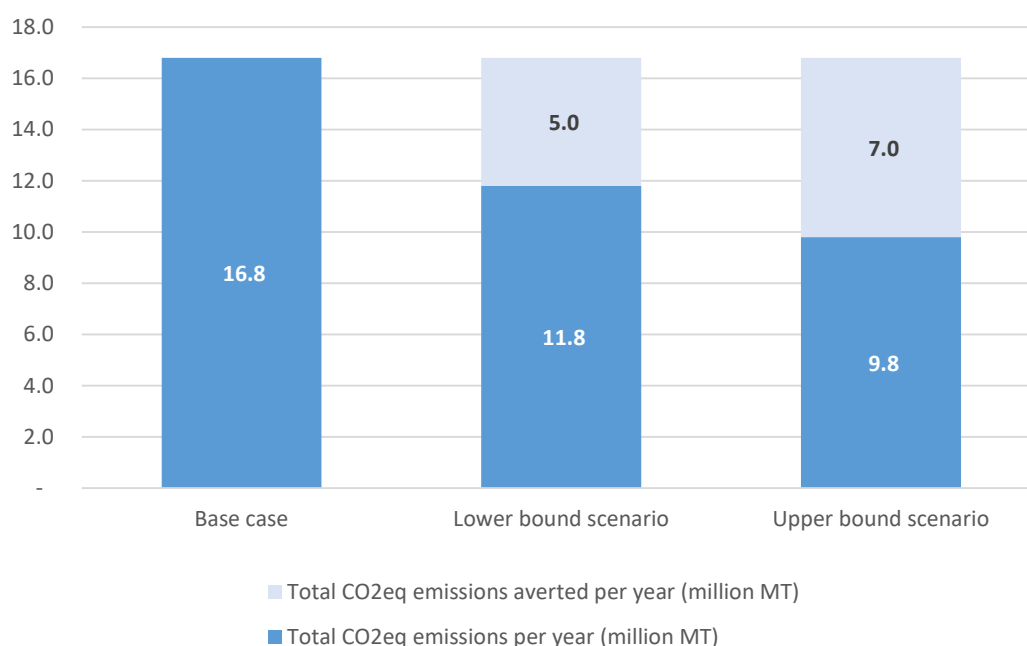
¹²⁶ Average values from literature were utilized due to the absence of relevant field study data in Cameroon.

CO₂eq emissions under expanded LPG availability scenarios from CO₂eq emissions in the base case projections scenario.

Combining the CO₂eq emissions from fuel use and fuel production, in 2018, an estimated 16.8 million MT of CO₂eq emissions were emitted in Cameroon from fuel use for cooking. In 2030, 5 to 7 million metric tonnes of CO₂eq emissions could be reduced per year under the expanded LPG availability scenarios, compared to the base case projections. Cumulatively, this amounts to 41 to 68 million MT of CO₂eq emissions averted between 2020 and 2030 compared to the base case.

This is shown in the following figure.

Figure 53. CO₂eq emissions and avoided emissions per year under base case, lower bound and upper bound adoption scenarios in 2030



Averted black carbon emissions

Black carbon (BC) is a key climate-active pollutant with high global-warming effect. Globally, it is estimated that household use of solid fuel contributes 25% of the total BC emissions.¹²⁷ In Africa and Asia, where usage of solid fuels is more common, residential usage of biomass can contribute 60 – 80% of total BC emissions.¹²⁸ Reducing the usage of biomass for residential cooking will directly reduce global BC emissions.

To estimate the BCeq emissions (i.e., the CO₂ equivalent of BC emissions) due to reduced firewood and charcoal usage and increased LPG adoption, the study calculated the total BCeq emissions for each scenario to 2030. To calculate annual BCeq emissions, a three-step approach was used, according to the Gold Standard Methodology: (i) The BCeq emissions per unit of fuel use was calculated using the formula in Gold Standard TPDDTEC Guidelines black carbon methodology; (ii) BCeq emission per fuel was multiplied

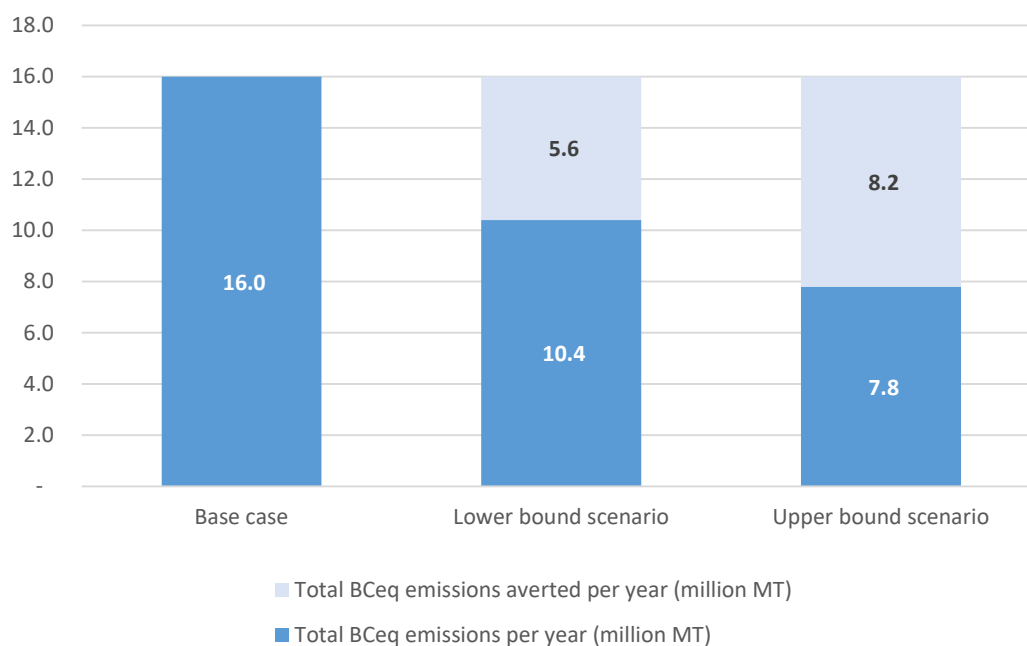
¹²⁷ Bond TC et al. (2013)

¹²⁸ Bond TC et al. (2013)

by the GWP of black carbon (1140)¹²⁹; (iii) the global warming potential of BCeq emissions per fuel was multiplied by the total consumption per fuel in kg. This calculation estimated the BCeq emissions from fuel use, calculated for LPG, charcoal, and firewood. In addition, the BCeq emissions for charcoal production were calculated following the approach laid out above but considered the BCeq emissions per fuel production rather than fuel use.¹³⁰ Only the production of charcoal was considered, as firewood is often collected (and is therefore it is difficult to quantify the BCeq emissions from firewood production) and LPG production produces negligible BCeq emissions.¹³¹

The total BCeq emissions in 2018 were estimated to be 16 million MT. As shown in the following figure, in 2030, 5.6 and 8.2 million MT of BCeq emissions could be reduced annually under the lower and upper bound LPG consumption scenarios, respectively, compared to base case projections projected trends.¹³² Cumulatively, this amounts to 46 to 76 million MT of BCeq emissions averted between 2020 and 2030 compared to the base case.

Figure 54. BCeq emissions and avoided emissions per year under base case, lower bound and upper bound adoption scenarios in 2030



Economic value of averted CO₂eq and BCeq emissions via carbon financing

Once emitted, CO₂ lasts about 100 years in the atmosphere, meaning that that the benefits of abating CO₂ emissions today will continue to be felt over the next century. Therefore, reducing CO₂eq and BC emissions from clean cooking will have positive environmental benefits. Both the Clean Development

¹²⁹ While the IPCC global GWP value = 690, Rypdahl et al (2009) provides an Africa-specific GWP value of 1140, which has been used in this analysis and is used in the impact literature related to clean cooking more broadly.

¹³⁰ Given the paucity of relevant field studies in Cameroon, the study relied on global averages obtained from literature, as detailed in the Annex.

¹³¹ World LP Gas Association and ESMAP (2015).

¹³² The per capita reduction does increase across the projected years, albeit by a small amount, resulting in the appearance of a consistent per capita emissions reduction.

Mechanism and Gold Standard Methodologies allow for carbon finance of LPG stoves. The economic value of abated CO₂eq emissions can be estimated by multiplying the total emissions averted through 2030 by the prevailing price of carbon in 2018.

It should be noted that there are currently no examples of carbon markets paying for BCeq abatement. To address this, the Gold Standard proposed a new BC methodology in 2017 for household cooking and BC emissions should be possible to value under this methodology in due course. For now, the potential value of BC abatement can be calculated by taking the CO₂eq quantities of BC emissions (i.e., BCeq emissions) and multiplying it by the prevailing price of carbon.

For both the estimations, there are two ways to determine the price of carbon:

- i. *Price carbon on prevailing carbon values* – A 2017 review of global carbon prices found that clean cookstove offsets from Africa were priced at an average of € 4.4/MT (US \$5/MT) of CO₂ (carbon prices ranged from € 1.7 – 17.2 (US \$2-20)¹³³
- ii. *Use a fair estimate of the price of carbon* – The fair price of carbon in the market is predicted to be € 34 – 69 (US \$40-80) per MT of CO₂ by 2020 and € 43 - 86 (US \$50-100) per tonne by 2030.¹³⁴ However, these carbon prices are not reflected in any market. In fact, 85% of global carbon emissions are currently not priced, and about three quarters of the emissions are priced at below € 8.6/MT (US \$10/MT) of CO₂.

Given that real carbon prices are consistently lower than the fair estimate of carbon price, the economic value of reduced carbon was estimated using the observed prevailing carbon price in Africa of US \$ 5.1/MT (€ 4.4/MT) of CO₂ and multiplying it by the carbon emissions averted.

The annual economic value of CO₂ emissions and BCeq emissions averted in 2030 range between of € 2.2 – € 3.3 million and € 4.4 – € 7.4 million, respectively, relative to business as usual. The cumulative economic value for these emissions averted between 2020 and 2030, could range from € 45 – € 147 million cumulatively between 2020 and 2030, depending on the LPG consumption scenarios compared to the based case, using the 2018 prevailing price of carbon.

Health impacts

Transitioning from charcoal and firewood to LPG can have significant health benefits due to reduced personal exposure to household air pollution (HAP) from burning solid fuels to meet household energy needs. HAP is causally related to ischemic heart disease, stroke, chronic obstructive pulmonary disease (COPD), lung cancer in adults, and acute lower respiratory infection in children (ALRI).¹³⁵ All of these diseases can result in premature death or a disability that can affect life expectancy. In 2013 in Cameroon, exposure to HAP from cooking with solid fuel resulted in 30,216 premature deaths and between 996,067

¹³³ World Bank (2017)

¹³⁴ Stiglitz and Stern (2018)

¹³⁵ Smith et al (2015)

and 1,950,777 Disability Adjusted Life Years (DALY)s.¹³⁶ A “DALY” is a measure of overall disease burden, expressed as the number of years lost due to ill-health, disability or early death.¹³⁷

For the purpose of this study, the health benefits from increased LPG use offsetting charcoal and firewood use was estimated by calculating (1) deaths averted, and (2) Disability-Adjusted Life Years (DALYs) saved due to reduced HAP from fine particulate matter (PM_{2.5}) exposure rates based on the five diseases included in the GBD only.¹³⁸ PM_{2.5} is one of a number of health-damaging products of incomplete fuel combustion that are emitted at relatively high concentrations when wood, charcoal, and other solid fuels are burned in open fires or cookstoves, but are negligibly emitted by combustion of LPG.

The World Health Organization (WHO) has published safe levels of PM_{2.5} for health, termed ‘air quality guidelines.’ The current recommended guideline for annual average PM_{2.5} level is 10 ug/m₃ (annual average). Recognizing the challenge of rapidly achieving such low concentrations of particulates, the WHO has also identified three interim targets for PM_{2.5} concentrations that would offer some health protection to support efforts towards meeting the WHO guidelines. The first (highest) of such targets is the interim-target 1 (IT-1), set at 35 ug/m³.

Compared with combustion of solid fuels in the home, LPG has a very clean emissions profile at point of use that consistently delivers low emissions independently of the operation, age, or condition of the stove used.¹³⁹ As such, and in the absence of other indoor or ambient sources of pollution, it is reasonable to assume that the concentrations of PM_{2.5} in households using LPG exclusively for cooking, will be below the WHO annual average Interim Target 1 (35 ug/m³). Higher exposure rates reported in certain other studies are likely due to background air pollution, including from neighboring households that continue to rely on polluting fuels and technologies, and/or from concurrent use of other, more polluting fuels in the homes studied. Given that there are still relatively few field studies conducted in Sub Saharan Africa which carefully document fuel stacking and levels of ambient air pollution (see Annex Chapter 22 (Detailed Impact Analysis and Findings) beginning on page 216), and that it was beyond the scope of this work to conduct a systematic review of all published studies, the modelling uses the WHO IT-1 annual PM_{2.5} concentration as a basis for assessing the health impacts of increased primary/exclusive LPG consumption in adults and children.

In terms of pre-intervention exposure data, the study relied on published concentrations of PM_{2.5} exposure for firewood and charcoal users taken from a systematic review of field studies conducted by Pope et al. (2017) (see Annex Chapter 22). Pre and post-intervention exposure values were inputted into the Household Air Pollution Intervention Tool (HAPIT version 3.1.1)¹⁴⁰, a tool based on established GBD methods that is in widespread use for modelling health impacts of interventions to reduce HAP

¹³⁶ Based on outputs from the WHO: HAPIT model, version 3.1.1, using GLSS 6 data

¹³⁷ IHME (2016); WHO (2016)

¹³⁸ PM_{2.5} refers to "Particulate Matter, 2.5 micrometers or less". These are air pollutants with a diameter of 2.5 micrometers or less, small enough to invade even the smallest airways and produce respiratory and cardiovascular illness

¹³⁹ Smith KR, et al. (2000); Zhang et al (2000); MacCarty et al. (2010); Shen et al. (2018)

¹⁴⁰ householdenergy.shinyapps.io/hapit3/

exposure.¹⁴¹ This tool was used to estimate the deaths averted and DALYs saved in Cameroon under each scenario.¹⁴²

It is important to note that using indoor PM_{2.5} concentrations will overestimate health benefits of LPG. 2011 DHS data shows that that 24% of urban and 23% of rural Cameroonian households cook outdoors. Outdoor cooking could result in somewhat lower exposure to PM_{2.5}, due to increased ventilation. This analysis uses indoor PM_{2.5} exposure concentrations. This was done because there are very few field studies that examine PM_{2.5} concentrations with outdoor cooking, and there is no consensus on the effect on HAP exposure of outdoor cooking. Other impact studies also apply indoor PM_{2.5} concentration. Similarly, that approach has been taken in this analysis.

To account for the effect of fuel stacking, an overall household PM_{2.5} emission level of 35 ug/m³ (representing LPG emissions plus HAP from non-LPG fuels) was assumed, instead of the actual emission level of pure LPG.

The health impacts of increased LPG adoption can be seen in the table below. Overall, 18,965 deaths could be averted cumulatively between 2020 and 2030, relative to base case projections. In addition, 926,484 DALYs could be saved. These values lead to a total economic value (based on the prevailing average wage rate times the labor time and productivity gained from the averted deaths and saved DALYs) of approximately € 207 million, relative to base case projections, based on prevailing wage rates. This economic impact does not consider the cost-savings to society from a reduced healthcare burden. It may overestimate the economic value of gained labor productivity, because not all working age adults affected by HAP are economically active.

Table 52. Summary of health benefits from increased primary LPG consumption relative to base case scenario, 2020-2030 (cumulative)

Cumulative impact (adults and children)	2020 – 2030
	Expanded LPG availability scenario
Cumulative deaths averted	18,985
Cumulative DALYs saved	926,484
Cumulative economic value of deaths averted and DALYs saved	€ 207 million

Premature deaths averted and DALYs saved

In 2011, 71% of Cameroon's households used solid fuels such as wood or charcoal.¹⁴³ Use of solid fuels results in HAP. Data taken from GBD shows that in 2013, 30,216 people died prematurely in Cameroon due to the main 5 HAP-related diseases. Women tend to be much more exposed to HAP than men, given that,

¹⁴¹ The HAPIT model uses disease rates and relationships as described in the Institute for Health Metrics and Evaluation's 2013 Global Burden of Disease and Comparative Risk Assessments efforts and estimates potential health changes due to interventions designed to lower household air pollution. See householdenergy.shinyapps.io/hapit3/#

¹⁴² A useful intervention lifespan of five years was assumed (with the results divided by five to obtain a per year output), and the default values for Cameroon were used, with a counterfactual of 7 ug/m³. This counterfactual is a measure of the ideal exposures, below which there is no risk to health.

¹⁴³ DHS (2012) and based on outputs from the HAPIT model, version 3.1.1, using GLPGP-Dalberg survey data (2018).

in Cameroon, they are primarily responsible for cooking. The leading cause of these deaths (10,528) was stroke, and the second leading cause was ischemic heart disease (6,407).¹⁴⁴

In 2013, between 996,067 and 1,940,777 DALYs were lost in Cameroon due to ill-health, disability, and early death as a result of HAP. Strokes and ischemic heart disease account for the majority of the years lost, with strokes accounting for an average of 227,881 years lost, and ischemic heart disease accounting for an average of 144,464 years lost.¹⁴⁵

The total number of deaths that could be averted and DALYs that could be saved per year due to nearly exclusive LPG use (displacing firewood or charcoal use), was estimated under the expanded LPG availability scenario and base case scenario projections using the HAPIT model. The difference between the expanded LPG availability scenario and the base case scenario shows the number of deaths that could be averted and DALYs that could be saved, should adequate LPG availability be achieved. Table 53 shows a summary of the results for each scenario. Between 2020 and 2030, 18,985 deaths could be averted and 926,484 DALYs could be saved, relative to base case projections, due to increased LPG usage.

Table 53. Deaths that can be averted and DALYs that can be saved from increased LPG consumption relative to base case projections¹⁴⁶ (annually in 2030 and cumulatively between 2020 and 2030)

Annual impact (adults and children)	2030
Expanded LPG availability scenario	
Annual adult deaths averted	1,325
Annual child deaths averted	921
Annual adult DALYs saved	30,982
Annual child DALY's saved	78,611

Cumulative impact (adults and children)	2020 - 2030
Expanded LPG availability scenario	
Cumulative adult and child deaths averted	18,985
Cumulative adults and child DALY's saved	926,484

¹⁴⁴ Based on outputs from the HAPIT model, version 3.1.1, using GLPGP-Dalberg survey data (2018).

¹⁴⁵ Based on outputs from the HAPIT model, version 3.1.1, using GLPGP-Dalberg survey data (2018).

¹⁴⁶ The number of DALYs saved depicts the difference in the number of potential DALYs saved under the enhanced availability scenario and base case scenario. The results should be interpreted accordingly. If the demand for LPG under the base case is lower in future than projected, for example, the number of DALYs saved will be higher.

Figure 55. HAP-related deaths per year and deaths averted per year under base case and expanded availability scenarios in 2030

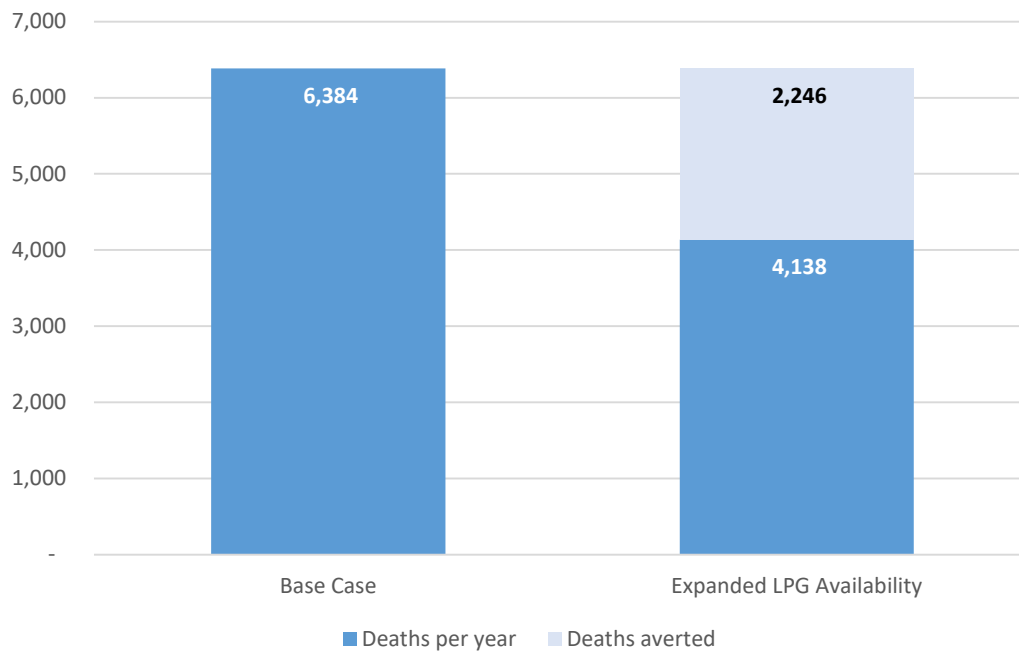
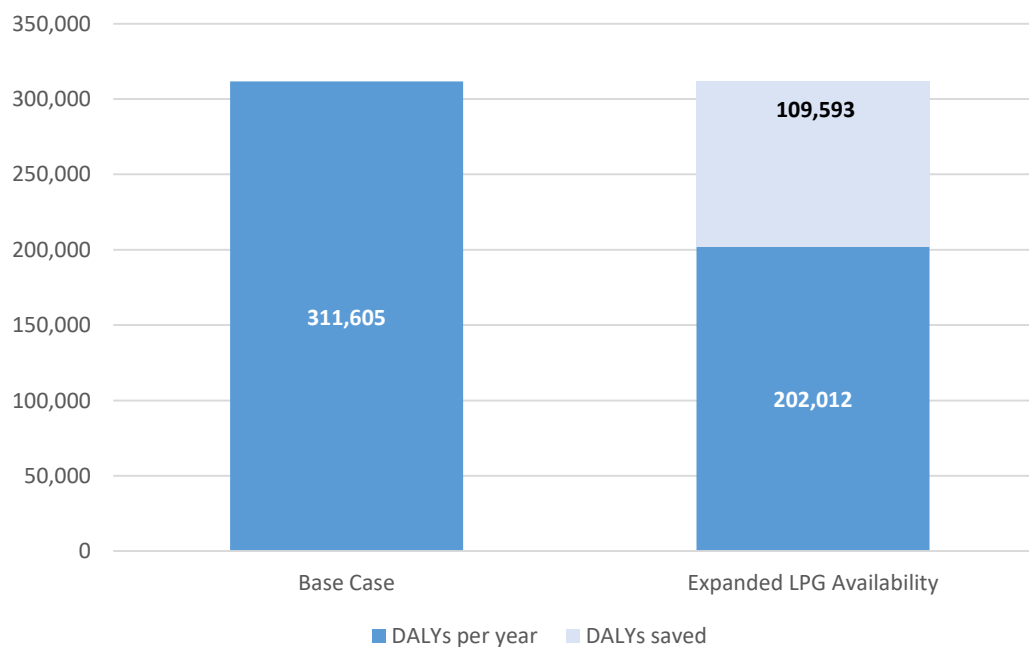


Figure 56. HAP-related DALYs per year and DALYs saved per year under base case and expanded LPG availability scenarios in 2030



Economic value of deaths averted and DALYs saved

Economic value of deaths averted: The economic value of the HAP-related deaths averted was estimated by multiplying the annual average GDP per capita in Cameroon¹⁴⁷ by the total number of adult deaths averted (as calculated above) adjusted for working age adults (age 15-64).¹⁴⁸

Economic value of DALYs saved: The economic value of HAP-related DALYs saved was calculated by multiplying the annual average GDP per capita in Cameroon by the number of DALYs saved across all households (as calculated above) adjusted for working age adults (age 15-64).

Table 54 shows that under the expanded LPG availability scenario, the annual economic value of the deaths averted and DALYs saved could reach € 1 million per year in 2030, relative to base case projections. The cumulative economic impact could reach € 23.5 million in 2030, relative to base case projections. Note that this likely represents an overestimation of the economic value deaths averted, as not all working age adults are productive.

It should be noted that the potential cumulative economic impact from LPG for Cameroon caused by health effects alone represents nearly half of the total investment capital expected to be required to deliver availability of LPG to all households that desire to use it, as detailed in Part VIII.

Table 54. Economic value of HAP-related deaths averted and DALYs saved from increased use of LPG relative to base case scenario in 2030¹⁴⁹ (annual and cumulative)

Annual impact (working age adults – age 15-64)	2030
Expanded LPG availability scenario	
Annual economic value of adult deaths averted (€)	1.0 million
Annual economic value of adult DALYs saved (€)	23.5 million
Annual total economic value of adult DALYs saved and deaths averted (€)	24.5 million
Cumulative impact (working age adults – age 15-64)	2020 - 2030
Expanded LPG availability scenario	
Cumulative economic value of adult deaths averted (€)	8.5 million
Cumulative economic value of adult DALYs saved (€)	199.0 million
Cumulative total economic value of adult DALYs saved and deaths averted (€)	207.5 million

Gender impacts

This section estimates whether, and how much, time could be saved from not having to collect fuel as households transition from firewood to primary use of LPG.

LPG potentially offers a time saving advantage when displacing firewood (and other collected biomass), as it provides storage of multiple weeks' worth of LPG within the home, saving time spent collecting fuel.¹⁵⁰ In

¹⁴⁷ A value of EURO 888.08/year was used. Source: World Bank Data Indicators (2018), "Cameroon GDP per capita."

¹⁴⁸ This was calculated by adjusting the adult deaths averted by the age dependency ratio for Cameroon in 2017 (85%). Source: World Bank (2017).

¹⁴⁹ The economic value of DALYs saved depicts the difference in the potential economic value of the DALYs saved under the full availability scenario and base case scenario. The results should be interpreted accordingly. If the demand for LPG under BAU is lower than projected, for example, the economic value of the DALYs saved will be higher.

addition, LPG stoves can offer time savings from increased speed of cooking, including time saved from having to start the fire, and reduced cleaning time as utensils and pots are not blackened by smoke.¹⁵¹ Although the number of studies quantifying the time spent on biomass collection activities and speed of cooking and cleaning is limited, some studies from different settings show that households, and women in particular, spend between 1 and 3 hours per day gathering biomass fuel (e.g., firewood in Sri Lanka^{152,153}), and between 1 and 5 hours per day cooking and preparing food in Africa.¹⁵⁴ In addition, some studies also report that transitioning to LPG has been shown to provide sufficient time to develop skills and generate income through labor market entry¹⁵⁵ and the establishment of small enterprises¹⁵⁶ in some settings.

The following table summarizes the results for Cameroon: increased LPG usage from expanded availability could save 3.1 hours per person per year from reduced fuel collection and 12.9 hours per person per year spent cooking, relative to the base case projections. This is equivalent to a total time saving for households switching to LPG of 38 minutes per person per day for formerly charcoal households, 34 minutes per person per day for formerly firewood households, and 24 minutes per person per day for formerly kerosene households. This reduction could result in an annual economic value of € 51.6 million a year, relative to the base case, if the saved time were converted to gainful employment at the prevailing minimum wage. (As a practical matter, that represents a hypothetical calculation; no data were obtained that quantify the value perceived by the individual from such time savings, nor on the value that society would place on the total saved time among all users.) A detailed description of these results is provided in the sections that follow.

Table 55. Time and time-value saved from increased LPG consumption under base case and expanded availability scenarios in 2030

Annual impact	2030
	Expanded LPG availability scenario
Avoided fuel collection time relative to base case	51.1 million hours saved
Saved cooking time relative to base case	418 million hours saved
Total value of time saved relative to base case	€ 51.6 million

Time savings from fuel collection and from cooking speed

Time savings from fuel collection was calculated by estimating the time spent collecting each fuel and estimating the total time saved due to households switching the portion of their cooking to LPG that existing Cameroon LPG users have switched, on average. Time spent collecting fuel (number of hours per year per fuel) was calculated from the GLPGP-Dalberg survey, wherein respondents were asked how frequently they purchased their primary cooking fuel and how much time it took to collect that fuel. Across the dataset, firewood-using households spent an average of 11 minutes a day, charcoal households spent 6

¹⁵⁰ A study from India showed that the introduction of LPG reduced time spent on fuel collection from 0.2 to 2.2 hours per day. In other studies, the time savings from LPG have been shown to be between 1.5 and 2 hours a day. Sources: Nautiyal S. (2013); Brooks N et al. (2016).

¹⁵¹ Savings on cleaning time estimated as between 15 and 30 minutes in the following study: Chandar M, Tandon V. (2004); Shashni S and Chander M. (2014).

¹⁵² Wickramasinghe A. (2011); Nautiyal S. (2013); Brooks N et al (2016); Chandar M, Tandon V. (2004); Shashni S and Chander M. (2014).

¹⁵³ In many LMICs, children and sometimes men help with fuel collection.

¹⁵⁴ ESMAP (2015)

¹⁵⁵ Wickramasinghe A. (2011)

¹⁵⁶ Shashni S and Chander M. (2014)

minutes a day, kerosene households spent 1.3 minutes a day, and LPG households spent an average of 1.2 minutes a day collecting fuel.¹⁵⁷ (“Collecting” means purchasing when fuel is paid for, and gathering, when not. In rural areas of Cameroon, most wood is gathered; in urban, a plurality or majority is purchased, based on the locality.)

The total number of hours saved per year due to increased LPG usage (through decreased firewood, charcoal, and kerosene usage) was calculated from the total hours spent per year to collect fuel under the expanded LPG availability and base case demand projections. In 2018, an estimated 255 million hours were spent on fuel collection.¹⁵⁸ 51 million hours could be saved per year from fuel collection under the expanded availability adoption scenarios in 2030, compared to projected base case. This is equivalent to a time saving of 10.4 minutes and 4.4 per person per day for users of firewood and of charcoal respectively, relative to base case projections.

Time savings from cooking was calculated by estimating the time spent cooking with each fuel and estimating the total time saved due to households switching the portion of their cooking to LPG that existing Cameroon LPG users have switched, on average. The average time spent cooking meals (including lighting a fire) was obtained from the GLPGP-Dalberg survey for each primary fuel. On average, firewood using households spent an average of 2.3 hours a day cooking, charcoal households spent 2.4 hours a day, kerosene households spent 2.3 hours a day, and LPG households spent an average of 1.9 hours a day.

Table 55 above shows that in 2030, 418 million hours could be saved per year from cooking under the expanded LPG availability scenario, compared to the base case projection. For the households that start to use LPG, formerly firewood-using households save an average of 24 minutes per day, charcoal-using households save an average of 33 minutes per day, and kerosene-using households save an average of 24 minutes per day.

Economic value of time saved

The transition from firewood and charcoal use to LPG use for cooking saves households time, and that this time might be put towards productive activities for a portion of the population, the economic value of time saved may be estimated. The economic value of time saved was calculated as the value to the individual if the hours saved were used for increased employed work or income generating activities. To approximate the economic value of time saved, the proportion of the time saved likely to be used for economic activity was considered. This was estimated to be 35% of the total time saved, based on the literature¹⁵⁹. It was further assumed for purpose of the calculation that such work would be paid the average hourly minimum wage in Cameroon (€ 0.33/hour)¹⁶⁰. This approach allows for a rough estimate of the economic value that could be realized, noting that regional variations could result in differences.

¹⁵⁷ The per day estimate was derived from the time spent one way to collect fuel and frequency of fuel collection. Values are lower than actual time to source, as households typically do not collect fuel daily. (Note: These data were self-reported by the survey respondents.)

¹⁵⁸ Calculated using the total number of households using each fuel and the average fuel collection time per year per fuel to obtain the total annual fuel collection time.

¹⁵⁹ The value 35% is the global average, and the range is 20-50%. Source: Jeuland (2016).

¹⁶⁰ A minimum wage value of € 0.33/hour (CFA 36,270/month) was used. Source: Minimumwage.org (2018), Cameroon.

In 2017-2018, the economic value of the time spent on fuel collection and cooking was estimated to be € 485 million.¹⁶¹ Under the expanded LPG availability scenario, the annual economic value of these time savings could reach € 51.6 million in 2030, relative to the base case. This is equivalent to a per capita economic value of time savings for the households that do switch to LPG of € 24 per year for former firewood users, € 26 for former charcoal users, and € 16 for former kerosene users.

Charcoal sector impacts

The Cameroon charcoal and firewood sector supported 90,000 jobs in 2016¹⁶², with an annual turnover of US \$304 million at that time, representing 1.3% of GDP. Charcoal and firewood production and distribution are thus an important source of income to households in Cameroon, especially rural households.

In 2016, 2.2 million MT of firewood and 356,530 MT of charcoal were consumed in urban areas of Cameroon¹⁶³. The informal charcoal and firewood sector represents a source of employment for women, and expansion of LPG use at the expense of charcoal and firewood use for cooking can be expected to reduce employment meaningfully in that sector, as well as motivate charcoal and firewood selling (and production) to shift to areas with lower levels of competition from, and availability of, LPG. Because detailed data about the charcoal and firewood sector were not available, it was not possible to estimate the potential loss of charcoal and firewood sector jobs associated with accelerated LPG adoption and use.

Consumer household expenditure impacts

Stove and fuel affordability are potential constraints to LPG initial adoption and sustained use, given the income and liquidity levels of Cameroon households. Yet, LPG could save households costs in the long run.

While LPG has a higher initial purchase price (in terms of the cost of the stove and cylinder) and large, multi-weekly refill transactions relative to daily or weekly woodfuel purchases, LPG is a more efficient fuel than purchased biomass fuels (on an energy to pot basis), which could result in annual cost savings for households.

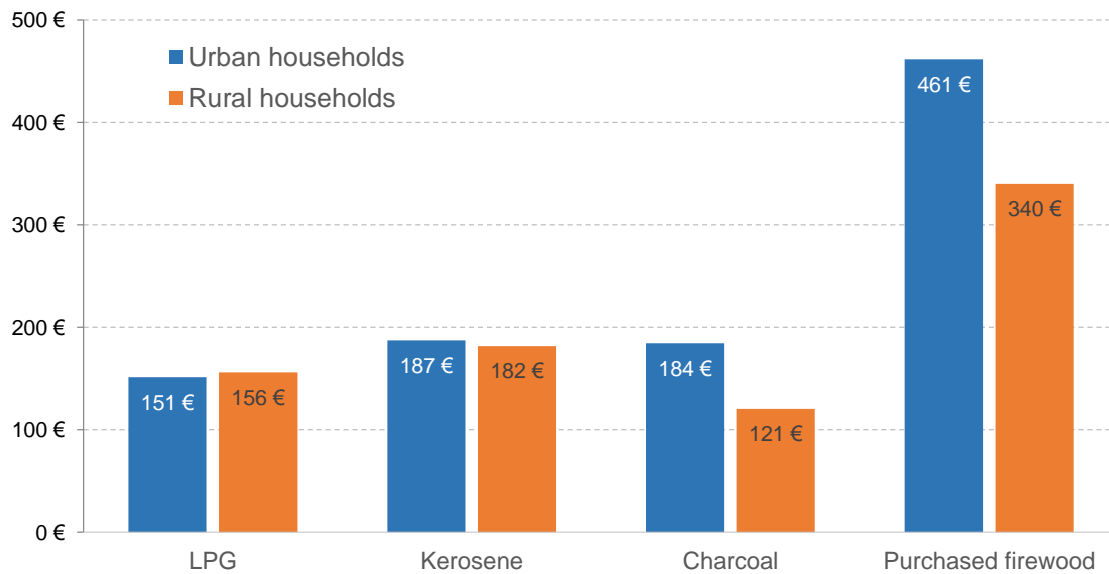
The following chart shows the comparative cost of cooking a meal in Cameroon with LPG, charcoal, kerosene and purchased firewood:

¹⁶¹ As calculated from the total time used for fuel collection, the total time used for cooking, and the minimum wage.

¹⁶² Eba'a Atyi, R. et al., *Economic and social importance of fuelwood in Cameroon*. International Forestry Review v. 18(S1) (2016).

¹⁶³ Ibid.

Figure 57. Average annual household fuel cost when cooking with LPG, kerosene, charcoal and firewood



Additional analysis regarding comparative household costs is presented in Part VI.

It is estimated that 7% of a household's income in Africa is spent on energy, and additional incremental spending is often viewed as unaffordable given competing essential household expenses, including food and shelter.¹⁶⁴ In general, the total expenditure on cooking fuel does not vary significantly by income, which means that low-income households spend a greater proportion of their income on energy relative to high-income households. The fuel cost savings were calculated using the average cost of fuel per year per household and the average annual consumption of each fuel per household to obtain total household fuel costs under each scenario, using the GLPGP-Dalberg (2018) market survey data. The average annual cost of cooking per household shows that, on average, LPG provides cost savings for households using any other of the main Cameroonian cooking fuels, excepting charcoal purchased in rural areas.

In 2018, urban and rural households in Cameroon spent a total of € 2.2 billion on residential cooking fuel.¹⁶⁵ Under the lower bound and upper bound scenarios, the estimated annual cost savings to consumers is € 780 million to € 1.2 billion in 2030, relative to base case projections.

Table 56. Cost savings per year from increased LPG consumption relative to base case scenario in 2030

Annual impact	2030	
	Lower-bound scenario	Upper-bound scenario
Annual cost savings for all households switching from firewood, charcoal and kerosene to LPG, relative to base case	€ 780 million	€ 1.2 billion

¹⁶⁴ ESMAP (2015).

¹⁶⁵ This was calculated using the total number of households, primary fuel use per household, the average consumption per household and the average price per fuel to obtain the total spent in 2018

Macroeconomic impacts

LPG, charcoal and firewood are all subject to tax in Cameroon. The total of LPG taxes (VAT on elements of the price build-up plus the stabilization tax) is approximately 14%, and firewood and charcoal are subject to VAT of 19%. Assuming that the taxes on these fuels remain unchanged over time, an increase in LPG consumption, combined with a decline in purchased firewood and charcoal consumption, will impact national tax revenue. The 80% of LPG supply to Cameroon which is imported is also subsidized¹⁶⁶; increased importation will increase the subsidy burden on Government, in addition to affecting the trade balance. There is no import tax on LPG and firewood and charcoal are not imported, so increasing or decreasing LPG imports will have no net impact on tax revenue.

For purposes of this analysis, production capacity of LPG, the pricing and price-formula of LPG, and the subsidy on LPG were assumed to be constant at 2018 values. Given the lack of price data on other fuels, the macroeconomic impact of change in firewood, kerosene and charcoal consumption was not possible to model; the results presented here should be interpreted accordingly.

Increased LPG demand could adversely affect both tax revenue and trade balance. Increased LPG usage and corresponding reduction in the use of other fuels could decrease the national tax base on an annual basis by € 150 to 220 million in 2030, relative to base case projections. This equates to a cumulative decrease in the national tax base of € 1.25 to 2.1 billion between 2020 and 2030, relative to base case projections. The LPG subsidy cost could increase by CFA 36 billion to CFA 48 billion per year in 2030, assuming no reforms to target or adjust the subsidy, and assuming the end-user price and average import prices remain at 2018 levels. The national trade deficit in 2030 could expand by € 131 million to € 175 million relative to base case projections.

Table 57. Summary of annual macro-economic impacts from increased primary LPG consumption relative to base case scenario in 2030

Annual impact	2030	
	Lower-bound scenario	Upper-bound scenario
Annual decrease in national tax base relative to base case projections	CFA 100 billion € 150 million	CFA 149 billion € 223 million
Annual expansion in national trade deficit relative to base case projections	CFA 87 billion € 131 million	CFA 117 billion € 175 million
Annual increase in subsidy cost relative to base case projections	CFA 36 billion € 54 million	CFA 48 billion € 72 million
Net job creation in the LPG value chain relative to base case projections	17,976	24,097

Tax revenue impact

The impact of increased LPG adoption will be felt on the CFA 271.9 billion (€ 407.9 million)¹⁶⁷ tax base on cooking fuels (in 2018) through changes in total volume of LPG-specific taxes, VAT, and other levies

¹⁶⁶ The LPG subsidy amount fluctuates based on variations in the market price of imported LPG. For this analysis, an average subsidy amount equal to 367 CFA/kg has been assumed.

¹⁶⁷ Calculated from market survey data (2018).

collected as applicable from LPG, firewood, kerosene and charcoal. An increase in LPG consumption and decrease in kerosene, charcoal and firewood use would decrease the amount of total taxes collected due to fuel usage in Cameroon. (Cameroon does not import charcoal or firewood.) Increasing the domestic consumption of LPG will create formal economic activity (e.g., LPG marketers, staff of bulk depots, staff of filling plants, truckers, etc.) which could positively affect the tax revenue from corporate tax in the country. This effect was not captured/modelled in the analysis.

To calculate the import tax contribution the total quantity of fuel imported was multiplied by the price per kg of fuel imported¹⁶⁸ and the import duties per fuel. To estimate the impact of fuel sales on the tax base (through VAT and other taxes on the various fuels), the total quantity of each fuel consumed in-country was multiplied by the domestic sales price per kg of that fuel¹⁶⁹ and the aggregate tax rate applicable to the fuel. The total import- and sales-based taxes were then added to obtain the total impact on the tax base in Cameroon. Changes in the LPG production capacity, sales and import fuel prices would change the tax revenue but projecting how they might change over time was beyond the scope of this analysis.

In 2018, the national tax base due to cooking fuels was calculated to be CFA 271.9 billion (€ 407.9 million).¹⁷⁰ The national tax base could decrease annually by CFA 149 billion (€ 223 million) in 2030, relative to the base case projections. If the government continues to subsidize LPG at an average level of CFA 366.8/kg, then the subsidy cost would be CFA 36 to 48 billion in 2030, relative to the base case.

Trade balance impact

This study assumed that the national production capacity of LPG would remain constant over the projected time frame, which kept Cameroon as a net importer of LPG. It was also assumed that charcoal and fuelwood production would remain domestic, with negligible international trade in these products. As a result, Cameroon's trade deficit would expand over time, as larger volumes of LPG would need to be imported in future to serve the growing demand. The impact on the trade balance was calculated by determining net imports of LPG and keeping the price per kg of each fuel imported/exported constant¹⁷¹.

To estimate the impact on trade balance, the study calculated the total impact of importing and exporting different cooking fuels on the national trade balance under various adoption scenarios (lower bound, upper bound, and base case projections) using the foregoing assumptions. The difference between the base case projections scenario and the upper/lower bound scenarios shows the national trade balance should investments in LPG availability be made.

In 2018, Cameroon's trade deficit for cooking fuels was CFA 77.6 billion (€ 116.4 million), representing 7.6% of the total trade balance in Cameroon. The national annual trade deficit could expand by CFA 87 to 117 billion (€ 131 to 175 million) in 2030, relative to the base case projections, based on the scenario.

¹⁶⁸ This was held constant over time and was calculated from domestic sales prices and sales and import duties. A value of GHC 0.57/kg was used for charcoal, GHC 1.69/kg for firewood, and GHC 5.17/kg for LPG.

¹⁶⁹ This was held constant over time, and was sourced from the market survey data. A value of CFA 151/kg was used for charcoal, CFA 128/kg for firewood, CFA 547.5/kg for kerosene, and CFA 520/kg for LPG.

¹⁷⁰ Calculated from market survey data (2018). This value must be used with caution, because tax collection in the charcoal and firewood sectors is less than what is theoretically possible due to the informality of those sectors.

¹⁷¹ Calculated from domestic sales prices and average fuel subsidy. A value of CFA 886.8/kg was used for LPG.

Subsidy impact

The subsidy cost could increase by CFA 36 to 48 billion per year in 2030, should sales price and import price stay constant at 2018 levels, based on the increased LPG importation under the lower and upper bound scenarios, respectively, relative to the base case projections. This assumes that the average amount of subsidy per MT remains at current levels, and domestic LPG production does not increase materially from its current level.

Net job creation across fuel value chains

As LPG consumption increases, there will be a corresponding rise in employment through jobs for the production and distribution of LPG to meet that demand. Simultaneously, jobs in charcoal and firewood will decrease with the declining demand for those two fuels to meet household energy needs. Given the challenges of accurately quantifying direct and indirect jobs (including construction, maintenance, and staff of retail shops) in multiple fuel value chains, only long-term direct jobs were considered in this analysis. Reliable estimates for the total number of jobs in each value chain could not be found and should be included as specific employment questions in future census and national representative surveys to allow proper quantification. The analysis also does not consider short-term jobs created from constructing the LPG distribution infrastructure (e.g. engineers, constructor workers, suppliers of raw materials etc.).

In the absence of national-level estimates, the total employment in the LPG value chain was obtained from an industry expert estimation and estimated at an average of 4,300 dedicated full-time jobs (including staff of bulk depots, filling plants, truckers, marketing companies, and appointed marketers' distributors).¹⁷² Approximately 93% of these jobs are within the LPG distribution channels.

Given that Cameroon imports LPG, an increase in LPG household consumption will increase jobs in LPG distribution rather than production. Given that about 93% of all current LPG jobs are in distribution, the number of non-production (bottling and distribution) jobs per kg of LPG consumed was calculated for 2018. Assuming this ratio remains constant over time, the total number of new jobs was calculated by multiplying the bottling and distribution jobs per MT of LPG by the total domestic LPG consumed under various adoption scenarios.

Across the LPG value chain, an estimated 4,300 jobs existed in 2018. As a result of increased LPG use, between 17,976 and 24,097 new jobs can be created by 2030. It is important to note that a wide uptake of LPG will result in job losses in charcoal and firewood value chains, particularly in the informal sector.

Unquantified impacts

The assessment excluded a few potential avenues for impact, due to the lack of reliable data, which in turn may underestimate the total positive impacts of transitioning to LPG.

¹⁷² This was estimated using the industry knowledge of how LPG value chains are structured. Employment in LPG can be divided into (1) Dedicated full-time jobs - through staff in bulk depots, filling plants, truckers, marketing companies, appointed marketers' distributors. These jobs can be permanent and non-permanent. As a rule of thumb, experts suggest about 8000-10000 direct jobs for 1 shift. (2) Indirect jobs such as distribution shops with or without at home delivery, cylinder maintenance companies, service companies for the marketing companies, which can amount to 28,000 to 30,000 jobs. The first set of jobs are easier to assess than the second.

- With respect to environmental impacts, the assessment does not consider cooling effects.
- The health analysis is restricted to the five Global Burden of Disease health outcomes, while noting that there is good quality and emerging evidence of other health outcomes associated with HAP (e.g., cataracts in women, stillbirth and low birth weight, tuberculosis) as well as burns in adults and children.
- Under macro-economic analysis, the assessment does not account for the job losses that may take place in the charcoal and firewood value chains as LPG adoption increases and charcoal and firewood consumption decrease.

The results reported in this Part demonstrate that scaling up LPG use has clear positive impacts on four of five socio-economic impacts assessed: environment, health, gender and consumer household expenditure.

Calculations, methodology, data sources and values

Details of the calculation equations and methodology used in the Part are presented in the Annexes, Chapter 29 (Impact Assessment Calculations and Methodology) beginning on page 301.

Details of the data sources and values are presented in the Annexes, Chapter 30 (Impact Assessment Data Sources and Values) beginning on page 303.

XI. Monitoring and Evaluation (M&E) Framework

This Part is intended to set the basis for the creation of a monitoring and evaluation (M&E) framework to measure progress and impacts of increased LPG access and use for cooking in Cameroon over time to meet the national policy goal. This is a guidance document intended to be further developed through working closely with national organizations and associated partners responsible for program monitoring and evaluation at the country level, and subsequently implemented upon identification of appropriate resources.

In this Part, a set of indicators - the **Indicators of Sustainable LPG Expansion (ISLE)** – is described in order to help the Government of Cameroon (and the governments of other relevant countries) to evaluate and report on progress in safely scaling up LPG adoption and sustained use at the household level.

23. M&E Goals and Context

M&E of LPG in an impacts context

LPG has been highlighted by several international organizations, including the World Health Organization (WHO) and the International Energy Agency (IEA), as one of the key fuels to be scaled up rapidly throughout the developing world. This is because LPG is a clean burning and easily transportable fuel that consistently achieves the best performing tier level for indoor emissions (Tier 4) under the International Organization for Standardization, International Workshop Agreement 11 (ISO/IWA-11)¹⁷³, in both laboratory and field conditions. Its performance in the field does not normally vary with user operation and equipment condition (which means that it burns cleanly not only initially but also over time). Nevertheless, there may be variations in the levels of personal exposure reductions due to local circumstances (e.g. ambient (outdoor) air pollution, fuel stacking etc.). For example, the benefits of LPG adoption in terms of reduced household air pollution might be reduced due to cross-contamination from neighboring households' continued use of polluting fuels/stoves, or LPG households not fully switching to using LPG for a sufficient portion of cooking tasks.

Types of evaluations

This proposed M&E framework covers two aspects of an evaluation: process and impact.

1. The *Process/outcome evaluation* is intended to understand better the effectiveness of policies and programs and to assess why particular interventions work or do not work. It measures program effects on the target population by assessing the progress towards the program's outcome objectives and how the program has been implemented.

¹⁷³ Shen, et al. (2018). Evaluating the performance of household liquefied petroleum gas cookstoves. *Environmental Science & Technology*, 52(2), 904–915.

2. The *Impact evaluation* focuses on the results and ultimate effects of the intervention program/policy in regard to achieving its goals for the target population.

The two types of evaluation go hand in hand. They draw from a mix of regularly-collected data on key aspects of an LPG national market, such as consumption, sales, distribution and safety, national population surveys with questions on household energy use, and ad hoc data collection efforts and research activities. The combination of different data gathering efforts is needed in order to quantify impacts in a more robust way. Specifically, without very accurate information on LPG household consumption and sustained use (i.e. primary and secondary fuel use), it is not possible to evaluate and accurately quantify the health, environmental, climate and other impacts of LPG uptake over time.

Population-based household surveys, conducted as part of ad hoc data collection efforts (e.g. research projects or programs), will be a key component in complementing and enhancing the proposed set of monitoring indicators that track LPG scale-up (see the following Chapter). Surveys and qualitative methods (e.g., in-depth interviews and focus group discussions) are, indeed, needed to capture the complexity of cooking behavior, including fuel usage patterns and decreased use of traditional cookstoves and fuels. Such surveys and methods will also be necessary in capturing gender related impacts of adoption and sustained use of LPG, which are currently difficult to quantify.

Household energy questions in existing national representative surveys

A number of nationally representative surveys are conducted in Cameroon at regular intervals, which are instrumental in tracking national estimates of household energy use and model household air pollution impacts. These include the:

- i. Population and Housing Census of Cameroon, conducted every 10 years (the last one was completed in 2015);
- ii. ‘Enquêtes Camerounaises Auprès des Ménages’ Household (ECAM) by the National Institute of Statistics (ISN), conducted every 7 years, with the last round completed in 2014 (ECAM 4).
- iii. USAID’s Demographic and Health Survey (DHS), conducted approximately every 6 years (the last one completed in 2014). As at the time of writing, a new round is ongoing, with data collection expected to be completed by December 2018.
- iv. UNICEF Multiple Indicator Cluster Surveys (MICS), conducted every 6 or more years (the last one completed in 2014).

All the listed surveys include a small set of household energy questions, in most cases only a single question on the main fuel used for household cooking. Often, the listed answer options and fuel categories are different in different surveys, limiting comparability.

Given the importance of tracking progress towards Sustainable Development Goal 7 (SDG7) and, specifically, SDG 7.1.2: Proportion of population with primary reliance on clean fuels and technologies, WHO and the World Bank have initiated in recent years a process of survey harmonization to agree on a set of ‘harmonized’ household energy survey questions to be incorporated in all the main nationally

representative surveys¹⁷⁴. Once the revised and harmonized set of household energy questions has been endorsed by statistical offices and major national surveys, it will be possible to track household fuel use, and specifically LPG uptake more accurately (see later sections for further discussion). For example, in a number of current surveys, LPG data is co-mingled with data about other gases (biogas and natural gas), and no data on secondary fuel use is captured. Asking about primary and secondary fuel use is, indeed, needed to assess the concurrent use of multiple stoves and fuels (known as stove/fuel stacking) and better quantify impacts.

Why is an M&E plan needed?

This work is embedded in the Government of Cameroon's efforts to scale up clean cooking with LPG to meet its SEforAll target of universal access to clean household energy. This target is defined as 58% of the population accessing, and using, LPG on an ongoing basis by 2030.

The Government of Cameroon recognizes the importance of monitoring and evaluation of its energy initiatives, as demonstrated by the intended inclusion of an M&E framework in the SEforALL Action Agenda (currently in development), although technical capacity and resources to implement M&E components fully is limited.

A properly designed and implemented M&E framework for LPG scaling up will allow national/international stakeholders to:

- i. Monitor progress with the implementation of agreed policy against program goals;
- ii. Apply evidence-based adjustments to improve program performance and reach;
- iii. Contribute (using harmonized survey questions) to the SDG7 and SE4All global tracking; and
- iv. Understand, quantify, and interpret the wider societal impacts (health, the environment, climate, gender empowerment and economic development) of scaling up LPG uptake.

Steps in developing and implementing the LPG-scale up M&E plan in Cameroon

The process of developing a national M&E plan for LPG scale up should begin during the initial stages of program planning and implementation, in consultation with local stakeholders responsible for program implementation, ministries and agencies with M&E expertise. The framework presented in this document and developed under the EU/KfW-sponsored Clean Cooking for Africa Program should, therefore, be considered as one of the initial steps in the process to help Cameroonian authorities develop and implement a full M&E plan, for which additional funding needs to be sought.

The proposed framework should be discussed and refined through stakeholder consultation and participation by local implementers and M&E authorities, according to the following steps:

- i. Conduct stakeholder consultation(s) convened by Cameroonian authorities;

¹⁷⁴ See www.who.int/airpollution/household/survey-harmonization/en/

- ii. Define processes for stakeholder involvement: identify the key local stakeholder(s) responsible for overseeing and implementing the M&E plan, determine which local capacity is available (and can also be strengthened), and identify which partners can support the process;
- iii. Discuss and revise the proposed M&E framework and the ISLE indicators developed under the Clean Cooking for Africa Program to determine elements to be monitored and evaluated;
- iv. Identify available resources to implement the plan, including over which timeframe; this is a key limiting factor that may influence how the plan is finalized and implemented;
- v. Determine M&E methods for data and information collection: (a) develop a data collection plan (including indicators to be collected, timing for data collection and analysis, tools, resources, training provision for staff, etc.); (b) determine M&E responsibilities (data collection, supervision, analysis, reporting, etc.);
- vi. Set M&E targets;
- vii. Define a reporting system for dissemination and utilization of results.

Status of the M&E planning process in Cameroon

During the course of 2017/2018, Clean Cooking for Africa/GLPGP engaged in discussions about M&E for LPG scale up in Cameroon through its research partnership with the University of Liverpool (UoL) and Douala General Hospital, as a first step to deepening the discussion with key national stakeholders.

This work is built as part of a newly established UK National Institute of Health Research (NIHR) Global Health Research Group - *CLEAN-Air (Africa)*. The Group will conduct a 3-year research and capacity building programme (2018-2020) to support scaled population transition from polluting solid fuels and kerosene for household energy to LPG (as a clean fuel) to address the substantial public health burden from mainly non-communicable diseases due to household air pollution. Focus countries for this work include Cameroon, Ghana, and Kenya. These countries were strategically chosen by UoL and GLPGP to build the research and evaluation components around the Clean Cooking for Africa Project and the ongoing national efforts to scale up LPG in these countries.

Research and health-sector capacity building activities under *CLEAN-Air (Africa)* will begin in the first quarter of 2019, following completion of an initial scoping phase (April – October 2018) required under the NIHR programme (see Annex I for project goals and main activities). The outputs of the *CLEAN-Air (Africa)* work will contribute directly to the M&E goals for LPG scale up in Cameroon.

24. ISLE Indicators for Monitoring and Evaluation

Indicators for Monitoring and Evaluation of LPG adoption, sustained use and infrastructure expansion over time

The **Indicators of Sustainable LPG Expansion (ISLE)** developed by Clean Cooking for Africa/GLPGP consist of a set of indicators to be routinely collected at the national level in order to inform the monitoring and evaluation of scaling safe adoption and sustained use of LPG as a clean household cooking fuel and the resulting social, environmental and economic impacts.

These indicators are the first step to conducting further, more detailed evaluation on different impact categories with metrics presented in the final section of this chapter. These impact metrics measure the extent and rate of the existing and projected social, health, environmental and economic impacts from increased LPG adoption and use and associated economic activity, including number of jobs created and lost across different fuel value chains. Quantifying impacts would require bespoke expertise and data collection efforts, including monitoring concentrations of and personal exposure to health damaging air pollutants such as fine particulate matter (PM_{2.5}), in order to reliably project the health impacts of scaling adoption of LPG over time.

Execution of this M&E plan aims to provide representative data which is sufficiently valid and precise for the purposes of review efforts to achieve desired LPG scale and subsequent improvements to related policies and actions. It is recommended to track the ISLE indicators on an annual basis (or as practical, based on availability of national representative surveys), depending on available resources and survey data already being collected.

As described in the section below, the proposed set of M&E indicators can be grouped into distinct categories according to different aspects of LPG scale up they intend to cover, for which bespoke data collection efforts are required in most cases.

Categories of indicators

There are three main categories of ISLE indicators:

- Category 1: LPG adoption and use (ISLE Table 1). This category measures the extent and rate of expansion of LPG adoption and consumption through national consumption data and nationally representative surveys.
- Category 2: LPG supply chain expansion and indicators of the safety of the LPG market (ISLE Table 2). This category measures the extent and rate of build-out of the LPG supply chain and associated investment, as well as the safety performance of the LPG sector.
- Category 3: LPG safety for households and occupational settings (ISLE Table 3). This category measures injuries and burn incidents related to LPG fuel use in the population.

While the Ministry of Energy and Water Resources (MINEE) and Societe Camerounaise des Depot Petroliers (SCDP) already collect information on key LPG metrics on an annual basis (e.g., LPG national consumption, national LPG production, LPG imports/exports, and several others), other indicators are not tracked as of yet. These include, for example, the LPG cylinder refill sales by cylinder size, the number of cylinders in

circulation in the market, the number of scrapped cylinders, and the number of jobs in the LPG supply chain (short-term and long-term), among others. In addition, key indicators such as the and number of LPG-related accidents at the occupational and household level are also not tracked making it difficult to enhance safety measures and plan for better consumer education.

The ability to collect all the proposed ISLE indicators depends on a number of factors: (i) endorsement by national stakeholders following discussion and adaptation, (ii) availability of resources, and (iii) staff capacity of the relevant agency(ies) involved in the implementation and monitoring of the new LPG policy. For example, in order to collect and track the ISLE safety indicators, it may be necessary to establish a national surveillance system to record the LPG and other fuel-related accidents in both occupational and household settings by involving the Health Sector.

Methodology used to develop the ISLE indicators

The proposed ISLE indicators were developed between June 2016 and July 2018 through a stakeholder consultation process with LPG industry experts (LPG policy and regulatory advisors, LPG business developers and industry technical experts, GLPGP country managers in Cameroon, Ghana and Kenya (among others), financial experts (planning and investment) and public health experts (academics with expertise in M&E and HAP/household energy use). Starting with the review of existing literature on indicators to track under SDG 7.1 ‘Ensure universal access to affordable, reliable and modern energy services by 2030’ and indicators of household energy adoption¹⁷⁵, two rounds of international expert consultations were conducted. The first consultation was hosted in 2016 in Frankfurt with the Clean Cooking for Africa Program scientific advisory board, comprising leading public health and climate experts. This initial set of indicators was then revisited, expanded and discussed during a consultation hosted with the KfW Clean Cooking for Africa Program appointed technical experts and UoL public health experts in February 2018.

Following the consultations, the indicators were piloted in Cameroon, Kenya and Ghana to test the feasibility and practicality of collecting the required data, to adjust and refine the indicator set. In a later stage of the process, input from public health experts from US CDC was also sought and incorporated into the proposed list, with focus on the safety indicators.

Additional piloting with specifically allocated resources is needed to further refine the ISLE Indicators’ list and finalize a set of “essential” vs. “desirable” indicators.

Guiding principles

The development of the ISLE indicators was guided by three key principles: (i) identifying and making the best use of existing routine and annual data collection systems, (ii) collecting new data at a minimal or no extra cost and (iii) not excluding metrics that would require full cooperation in data sharing from private sector players, which may result in added costs to conduct stakeholders interviews/surveys.

In the case of Cameroon, data for 2017 presented in this document has been collected with support from MINEE and SCDP, using existing sources and desk reviews. Some information could not be obtained and

¹⁷⁵ See cleancookstoves.org/binary-data/RESOURCE/file/000/000/379-1.pdf

supporting explanations are included in the ‘source and comments’ column of each table. The rationale for the indicator categories, and certain key features of the ISLE indicators, are presented in the next sections.

Category 1: ISLE Indicators of LPG market expansion and household adoption and use

The Indicators proposed in ISLE Table 1 include some of the key performance indicators (KPIs) used by the worldwide LPG industry, and indicators of population access to LPG that can be compiled through existing data collection systems. These indicators should be collected on an annual basis (or as frequently as survey information from nationally representative surveys is available, estimated as every 2-3 years). They would serve to track progress towards the Cameroon Government’s goal of achieving 58% of the population using LPG by 2030.

Selected highlights on the proposed indicators:

- Indicator 1.1 – *Total LPG kg per capita consumption per year* – is the ‘gold standard’ or preferred LPG industry KPI to track LPG market expansion and uptake. It also allows international comparisons of LPG penetration to be made (see Box 1)¹⁷⁶. However, this indicator would over-estimate household use of LPG if other sectors (e.g., autogas, such as in the case of Ghana) also make up a substantial proportion of total LPG consumption. For this reason, Indicator 1.2 on residential LPG consumption should also be jointly tracked.
- Indicator 1.2 – *Residential LPG kg per capita consumption per year* – is specific to the residential sector and is based on consumption of LPG in cylinders of 3-15 kg sizes (as compared to larger cylinders, typically of 35-50 kg that are used in institutional and commercial settings), divided by the total population.

Box 1 – LPG market stage according to international industry standards

- **Early stage/growth markets:** Defined as <10 kg per capita per year.
- **Transitioning stage markets:** Defined as around 15 kg and aspiring to increase (e.g., up to 40 kg capita per year or more).
- **Mature/advanced stage markets:** Usually >15 kg/capita but not necessarily defined by high LPG consumption (some are well below this). This market classification is based on sophistication and diversity of the LPG value chain as well as an excellent overall safety record.

In Cameroon, current cylinder sizes include 12.5 kg, 6 kg and 15 kg. However, small businesses such as roadside food-street vendors can also make use of cylinders of smaller capacity and their consumption would be captured as part of the total residential consumption (unless a digitized system is put in place for a more accurate tracking and monitoring; see later section in this Part on *The role of a digital recording system for LPG tracking*. Note that in most Sub-Saharan African markets, the residential use of LPG is for cooking and not for heating purposes with LPG portable heaters so the kg/capita of LPG residential consumption would effectively correspond to the amount of LPG used for cooking. In addition, it is helpful to note that if the national LPG market is primarily for residential use, the correspondent kg/capita value will be close to the Total LPG kg/capita consumption.

¹⁷⁶ Source: WLPGA 2014. Guidelines for the Development of Sustainable LPG Markets – Transitioning-Stage Markets. Pairs: World LP Gas Association.

- Indicator 2.1 – *Percentage of population cooking primarily with LPG in a given year* – and its sub indicators (urban / rural primary usage), rely on nationally representative population-based surveys that are used to monitor household energy use, including for SDG 7 reporting. As indicated in Section 2, large-scale nationally representative surveys (e.g., DHS, MICS, etc.), take place every 5 to 10 years. However, due to their different frequency, it may be possible to track primary LPG use in a range of 2-3 years. This interval is appropriate for tracking purposes, as extremely large changes in percentage of LPG use are unlikely to occur in periods of less than 2-3 years. These data, complemented by indicator 2.2 below, provide the best means of tracking progress on LPG uptake based on existing routine information. The suggested new question under the WHO-World Bank survey harmonization process is designed to capture primary, secondary and tertiary fuel/stove use as three answers are allowed. The proposed question is: *‘What does this household use for cooking most of the time, including cooking food, making tea/coffee, boiling drinking water? Please tell me the cookstove or device that is used for the most time, followed by the other cookstove(s) or device(s) used most often, if applicable’.*
- Indicator 2.2 – *Percentage of population using LPG for cooking (any use) per year* – intends to capture primary and secondary use of LPG for household cooking and boiling water. Secondary use of LPG is common, particularly for households that have recently adopted LPG but don’t yet use it for all their cooking/boiling water needs. Lack of such secondary use recording may underestimate total LPG household usage figures. By endorsing the full set of household energy questions, countries will be able to track this indicator.
- Indicator 2.3 – *LPG consumption per LPG user (kg/capita among LPG-using households) per year* – is calculated as the total LPG consumption in the Residential sector in a given year, divided by the percentage of households using LPG in the same year multiplied by the mean household average size for the country. The accuracy for tracking this number depends on the accuracy of the residential LPG consumption estimates (that may be a slight overestimate if it includes LPG use for cooking by small commercial entities) and the number of households using LPG (whether primary or secondary users, and the year the number of households is estimated for). Without a digitised system that tracks exactly how many households make use of LPG (and their refilling patterns), national representative surveys should be used as an alternative source to estimate household LPG consumption.

Indicators of LPG supply chain expansion and safety of the LPG market

The set of indicators presented in ISLE Table 2 is a selection of key metrics for tracking and recording LPG infrastructure expansion, as well as detecting and responding to market dysfunctions (e.g. cross-filling of cylinders of different brands, interchangeability of cylinders etc., that are detrimental for LPG marketers). It also contains a section on indicators for tracking economic development, including the quantity of direct jobs created as a result of LPG market expansion.

Obtaining the information needed to compile this set of indicators may present challenges as most of the data is not routinely collected and would need some bespoke data collection efforts. Challenges may include: (i) obtaining information on cylinders in circulation from each private sector player (e.g. LPG marketers operating under the CRM) for pooling into national estimates, due to private firms’ possible concerns about this information being proprietary (e.g. see indicators 3.2 and 3.3); (ii) procuring the data, if the information is scarce (e.g. on safety) and/or not currently compiled (e.g. indicator 5.2); and (iii) sourcing

the number of LPG-related jobs created under the different categories without asking each individual company on a bespoke basis (e.g. indicators 5.3 and 5.4). It is anticipated that obtaining some of these data will be labour intensive and require special data collection efforts and resources along with good technical knowledge of the LPG sector. It is, therefore, strongly recommended that collection and compilation tasks are assigned in the first instance, to technical experts with a thorough understanding of the LPG system and the private sector rules in the country.

MINEE/SCDP may need to consider legislation on mandatory data reporting from all LPG marketing companies and private sector players, especially on safety aspects.

Selected highlights:

- ISLE Table 2, Section 3 – LPG supply infrastructure development (cylinders and bulk infrastructure): includes a number of indicators and sub-indicators to track the number of cylinder assets added and taken out from circulation and bulk infrastructure expansion. All the information regarding cylinders is critical in terms of measuring both supply and demand (and safety). For example, with regards to indicators 3.2 - 3.4, the best way to collect the total numbers of cylinder deployed, scrapped and circulating into the market is to have numbers submitted by the individual LPG marketers to an appointed body (e.g. MINEE, CSPH or others) on a mandatory basis. Information about cylinders which are imported should also be made available from customs duties, as a cross-check.
- ISLE Table 2, Section 4 – LPG industry safety metrics: presents a recommended set of indicators for tracking safety in relation to LPG use at all nodes in the value chain. The indicators are tailored for countries operating under BCRM, such as Cameroon. Cylinder scrapping, testing and recertification are examples of standard industry practices for ensuring safety, but national level monitoring or compilation of information is rarely implemented in Sub-Saharan African settings. Stakeholder consultation will be key in this area to determine what is possible to monitor and consider for inclusion, as the data is currently very sparse. Strengthening safety monitoring and the use of good practices throughout the LPG value chain is vital to protecting both LPG consumers and LPG operators and can help address the root causes of LPG incidents and injuries.
- ISLE Table 2, Section 5 – Economic aspects in relation to LPG expansion: includes a selection of indicators to capture the amount of investment in LPG infrastructure and the jobs created as a consequence of market expansion. While these data are critical to monitor contributions to national economic growth and mobilization of international capital, these are not currently compiled, and sourcing may pose challenges. Other indicators, such as the indirect jobs created by LPG infrastructure expansion, are useful to include in the list, recognizing that obtaining reliable information will be difficult; the wider impacts of LPG expansion on the macroeconomics should not be underestimated or ignored. Similarly, systems to track the number of jobs in the charcoal and firewood sectors over time should be put in place to monitor overall impacts on job loss/creation at the national level. This requires an expanded set of indicators and information sources, going beyond the focus of the ISLE indicators on LPG-related metrics.

The ISLE LPG supply chain expansion and safety indicators should be ideally compiled on an annual basis to measure progress over time. Tracking this information is valuable and necessary also for making international comparisons about market expansion, especially for countries starting with similar LPG market conditions and LPG consumption rates to Cameroon.

Safety indicators in relation to LPG

ISLE Table 3 is specifically designed to track LPG-related explosions and accidents (burns and injuries) in both home and occupational/institutions settings. Being able to track, monitor and report on safety-related indicators is the first step to help prevent and intervene when such events occur.

Notwithstanding the importance of safety, recording, compiling and acting on the results of such data poses certain challenges. Often, these actions are not possible to implement unless a specific surveillance system coordinated by the health sector is put in place (e.g. at hospital's level). It is therefore recommended that national stakeholders in Ghana consider establishing such a mechanism for data gathering and reporting in order to monitor safety accidents closely and put in place measures to address the root causes of LPG-related safety accidents. The Ministry of Health, working together with fire services, may lead this process.

Douala General Hospital has a burns unit which could serve as a hub for national burns surveillance. Note also that WHO has made available a Global Burn Registry (GBR) for health facilities, which collects information on main risk factors, mechanisms, and risk groups for burn injuries requiring a hospital stay (see www.who.int/violence_injury_prevention/burns/gbr/en/). Participation in the GBR would allow standardized data collection from burn victims, help prioritizing prevention programs in Cameroon and allow global tracking of burn victims and their causes, including LPG-related burns and injuries.

The role of a digital recording system for LPG tracking: relevant experiences from other LMICs

The advantages of setting up digital recording for LPG adopting households and businesses are multiple and are summarized below.

Several high-income and middle-income countries have been making use of digital databases over the years for taxation and other purposes, and have been able to digitize LPG consumers' data successfully. India, Brazil, and El Salvador are just a few examples. This section presents the case of LPG data tracking in India, one of the countries that most recently have embraced such digitalization (see socialcops.com/case-studies/tracking-pmuy-beneficiaries-using-data-intelligence).

Under Indian law, LPG distributors must maintain an electronic register with names and addresses of persons registered to obtain their first LPG cylinder and equipment (LPG connection) and subsequent refills. Each household is registered with a unique identification number.

The advantages of such a digital recording system of LPG customers are multifold, and include:

- i. Accurately tracking LPG household consumption as compared to LPG use by other sectors (e.g. autogas, power generation, etc.) and by small and medium enterprises (e.g. food street vendors). Monitoring refill patterns across consumers and over time is needed to understand factors influencing refill rates and contribute to better delivery planning;
- ii. Recording precisely the number and location of households using LPG – which is important for both creating new distribution centers (sales outlets under the CRM) and creating potential for booking of cylinder refills online or through mobile phone apps for home delivery;
- iii. Tracking seasonal and other cyclical demand variations (e.g. tied to agricultural production) for planning of distribution;

- iv. Identifying gaps between refill requests and actual refills to identify bottlenecks in supply or under-performing distributors;
- v. Providing a tracking system for cylinders that LPG marketers and distributors can rely on to control their cylinder assets;
- vi. Tracking households that receive subsidized equipment/fuel as part of pro-poor initiatives (e.g. PMUY program in India that provides free initial LPG equipment to below-poverty line women); and
- vii. Avoiding abuse of LPG subsidies as registered households are tracked and only one household member is allowed to receive the subsidized equipment and LPG refills.

Overall, such a digital system provides a platform for benefit transfer to the right people at the right time, and for identifying where processes are failing to deliver and need to be improved.

Regardless of specific hardware/software specifications, which go beyond the scope of this document, a number of principles would need to be considered:

- Security of the system for ensuring confidentiality of records;
- Creation of unique ID systems tied to individual customers;
- Ensuring standardization in data entry – for example, having village names spelled differently, or addresses entered using more than one convention (e.g. village name + district name in one field versus in two separate fields) would create problems later in ensuring households are assigned to the right village in analysis;
- Ability to easily export data into one or more widely-used file formats and ability to select subsets of data for export; and
- Data fields to distinguish different classes of customers (e.g. those benefiting from LPG subsidy / subsidized equipment versus those who do not).

Cameroon would stand to benefit from embracing the digital revolution for the LPG sector (and other sectors) over time, although challenges are acknowledged. In addition, considering that over 80% of the population uses mobile phones in Cameroon and that mobile banking has experienced significant growth recently (first launched by Afriland First Bank and MTN in 2015)¹⁷⁷, there is potential for using mobile phone systems for booking, tracking and paying for LPG refills. The mobile phone infrastructure could support digitization of cylinder tracking by SMS and bar-coding applications, for example, eliminating some of the paperwork needs.

¹⁷⁷ See www.businessincameroon.com/finance/1009-5614-cameroon-afriand-first-bank-and-mtn-launch-mobile-banking-transactions

Potential for additional indicators based on digital LPG records

Additional key indicators could be added to the current ISLE list if certain conditions, such as a unified system for digital recording of LPG-adopting households and businesses, are put in place. Two examples are presented below:

- *Average number of LPG 12.5kg cylinder refills-equivalent per year by household using LPG.* This indicator and potential sub-indicators (urban, rural and regional averages) would help to measure primary and secondary LPG usage accurately across the national territory. This value could then be compared to the number of refills that is needed as an indicator of primary use in the country to ensure that the public health and other benefits from transition to LPG are achieved.
- *Percentage of calls to emergency service helpline for LPG leakage complaints per year.* This indicator would contribute to the safety and prompt intervention tracking. It could be considered only if LPG marketing companies under the CRM operate an emergency service helpline as most middle and high-income countries do.

Final considerations

The proposed ISLE indicators are intended as a resource to be used in all countries that promote LPG as a household fuel. They are particularly important to be adopted in low and middle-income settings that are trying to create a robust monitoring system for LPG sustainable scale up.

It should be noted that these indicators assume that the regulatory environment—a crucial enabling ingredient for successful, sustainable scale-up of safe LPG use—is adequate and adequately enforced, or will become so. If that is not done, then there is limited value to be created by implementing the ISLE indicators. The regulatory characteristics are not included in the ISLE measures because they do not (and should not) change annually, but only over much longer time scales, or when there is a significant reform.

It is however recommended that the market model scorecard presented in Chapter 7 be reviewed triennially, or as driven by events (such as a change to the framework or a change to enforcement activities), as a supplement to the annual ISLE measures.

25. ISLE Indicators Compiled

For Cameroon, 2017 data have been collected and presented by the GLPGP Clean Cooking for Africa Cameroon team in ISLE Tables 1-3, using a wide range of sources. Existing gaps in the available data result from either a lack of systematic tracking (e.g. number of jobs in the LPG supply chain), or because the indicator in question will not apply until the CRM is implemented.

The recommended set of ISLE indicators for Cameroon should be considered provisional until endorsed by the relevant authorities following appropriate national stakeholder consultation. As much as they have been designed as a flexible tool to incorporate in-country variations, their added value is also as a harmonized set of indicators for international comparison, and for reviewing trends over time at the country level.

Among the whole set of proposed indicators, an 'essential' set of indicators could be also prioritized for regular annual updating and public reporting. The essential set should include a mix of indicators from the three listed categories (including safety, if a national surveillance system can be successfully established).

ISLE TABLE 1: ISLE Indicators of LPG adoption and use					
Domain	Indicator	Sub-indicator / Component needed for main indicator and rationale	Indicator measured or calculated ¹⁷⁸	Results	Sources and comments
1. LPG consumption					
1.1	Total LPG kg/capita consumption per year	This indicator is the standard and universally accepted <u>key performance indicator</u> (KPI) to describe the degree of development of the LPG market in a country (all sectors). To be measured using: (i) The total national LPG consumption in a given year divided by (ii) the population in the same year.	Calculated	National LPG per capita consumption in 2017 = 4.3 kg/capita	Calculated as LPG quantity consumed divided by the national population
				(i) Total LPG consumption in 2017 (all sectors): 103,359 metric tonnes (MT) (ii) Population 2017: 24,053,727	(i) Source: National sales report compiled by MINEE (ii) Population source: data.worldbank.org/country/cameroon
1.2	LPG kg/capita consumption for the Residential sector per year	This is a specific indicator to measure the degree of development of the residential LPG sector. In Sub-Saharan Africa, the residential use of LPG is almost exclusively for cooking/water boiling and	Calculated	LPG consumption for the residential sector in 2017: ~3.95 kg/capita in 2017	Calculated as LPG residential consumption divided by the national population.
				(1) Residential sector: 95,000 MT	Estimate based on the assumption that the residential LPG market in Cameroon has remained stable since 2009 at 92% of total LPG consumption. Source: 'Bienvenue au Seminaire de Presentation du Tableau de

¹⁷⁸ 'Measured' indicator = data have to be gathered. 'Calculated' indicator = it can be calculated using already measured and available data.

ISLE TABLE 1: ISLE Indicators of LPG adoption and use

Domain	Indicator	Sub-indicator / Component needed for main indicator and rationale	Indicator measured or calculated ¹⁷⁸	Results	Sources and comments
		not for heating purposes. To be measured using: (i) the total LPG consumption in the Residential sector in a given year (as compared to other sectors such as Industry; Transport; Refinery; Chemical and Agriculture), divided by (ii) the population in the same year.			Bord 2009 du GPL'. MINEE (2009).
				(2) Transport/Autogas: none	
				(3) Commercial & Industrial: 8,200 MT	Estimated at 8% based on 2009 figures. Source: 'Bienvenue au Seminaire de Presentation du Tableau de Bord 2009 du GPL'. MINEE (2009).
				(4) Power Generation: none	
2. Population cooking with LPG					
2.1	Percentage of population cooking primarily on LPG in a given year	The source for this indicator and its sub-indicators are nationally representative surveys such as census, DHS, MICS, World Bank Multi-Tier Tracking Framework and others national surveys that are usually conducted every 5 to 10 years.	Measured	Last publicly available data point from national representative surveys: 21.2% primary LPG use in 2014	Source: MICS 2014, extracted from WHO Household Energy Database. Previous data: 17.5% in 2011. Source: DHS (2012).
2.1.1		Percentage of URBAN population cooking primarily on LPG in a given year	Measured	Last publicly available data point from national representative surveys: 39,1% primary LPG use in 2014	Source: MICS 2014, extracted from WHO Household Energy Database
2.1.2		Percentage of RURAL population cooking primarily	Measured	Last publicly available data point from national representative surveys: 2,1%	Previous data: 32,8% for urban areas and 1,5% in rural areas in 2011. Source: DHS 2012

ISLE TABLE 1: ISLE Indicators of LPG adoption and use					
Domain	Indicator	Sub-indicator / Component needed for main indicator and rationale	Indicator measured or calculated ¹⁷⁸	Results	Sources and comments
		on LPG in a given year		in 2014	
2.2	Percentage of population using LPG for cooking (any use) in a given year	The source for this indicator and its sub-indicators would be nationally representative surveys that include question on secondary cookfuels (up to 2018, this was not included in DHS, MICS and other global surveys).	Measured	Last publicly available data point from national representative surveys (ECAM 4): 25.1% of households having access to LPG (primary or secondary use) as of 2014.	Source: Quatrième Enquête Camerounaise Auprès des Ménages (ECAM, 4) by Institute National de Statistique (INS, 2014).
2.2.1		Percentage of URBAN population using LPG for cooking (any use) in a given year	Measured	Last publicly available data point from national representative surveys: 48.8% of urban households having access to LPG in 2014	
2.2.2		Percentage of RURAL population using LPG for cooking (any use) in a given year	Measured	Last publicly available data point from national representative surveys: 6.2% of rural households having access to LPG in 2014	
2.3	LPG consumption per LPG user (kg/capita) per year	This is the recommended indicator to be used to monitor LPG adoption and sustained use at the household level. To be measured using:	Calculated	LPG consumption per LPG user in 2017: ~15.7 kg/capita	Sources used for calculations: <ul style="list-style-type: none"> Residential consumption for 2017 = 95,000,000 kg (see Indicator 1.2) Total number of households = 4,625,716 (calculated dividing the total population by the average household size)

ISLE TABLE 1: ISLE Indicators of LPG adoption and use					
Domain	Indicator	Sub-indicator / Component needed for main indicator and rationale	Indicator measured or calculated ¹⁷⁸	Results	Sources and comments
		(i) the total LPG consumption in the Residential sector in a given year, divided by the (ii) percentage of households using LPG in the same year multiplied by the (iii) mean household average size for the country.			<ul style="list-style-type: none"> Percentage of households using LPG in 2014 = 25.1% (primary and secondary use) Average household size = 5.2 (UNDSEA, 2017, see population.un.org/Household/index.html#/countries)

ISLE TABLE 2: ISLE Indicators of LPG supply chain expansion and safety of the LPG market					
Domain	Indicator	Sub-indicator / component needed for main indicator and rationale	Indicator measured or calculated	Results	Sources used and comments
3. LPG infrastructure development: cylinders and bulk infrastructure					
3.1	Amount and percentage of LPG produced and/or imported per year	1.3.1 Production	Measured	12,683 MT(2017)	Source: MINEE data
		1.3.2 Import	Measured	93,015 MT(2017)	Source: MINEE data
3.2	Number of new cylinders deployed into the market per year (by cylinder size)	<p>This indicator helps to understand the level of LPG market expansion. The more cylinders are injected into the market (i.e. new cylinders), the more the market is in expansion.</p> <p>This indicator includes both imported and locally manufactured cylinders, by cylinder size.</p>	Measured	Last publicly available data point: 2,029,291 new cylinders injected in 2014. Of this, 90% were 12.5 kg (1,826,362 cylinders) and 10% were 6 kg.	<p>Source: MINEE - Rapport sur la situation énergétique du Cameroun édition 2015, page 98</p> <p>Comment: This information is not routinely collected by MINEE and would require a bespoke data collection effort and cooperation from the LPG marketers in releasing the cylinder figures.</p>

ISLE TABLE 2: ISLE Indicators of LPG supply chain expansion and safety of the LPG market					
Domain	Indicator	Sub-indicator / component needed for main indicator and rationale	Indicator measured or calculated	Results	Sources used and comments
3.3	Total number and percentage of cylinders being scrapped per year (by cylinder size)	This is an indicator of the end of a cylinder 'lifecycle'; cylinders that are beyond repair need to be scrapped. If a maximum shelf life for a cylinder is prescribed, then there should be no reported cases of LPG cylinders returned for refilling, or refilled, beyond the permitted shelf life.	Measured	Data not available	This information is not routinely compiled but it should be possible to obtain it from SCDP
3.4	Total number of 12.5 kg ¹⁷⁹ cylinders-equivalent in	This is an indicator used by the worldwide LPG industry to measure and compare LPG market development ¹⁸⁰ .	Measured	Not available for 2017	Comment: The data is not routinely collected. Some of the information for this indicator may be obtained from the Ministry of Commerce, Ministry of Mines, Industry and

¹⁷⁹ The chosen cylinder size to calculate the kg-equivalents can be adapted depending on what the most popular cylinder size is a country.

¹⁸⁰ In mature/developed LPG markets this measure falls in the range of 3-4 cylinders every 10 people. In Morocco, one of the most developed LPG household markets, the ratio is almost 1 to 1.

ISLE TABLE 2: ISLE Indicators of LPG supply chain expansion and safety of the LPG market					
Domain	Indicator	Sub-indicator / component needed for main indicator and rationale	Indicator measured or calculated	Results	Sources used and comments
	circulation per capita	To be measured using: (i) the total number cylinder imported/manufactured equivalent to a 12.5 kg cylinder (where a 6 kg cylinder would count as 0.48), less (ii) those scrapped and (iii) those exported to other affiliates, divided by (iv) the total national population			Technological Development (MINMIDT).
3.5	Cylinder rotation rate per year	This is a KPI used by the LPG industry as an indirect measure of LPG sustained use; the higher is the rotation rate in a country, the more households are refilling their cylinders and	Calculated	Not available for 2017	Note: Based on industry data, the minimum rotation rate to help achieve efficient recirculation is 3. In low and middle-income countries, households tend to have more than 1 cylinder at home, which reduces the overall rotation rate and affects the profitability of private sector investment in

ISLE TABLE 2: ISLE Indicators of LPG supply chain expansion and safety of the LPG market												
Domain	Indicator	Sub-indicator / component needed for main indicator and rationale	Indicator measured or calculated	Results	Sources used and comments							
		<p>using LPG for most of their cooking.</p> <p>To be measured using</p> <p>(i) Quantity of LPG sold in a given year, (ii) divided by the number of 12.5kg cylinder-equivalents</p>			additional cylinders.							
3.6	Total national LPG infrastructure capacity by type per year	3.6.1 Bulk transport – Bulk Road Vehicle (BRV)	Measured	Not available	Source: to be requested to SCDP							
		3.6.2 Bulk storage capacity in MT	Measured	3970 MT (both import and export) as of 2017	Sources: SCDP figures (this is total storage capacity for both production and import)							
		<p>3.6.3 Refilling capacity and number of bottling plants (or refilling stations) over the national territory</p> <p>Rationale: the number of filling plants should be</p>	Measured	<p>17 bottling/filling plants both private and para-public.</p> <table border="1"> <thead> <tr> <th>Marketer</th> <th>Filling Plant</th> <th>Overall Capacity (MT)</th> </tr> </thead> <tbody> <tr> <td>SCDP</td> <td>6</td> <td>3970</td> </tr> <tr> <td>SCTM</td> <td>2</td> <td>170</td> </tr> </tbody> </table>	Marketer	Filling Plant	Overall Capacity (MT)	SCDP	6	3970	SCTM	2
Marketer	Filling Plant	Overall Capacity (MT)										
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ISLE TABLE 2: ISLE Indicators of LPG supply chain expansion and safety of the LPG market							
Domain	Indicator	Sub-indicator / component needed for main indicator and rationale	Indicator measured or calculated	Results			Sources used and comments
		tracked to check progress against the country's plant for LPG expansions. However, it is the refilling capacity represented by the bottling plants that is more important to measure.		AZA.INC	5	130	Ombe/Limbe
				GlocalGaz	1	60	
				Stargas	1	95	
				Green Oil	1	440	
				Bocom	1	1500	
		3.6.4 Cylinder manufacturing capacity (if applicable)	Measured	Not applicable – As of 2017, all cylinders are imported in Cameroon			
		3.6.5 Number of construction permits for building filling plants / or plants built per year	Measured	Not available			
		3.6.6 Number of construction permits for building or expanding import terminals, including	Measured	Not available			

ISLE TABLE 2: ISLE Indicators of LPG supply chain expansion and safety of the LPG market					
Domain	Indicator	Sub-indicator / component needed for main indicator and rationale	Indicator measured or calculated	Results	Sources used and comments
		storage capacity, per year			
3.7	Number of licensed marketers/cylinder brand owners per year	This indicator is a proxy for LPG industry consolidation/fragmentation	Measured	12 LPG marketers/distribution companies (SCTM, TOTAL, AZA, CAMGAZ, TRADEX, LIBYA Oil, Kosan/GLOCALGAZ, CORLAY/MRS, STARGAS, Infotech/Pleingaz, Green Oil (from 2017), Bocom Gaz (from 2017))	Source: MINEE
3.8	Total number of authorized retail outlets per year	This indicator and its sub-indicator is an important measure to track LPG market expansion over the national territory and harder to reach regions. The more retail outlets are available, the more households can access LPG at relatively short distances.	Measured	<p>Last available data point for 2015: 5086 points of sale, based on the following three categories</p> <ul style="list-style-type: none"> - Number of exclusive gas stations and gas depots marketing LPG (n=806) - Distributors (n=320) - Estimated number distributor sales outlet (n=3960) 	<p>Source for 2015 data: MINEE & GLPGP. The LPG Master Plan of Cameroon. 2016.</p> <p>Comment: Information not routinely collected.</p> <p>It could be obtained jointly from the Ministry of Commerce and Ministry of Mines, Industry and Technological Development (MINMIDT).</p> <p>The legislation regulating installation and exploitation of LPG depots and LPG</p>

ISLE TABLE 2: ISLE Indicators of LPG supply chain expansion and safety of the LPG market																																																					
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					distribution is n°6779/15, 14 November 2015.																																																
3.8.1		Total number of authorized retail outlets by region/province in a given year	Measured	Last available data point for 2015: 3960 sales outlets <table border="1"> <thead> <tr> <th>Regions</th> <th>Number of exclusive gas stations and Gas Depots marketing LPG</th> <th>Total Distributors</th> <th>Estimated number distributor sales outlet</th> </tr> </thead> <tbody> <tr> <td>FAR NORTH (Maroua)</td> <td>16</td> <td>12</td> <td>97</td> </tr> <tr> <td>NORTH(Garoua)</td> <td>15</td> <td>9</td> <td>37</td> </tr> <tr> <td>ADAMAWA</td> <td>24</td> <td>25</td> <td>137</td> </tr> <tr> <td>CENTRE (Yaounde)</td> <td>234</td> <td>86</td> <td>1 097</td> </tr> <tr> <td>SOUTH (Kribi)</td> <td>17</td> <td>13</td> <td>55</td> </tr> <tr> <td>ESAT (Bertoua)</td> <td>8</td> <td>9</td> <td>37</td> </tr> <tr> <td>LITTORAL (Douala)</td> <td>356</td> <td>89</td> <td>1 924</td> </tr> <tr> <td>SOUTH WEST (Kumba)</td> <td>23</td> <td>22</td> <td>241</td> </tr> <tr> <td>NORTH WEST (Bamenda)</td> <td>27</td> <td>20</td> <td>166</td> </tr> <tr> <td>WEST (Bafoussam)</td> <td>86</td> <td>35</td> <td>169</td> </tr> <tr> <td>Cameroon</td> <td>806</td> <td>320</td> <td>3 960</td> </tr> </tbody> </table>	Regions	Number of exclusive gas stations and Gas Depots marketing LPG	Total Distributors	Estimated number distributor sales outlet	FAR NORTH (Maroua)	16	12	97	NORTH(Garoua)	15	9	37	ADAMAWA	24	25	137	CENTRE (Yaounde)	234	86	1 097	SOUTH (Kribi)	17	13	55	ESAT (Bertoua)	8	9	37	LITTORAL (Douala)	356	89	1 924	SOUTH WEST (Kumba)	23	22	241	NORTH WEST (Bamenda)	27	20	166	WEST (Bafoussam)	86	35	169	Cameroon	806	320	3 960	Source for 2015 data: MINEE & GLPGP. The LPG Master Plan of Cameroon. 2016. Comment: Information not routinely collected. It could be obtained from MINMIDT but it would require a special data collection effort.
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4. LPG Industry safety metrics																																																					
4.1	Percentage of LPG facilities (by type) audited by year	This indicator serves and its sub-indicators measure how compliant is the LPG system with safety norms and regulations	Measured	Not available	Comment: The metrics in category 4 are not usual information in Cameroon. An official request from MINEE would be needed to request this data from industry.																																																

ISLE TABLE 2: ISLE Indicators of LPG supply chain expansion and safety of the LPG market					
Domain	Indicator	Sub-indicator / component needed for main indicator and rationale	Indicator measured or calculated	Results	Sources used and comments
4.1.1		Percentage of LPG facilities (by type) in non-compliance	Measured	Not available	The information could be collected either from LPG Marketing Companies or from SCDP, which is responsible for filling cylinders for most of the LPG Marketing Companies.
4.1.2		Percentage of LPG facilities (by type) in full compliance	Measured	Not available	
4.2	Percentage of total cylinders being hydro tested per year	This is a measure for LPG safety in a market and regulatory compliance with safety norms. During hydro testing a cylinder is examined to ensure it can safely hold its rated pressure.	Measured	Not available	
4.3	Percentage of total cylinders being refurbished/ recertified per year	This is a measure for LPG safety in a market and regulatory compliance with safety norms.	Measured	Not available	

ISLE TABLE 2: ISLE Indicators of LPG supply chain expansion and safety of the LPG market					
Domain	Indicator	Sub-indicator / component needed for main indicator and rationale	Indicator measured or calculated	Results	Sources used and comments
4.4	Percentage of cylinders with valve being replaced per year	This is a measure for LPG safety in a market and regulatory compliance with safety norms.	Measured	Not available	
4.5	Percentage of trucks presented for loading turned away (rejected) for non-compliance with Safety, Health, Environmental and Quality requirements	This is an indicator of compliance with safety rules and practices. To be collected by individual filling plants where trucks discharge empty cylinders and upload filled cylinders.	Measured	Not available	

ISLE TABLE 2: ISLE Indicators of LPG supply chain expansion and safety of the LPG market					
Domain	Indicator	Sub-indicator / component needed for main indicator and rationale	Indicator measured or calculated	Results	Sources used and comments
4.6	Percentage of drivers that have attended refresher courses in defensive driving / LPG truck driving within the stipulated refresher training requirement.	This is an indicator of compliance with safety rules and practices.	Measured	Not known	
5. Economic aspects in relation to LPG					
5.1	Amount and percentage of LPG price volatility in a given year	This indicator is useful in a market where there are no price controls in the LPG market allowing for full cost pass through to the end	Calculated	The price of LPG is subsidized in Cameroon and subject to a uniform national LPG price. However, some price variations based on added transport cost do exist depending on	Source: LPG price structure decree n°25/2015, of February 26, 2015.

ISLE TABLE 2: ISLE Indicators of LPG supply chain expansion and safety of the LPG market					
Domain	Indicator	Sub-indicator / component needed for main indicator and rationale	Indicator measured or calculated	Results	Sources used and comments
		user. Components: maximum and minimum LPG retail price across the national territory and impact on LPG cylinder refill sales.		the location. The cost of a 12.5kg cylinder refill is CFA 6,500 (CFA 520 /kg) with some small price variations due to added transport cost (e.g., CFA 100 – 1000 extra).	
5.2	Net amount of new investment in LPG infrastructure, per capita, per year	This is an indicator of impact on society and macro-economics.	Measured	Not available	Initially, GLPGP investment plan for Cameroon, 2018 Comment: This is not usual information to be sourced in Cameroon. It would necessitate a bespoke data collection effort coordinated by MINEE or other key national stakeholder.
5.3	Direct number of new short-term jobs created during construction of LPG-infrastructure per year	This is an indicator of impact on society and macro-economics.	Measured	Not available	Comment: This is not usual information to be sourced in Cameroon. It would necessitate a bespoke data collection effort coordinated by MINEE or other key national stakeholder.

ISLE TABLE 2: ISLE Indicators of LPG supply chain expansion and safety of the LPG market					
Domain	Indicator	Sub-indicator / component needed for main indicator and rationale	Indicator measured or calculated	Results	Sources used and comments
5.4	Direct number of new long-term job created in the LPG sector during operations per year	<p>This is an indicator of impact on society and macroeconomics.</p> <p>To be calculated using the following sub-categories:</p> <ul style="list-style-type: none"> 5.4.1 Importation operations 5.4.2 LPG Bulk Transporters 5.4.3 LPG Storage Companies 5.4.4 Cylinder manufacturing companies 5.4.5 Filling plant operators 5.4.6 Safety inspectors 5.4.7 Cylinder revalidation/recertification personnel 5.4.8 LPG Distribution companies 5.4.9 LPG retailers 5.4.10 Consumer education/marketing 	Measured	Not available	Comment: This is not usual information to be sourced in Cameroon. It would necessitate a bespoke data collection effort coordinated by MINEE or other key national stakeholder.

ISLE TABLE 3: ISLE Safety indicators (occupational and household settings)					
Domain	Indicator	Sub-indicator / component needed for main indicator	Indicator measured or calculated	Results	Sources used and comments
6. LPG-related Incidents and burns					
6.1	Number of LPG-related incidents (fires or explosions) <u>in occupational and institutional settings</u> per year	<p>Occupation settings:</p> <p>6.1.1 LPG Primary Distribution operations (bulk importation and bulk transportation to bottling plants) incidents.</p> <p>6.1.2 LPG Secondary Distribution Operations (bulk delivery to bulk consumers for primary storage and transportation/distribution of bottled LPG) incidents.</p> <p>Institutional settings:</p>	Measured	<p>Not available for 2017.</p> <p>The last available collected data point is for 2015, when 12 fire accidents were documented. This information was collected by the MINEE-led Ad Hoc Committee in preparing the national LPG Master Plan.</p>	Comment: This requires bespoke data collection effort and request to fire services.

ISLE TABLE 3: ISLE Safety indicators (occupational and household settings)					
Domain	Indicator	Sub-indicator / component needed for main indicator	Indicator measured or calculated	Results	Sources used and comments
		6.1.3 Hotel, restaurants, hospitals, schools, prisons, street vendors, etc. LPG-related incidents.			
6.2	Number of LPG-related incidents (fires of explosions) <u>in homes</u> per year		Measured	Not available	Comment: This requires bespoke data collection effort and request to fire services.

ISLE TABLE 3: ISLE Safety indicators (occupational and household settings)					
Domain	Indicator	Sub-indicator / component needed for main indicator	Indicator measured or calculated	Results	Sources used and comments
6.3	Number of reported LPG burns (injuries and deaths) per year	6.3.1 LPG-reported non-fatal burn injuries 6.3.2 LPG-related burns deaths 6.3.3 Percentage of cases attending hospital	Measured	Not known	Data not collected

26. Impact Evaluation of LPG Uptake for Household Cooking

Evaluation of impacts related to LPG adoption and sustained use for household cooking is recommended to establish the effects of LPG uptake on individuals and society. Such evaluation is only possible when accurate LPG household consumption figures and associated data are available at baseline and over time as households make the transition to the adoption of LPG and/or more exclusive use. Designing and implementing a systematic and rigorous tracking system through the ISLE indicators described earlier in this document is the first key step needed in this process, although additional data collection and interpretation are required to understand the impacts of expanding the LPG market.

In terms of impacts, LPG uptake for cooking by households has the potential to deliver a wide range of benefits, chiefly on health, the environment and time saving. This is because LPG is a highly efficient and clean-burning fuel at point of use, and it avoids depletion of forest resources where these are at risk from household fuel demand.

For a comprehensive evaluation of key impacts, six categories of impacts can be considered and assessed over time: (i) health, (ii) environment, (iii) climate, (iv) gender, (v) employment and (vi) macro-economic. The table below provides an overview of the key metrics and methods for these six dimensions of impact assessment. It is important to note that impacts are assessed by comparing the population transitioning to LPG with those continuing to rely on traditional polluting fuels (e.g. charcoal, firewood, agricultural residues, kerosene etc.).

Table 58. Outline of impact categories for population projected to transition to LPG

Categories of Impacts	Metric	Comments and methodology
I. Health	Deaths averted per year (estimates)	<p>Household air pollution (HAP) is associated with several adverse health effects on both adults and children due to exposure to products of incomplete combustion, chiefly fine particulate matter (PM_{2.5}) and carbon monoxide (CO).</p> <p>In the Global Burden of Disease (GBD) assessments, HAP is causally related to six important diseases: ischemic heart disease, stroke, chronic obstructive pulmonary disease, lung cancer, acute lower respiratory infection in children, and cataract (women only). Current estimates by the Institute of Health Metrics Evaluation (IHME) show that HAP is responsible for around 2.6 million premature deaths from the first five of these conditions each year¹⁸¹. There is also evidence that HAP is associated with adverse pregnancy outcomes such as low birth weight, tuberculosis, and other conditions that are also seen with tobacco smoking, all of which can result in premature death or a disability that can affect</p>

¹⁸¹ www.healthdata.org

Categories of Impacts	Metric	Comments and methodology
		<p>quality of life and /or life expectancy.</p> <p>Impacts of the transition to LPG as compared to continued reliance on polluting fuels for household energy needs can be modeled using the established GBD methods for HAP-associated health outcomes (the HAPIT model)¹⁸². This model yields estimates of premature deaths and Disability-adjusted Life Years (DALYs) averted.</p> <p>Input data: Ideally, use nationally representative measured personal exposures to PM_{2.5} collected in the field for both traditional fuels/stoves users and LPG-using homes (for primary cooks and children using personal exposure monitors).</p> <p>Alternatively, personal exposure rates to PM_{2.5} can be estimated by measuring kitchen area concentrations and published GBD/Comparative Risk Assessment (CRA) conversion ratios¹⁸³.</p> <p>Measuring kitchen PM_{2.5} concentrations, and especially personal exposure levels, requires intensive field work and is resource intensive.</p> <p>Note: Directly measuring impacts on disease rates requires more complex, longer study designs (multi-years), and is very expensive. It is not expected that this will be possible for more routine evaluation in most countries and settings, but where suitable research infrastructure is available, this can be considered.</p>
	DALYs saved per year (estimates)	<p>Disability Adjusted Life Years (DALYs) is a standard measure used to estimate disease burden. Adoption and sustained use of LPG can result in DALYs saved due to reduced HAP exposure to PM_{2.5} for the same five disease outcomes stated above as part of GBD.</p> <p>Input data: Impacts of the transition to LPG on DALYs can be modeled using the same approach and input data described above.</p>
	Cooking-related burns (injuries and deaths) per year	<p>Traditional household energy practices (i.e. use of open fires, simple stoves, kerosene stoves, etc.) are linked to a high risk of burns (e.g. from children falling into fires, spilled fuel, etc.). In general, use of LPG is safer, but poor industry, retailer, or home</p>

¹⁸² See householdenergy.shinyapps.io/hapit3/

¹⁸³ Smith et al. (2014). Millions dead: how do we know and what does it mean? Methods used in the comparative risk assessment of household air pollution." *Annu. Rev. Public Health* 35: 185–206.

Categories of Impacts	Metric	Comments and methodology
		<p>practices in terms of checking, replacing and using LPG can result in fires and explosions with serious consequences.</p> <p>Data needed: Information on fires, explosion and resulting burn deaths and injuries at the country level may be obtained from a range of sources, including the press/media, occupational accident reporting, and the health system. Thorough assessment of burns injuries and death resulting from LPG use (and other causes) will require the establishment of a burns surveillance system, located within health facilities. Most commonly this is done in a sub-sample of hospitals representing various settings, as instituting nation-wide surveillance would be prohibitively resource intensive.</p> <p>Cases of LPG-related burns should be tracked using the proposed safety ISLE indicators (Table 3) on both households and occupational settings.</p>
	Economic value of deaths averted and DALYs saved	<p>There is no single standardized method to calculate the economic value of the deaths and DALYs averted due to transition to clean fuels for household cooking in developing countries.</p> <p>An approach would be to stratify the population by 10-year age bands and weight the GDP per capita for each age band by the productive index for the age bands.</p>
II. Environment	Averted deforestation (number of trees or total fuelwood displaced)	<p>Transition to cooking with LPG has the potential to significantly reduce the pace of forest degradation and deforestation in countries (or sub-regions) where household use of fuelwood and charcoal for cooking is known to contribute to forest degradation.</p> <p>The number of trees saved can be calculated based on avoided fuelwood and charcoal use, considering the proportion of biomass consumed that is produced unsustainably. Input data include: firewood and charcoal consumption data, fraction of nonrenewable biomass (fNRB) and typical mass of a tree.</p>
III. Climate	Averted carbon dioxide emissions and co-emitted species	<p>LPG combustion leads to some net CO₂ emission but in most situations this contribution is effectively offset by the avoidance of net CO₂ emissions from burning of non-renewable biomass fuel.</p> <p>Carbon dioxide equivalents (CO₂eq) include emissions from the three main greengases – CO₂, methane (CH₄), and nitrous oxide (N₂O). CO₂eq should be calculated based on fuelwood and charcoal displaced from increased access to LPG, under different biomass renewability scenarios. It is known that not all harvested fuelwood</p>

Categories of Impacts	Metric	Comments and methodology
		<p>is renewable, and the fraction of nonrenewable biomass (fNRB) extracted is typically in the range of 27–34% on a global scale, with large geographical variations. In East Africa for example, the fNRB exceeds 50%¹⁸⁴.</p> <p>A higher fNRB would ascribe correspondingly higher emissions to biomass fuels and a greater benefit of a switch to LPG.</p> <p>Input data: Emission factors for technology/fuel combinations. LPG consumption data to be obtained through the ISLE indicators presented earlier in this document. Fuelwood and charcoal consumption data to be obtained by census and nationally representative surveys. Renewability data to be obtained from published and widely accepted data sources such as the Geospatial Analysis and Modelling of Non-Renewable Biomass (WISDOM) model¹⁸⁵ or others.</p>
	Averted black carbon emissions and co-emitted species	<p>Burning of biomass contributes to the emissions of short-lived climate forcing products of incomplete combustion, such as black carbon (BC) and other co-emitted species. Transition to fuels such as LPG, which burn the fuel-carbon much more completely, can therefore reduce emissions of these climate pollutants, which have a warming impact in the short term.</p> <p>The other chemical species emitted through incomplete combustion of carbon fuels beyond BC include: carbon monoxide (CO), organic carbon (OC) - a cooling agent, nitrogen oxides (NOx), non-methane volatile organic compounds (NMVOCs), and others. Calculations are based on emissions at point of use.</p> <p>Input data: fuelwood and charcoal consumption data to be obtained by census and nationally representative surveys. Stove emissions data to be obtained by latest available literature. Renewability data to be obtained from the Geospatial Analysis and Modelling of Non-Renewable Biomass (WISDOM) model or other published and widely accepted data sources.</p> <p>Using the Gold Standard BC methodology¹⁸⁶, climate-related emission reductions are accounted for by comparing fuel</p>

¹⁸⁴ Bailis et al. 2015. The carbon footprint of traditional woodfuels Nat. Clim. Change. 5 266–72

¹⁸⁵ See www.wisdomprojects.net/global/method.asp

¹⁸⁶ Gold Standard Quantification of Climate Related Emission Reductions of Black Carbon and Co-emitted Species due to the Replacement of Less Efficient Cookstoves with Improved Efficiency Cookstoves.

Categories of Impacts	Metric	Comments and methodology
		consumption in the intervention scenario (i.e. after adoption of LPG for clean cooking) to the applicable baseline scenario (e.g. biomass burnt in traditional low efficiency stoves or open fires).
	Effects on global temperature	<p>Quantification of CO₂eq and BCeq differentials from switching to LPG, as compared to relying on traditional polluting fuels, can be used to estimate the overall effect on the global temperature over time (short-term and long-term).</p> <p>An overall cooling effect due to LPG adoption for clean cooking is expected in countries where the fraction of renewable biomass is relatively low, as indicated by studies in India and Cameroon^{187,188}.</p>
IV. Gender	Time savings from cooking with LPG per day	<p>Use of LPG is expected to save time through faster cooking, reheating of food and pot cleaning, if households primarily use LPG for their daily cooking activities.</p> <p>Input data: There is a need for population-based surveys in countries, including Cameroon, to track this impact as part of bespoke data collection efforts. The Multi-Tier Tracking Framework contains suitable survey questions that could be used across countries for making the results comparable.</p>
	Time savings from avoided fuel collection per day	<p>Use of LPG is expected to reduce the need to collect firewood once households use LPG for a significant part of their daily cooking activities. (According to the findings presented in Parts VI (LPG Demand Potential to 2030) and X (Environmental, Health, Social and Economic Impact Potential), a meaningful portion of firewood-gathering households located in rural areas which are within a commercially and physically viable service distance of distribution facilities are expected to switch to LPG in Cameroon by 2030.) While the poorest firewood-gathering households may never adopt LPG, those which do can be expected to use LPG, in an initial transition stage, as a complementary fuel for certain tasks or during times of year when dry firewood is scarce or difficult to keep dry. To the extent there is increased switching to LPG from such households, this measure quantifies one of the anticipated main</p>

¹⁸⁷ Singh et al. (2017). Environmental payoffs of LPG cooking in India. Environ. Res. Lett. <https://doi.org/10.1088/1748-9326/aa909d>

¹⁸⁸ Pope et al. (2018). Climate and health impacts of scaling adoption of LPG for clean cooking through the Cameroon LPG Master Plan. Policy brief.

Categories of Impacts	Metric	Comments and methodology
		<p>motivators for them to do so.</p> <p>Input data: There is a need for population-based surveys in countries to track this impact as part of bespoke data collection efforts. The Multi-Tier Tracking contains suitable survey questions that could be used across countries for making the results comparable.</p>
	Economic value of time saved	<p>The time gained from faster cooking with LPG (including preparation and clean-up), and, where applicable, from reduced fuel gathering, can result in a number of benefits, including allowing women to find more paid work¹⁸⁹, or pursue education, or have more time for themselves and their well-being. It should be noted, however, that increased economic activity for women (in any sector) from savings in cooking-related time will be countered at a macro level by a potentially significant loss of jobs in the charcoal and firewood informal sectors (for which specific, complementary metrics should be designed). The economic value of time can be calculated as a proportion of the time saved likely to be used for economic activity (which is expected to be very low in some settings) multiplied by the average hourly minimum wage in the country.</p>
IV. Employment	Job creation/loss across the LPG value chain (and indirect jobs)	<p>Scaling up of LPG means job opportunities in construction and long-term LPG operations.</p> <p>Data input: Direct LPG-related job creation (short-term and long-term jobs) to be calculated using the ISLE indicators. Indirect jobs include maintenance, staff of retail shops, etc. and these may be more difficult to measure.</p>
	Job losses across non-LPG value chains	<p>Scaling up of LPG may result in a reduction of jobs in relation to firewood and charcoal production and supply, especially in the informal sector. Such reduction might be offset, in part, by increased production of firewood and/or charcoal for export, if the Government permits increased export of woodfuel products. (Climate and environmental considerations should be taken into account in such policy-making.)</p> <p>Data input: direct jobs in the firewood, charcoal, etc. supply chains</p>

¹⁸⁹ Countries like India have encouraged LPG business operations by families (husband and wife) operating in rural areas. An example of such schemes is Rajiv Gandhi Gramin LPG Vitaran (RGGLV), launched by India in 2009.

Categories of Impacts	Metric	Comments and methodology
		<p>to be based on the best available sources. It should be noted that reliable estimates for the total number of jobs in the different fuel value chains are generally difficult to obtain in low and middle income settings, as there is an overall scarcity of data, and employment surveys do not always adequately capture the different employment categories.</p>
VI. Macro-economics	Tax revenue	<p>The impact on taxes is comprised by changes to the volume of LPG and non-LPG fuels subject to sales taxes that are actually collected (e.g., VAT and, for LPG, hydrocarbon and LPG-specific taxes), and to corporate (income) taxes in the LPG and non-LPG fuel sectors that are actually collected. In the case of Cameroon, a lack of data regarding corporate profitability across the supply chains of the various cooking fuel alternatives did not allow evaluation of corporate tax effects.</p> <p>In most SSA countries, firewood and charcoal are informal businesses. Therefore, the tax effects depend mainly on how, and how much, LPG fuel and LPG businesses are taxed, and partially on how, and how much, wood and charcoal products and businesses are taxed.</p> <p>The increasing replacement of wood and charcoal and kerosene by LPG in Cameroon is expected to lead to a decrease in national tax revenues, based on the increased LPG-specific taxes and levies collected on increased LPG volumes being more than offset by reduction in taxes collected on reduced sales by the tax-paying wood and charcoal industries, and on kerosene.</p> <p>Increased use of LPG would create a larger corporate tax stream from increased formal economic activity (LPG marketers, staff of filling plants and bulk depots, etc.) and lead to higher corporate taxes.</p> <p>The net impact on tax revenues would depend on the foregoing factors and the relative LPG and firewood/charcoal use.</p> <p>Input data: To estimate the impact of fuel sales on the tax base (including VAT and any additional levies), the total quantity of fuel consumed in-country should be multiplied by the fixed-amount-per-unit taxes and levies (applicable to LPG), and multiplied by the domestic sales price and VAT per kg of fuel (applicable to biomass fuels). To calculate the import tax contribution, the total quantity of fuel imported (that is generally only LPG and kerosene in SSA) should be multiplied by the price per kg of fuel imported and the</p>

Categories of Impacts	Metric	Comments and methodology
		<p>import duties per kg of fuel. (In Cameroon, this aspect can be disregarded for so long as LPG imports remain not subject to import duties and woodfuels are not imported.) The total imports and sales taxes and increased LPG production would be added to obtain the total impact on the tax base.</p> <p>Measuring the increased use of LPG would depend on the ability to isolate and calculate the commercial benefits of the different effects mentioned above.</p>
	Trade balance	<p>In countries that import LPG, greater use of LPG may worsen the trade balance. This might be partially offset by reduced usage of charcoal for the domestic market and therefore its increased availability for export. However, charcoal production for export should not be encouraged as this contributes to forest degradation and deforestation and has net climate warming impacts.</p> <p>Approach: To measure the effect on the trade balance, fuel imports for LPG and charcoal (or other fuels as applicable) should be subtracted from the fuel exports for the same fuels.</p>
	Subsidy	<p>In countries that subsidize LPG in order to lower its end-user price—in particular, countries which do not target the subsidy to those in need, but apply it to all LPG sold within the country, such as Cameroon—increased use of LPG will proportionally increase the cost of the subsidy to the Government, unless entirely offset by a countervailing tax mechanism in the national LPG pricing formula.</p> <p>Approach: Any fuel subsidy, as a significant line item in the governmental budget, will be monitored by the government.</p>

Considerations on data needs and methods

Conducting a comprehensive impact evaluation of a national LPG scale-up program, while important and valuable, is a substantial undertaking. A key aspect of this is the collection and analysis of a wide range of data. Some of the main considerations with respect to these data requirements are discussed below.

Health data

- To calculate the health benefits from a transition to sustained use of LPG for the population, there is need to collect personal exposure data to health-damaging pollutants such as PM_{2.5} in the field during daily cooking operations. As an alternative, kitchen area concentrations can be measured, and personal exposure rates can be estimated using published GBD/CRA conversion ratios. These data are unlikely to be readily available, and therefore need to be obtained using exposure

monitors in suitable samples of homes and their occupants. Measurement of personal exposure is time-consuming, and requires access to instruments, analysis facilities and staff trained in the necessary skills, all of which carry significant resource implications.

- Interpreting the personal exposure data is also important and care must be taken in generalizing from a specific context where a field evaluation is conducted. High recorded PM_{2.5} exposure levels (i.e. above WHO recommended safe levels for health) in LPG-using homes may occur for a number of reasons including: (i) high background levels of ambient pollution (e.g. in urban areas, where other sources of pollution contribute to poor air quality; in rural areas, where the practice of trash burning or wood burning for agricultural purposes may be common); (ii) community effect, where neighboring households continue to rely on polluting fuels and technologies impacting the air quality of neighbors who have transitioned to LPG for cooking; and (iii) fuel stacking, when those who have transitioned to LPG have not fully abandoned their traditional stoves and therefore experience residual exposure to health-damaging pollutants. In addition, the continued use of traditional or other solid fuel stoves for heating purposes, or other combustion sources such as kerosene lamps, can contribute substantially to HAP and personal exposure.
- Despite the importance of household fuels in causing burn deaths and injuries through contact with ignited fuel (e.g., solid fuels, kerosene and LPG), reliable data on such events and injuries are scarce. It is therefore important that more effort, including by the Ministry of Health, is made to collect and report such data.

Environmental and climate data

The ability to accurately project net emissions reductions associated with fuelwood and charcoal displacement by LPG for cooking greatly depends on the input sources and biomass renewability scenarios.

Climate impacts from LPG adoption should consider both Kyoto (e.g. CO₂, CH₄) and non-Kyoto climate pollutants (e.g. BC, OC, etc.). LPG use is associated with lower emissions of BC and other co-emitted species, as well as almost no methane emissions. This is due to the fuel composition (LPG is made of butane and propane) and higher efficiency of LPG stoves compared to traditional or simply manufactured stoves. Conversely, biomass burning leads to CH₄, BC and other non-Kyoto climate pollutant emissions, which warm the climate in the short-term.

The input needed for the modeling would include:

- Baseline emissions data of Kyoto gases and short-lived climate pollutants for the household sector
- Emission factors (i.e. the mass of pollutant emitted for a given task)
- Fuel use data for biomass consumption (renewable and non-renewable fractions). The literature estimates reveal large uncertainties when it comes to the fNRB, particularly in low and middle-income countries.

Gender, employment and macroeconomics

For these categories of impact, the necessary data are generally not readily available (e.g. for sections of the fuel market operating informally, for the amount of time spent in collecting fuels etc.). This means new data collection work is required (i.e. through special surveys if routine ones such as the DHS, GLSS do not

include the topics), or assumptions must be made. An example would be impacts on employment, data for which might be included in routine national surveys. These would need to cover all of the relevant fuel value chains. In some cases, it may be possible to rely on research studies to measure some of the impacts on a small scale (e.g. for gender) and extrapolate on a national scale.

Resources needed to conduct an impact evaluation

Adequate funding is critical to ensure appropriate evaluation. The greater the need for primary data collection (i.e. household surveys, stakeholder surveys to obtain accurate figures on number of jobs, personal exposure monitoring etc.), the more resource-intensive the evaluation will be. Selecting representative study areas, applying rigorous study design methods and having access to digitized data are the first ways to optimize costs. In addition, the evaluation team needs to include personnel with the technical competence to implement the evaluation methods and amenability to training.

Governments and project implementers need to prioritize the information to be collected and what impacts are to be assessed. It is beyond the scope of this document to make suggestions for prioritization.

Conclusions

A properly designed impact evaluation can answer the question of whether a national LPG scale-up program is achieving the program goals and the wider societal benefits. This would assist in decision-making with regards to LPG market expansion. It would also inform the steps to reduce fuel/stove stacking, encourage safer practices in the home, and re-train traditional fuel workers so they can contribute to the clean fuel market, etc.

For a national evaluation, a robust monitoring program that includes the collection of primary and secondary data is an efficient way to help with impact assessment. A key consideration when designing, planning and implementing an impact evaluation is to focus on what the program should achieve, and concentrate the resources available on ensuring that the most relevant information is collected as accurately as possible.

Annex

Please refer to Annex Chapter 31 on page 312 for further information about the CLEAN-AIR (Africa) Group.

XII. Recommendations for Further Technical Assistance and Research

This Part summarizes recommendations for further technical assistance or research which arose during the national assessment process. A more detailed treatment is presented in the companion *Cameroon LPG Investment and Implementation* report.

Recommendations for further technical assistance

1. Within the scope and resources for this stage of the Clean Cooking for Africa Program in Cameroon, deep assessments and recommendations were not developed with respect to certain aspects of the LPG sector, with priority given to the aspects that were reported herein. The aspects which received a lesser level of attention to date should be assessed and recommendations developed (assuming events do not outpace the assessing) in a later stage of the program. They include:
 - Bulk Road Vehicles;
 - Alternatives for increasing domestic LPG production for Sonara;
 - Importation strategies and opportunities for regional coordination and infrastructure planning in order to reduce costs and improve volatility;
 - Feasibility of pay-as-you-go business models in context of Cameroon LPG pricing regulations (and potential exceptions to those regulations);
 - Targeting of cylinder exchange points and depots;
 - Feasibility to use a mixture of 50% butane and 50% propane in current cylinders in Cameroon. If safe to do, increasing the share of propane in the LPG mix could reduce costs by (i) lowering the average price of LPG per kg (propane costs less than butane, but is slightly less energy dense) and (ii) increasing importation choices.
2. Study and planning for effective LPG microfinance scale up, followed by appropriate support and underwriting for expanded LPG microfinance program execution.
3. The potential role of bio-LPG in the Cameroon market for the long term.
4. With investment funding prearranged (as a precondition of Cameroon business cooperation in sharing proprietary information), evaluation of financial statements and business plans from a critical mass of companies in the bottling and marketing nodes of the supply chain, to refine the projections of scale and impact from this report, and to develop firm-specific investment cases for actual counterparties.
5. Assessing the impact potential of targeted interventional mechanisms for increasing availability (on a commercially viable basis) and affordability of LPG for the rural poor.

Recommendations for further research

1. Household surveying of an expanded population across a broader number of towns and villages strengthen findings with respect to comparative fuel economics, and other drivers of fuel-switching and fuel-stacking.
2. Assessing demand elasticity with respect to specific consumer offers deemed feasible by LPG marketing and distribution companies. (Such offers may include both traditionally distributed LPG and pay-as-you-go LPG.)
3. Evaluating fuel-stacking behavior longitudinally, including drivers which motivate more or less stacking among different consumer segments.
4. The potential impacts of LPG expansion on the charcoal sector.
5. The potential effects and practicality of imposing limitations on charcoal activity, such as logging bans, charcoal export taxes, etc.
6. Assessing the effectiveness of educational and promotional campaigns to consumers regarding their preferences for LPG.
7. Cost-benefit analysis to determine the role which credit screening should play in LPG microfinance programs.

XIII. Annexes

27. Household Survey and Findings

Summary of Methodology

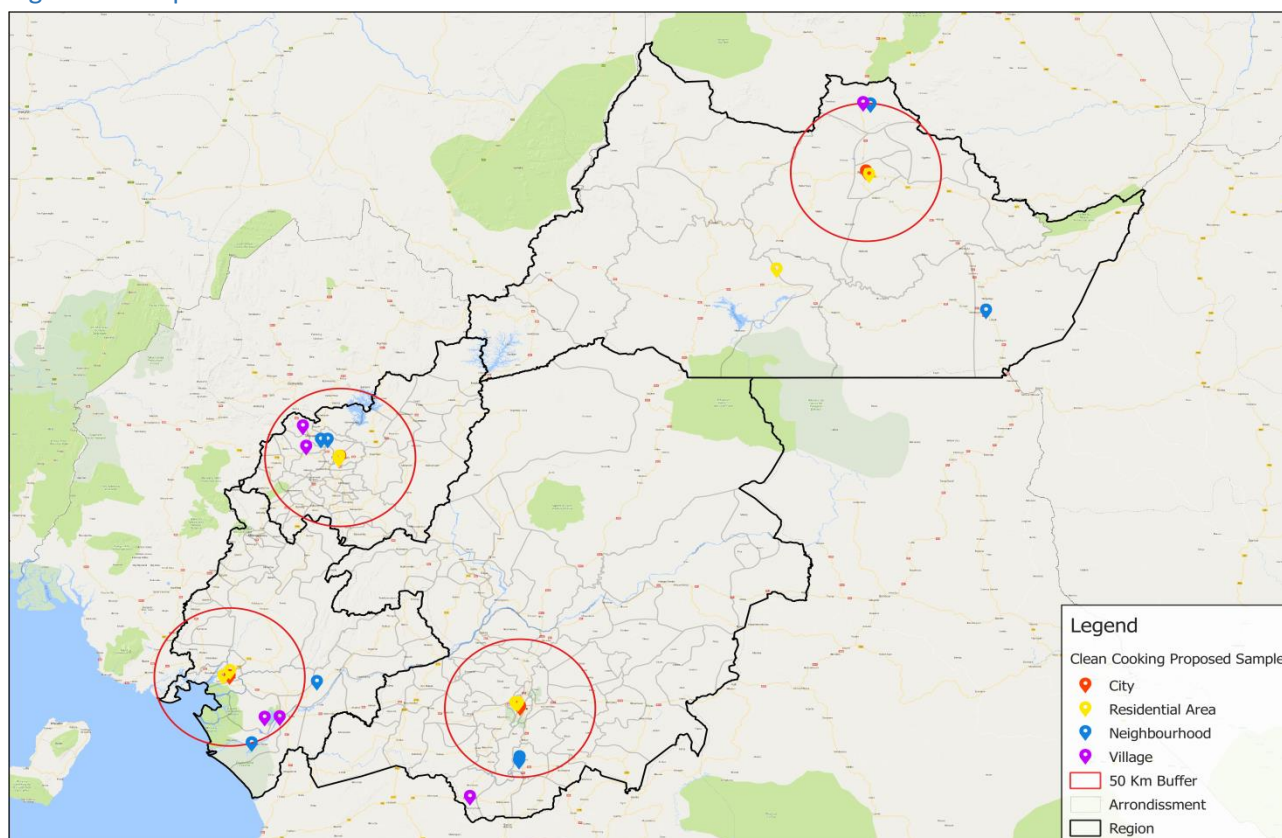
GLPGP commissioned Dalberg Research to collect data at the household level in Cameroon for the Clean Cooking for Africa project. The objectives of the survey were to:

- Conduct a household survey, building on tools from the University of Liverpool (LACE) study
- Estimate household fuel usage with data from the survey
- Map accessibility based on basic infrastructure
- Collect respondent data on perceived availability, relative fuel price, and (if possible) willingness to pay and switching behavior
- Use these inputs to triangulate potential demand

Location and sampling

The following regions and cities were purposively selected to be surveyed: Littoral (Douala), Centre (Yaounde), East (Bertoua) and Adamawa (Ngaoundere), including peri-urban and rural areas within 50 km from these main cities.

Figure 58. Map of selected enumeration areas



Before fieldwork started, the study selected areas with affluent/fairly affluent (*affluent here referred to high-end and middle-class consumers*) neighborhoods and areas with poorer neighborhoods. The aim was

to get insights and comparability on usages, expenditures on different fuels, and other characteristics of the communities' households. In the rural areas, villages were selected that were not extremely remote and that were situated around a trading center where the study hypothesized that fuels could likely be purchased.

The GLPGP-Dalberg survey targeted 1,081 households equally distributed across the four regions. Within the regions, the sample was split equally among urban, peri-urban and rural populations. Two neighborhoods were selected within the target urban and peri-urban areas and two villages within the target rural areas as the Enumeration Areas (EA). Within these enumeration areas, the sample was split equally. The survey therefore had 41 to 42 target households within each EA.

Table 59. Cameroon household survey target sample spread (GLPGP-Dalberg Survey 2018)

Survey region	Sample per region	Urban		Peri-urban		Rural	
		Neighborhood 1	Neighborhood 2	Neighborhood 1	Neighborhood 2	Village 1	Village 2
Littoral	250	42	42	41	42	41	42
Centre	250	42	42	41	42	41	42
West	250	42	42	41	42	41	42
Admaoua	250	42	42	41	42	41	42
Total	1,000	336		332		332	

Survey questions and data collection

Survey questions were based on those previously used in field-based research conducted by the University of Liverpool LACE studies and Practical Action in Nepal, Kenya and Sudan (PAC, 2005). Questions on fuel use were based on WHO Household Energy Survey Questions designed to monitor Sustainable Development Goal 7.1.2. The survey also include a detailed section with pictorial information collected at local markets on the most commonly used fuels to help respondents estimate fuel costs accurately. The questionnaire, first created in English, was translated into French. It was piloted with 77 households in Doula over the course of one day. The questionnaire was then slightly amended, and some questions were improved for clarity based on the learnings from the pilot. The survey was conducted through face-to-face interviews with the main cook and household head, if they were present, and data were captured electronically through handheld devices.

Main Results

Table 60 provides a breakdown of the main demographic characteristics of households surveyed, stratified by urban, peri-urban and rural locations. In terms of the household head, the majority of the sample were female (54%) and educated to secondary school or above (75%); 38% (the largest percentage in the marital status category) were single. There was significant difference in number of residents per households (p value < 0.001), with rural and peri-urban households reporting six residents on average and urban households, five. Table 61 and Table 62 show breakdowns of the economic resources (income and assets owned) of households in the sample, stratified by urban, peri-urban and rural settings, for LPG users and non-users, respectively. Among LPG users, more than 28% of households reported earning a monthly household income of 50,000 CFA or less with significant differences (p value < 0.001) across urban, peri-urban and rural households.

Table 60. Demographic characteristics of household survey sample
(stratified by urban, peri-urban and rural communities; GLPGP-Dalberg Survey 2018, N=1081)

Characteristic	Total sample (n=1081; 100%)		Urban (n= 395; 36.5%)		Peri-urban (n=339; 31.4%)		Rural (n=347; 32.1%)		p-value
	No	%	No	%	No	%	No	%	
Head of household:									
Gender ¹⁹⁰									
Male	241	46.1%	77	39.9%	72	41.9%	92	58.2%	p= 0.013
Female	282	53.9%	116	60.1%	100	58.1%	66	41.8%	
Education									
No formal education	60	5.6%	16	4.1%	15	4.4%	29	8.4%	p<0.001
Primary	200	18.5%	55	13.9%	58	17.1%	87	25.1%	
Secondary/High school	583	53.9%	194	49.1%	205	60.5%	184	53.0%	
University	229	21.2%	128	32.4%	59	17.4%	42	12.1%	
Seamstress trainee	2	0.2%	1	0.3%	1	0.3%	0	0.0%	
Don't know	7	0.6%	1	0.3%	1	0.3%	5	1.4%	
Marital status ^{Error!} Bookmark not defined.									
Married	178	34.0%	53	27.5%	65	37.8%	60	38.0%	p=0.140
Living together with partner/ Cohabiting	70	13.4%	17	8.8%	27	15.7%	26	16.5%	
Widowed	50	9.6%	23	11.9%	14	8.1%	13	8.2%	
Divorced	9	1.7%	5	2.6%	4	2.3%	0	0.0%	
Separated	15	2.9%	3	1.6%	7	4.1%	5	3.2%	
Single	201	38.4%	92	47.7%	55	32.0%	54	34.2%	
Household composition:									
People resident in house (Mean/Sd)	5	3	5	3	6	3	6	3	p<0.001
Children 0-5 years (Mean/Sd)	1	1	1	1	1	1	1	1	p<0.001
Number of rooms (Mean/Sd)	3	1	3	2	3	1	3	1	p<0.001
Water source									
Pipe in home	390	36.1%	159	40.3%	125	36.9%	106	30.5%	p=0.017
Pump (deep well)	112	10.4%	32	8.1%	47	13.9%	33	9.5%	
Well (pit with bucket)	294	27.2%	97	24.6%	92	27.1%	105	30.3%	
Communal standpipe	219	20.3%	74	18.7%	64	18.9%	81	23.3%	
Collect from river	55	5.1%	27	6.8%	9	2.7%	19	5.5%	
Supermont	1	0.1%	1	0.3%	0	0.0%	0	0.0%	
Buys	9	0.8%	5	1.3%	2	0.6%	2	0.6%	
From the forest	1	0.1%	0	0.0%	0	0.0%	1	0.3%	
Sanitation									
Septic toilet in house	399	36.9%	230	58.2%	107	31.6%	62	17.9%	p<0.001
Latrine in yard	817	75.6%	248	62.8%	274	80.8%	295	85.0%	p<0.001

¹⁹⁰ Data were only collected if respondent was head of household (total sample n=523; urban n=193; peri-urban n=172; rural n=158)

Table 61. Economic characteristics of LPG users in survey sample
(stratified by urban, peri-urban and rural communities; GLPGP-Dalberg Survey 2018, N=1,081)

Characteristic	Total sample (N=590; 100%)		Urban (N= 288; 36.5%)		Peri-urban (N=171; 31.4%)		Rural (N=131; 32.1%)		p-value
	No	%	No	%	No	%	No	%	
Household income method									
Cash only	444	75.3%	215	74.7%	126	73.7%	103	78.6%	p=0.744
Kind only	3	0.5%	2	0.7%	1	0.6%	0	0.0%	
Cash and kind	19	3.2%	7	2.4%	8	4.7%	4	3.1%	
Not paid	124	21.0%	64	22.2%	36	21.1%	24	18.3%	
Household income (CFA)									
Less or equal to 25k	23	3.9%	12	4.2%	8	4.7%	3	2.3%	p=0.328
26-50k	94	15.9%	42	14.6%	28	16.4%	24	18.3%	
51-100k	153	25.9%	76	26.4%	44	25.7%	33	25.2%	
101-200k	150	25.4%	72	25.0%	40	23.4%	38	29.0%	
201-300k	59	10.0%	26	9.0%	20	11.7%	13	9.9%	
301-500k	17	2.9%	15	5.2%	1	0.6%	1	0.8%	
>500k	2	0.3%	2	0.7%	0	0.0%	0	0.0%	
Don't know	70	11.9%	32	11.1%	22	12.9%	16	12.2%	
Won't answer	22	3.7%	11	3.8%	8	4.7%	3	2.3%	
Assets - general (mean/Sd)									
Refrigerator	0.5	1.30	1.3	0.44	1.4	0.48	1.3	0.46	p=0.076
Electricity connection	0.3	1.10	1.1	0.29	1.1	0.33	1.1	0.30	p=0.379
Access to electricity generator	0.2	1.96	2.0	0.21	2.0	0.11	2.0	0.19	p=0.102
Radio	0.5	1.33	1.3	0.47	1.4	0.48	1.3	0.47	p=0.544
Hi-Fi / CD-player	0.5	1.39	1.4	0.48	1.5	0.50	1.4	0.49	p=0.044
TV	0.2	1.04	1.0	0.15	1.1	0.24	1.1	0.19	p=0.169
Cellphone	0.0	1.01	1.0	0.08	1.0	0.13	1.0	0.09	p=0.238
Livestock	0.5	1.80	1.8	0.37	1.8	0.37	1.7	0.40	p<0.001
Assets – transport (Mean/Sd)									
Car owned	0.3	1.83	1.8	0.40	1.9	0.35	1.9	0.37	p=0.100
Truck owned	0.1	1.98	2.0	0.18	2.0	0.08	2.0	0.14	p=0.054
Motorbike owned	0.5	1.77	1.8	0.40	1.8	0.40	1.7	0.42	p=0.024
Bicycle owned	0.2	1.93	1.9	0.27	1.9	0.28	2.0	0.26	p=0.610

Table 62: Economic characteristics of LPG non-users in survey sample
(stratified by urban, peri-urban and rural communities; GLPGP-Dalberg Survey 2018, N=1,081)

Characteristic	Total sample (N=310; 100%)		Urban (N= 107; 36.5%)		Peri-urban (N=168; 31.4%)		Rural (N=96; 32.1%)		p-value
	No	%	No	%	No	%	No	%	
Household income method									
Cash only	297	60.5%	78	72.9%	105	62.5%	114	52.8%	p=0.006
Kind only	10	2.0%	4	3.7%	2	1.2%	4	1.9%	
Cash and kind	115	23.4%	12	11.2%	39	23.2%	64	29.6%	
Not paid	69	14.1%	13	12.1%	22	13.1%	34	15.7%	
Household income (CFA)									
Less or equal to 25k	36	7.3%	8	7.5%	7	4.2%	21	9.7%	p=0.130
26-50k	156	31.8%	33	30.8%	46	27.4%	77	35.6%	

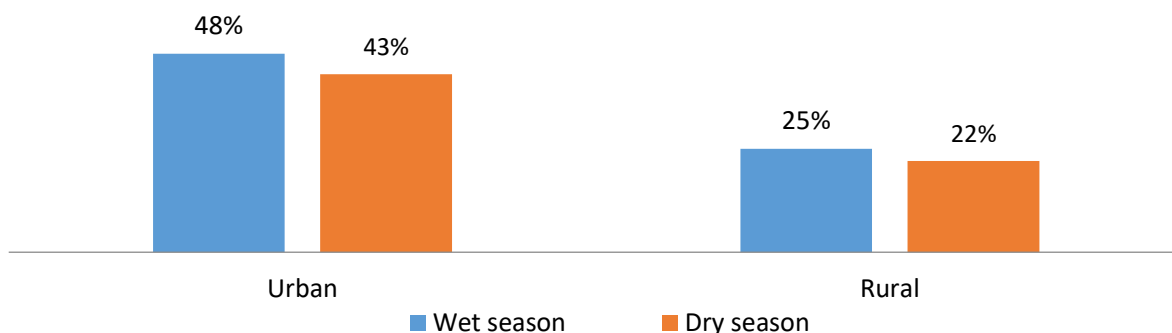
Characteristic	Total sample (N=310; 100%)		Urban (N= 107; 36.5%)		Peri-urban (N=168; 31.4%)		Rural (N=96; 32.1%)		p-value
	No	%	No	%	No	%	No	%	
51-100k	144	29.3%	28	26.2%	50	29.8%	66	30.6%	
101-200k	63	12.8%	16	15.0%	29	17.3%	18	8.3%	
201-300k	14	2.9%	3	2.8%	7	4.2%	4	1.9%	
301-500k	0	0.0%	0	0.0%	0	0.0%	0	0.0%	
>500k	1	0.2%	0	0.0%	1	0.6%	0	0.0%	
Don't know	69	14.1%	16	15.0%	24	14.3%	29	13.4%	
Won't answer	8	1.6%	3	2.8%	4	2.4%	1	0.5%	
Assets - general (mean/Sd)									
Refrigerator	1.9	0.35	1.8	0.43	1.9	0.29	1.9	0.33	p=0.004
Electricity connection	1.5	0.50	1.3	0.46	1.5	0.50	1.5	0.50	p<0.001
Access to electricity generator	2.0	0.18	2.0	0.10	1.9	0.24	2.0	0.17	p=0.065
Radio	1.4	0.49	1.4	0.49	1.4	0.48	1.4	0.50	p=0.499
Hi-Fi / CD-player	1.8	0.41	1.7	0.46	1.8	0.38	1.8	0.40	p=0.041
TV	1.5	0.50	1.2	0.41	1.5	0.50	1.6	0.50	p<0.001
Cellphone	1.0	0.18	1.0	0.17	1.0	0.20	1.0	0.17	p=0.716
Livestock	1.6	0.49	1.8	0.44	1.6	0.49	1.5	0.50	p<0.001
Assets – transport (Mean/Sd)									
Car owned	2.0	0.18	1.9	0.25	2.0	0.15	2.0	0.15	p=0.096
Truck owned	2.0	0.11	2.0	0.17	2.0	0.08	2.0	0.10	p=0.232
Motorbike owned	1.8	0.42	1.8	0.40	1.7	0.44	1.8	0.42	p=0.351
Bicycle owned	1.9	0.25	2.0	0.19	2.0	0.21	1.9	0.29	p=0.088

Household energy use

Table 63 and Table 64 present key characteristics of household energy use, providing a summary of reported primary fuel use for cooking and lighting for all households and detailed characteristics on LPG use for households that reported using LPG (primary and secondary users).

LPG use in Cameroon was observed to vary with weather seasons, with more use reported during the wet season compared to the dry season. However, this variation was not significant – urban areas reported a 5 percentage point decrease with the dry season while rural areas reported a 3 percentage point decrease, as can be seen in the figure below.

Figure 59. Reported use of LPG: wet season vs. dry season
(% of total households, GLPGP-Dalberg survey 2018, N=1081)



40% of LPG users reported having been using LPG for more than five years with 26% reporting usage for more than 10 years. For those using LPG for 5 years, 24% of users reported having purchased one gas stove ever, and 19% reported having purchased two stoves during the duration of their LPG use. A majority cited defects and spoilage as the main reason for replacing a stove. 69% of LPG users reported being satisfied with their current consumption level, with 40% citing cost as the primary reason for not using more LPG.

Table 63. Reported primary fuels for cooking and lighting, stove type and cooking location
(stratified by urban, peri-urban and rural communities; GLPGP-Dalberg Survey 2018, N=1081)

Characteristic	Total sample (n=1081; 100%)		Urban (n= 395; 36.5%)		Peri-urban (n=339; 31.4%)		Rural (n=347; 32.1%)		p-value
	No	%	No	%	No	%	No	%	
Primary cooking fuel during dry season									
LPG	399	36.9%	215	54.4%	106	31.3%	78	22.5%	p<0.001
Charcoal	52	4.8%	26	6.6%	20	5.9%	6	1.7%	
Kerosene or paraffin	55	5.1%	27	6.8%	19	5.6%	9	2.6%	
Firewood	554	51.2%	119	30.1%	183	54.0%	252	72.6%	
Other fuels	21	2%	8	2%	11	3%	2	1%	
Primary cooking fuel during wet season									
LPG	442	40.9%	233	59.0%	122	36.0%	87	25.1%	p<0.001
Charcoal	61	5.6%	28	7.1%	26	7.7%	7	2.0%	
Kerosene or paraffin	66	6.1%	35	8.9%	21	6.2%	10	2.9%	
Firewood	491	45.4%	92	23.3%	159	46.9%	240	69.2%	
Other fuels	21	2%	7	2%	11	3%	3	1%	
Lighting									
No lighting	11	1.0%	4	1.0%	6	1.8%	1	0.3%	p<0.001
Electricity (from grid/mini-grid)	883	81.7%	379	95.9%	251	74.0%	253	72.9%	
Electricity (solar home system)	18	1.7%	3	0.8%	10	2.9%	5	1.4%	
Solar lantern	52	4.8%	1	0.3%	18	5.3%	33	9.5%	
Rechargeable flashlight, torch or lantern	56	5.2%	3	0.8%	21	6.2%	32	9.2%	
Battery flashlight, torch or lantern	24	2.2%	0	0.0%	16	4.7%	8	2.3%	
Kerosene lamp	24	2.2%	4	1.0%	6	1.8%	14	4.0%	
Other	13	1%	1	0%	11	3%	1	0%	
Stove used									

Characteristic	Total sample (n=1081; 100%)		Urban (n= 395; 36.5%)		Peri-urban (n=339; 31.4%)		Rural (n=347; 32.1%)		p-value
	No	%	No	%	No	%	No	%	
Open fire/ traditional	560	51.8%	118	29.9%	190	56.0%	252	72.6%	p<0.001
Manufactured	521	48.2%	277	70.1%	149	44.0%	95	27.4%	
Cooking location									
Indoor	669	61.9%	282	71.4%	195	57.5%	192	55.3%	p<0.001
Outdoor	224	20.7%	43	10.9%	86	25.4%	95	27.4%	
Both	188	17.4%	70	17.7%	58	17.1%	60	17.3%	
Has separate room for cooking	600	70.0%	210	59.7%	179	70.8%	211	83.7%	p<0.001

Table 64. Details of LPG use reported by self-described users of LPG
(stratified by urban peri-urban and rural communities; GLPGP-Dalberg Survey 2018, N=1081)

Characteristic	Total sample (n=590; 100%)		Urban (n=285; 36.5%)		Peri-urban (n=175; 31.4%)		Rural (n=130; 32.1%)		p-value
	No	%	No	%	No	%	No	%	
Frequency of refill purchase									
About 2 weeks	12	2.0%	9	3.2%	2	1.1%	1	0.8%	p=0.162
About 3 weeks	18	3.1%	11	3.9%	3	1.7%	4	3.1%	
About a month	165	28.0%	87	30.5%	44	25.1%	34	26.2%	
About 5-6 weeks	41	6.9%	21	7.4%	11	6.3%	9	6.9%	
About 2 months	135	22.9%	63	22.1%	34	19.4%	38	29.2%	
2 -3 months	114	19.3%	54	18.9%	36	20.6%	24	18.5%	
More than 3 months	60	10.2%	23	8.1%	25	14.3%	12	9.2%	
Other, specify	45	7.6%	17	6.0%	20	11.4%	8	6.2%	
Number of bottles kept in house									
1 bottle	478	81.0%	236	82.8%	143	81.7%	99	76.2%	p=0.407
2 bottles	99	16.8%	42	14.7%	28	16.0%	29	22.3%	
3 or more	13	2.2%	7	2.5%	4	2.3%	2	1.5%	
Length of time using LPG									
Less than a year	19	3.2%	11	3.9%	5	2.9%	3	2.3%	p=0.610
More than a year but less than 2 years	36	6.1%	14	4.9%	12	6.9%	10	7.7%	
Between 2 to 5 years	156	26.4%	79	27.7%	38	21.7%	39	30.0%	
Between 5 to 10 years	131	22.2%	62	21.8%	41	23.4%	28	21.5%	
More than 10 years	243	41.2%	116	40.7%	79	45.1%	48	36.9%	
Don't know	5	0.8%	3	1.1%	0	0.0%	2	1.5%	
Number of burners purchased									
Only one stove	221	37.5%	111	38.9%	64	36.6%	46	35.4%	p=0.684
Two stoves	178	30.2%	84	29.5%	58	33.1%	36	27.7%	
Three stoves	106	18.0%	49	17.2%	34	19.4%	23	17.7%	
More than three stoves	77	13.1%	37	13.0%	18	10.3%	22	16.9%	
Don't know	8	1.4%	4	1.4%	1	0.6%	3	2.3%	
Reasons for buying extra burners									
Old	33	9.10%	11	6.50%	12	10.90%	10	12.30%	p=0.288
Spoil	155	42.90%	66	38.80%	46	41.80%	43	53.10%	
Defect	57	15.80%	32	18.80%	15	13.60%	10	12.30%	
Rust	28	7.80%	14	8.20%	11	10.00%	3	3.70%	

Characteristic	Total sample (n=590; 100%)		Urban (n=285; 36.5%)		Peri-urban (n=175; 31.4%)		Rural (n=130; 32.1%)		p-value
	No	%	No	%	No	%	No	%	
Quality	21	5.80%	9	5.30%	11	10.00%	1	1.20%	
Leakage	17	4.70%	8	4.70%	4	3.60%	5	6.20%	
Wastage	5	1.40%	2	1.20%	0	0.00%	3	3.70%	
Upgrading	19	5.30%	12	7.10%	4	3.60%	3	3.70%	
Others	26	7.20%	16	9.40%	7	6.50%	3	3.80%	

Perceptions of LPG among LPG users and non-users

The GLPGP-Dalberg survey collected data on perceptions of LPG among LPG users and non-users. All households were asked seven preference questions on perceptions of LPG, use whether or not they currently use LPG. The responses were recorded on a 4-point Likert scale. Respondents were asked to rank LPG on key fuel characteristics, including speed of cooking, ability to cook most foods, cleanliness, ease of exchanging an empty cylinder for a filled cylinder, affordability of cylinder refills, availability of LPG and safety of using LPG, as shown in the figures below.

A majority of respondents ranked LPG favorably on speed of cooking and cleanliness. In particular, 77% and 74% of users and non-users ranked LPG as being fast or very fast in speed of cooking and 98% and 78% of users and non-users ranked it as being clean.

Many users and non-users also perceived LPG as being expensive to refill and difficult to obtain. 68% and 55% of users and non-users ranked LPG refills as being very expensive or expensive. 44% and 41% of users and non-users ranked LPG as being very difficult or difficult to obtain.

A majority of respondents perceived LPG as being either very dangerous or dangerous to use, which could be as a result of a high number of safety related incidents occurring in Cameroon. In particular, 77% and 90% of users and non-users ranked LPG as being dangerous to use. In addition, 19% of LPG users reported having experienced a gas-related safety issue of some sort at home, of which 64% experienced a gas leak (indicative of a poor safety national regime with respect to valve integrity) and 15% experienced a fire incident. These findings show that there is an opportunity to improve safety of LPG cylinders and of LPG use in households, through investment on good safety practices within the supply chain, and through educational campaigns on safe household cooking practices.

Figure 60. Perception of speed of cooking when using LPG
(% total households, GLPGP-Dalberg survey 2018, N=1081)

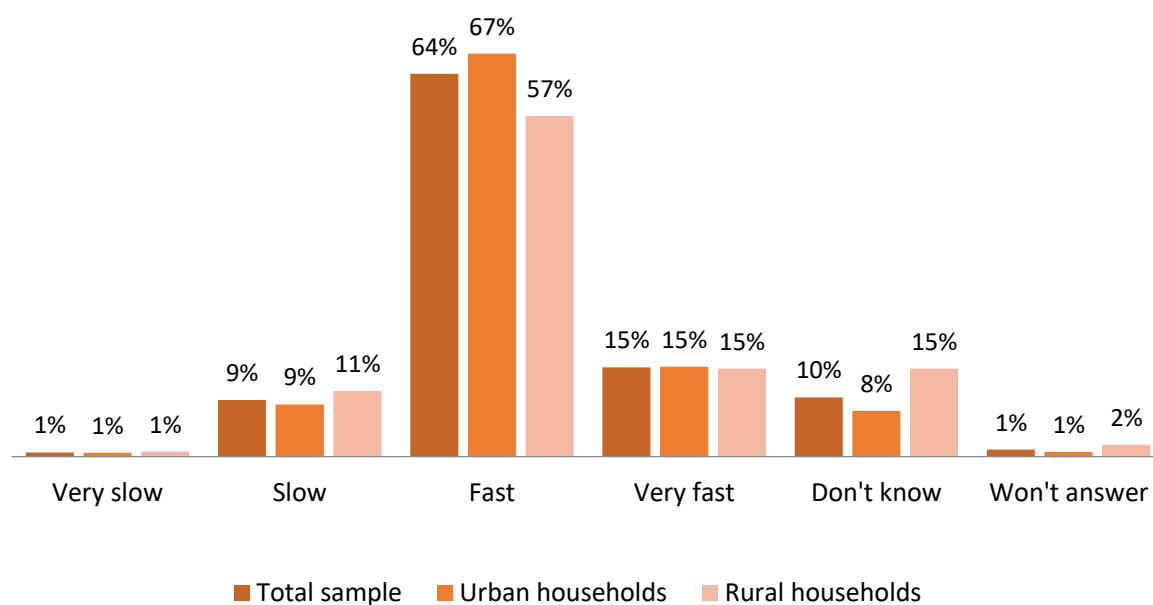


Figure 61. Perception of ability to cook most dishes when using LPG
(% of users and non-users, GLPGP-Dalberg survey 2018, N=1081)

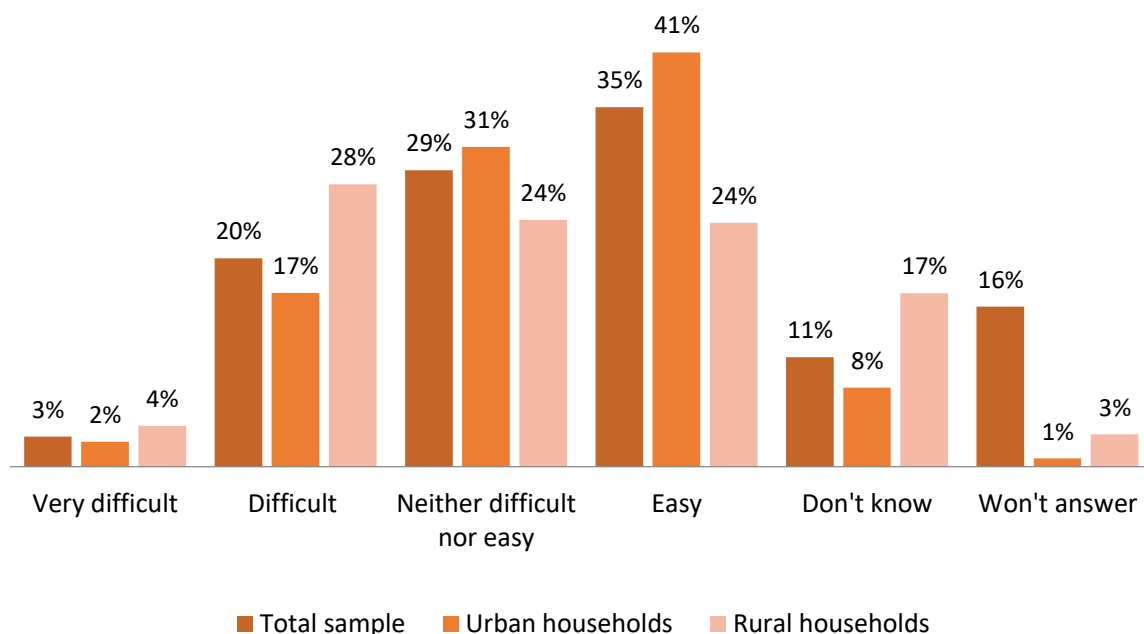


Figure 62. Perception of cleanliness when using LPG
(e.g., level of soot from smoke; % of users and non-users, GLPGP-Dalberg survey 2018, N=1081)

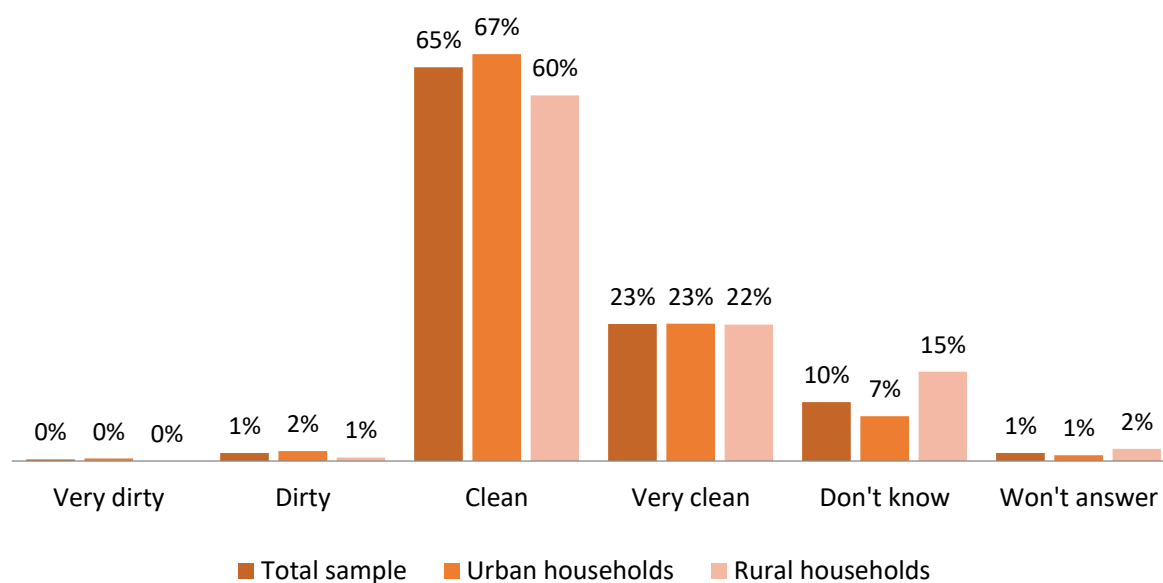


Figure 63. Perception of ease of exchanging an LPG cylinder
(% of users and non-users, GLPGP-Dalberg survey 2018, N=1081)

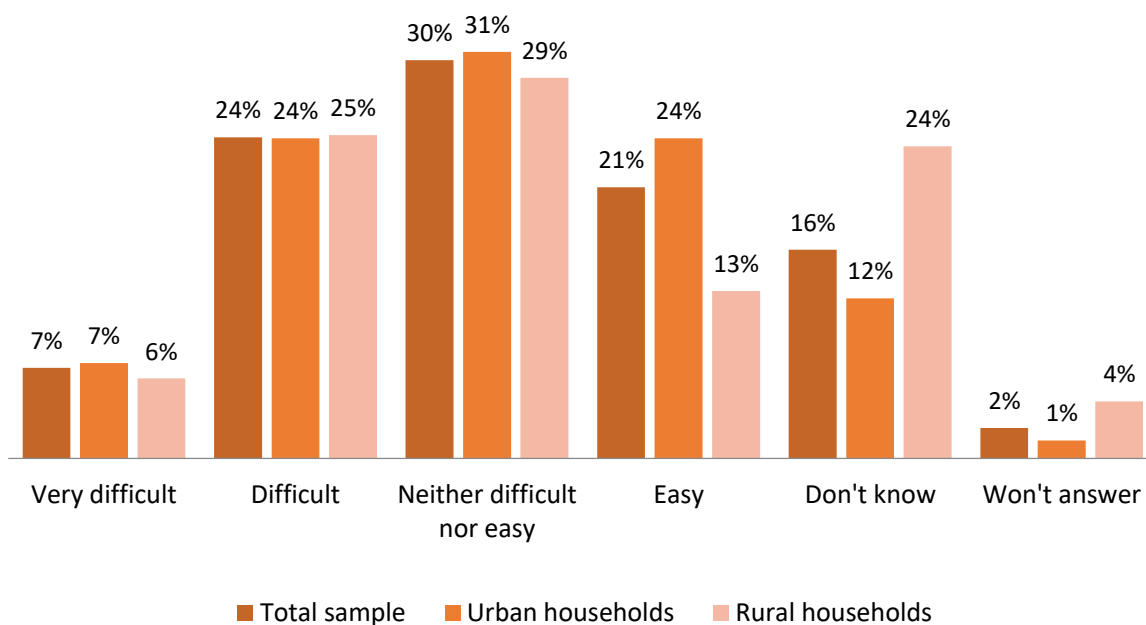


Figure 64. Perception of affordability of LPG refills
(% of users and non-users, GLPGP-Dalberg survey 2018, N=1081)

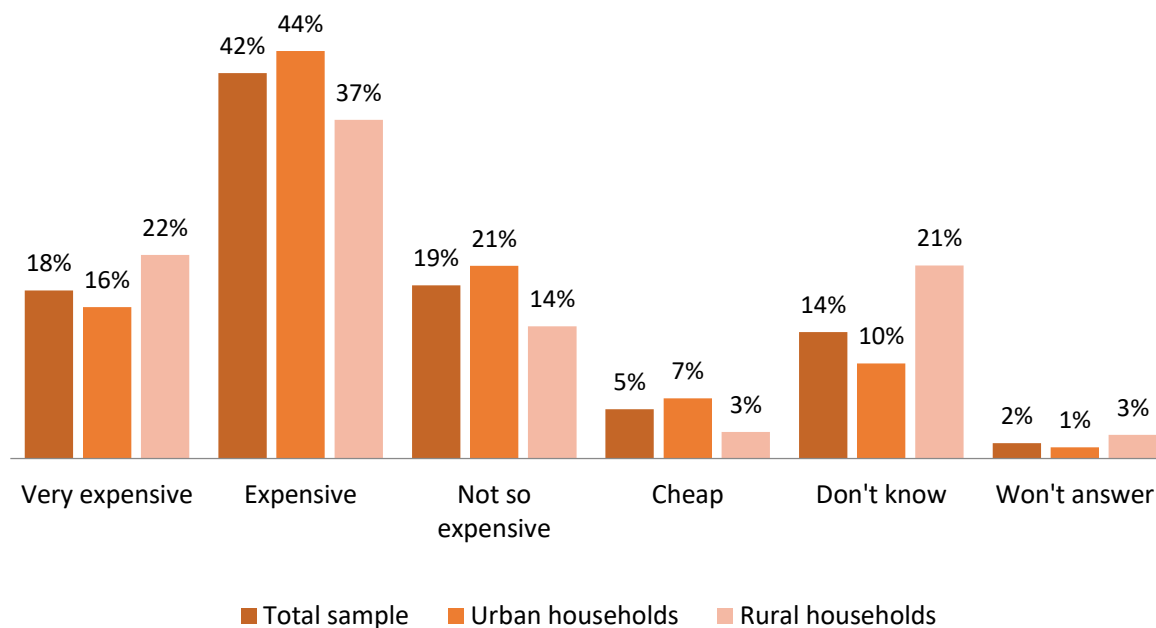


Figure 65. Perception of availability of LPG
(% of users and non-users, GLPGP-Dalberg survey 2018, N=1081)

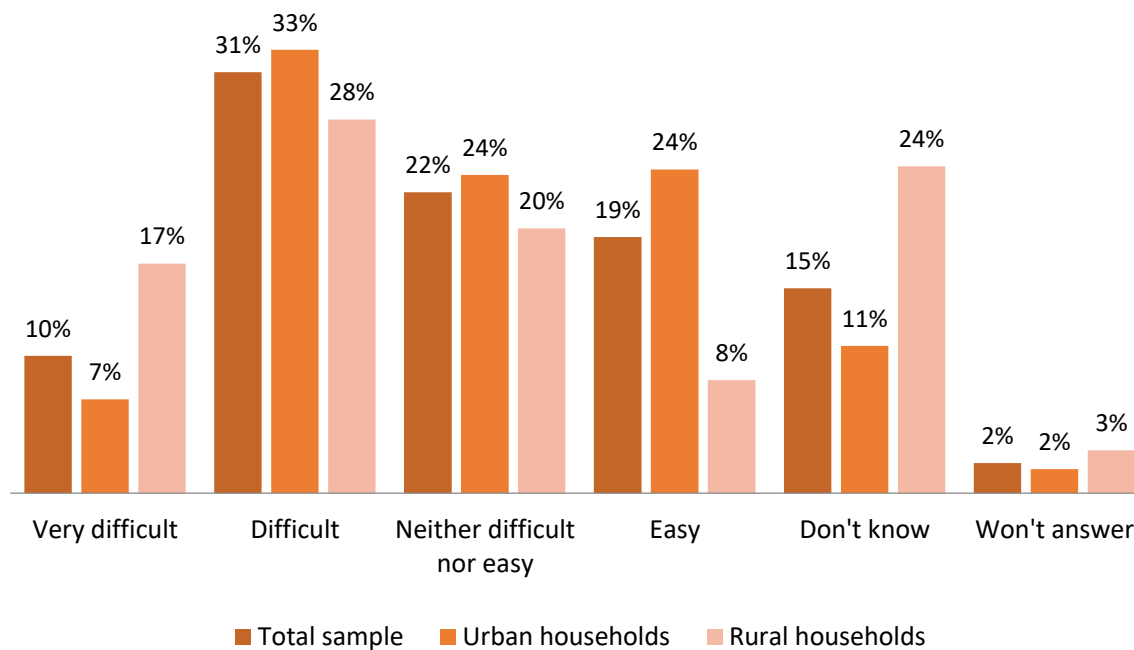
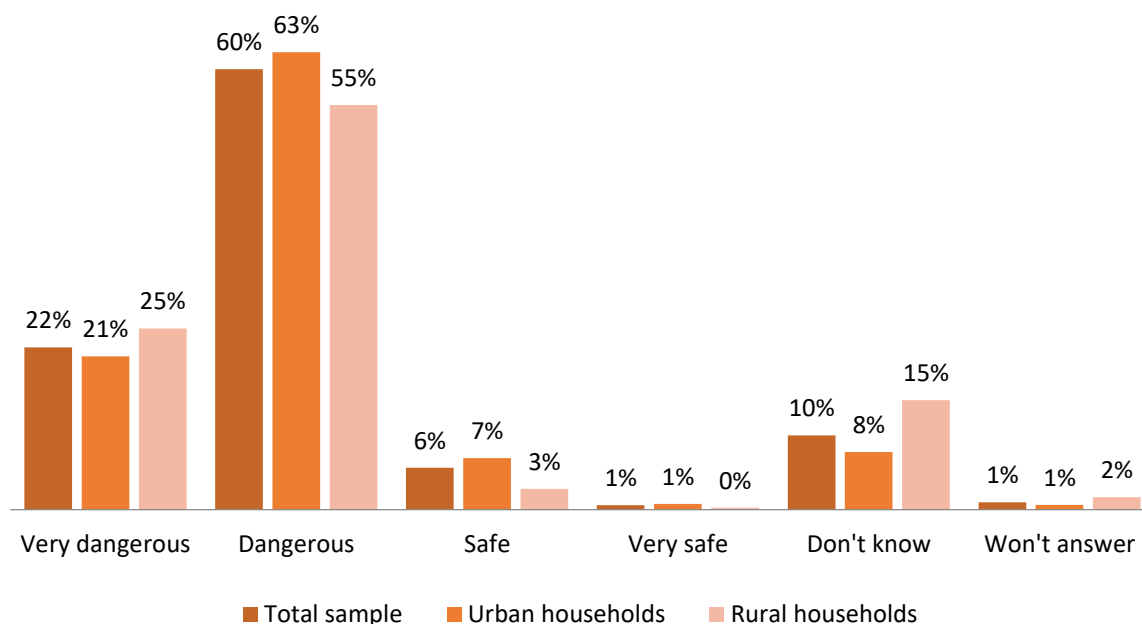


Figure 66. Perception of safety of using LPG for cooking
(% of users and non-users, GLPGP-Dalberg survey 2018, N=1081)



Barriers to LPG adoption among non-users

The survey posed questions to non-LPG users about critical barriers to LPG adoption and aspirations to use LPG in the future. 61% of non-users expressed interest in using LPG in the future. 30% of this group expressed desire to start using LPG within one year, with 17% stating they may do so within the next two to four months. Improved cooking speed, cost savings, convenience and aspiration were the most cited primary reasons for wanting to use LPG.

Table 65. Barriers to LPG use and aspirations for future use in non-users of LPG
(stratified by urban, peri-urban and rural communities; GLPGP-Dalberg Survey 2018, N=1081)

Characteristic	Total sample (n=492; 100%)		Urban (n=111; 36.5%)		Peri-urban (n=164; 31.4%)		Rural (n=217; 32.1%)		p-value
	No	%	No	%	No	%	No	%	
Would like to use in the future	300	61.0%	76	68.5%	110	67.1%	114	52.5%	p=0.003
When in the future?									
In the next 2-4 months	51	17.0%	17	22.4%	22	20.0%	12	10.5%	p=0.059
Within one year	39	13.0%	12	15.8%	12	10.9%	15	13.2%	
More than a year	38	12.7%	9	11.8%	19	17.3%	10	8.8%	
Don't know	172	57.3%	38	50.0%	57	51.8%	77	67.5%	
First reason reported to use in the future									
Easy to cook	57	11.60%	10	9.00%	25	15.20%	22	10.10%	p=0.065
Cost save/ cheaper	62	12.60%	9	8.10%	15	9.10%	38	17.50%	
Convenience/ pleasure	48	9.80%	13	11.70%	14	8.50%	21	9.70%	
Cooking speed	64	13.00%	14	12.60%	25	15.20%	25	11.50%	
Cleaner/ advanced fuel	45	9.10%	10	9.00%	16	9.80%	19	8.80%	
Avoid smoke	4	0.80%	0	0.00%	1	0.60%	3	1.40%	
Save gathering/ wood scarcity	8	1.60%	1	0.90%	3	1.80%	4	1.80%	

Characteristic	Total sample (n=492; 100%)		Urban (n=111; 36.5%)		Peri-urban (n=164; 31.4%)		Rural (n=217; 32.1%)		p-value
	No	%	No	%	No	%	No	%	
Aspirational	51	10.40%	16	14.40%	19	11.60%	16	7.40%	
None	122	24.80%	30	27.00%	37	22.60%	55	25.30%	
Given/offered to me	7	1.40%	4	3.60%	3	1.80%	0	0.00%	
Safety measures observed	14	2.80%	4	3.60%	5	3.00%	5	2.30%	
Not interested	8	1.60%	0	0.00%	1	0.60%	7	3.20%	

28. Demand Analysis Detailed Methodology

Potential baseline and future demand for LPG – Propensity Score Matching Method

The analysis modelled the probability of households switching to LPG if there is no LPG availability constraint for urban and rural non-remote households. The study followed a two-step approach using a tailored Propensity Score Matching method.

1. Segment households according to their perception of LPG availability, to identify which households may switch under conditions of expanded LPG availability. Dalberg segmented the households in the sample in two: households in areas with limited or no LPG availability (Group A) and households in areas with LPG availability (Group B). Dalberg defined availability according to a household's reported perception of LPG availability. The study considered LPG to be available if a household reported LPG as being okay or easy to obtain and considered LPG to be unavailable if a household reported LPG as being very difficult or difficult to obtain. The study got the following number of households for each segment¹⁹¹:
 - a. Group A: 2 million households (59% of households) with no LPG availability
 - b. Group B: 1.4 million households (41% of households) with LPG availability
2. Determine the probability of being an LPG user for households with LPG availability (Group B).
 - a. The study assumed that households in Group B can reveal preferences of households in Group A when LPG is available. The study applied this understanding of preferences to equivalent households in Group A to identify which households are likely to switch under expanded availability. The study assumed that only households in Group A are likely to switch under expanded availability as households in Group B already have LPG availability.
 - b. Dalberg ran a logit regression model for households in Group B using household income, age and education level (secondary or above) of respondents if they were decision-makers on fuel purchase, and whether or not a household was in an urban area or rural area. The results of the regression model are displayed in the figure below.

¹⁹¹ Includes urban households and rural (non-remote households only)

Figure 67. Stata output for Logit regression for households in Group B

```

Logistic regression                               Number of obs   =       367
                                                    LR chi2(4)      =       27.16
                                                    Prob > chi2     =       0.0000
Log likelihood = -197.33509                       Pseudo R2      =       0.0644

```

LPG_user	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
HH_income	.852281	.2912558	2.93	0.003	.2814301	1.423132
age_HH	.0276625	.0133007	2.08	0.038	.0015937	.0537314
urban	.7538861	.2911802	2.59	0.010	.1831834	1.324589
hassecondary	.6805799	.3507089	1.94	0.052	-.0067969	1.367957
_cons	-1.230638	.6061016	-2.03	0.042	-2.418576	-.0427011

- c. The coefficients outlined above were used to calculate the probability of a household using LPG for households in Group B, using a standard logit regression probability methodology, as shown by the following two equations:

$$L = \beta_c + \sum_{i=1}^n \beta_i X_i \quad (1)$$

$$P(s) = \frac{1}{1 + e^{-L}} \quad (2)$$

In equation 1, β represents the coefficients, where the subscript (C) represents the constant, and (i) represents each of four variables considered. $X(i)$ represents the independent variables. The output of equation 1 was then used to obtain the probability of switching in equation 2, through an anti-log equation.

- d. The study used the probabilities calculated for households in Group B (as shown above) to allocate households within Group B into quintiles. Dalberg calculated the proportion of LPG users per quintile in Group B.

Table 66. Probability of using LPG for Group B

Decile	Number of households	Number of households using LPG	Percent of households using LPG
5 (Probability >0.8)	364,599	301,737	83%
4 (Probability >0.6 and <0.8)	628,619	468,321	75%
3 (Probability >0.4 and <0.6)	248,305	163,441	66%
2 (Probability >0.2 and <0.4)	160,298	113,151	71%
1 (Probability <0.2)	-	-	0%

3. Determine the number of households that may switch under conditions of expanded availability for households with no LPG availability (Group A)
- a. The study assumed that the same consumer behaviour that drives LPG usage in Group B, drives usage in Group A as well. Therefore, Dalberg used the regression coefficients from Group B to calculate the probability of using LPG in Group A. These coefficients were used to calculate the probability that a household in Group A will use LPG if it was available. The study inferred the

distribution of households in Group A (across the quintiles) from the distribution of households in Group B.

Table 67. Probability of using LPG for Group A

Decile	Number of households	Number of households using LPG	% households using LPG (as in Group B)
5 (Probability >0.8)	348,884	289,165	83%
4 (Probability >0.6 and <0.8)	748,057	556,328	75%
3 (Probability >0.4 and <0.6)	534,326	352,027	66%
2 (Probability >0.2 and <0.4)	364,599	254,591	71%
1 (Probability <0.2)	-	-	0%

Seven assumptions were tested for the logit regression:

1. *One dependent variable is nominal.* This is true, as a household either does or does not using LPG.
2. *One or more independent variables are either continuous or nominal.* This is true, as education level of respondent is nominal, and age of respondent is continuous.
3. *Observations are independent, and independent variables are mutually exclusive and exhaustive.* This is true, as there are no relationships between the observations in each category (as they are separate households), and each variable is independent.
4. *There is a minimum of 50 cases per independent variable.* This is true, as there are 367 observations per variable.
5. *There is a linear relationship between the continuous independent variables and the logit transformation of the dependent variable.* This was observed through the Box-Tidwell test, as seen in the figure below:

Figure 68. Stata output for the Box-Tidwell test to analyze assumption 5 for logit regression

```

Logistic regression                                Number of obs   =       367
                                                    LR chi2(5)      =       27.36
                                                    Prob > chi2     =       0.0000
Log likelihood = -197.23442                       Pseudo R2      =       0.0649
  
```

LPG_user	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]
HH_income	.8444347	.2918183	2.89	0.004	.2724814 1.416388
age_HH	.16834	.3118348	0.54	0.589	-.442845 .7795249
ln_age	-.0308874	.0683623	-0.45	0.651	-.164875 .1031002
urban	.7479975	.2914294	2.57	0.010	.1768064 1.319189
hassecondary	.665733	.3522231	1.89	0.059	-.0246116 1.356078
_cons	-2.23638	2.311483	-0.97	0.333	-6.766804 2.294044

The log age variable is a product of the natural logarithms of the continuous variable age and the variable itself. It can be seen that the continuous independent variable is not linearly related to the logit of the dependent variable (it has failed the assumption of linearity). This proves the assumption.

6. *There should be no multicollinearity.* This can be seen through the variance inflation factor (VIF). A VIF of greater than 10 is often considered to indicate multicollinearity (or a tolerance of less than 0.1). As can be seen in the figure below, this is not true for the variables considered, validating the assumption.

Figure 69. Stata output for the VIF test to analyze assumption 6 for the logit regression

Variable	VIF	1/VIF
age_HH	4.96	0.201726
urban	4.78	0.209039
hassecondary	4.60	0.217343
HH_income	1.57	0.637871
Mean VIF	3.98	

Impact of changing fuel prices on the quantity of LPG consumed by LPG using households

Impact of changes in relative price of LPG versus other commonly used fuels was modelled for households currently using LPG but that are stacking with other fuels using GLPGP-Dalberg Household Survey data. OLS regression analysis was used to determine the impact of changes in the relative price of LPG to the prices of charcoal, firewood and kerosene. The analysis was run separately for households that stack LPG with charcoal, those that stack LPG with firewood, and those that stack LPG with kerosene. There are instances where the same household stacks with more than one of these fuels, but we did not consider this as it represents a very small portion of the households.

Table 68. Summary statistics for fuel prices derived from the household survey (CFA, GLPGP-Dalberg Survey 2018, N=1,081)

Fuel	Average price	Std. deviation	Minimum price	Maximum price
LPG (per kg)	CFA 536	30	417	760
Kerosene (per litre)	403	78	150	833
Charcoal (per kg)	143	267	1.4	2,500
Firewood (per kg)	85	333	0.03	4,444

The analysis showed that the price of LPG relative to the price of other fuels (charcoal, firewood, kerosene) has no statistically significant correlation to the quantity of LPG consumed by a household. It is probable that these statistically insignificant results are due to the limitations in the self-reporting price data by households as well as a limited number of households that stack LPG with the other fuels (given the limited sample size). Additionally, if the future relative prices of kerosene, charcoal, and firewood change, it is very likely to affect the amount of LPG consumed. Given the limitations of the data—in particular the large standard deviation in price data—it was not possible to estimate reliably the impact of changes in fuel price on the level of LPG consumed.

Figure 70. OLS regression on price of LPG vs. the price of kerosene and LPG consumption for households currently consuming LPG

Source	SS	df	MS	Number of obs	=	55
Model	1.51688211	8	.189610263	F(8, 46)	=	0.50
Residual	17.4580041	46	.379521827	Prob > F	=	0.8501
				R-squared	=	0.0799
				Adj R-squared	=	-0.0801
Total	18.9748862	54	.351386781	Root MSE	=	.61605

ln_LPGquantity	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
relative_ker	-.0932443	.2140922	-0.44	0.665	-.5241896 .337701
LPG_avail	.0784873	.1732158	0.45	0.653	-.270178 .4271525
income_100k	.0397751	.1935698	0.21	0.838	-.3498607 .429411
income_200k	0	(omitted)			
income_200kplus	.2086685	.2715838	0.77	0.446	-.3380012 .7553383
HH_size	.0317864	.033133	0.96	0.342	-.0349068 .0984796
age_HH	.0055839	.0088804	0.63	0.533	-.0122915 .0234592
female_HH	.0754713	.219453	0.34	0.732	-.3662646 .5172072
hassecondary	.0367251	.2361805	0.16	0.877	-.4386817 .5121319
_cons	4.017346	.4826205	8.32	0.000	3.045881 4.98881

Figure 71. OLS regression on price of LPG vs. price of charcoal and LPG consumption for households currently consuming LPG

Source	SS	df	MS	Number of obs	=	174
Model	10.4679064	8	1.30848831	F(8, 165)	=	4.64
Residual	46.5292163	165	.281995251	Prob > F	=	0.0000
				R-squared	=	0.1837
				Adj R-squared	=	0.1441
Total	56.9971228	173	.329463137	Root MSE	=	.53103

ln_LPGquantity	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
relative_char	.0016876	.0019886	0.85	0.397	-.0022387 .0056139
LPG_avail	.0363377	.0835091	0.44	0.664	-.1285464 .2012218
income_100k	.0589334	.0943714	0.62	0.533	-.1273977 .2452646
income_200k	0	(omitted)			
income_200kplus	.0013977	.1183349	0.01	0.991	-.2322481 .2350435
HH_size	.0718818	.0189052	3.80	0.000	.0345545 .1092091
age_HH	.0073206	.0039249	1.87	0.064	-.0004289 .01507
female_HH	-.1485474	.1221189	-1.22	0.226	-.3896645 .0925696
hassecondary	.5212658	.1519719	3.43	0.001	.2212055 .8213261
_cons	3.540581	.2865484	12.36	0.000	2.974807 4.106355

Figure 72. OLS regression on price of LPG vs. price of firewood and LPG consumption for households currently consuming LPG

Source	SS	df	MS	Number of obs	=	210
Model	8.19667147	8	1.02458393	F(8, 201)	=	2.36
Residual	87.1034567	201	.433350531	Prob > F	=	0.0188
				R-squared	=	0.0860
				Adj R-squared	=	0.0496
Total	95.3001282	209	.455981475	Root MSE	=	.65829

ln_LPGquantity	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
relative_wood	.0000556	.0000433	1.28	0.201	-.0000299 .000141
LPG_avail	-.1355791	.0940435	-1.44	0.151	-.3210176 .0498594
income_100k	-.1484097	.1020366	-1.45	0.147	-.3496091 .0527898
income_200k	0	(omitted)			
income_200kplus	.0634248	.1555272	0.41	0.684	-.2432494 .370099
HH_size	.0298866	.0185464	1.61	0.109	-.0066839 .0664571
age_HH	.0057918	.0041675	1.39	0.166	-.0024258 .0140094
female_HH	-.2429984	.1217528	-2.00	0.047	-.483075 -.0029219
hassecondary	.2464574	.1309048	1.88	0.061	-.0116655 .5045803
_cons	4.105918	.2574762	15.95	0.000	3.598217 4.613619

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29. Impact Assessment Calculations and Methodology

Environment and climate assessment

Averted deforestation

Averted deforestation was calculated as the difference between the number of trees used per year before and after households begin using LPG as their primary fuel (i.e. the difference between the baseline and a scenario). This was calculated as the sum of the number of trees necessary for firewood use and the number of trees necessary for charcoal use.

The equivalent number of trees for firewood use and charcoal use was calculated using the equations below.

$$\begin{aligned} \text{Trees}(\text{Firewood}) &= (\text{Forest non renewability}) \left(\frac{\text{Firewood consumption}}{\text{Mass per tree}} \right) & (1) \\ &= (82\%) \left(\frac{\text{Firewood consumption}}{100 \text{ kg/tree}} \right) \end{aligned}$$

$$\begin{aligned} \text{Trees}(\text{Charcoal}) &= (\text{Forest non renewability})(\text{Ratio charcoal: wood}) \left(\frac{\text{Charcoal consumption}}{\text{Mass per tree}} \right) & (2) \\ &= (82\%)(7) \left(\frac{\text{Charcoal consumption}}{100 \text{ kg/tree}} \right) \end{aligned}$$

The forest non-renewability factor indicates what proportion of wood for fuel was unsustainably harvested.

Carbon emissions

The mass method considers the grams of particles per kilograms of fuel and stove.

In this method, the following equation was used to calculate the metric tonnes of carbon emissions per household.

$$\begin{aligned} \text{CO}_2(\text{eq}) &= 10^{-6} \left[\frac{\text{Fuel consumption}}{\text{Number of households}} \right] [(\text{CO}_2 \text{ emissions factor})(\text{Non renewability}) & (3) \\ &+ (\text{N}_2\text{O emissions factor})(\text{GWPN}_2\text{O}) + (\text{CH}_4 \text{ emissions factor})(\text{GWPC}_{\text{H}_4})] \end{aligned}$$

The emissions factors used vary depending on both fuel and stove, and the non-renewability factor was dependent on the fuel used. All values used can be found in the annex. The global warming potential of nitrous oxide and methane was 298 and 25, respectively¹⁹².

The energy method considers the emissions rate of particles as grams per mega-Joule.

In this method, the following equation was used to calculate the metric tonnes of carbon emissions per household.

$$CO_2(eq) = 10^{-6} \left[\frac{\text{Fuel consumption}}{\text{Number of households}} \right] [(CO_2 \text{ emissions rate})(\text{Non renewability}) + (N_2O \text{ emissions rate})(GWPN_2O) + (CH_4 \text{ emissions rate})(GWPC_{H_4})](NCV)(\text{Thermal efficiency}) \quad (4)$$

The net calorific value of the fuel (NCV), thermal efficiency of the stove, and the emissions rates for carbon dioxide, nitrous oxide, and methane can be seen in the annex.

The tonnage differential of black carbon emissions is calculated as the difference between the CO₂-equivalent tonnage emitted in the baseline analysis and both the upper and lower bound scenarios.

$$\text{Black carbon} = 10^{-6} (\text{Fuel consumption}) [BC \text{ emissions factor} - 0.1(OC \text{ emissions factor}) + 0.002(CO \text{ emissions factor}) + 0.006(TNMOC \text{ emissions factor})] \quad (5)$$

The values for the emissions factors can be found in the following chapter in the Annexes.

¹⁹² EPA: "Emissions Factors for Greenhouse Gas Inventories", 2018

30. Impact Assessment Data Sources and Values

Environment and climate data

Table 69. Average stove emissions factors for laboratory or simulated kitchen measurements compiled from various sources (when two values were available, the higher value was used)

Stove type (as in survey)	Emissions factor - CO ₂ (g/kg) ¹⁹³	Emissions factor - CH ₄ (g/kg) ¹⁹³	Emissions factor - N ₂ O (g/kg) ¹⁹⁴	CO ₂ emissions rate (g/MJd) ¹⁹³	CH ₄ emissions rate (g/MJd) ¹⁹³	N ₂ O emissions rate (g/MJd) ^{194, 195}	Emissions factor - BC (g/kg)	Emissions factor - OC (g/kg)	Emissions factor - CO (g/kg) ¹⁹³	Emissions factor - TNMOC (g/kg) ¹⁹³
FIREWOOD										
Traditional Stone Fire	1610	8.9	0.28	577	3.4	0.0713	0.70 ¹⁹³ 0.70 ¹⁹⁶	0.44 ¹⁹⁷ 0.41 ¹⁹⁸	52.8	8.5
Improved stove (unvented)	1580	8.8	0.17	398	2.6	0.0391	1.4 ¹⁹³ 1.16 ¹⁹⁵	0.55 ¹⁹⁴ 0.51 ¹⁹³	42.4	9
CHARCOAL										
Ordinary Jiko	2559	6.9	0.16	382	1.2	0.0609	0.24 ¹⁹⁴ 0.22 ¹⁹⁹	1.71 ¹⁹⁴ 4.77 ¹⁹⁹	162.3	10.3
Improved Jiko	2622	6.6	0.24	245	0.8	0.0535	0.20 ¹⁹⁴ 0.19 ¹⁹⁶	1.43 ¹⁹⁴ 2.92 ¹⁹⁷	198.5	8.6
KEROSENE										
Kerosene Stove	3180	0.48	0.08	137	0.02	0.0037	0.10 ¹⁹⁶ 90 ²⁰⁰	0.03 ¹⁹² 0.4 ¹⁹⁸	27.2	0.34
LPG										
Gas Cooker	2532	0.04	0.15	121.025	0.02525	0.006	0.10 ¹⁹⁶ 0.011 ²⁰¹	0.02 ¹⁹⁶ 0.029 ²⁰¹	14.2	3.7

¹⁹³ Edwards et al. (2014). Review 2 in: WHO Indoor Air Quality Guidelines: Household fuel combustion

¹⁹⁴ Mercy Corps Database (2018) with data from IPCC (2001 and 2006)

¹⁹⁵ USAID (2010)

¹⁹⁶ Jeuland (2016)

¹⁹⁷ Obeng et al. (2017)

¹⁹⁸ IEA Bioenergy (2015)

¹⁹⁹ Climate Solutions Consulting (2016)

²⁰⁰ Lam et al. (2012)

²⁰¹ Shen et al. (2018)

Data used for the health analysis

To estimate the health impacts of transitioning from charcoal and firewood to LPG using the HAPIT tool, we used the following set of assumptions for PM_{2.5} exposure data as summarized in Table 70.

Firewood and charcoal exposure data

Due to lack of nationally representative exposure data in Cameroon, the PM_{2.5} concentrations for firewood and charcoal using homes at baseline and in 2030 were derived from Pope et al.'s (2017) systematic review and meta-analysis of real-life effectiveness of cooking interventions on a global scale. The review covers 42 studies (112 estimates) of solid fuel stoves (kitchen concentrations or exposure levels measured in the field, including Cameroon and other Sub-Saharan African countries), with the majority of the studies identified for firewood-burning stoves. The following assumptions were held constant at baseline and in 2030 for each scenario, using typical fuel/stoves combinations for Cameroon (i.e., improved stoves without a chimney):

- Exposures levels for firewood users:
 - 578 ug/m³ for traditional stoves (derived from kitchen concentrations of 780 ug/m³ applying the published conversion factor of 0.742 for women by Smith et al. 2014)
 - 304 ug/m³ for improved stoves without chimney (derived from kitchen concentrations of 410 ug/m³ applying the published conversion factor of 0.742 for women by Smith et al. 2014)
- Exposures levels for charcoal users:
 - 519 ug/m³ for traditional stoves (derived from kitchen concentrations of 700 ug/m³ applying the published conversion factor of 0.742 for women by Smith et al. 2014)
 - 245 ug/m³ for improved stoves without chimney (derived from kitchen concentrations of 340 ug/m³ applying the published conversion factor of 0.742 for women by Smith et al. 2014).

LPG exposure data

Literature review and expert consultation identified six field studies that measure PM_{2.5} exposure data and/or kitchen concentration for LPG using homes in Sub-Saharan Africa at the time of the search (see list below). It is important to note that the list does not represent a systematic review, and as such a review was beyond the scope of this work.

Based on the identified studies, PM_{2.5} personal exposure measured in the field ranges between 14 ug/m³ to 43.9 ug/m³ (average 24.9 ug/m³) with the exception of one study from Sudan. In this study, conducted in the outskirts of Kassala city, kitchen concentration data of the respirable fraction of particulate matter (which includes particulates up to PM 10um, not just PM_{2.5}) was 280 ug/m³ across wet and dry season from baseline average concentrations values of 900 ug/m³ (pre-LPG intervention). 280 ug/m³ corresponds to personal exposure levels of 207.8 ug/m³ applying the published conversion factor of 0.742 for women by Smith et al. 2014. Background levels of ambient air pollution were not measured in the study. Given that there are still relatively few field studies conducted in Sub-Saharan Africa, which carefully document levels

of ambient air pollution and stacking with other fuels/stoves combinations, and that LPG burns with minimal PM_{2.5} formation, the WHO annual average Interim Target 1 (IT-1) (35 ug/m³) was used as a basis for assessing the health impacts of increased primary/ nearly exclusive LPG consumption. Note that the IT-1 accounts for some level of fuel/stove stacking.

Scenarios assumptions

It was beyond the scope of this study to model how firewood and charcoal using households might start using improved firewood and improved charcoal stoves over time (if they did not transition to LPG). The GLPGP-Dalberg survey shows that in 2018, 30% and 0% of urban and rural households using charcoal as a primary fuel used improved cookstoves (ICS), respectively. 2% and 0% of urban and rural firewood using households used ICS, respectively. These figures are consistent with the data cited in the 2016 SEforAll Cameroon report and Cameroun: Note Technique Sure L'Access a L'Electricite et aux Energies Modernes de Cuisson that suggest that, in 2014, 10% of urban and 5% of rural households used ICS (the data are not disaggregated by fuel)²⁰². This corresponds to 7.5% use of ICS in 2014.

Optimistic assumptions of improved access and adoption of improved firewood and charcoal stoves in 2030 were considered as per the SEforALL predictions, in each of the scenarios (see [Table 70](#) for the projected number of households in each scenario). However, the SEforAll report itself notes that these ambitious penetration targets will not be achieved unless Cameroon sets up industrial scale production of improved firewood and charcoal stoves.

- Firewood
 - 2020 – 1% of households using improved stoves
 - 2030 – 80% of households using improved stoves (of the projected % of households under each scenario)
- Charcoal
 - 2020 – 30% of households using improved stoves (of the projected % of households under each scenario)
 - 2030 – 100% of households use improved stoves (of the projected % of households under each scenario)

In addition, as it was not possible to predict how many biomass users will switch to LPG from traditional or improved firewood/charcoal stoves, we assumed an equal split:

- Firewood
 - 2020 – 0% of households that switch to LPG use improved stoves (of the projected % of households under each scenario)
 - 2030 – 50% of households that switch to LPG use improved stoves (of the projected % of households under each scenario)
- Charcoal

²⁰² SE4All (2016); Cameroun: Note Technique Sure L'Access a L'Electricite et aux Energies Modernes de Cuisson.

- 2020 – 50% of households that switch to LPG use improved stoves (of the projected % of households under each scenario)
- 2030 – 50% of households that switch to LPG use improved stoves (of the projected % of households under each scenario)

Table 70. National breakdown of LPG adoption scenarios and stove/fuel use, PM_{2.5} exposure level at 2020 (baseline) with projection to 2030

Fuel and scenarios of LPG adoption	% of households (2020) (projected baseline)	% of households using traditional vs improved stoves in 2020 and PM _{2.5} exposure levels	% of households using the different fuels (primary use) (2030)	% of households using traditional vs improved stoves in 2030 and PM _{2.5} exposure levels
FIREWOOD				
Base case scenario	38.5%	For each scenario, assumed 100% of HH use traditional stoves without chimney PM _{2.5} = 578 ug/m ³ (Pope et al. (2017))	34.0%	For each scenario, assumed 25% of HH use improved stoves PM _{2.5} = 304.2 ug/m ³ 75% of HH use traditional stoves without chimney = 578 ug/m ³ (Pope et al. (2017))
Expanded availability scenario	35.8%		31.5%	
CHARCOAL				
Base case scenario	28.8%	For each scenario, assumed 35% of HH use improved stoves PM _{2.5} = 244.8 ug/m ³ 65% of HH use traditional stoves PM _{2.5} = 519.4 ug/m ³ (Pope et al. (2017))	24.2%	For each scenario, assumed 80% of HH use improved stoves PM _{2.5} = 244.8 ug/m ³ 20% of HH use traditional stoves PM _{2.5} = 519.4 ug/m ³ (Pope et al. (2017))
Expanded availability scenario	22.0%		15.0%	
LPG				
Base case scenario	27.6%	For each scenario, assumed use of standard LPG burner PM _{2.5} = 35 ug/m ³ (WHO IT-1)	36.6%	For each scenario, assumed use of standard LPG burner PM _{2.5} = 35 ug/m ³ (WHO IT-1)
Expanded availability scenario	37.0%		46.2%	

Identified studies measuring LPG exposure or kitchen concentration, conducted in Sub-Saharan Africa

Study No.	1
Study Name	Bruce, et al. (2018). "The Government-led initiative for LPG scale-up in Cameroon: Program development and initial evaluation". Energy for Sus. Dev. 46:103-110
Country/setting	Cameroon, Southwest region (peri-urban and rural)
Kitchen or personal exposure	Both kitchen and personal exposure measurements
Measurement duration	48 hours
Sample size	Total sample for both kitchen and women: exclusive wood fuel (n=61) and primary LPG fuel (n=67). Children (n=60)
Methodology	This study reports some of the findings from the LPG Adoption in Cameroon Evaluation (LACE-1), which include PM _{2.5} exposure measurements in different fuel users groups: wood (exclusive use) and LPG (primary use) for kitchen, women, and children. RTI MicroPEMs were used
Evidence of stacking/ community level exposures	LPG used in combination with other fuels (stacking) for some cooking tasks
PM2.5 exposure measurements ± standard deviations (where available)	Personal: LPG users: 14 ug/m ³ Kitchen: LPG users 21.1 ug/m ³ Children exposure data not included in the publication
Study No.	2
Study Name	Bates, et al. (2005). "Smoke, health and household energy Volume 1. Participatory methods for design, installation, monitoring and assessment of smoke alleviation technologies". Final Technical Report.

Country/setting	Sudan, Kassala outskirts (peri-urban) (Nepal and Kenya – not relevant for LPG kitchen concentrations data)
Kitchen or personal exposure	Kitchen concentrations
Measurement duration	24 hours
Sample size	Total of 30 households
Methodology	Levels of carbon monoxide (CO) and particulates (PM respirable fraction, including particulates up to PM 10µm particle size) were measured four times for each household that was offered the LPG intervention (before and after invention). Kitchen concentrations values (24 Hr PMresp Mean) were reported as 1180 ug/m ³
Evidence of stacking/ community level exposures	By the last measurement in round 4, there is an almost complete switch to LPG. Ambient air pollution
PM2.5 exposure measurements ± standard deviations (where available)	Kitchen concentrations (for PM resp): 250 ug/m ³ weighted mean across wet and dry season Converted to personal exposure using the published conversion factor for women (0.742 from Smith et al. 2014): 185 ug/m ³
Study No.	3
Study Name	Delapena, S., et al. (2018). “Using personal exposure measurements of particulate matter to estimate health impacts associated with cooking in peri-Urban Accra, Ghana”. Energy for Sus Dev. 45:190-197
Country/setting	Ghana, peri-urban Accra
Kitchen or personal exposure	Personal
Measurement duration	48 hours

Sample size	Total sample size of 45 households, with: (i) LPG only group (n=7), (ii) LPG and charcoal (n=18), charcoal only (n=11), wood only (n=9)
Methodology	This study assessed personal exposure for four fuel user groups: LPG-only, LPG and charcoal, charcoal only, and wood use alone or in combination with any other fuel. Over the duration of the monitoring period, the study conducted three consecutive daily household visits to measure: continuous measurements of personal exposure to PM _{2.5} using gravimetric equipment (UPAS); real-time measurements of personal exposure to PM _{2.5} collected using light scattering monitors (only for 50% of households), and stove usage of the two most commonly used stoves
Evidence of stacking/ community level exposures	Ambient air pollution recognized as a factor driving the majority of PM _{2.5} exposures in LPG and charcoal using homes. Measurements taken in fuel stacking homes
PM2.5 exposure measurements ± standard deviations (where available)	Personal exposure for LPG only using households: 24 ± 13 ug/m ³ LPG and charcoal: 31 ± 44 ug/m ³ Charcoal only: 30 ± 24 ug/m ³ Wood only: 79 ± 46 ug/m ³
Study No.	4
Study Name	Kanyiva, et al. (2016). "Household Air Pollution: Sources and Exposure Levels to Fine Particulate Matter in Nairobi Slums" <i>Toxics</i> . Jul 13;4(3)
Country/setting	Kenya, Nairobi slums (urban)
Kitchen or personal exposure	Kitchen concentrations
Measurement duration	<24 hr (between 10.4 and 11.8 hours)
Sample size	72 households from two slums in Nairobi; 69.7% of households used kerosene

Methodology	The PM _{2.5} level data was collected using the DustTrak II Model 8532 monitor Measurements were taken during daytime and using sources of household air pollutions
Evidence of stacking/ community level exposures	The report mentions that measurements were taken for LPG households using also electricity. No direct mention that the community level exposure was very high due to ambient air pollution in the urban setting
PM2.5 exposure measurements ± standard deviations (where available)	Kitchen concentrations on LPG/electricity using homes: 59.1 ug/m ³ Converted to personal exposure using the published conversion factor for women (0.742 from Smith et al. 2014): 43.9 ug/m ³
Study No.	5
Study Name	Pope et al. (2018) "The Bottled Gas for Better Life Pilot: An Evaluation of the First Microfinance Initiative in Cameroon to Support Households Switch from Solid Fuel to LPG for Cooking". 2018 Abstract Book. ISEE, Ottawa.
Country/setting	Cameroon, Southwest region (peri-urban)
Kitchen or personal exposure	Both kitchen and personal, before and after the LPG cooking equipment was introduced
Measurement duration	48 hours
Sample size	35 households using firewood at baseline and LPG at follow up (same households)
Methodology	This study assessed the impacts on exposure of a microfinance scheme (paid back over 6 months) for LPG start-up equipment (stove, equipment and gas; US\$95). A subsample (n=35) of the total households who took up the loan (n=150) took part in exposure measurements at two data points: (i) before they start cooking on LPG, (ii) and around 6 months after they received their equipment through the microloan. RTI microPEMs used
Evidence of stacking/ community level exposures	Households used LPG as primary fuel after they bought the LPG equipment (no exclusivity of use)

PM2.5 exposure measurements \pm standard deviations (where available)	LPG users: $14 \pm 3 \text{ ug/m}^3$ Personal: Before LPG intervention (wood) = 73.8 ug/m^3 ; after LPG intervention = 28.6 ug/m^3 Kitchen: Before LPG intervention = 337.9 ug/m^3 ; after LPG intervention = 32.3 ug/m^3
Study No.	6
Study Name	Titcombe, et al. (2011). "Personal and indoor exposure to PM2.5 and polycyclic aromatic hydrocarbons in the southern highlands of Tanzania: a pilot-scale study". Environmental Monitor and Assess., 180:461-476
Country/setting	Tanzania, Njombe district (rural)
Kitchen or personal exposure	Personal
Measurement duration	24 hours
Sample size	72 households from two slums in Nairobi; 69.7% of households used kerosene Sample size of 3 households for each fuel or fuel mix: LPG, open wood fires, charcoal and charcoal/kerosene
Methodology	Data were collected in Njombe district, where cooking is conducted indoors due to high elevation, cool climate, and heavy seasonal rainfall. Kitchens are often poorly ventilated, resulting in high exposures to combustion-related pollutants. Sampling sites were selected to represent typical cooking practices for different income groups, including stacking with other fuels. Measurements were collected using Personal Microenvironment Aerosol Speciation Samplers (PMASS; MSP Corporation, Model 240 PMASS)
Evidence of stacking/ community level exposures	Discussion on stacking or community level exposures not reported
PM2.5 exposure measurements \pm standard deviations (where available)	LPG users: $14 \pm 3 \text{ ug/m}^3$

31. LPG-Related Laws and Regulations

Law 090/031 of 10 August 1990

Governs business activity in Cameroon

Law 096/12 of 5 August 1996

Legal framework for environmental management

Law 098/015 of 14 July 1998

Establishments classified as dangerous, unhealthy and noxious, and instruments of application

Law 098/020 of 24 December 1998

Governs devices operating under gas and steam pressure

Law 11 099/031 of 22 December 1999

Institutes the national petroleum code

Law 10 0 2012/006 of 19 April 2012

Institutes the national gas code

Decree 0 77/528 of 23 December 1977

Regulates storage and distribution of petroleum products, modified by decrees 092/304/PM of 18 September 1992 and 0 95/135/PM of 3 March 1995

Decree 11 02011/408 and /410 of 9 December 2011

Reorganizes and forms the Government, respectively

Decree f 2012/501 of 7 November 2012

Organizes the Ministry of Water and Energy

Decree 99/818/PM of 9 November 1999

Defines modalities for setting up and operating establishments classified as dangerous, unhealthy or noxious

Decree 02000/935/PM of 13 November 2000

Specifies conditions for downstream petroleum sector activities

Decree 0 2014/3438/PM of 27 October 2014

Defines modalities of application of Decree f 2012/006 of 19 April 2012 to institute the gas code

Decree 0 2005/577/PM of 23 February 2005

Defines modalities to conduct environmental impact assessments

Order 0 006/PM of 12 January 2009

Defines modalities, technical and safety rules relating to the implementation, development and operation of storage depots and Liquefied Petroleum Gas (LPG) filling plants

Order 0016/MINMEE of 13 July 1995

Defines modalities and control procedures for petroleum products

Order 0 009/MINT/DTT of 23 February 1998

Sets regulations governing the transportation of hazardous materials

Order 0 22/MINMEE of 8 September 2001

Specifies certain petroleum sector operating conditions

Joint ministerial order 0 009/MINDIC/MINMEE of 21 February 2002

Enacts propane/butane LPG standard (NC 02 : 2000—08) for the national territory

Order 0 011/MINDIC/CSPH of 30 April 2003

Establishes and sets LPG cylinder deposit rate (at 80% of cost) for the national territory

32. Conditions and Consequences of the CCCM LPG Market Model

In developing country contexts, this model has been shown to create a temporary surge in cylinder inventory and LPG consumption followed eventually by debilitating market dysfunction, the cessation of investment in new LPG cylinders, a rapid decline in cylinder safety, a corresponding rapid increase in fires and explosions, a surge in black market LPG activity, and eventual market stagnation or implosion. At the heart of CCCM is consumer ownership of, and control over, the LPG cylinder. This works well in America and Canada because:

- The consumer is very conscious of liability for cylinder safety, and will accept liability and the responsibility that goes with it;
- The consumer is well educated;
- The consumer has a vehicle and is easily able to transport his/her cylinder for periodic inspection and, when necessary, repair and recertification;
- The consumer is universally willing to pay to replace a damaged, unsafe cylinder that requires scrapping;
- The potential penalties (governmental, from civil lawsuit, and in terms of access to and of insurance) related to an LPG accident for which the consumer bears responsibility are very large, and are very likely to be experienced in practice;
- Corporations and SMEs in the U.S. and Canadian LPG sector are likewise very conscious of liability, and they are almost always unwilling to take non-compliant actions or to make non-compliant omissions in their activities, whether for the purpose of satisfying a consumer who does not want to pay to replace his/her unsafe cylinder, or for the purpose of avoiding business costs related to required safety practices;
- Corporations and SMEs are also conscious of, and comply with, generally strong and well-enforced consumer protection laws and competition laws that prohibit bad and unethical business practices;
- Corporations and SMEs are conscious of, and comply with, strict and well-enforced licensing requirements. One will almost never find an unlicensed or uncertified LPG business operating in the U.S. and Canada, or a licensed operator acting in intentional violation of its license terms.

Most developing countries do not have the above preconditions for success with CCCM.

The cost of regulation under CCCM model is high, because hundreds (as in Ghana) or thousands (in America) of points of LPG cylinder refilling and exchange must be monitored for compliance.

When tried for the first time in a market where cylinders were previously not consumer-owned and controlled, CCCM has been shown to unlock pent-up demand for the first few years, but the seeds of the LPG market's stagnation or demise will have been planted.

The following are main reasons why CCCM has not worked over the long term in the other countries that have tried it:

- Consumers will shop around for a refill point that does not require the consumer to replace or repair an unsafe cylinder or valve at the consumer's cost; this "shopping around" favors black marketers, who as a group will disregard safety if it means getting paid to refill a given cylinder vs. not refilling one.
- Consumer control of cylinders makes it very easy for black market operators (who do not spend any resources on cylinder safety) to interpose themselves in the supply chain to take business away from legitimate market players. They do this by locating closer to the consumer than the nearest legitimate player, charging a lower price, and thus stealing profits from the legitimate player who used to serve that customer. This leads to the black marketeers driving out the good players, and unsafe cylinders driving out the good cylinders. This in turn leads to market stagnation, higher infrastructure investment risk, and increasing numbers of safety incidents—including fatalities.
- Without strong institutions to inspect and enforce pro-safety market rules, these factors eventually halt market growth.

Businesses seeking LPG customers in a new geographic area require as a precondition a critical mass of initial customers to have cylinders to be refilled. Consumers in such an area who may wish to become LPG users require as a precondition to purchasing LPG equipment the presence of a reliable and trustworthy supplier who can refill their cylinders. Therefore, there is minimal incentive for either the supplier or the consumer to start the process of buying and selling.

33. Note Regarding LPG Accounting Treatments

In the presentation of financial models for the LPG sector and firms operating in the LPG sector, for sake of both conservatism and simplification, the following two financial statement/cashflow items have been omitted, with certain implications:

1. *LPG passthrough costs and arbitrage.* The financial performance of an LPG company, by industry convention, does not typically consider the asset value of the LPG fuel which it acquires and sells. In this report, the portion of turnover (revenue) and the cost of goods sold (COGS) associated with the LPG commodity itself are treated as equivalent and are disregarded. In Cameroon, because LPG costs and prices are fixed by regulation, and because CSPH hides the subsidy from the LPG companies, there is certainty about these two income statement items. That is, the LPG company creates gross profit from the unit margins applicable to its LPG volumes. Accordingly, what is presented in this report as “turnover” (or revenue) is in actuality the aggregate unit margins, and the cost to acquire the LPG commodity is disregarded. While it is possible in principle for an LPG company to “buy low and sell high”, by having sufficient storage to exploit time-based arbitrage, in Cameroon, this is not feasible to exploit given the governmentally-fixed price structure downstream of CSPH.
2. *LPG gain.* LPG gain is an LPG industry term for the small quantity of LPG that remains in returned cylinders when customers return their “empty” cylinders to the cylinder recirculation system. This amount may run to 1-3%. It is normative in the LPG industry that the LPG Marketer does not provide a credit to the consumer for this leftover LPG quantity. This is a practical matter: it is not operationally or economically feasible to measure the leftover quantity accurately and efficiently across thousands of retail cylinder exchange points. Thus, the LPG Marketer gets a small head-start on the refill of every cylinder that passes safety inspection at the filling plant. This head-start is a potentially significant contributor to the profit stream of the Marketer, because it is effectively “free LPG” to the Marketer, the value of which passes directly through to the Marketer’s pretax net income. The notional value of the LPG gain has not been included in the financial modelling presented in this report, in part because it is not practical to assign a specific, reliable value, and in part in order to err on the side of conservative forecasting of firms’ financial performance. Therefore, the financial rate of return generated by an expansion investment in an LPG Marketer will, in practice, be somewhat higher than presented in this report’s financial models, and the cash flow and debt service risk will be slightly lower than suggested by those models.

34. Note Regarding Long-Term LPG Pricing and Availability

LPG pricing trends over spans of 10 years and beyond are not feasible to predict. Historically, global and regional LPG prices tracked directionally with the long-term movements in global and regionally-applicable crude oil price indices. Thus, price spikes of intermediate durations are possible. (The governments of some LPG-using countries protect their populations from such spikes through price-stabilization mechanisms.)

From the 2010s, LPG has increasingly tracked directionally with regional natural gas and LNG prices as natural gas / LNG pricing decoupled from crude oil pricing in international markets.

It should be noted that the LPG market clearing function performed by the petrochemical / plastics sector currently represents approximately 30-35% of total LPG global consumption. This segment is the most price-sensitive of all consuming segments. Therefore, petrochemicals/plastics consumption may provide a buffer that insulates LPG pricing to some degree from the other consuming sectors (residential, industrial, etc.), if global LPG supply tightens toward, and after, 2030.

This document assumes that LPG source pricing applicable to Cameroon will remain relatively stable toward and through 2030. To estimate the effect of significant LPG price change on adoption and consumption on an absolute basis, a sensitivity analysis has been included in the demand and impacts Parts of this report.

Across a 10+ year time scale, it was beyond the practical scope of the study and analysis presented in this report to attempt to assess how relative price changes among LPG and the main Cameroonian cooking energy and technology alternatives might affect adoption and consumption as of 2030 and beyond.

35. About the NIHR CLEAN-AIR (Africa) Global Health Research Group

Goals and outline of main activities

The CLEAN-AIR (Africa) Nation Institute of Health Research Group has four main objectives:

1. Inform strategies to support scaled equitable uptake (and sustained use) of clean fuels across the population;
2. Quantify the impacts of scaled LPG adoption in line with governmental targets on health and climate;
3. Develop capacity through strengthening health systems to address the burden of disease from household air pollution in the partner countries;
4. Facilitate engagement between the general public and policymakers as research is undertaken to maximize the likelihood for success in national policies to scale LPG adoption and use.

Main research and capacity building activities under CLEAN-AIR (Africa) will include:

1. Understanding current fuel use patterns, drivers for fuel choice and associations with health in rural and peri-urban communities (using surveys and qualitative methods),
2. Quantifying concentrations of, and exposure to, household air pollution in households that use LPG and those that do not, to model impacts on both health and climate,
3. Evaluating interventions to assist communities both adopt LPG and use it in a sustained way (for example using microfinance to support purchase of LPG equipment for cooking)
4. Promoting health sector capacity building activities around HAP for health professionals, in collaboration with the World Health Organization (WHO) to inform the Clean Household Energy Solutions Toolkit (CHEST).
5. Using mixed-methods research methods, evaluate the proposed capacity building activities to bring HAP to the health training agenda in order to help practitioners sensitize communities to change their cooking fuels/ practices for prevention.

36. About the Global LPG Partnership

The Global LPG Partnership (GLPGP) is a United Nations (UN)-backed, non-profit Public-Private Partnership formed in 2012, under the UN Sustainable Energy for All initiative, to aggregate and deploy needed global resources to help developing countries transition large populations rapidly and sustainably to liquefied petroleum gas (LPG) for cooking.

GLPGP is evidenced-based and competition-neutral in its work.

GLPGP partners with host country governments at their invitation, and other relevant stakeholders, to create national plans for rapid, sustainable scale-up of LPG infrastructure, distribution and demand. GLPGP then assists with financing and implementation of key plan elements to transition the maximum viable population to LPG for cooking.

Developing countries request GLPGP's assistance to achieve the three main prerequisites for making LPG widely available and affordable:

- Plan and implement enhancements to government policies, regulations and regulatory enforcement to create the enabling environment for a viable, scalable, sustainable LPG sector;
- Provide knowledge and expansion capital to achieve critical mass of LPG supply, infrastructure and distribution systems quickly and sustainably; and
- Empower consumers, who can otherwise afford LPG fuel, to pay the upfront cost of appliances to use LPG and thereby unlock additional demand.

More information is available at www.glpgp.org.

37. Disclaimer and Safe-Harbor Statement

This document is not an investment prospectus nor a solicitation to buy or sell securities.

Certain portions of this document contain forward-looking statements that are based on expectations, estimates, projections and assumptions. Words such as “expect,” “anticipate,” “plan,” “believe,” “scheduled,” “estimate” and variations of these words and similar expressions are intended to identify forward-looking statements, which include, but are not limited to, projections of supply, demand, consumption, prices, policies, regulations, investment activity, economic and financial performance, business performance, cash flows, contracts and tenders, and other projections. These statements are not guarantees of future performance with respect to the parties associated with, or referred to in, such statements. These statements involve certain risks and uncertainties, which are difficult to predict. Therefore, actual future results and trends may differ materially from what is forecast in forward-looking statements due to a variety of factors, which include, but are not limited to, changes in (i) government policies and regulations, (ii) pricing, (iii) business strategies, (iv) the national and/or global economy, (v) exchange rates, (vi) project costs, (vii) consumer demand or preferences for energy products and services, (viii) competition conditions, (ix) market structures, (x) outcomes of litigations, (xi) outcomes of political and legislative processes, and others.

All forward-looking statements speak only as of the date shown on the front page of this document, or, in the case of any document incorporated by reference, the date of that document. The Clean Cooking for African Project and GLPGP do not undertake any obligation to update or publicly release any revisions to forward-looking statements to reflect events, circumstances or changes in expectations after the date of this report.