

The Global LPG Partnership

KfW

The European Union



Clean Cooking for Africa Program

LPG for Clean Cooking in Ghana: Investment and Implementation

Prepared by the Global LPG Partnership

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Household cooking smoke in Ghana:
Before and after switching from biomass to LPG

Photo credit: XpressGas Ghana

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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
BoG	Bank of Ghana
BOST	Bulk Oil Storage and Transport Company
BP	LPG Bottling Plant (also referred to as LBP)
CCA	Clean Cooking Alliance (formerly, the Global Alliance for Clean Cookstoves)
CCCM	Consumer-Controlled Cylinder Model
CDM	Clean Development Mechanism
CO	Carbon Monoxide
CO ₂	Carbon Dioxide
CRM	Cylinder Recirculation Model Term of national policy used in Ghana to refer to Ghana's instance of the BCRM
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
GCMC	Ghana Cylinder Manufacturing Company
GGC	Ghana Gas Company
GHACCO	Ghana Alliance for Clean Cookstoves
GHC	Ghana Cedis
GHG	Greenhouse Gases
GIPC	Ghana Investment Promotion Centre
GLSS [6–7]	Ghana Living Standard Survey 6 or 7
GOIL	Ghana Oil Company

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

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
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
LMICs	Low and Middle Income Countries
LBDC	LPG Bulk Distribution Company (also referred to as BDC)
LMC or LPGMC	LPG Marketing Company
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
LPGBC	LPG Bottling Company A new category of supply chain participant for 2019 under BCRM, owning/operating a regional bottling (cylinder filling) plant
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
MoE	Ministry of Energy and Petroleum
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
NPA	National Petroleum Authority Ghana Government agency responsible for implementing Ghana's LPG policy and regulating the LPG sector
OC	Organic Carbon
OMC	Oil Marketing Company
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
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
TA	Technical assistance
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



Cooking smoke-free on a basic
LPG burner and cylinder

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 Ghana, Cameroon 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, discusses the main LPG investment projects for scaling up LPG as a major clean cooking energy solution for Ghana through 2030 from a finance provider and implementer perspective.

Companion report

A companion report, the *National Feasibility Study: LPG for Clean Cooking in Ghana*² (Feasibility Study), examines the overall ecosystem in which the essential investment projects required for scale-up of LPG consumption, supply, infrastructure and distribution will occur. This report presumes the reader is familiar at a high level with the Feasibility Study report.

Beyond 2030

The Clean Cooking for Africa Program limits its time horizon to 2030, on the twin premise that the LPG clean cooking solution is likely to be transitional and that funders of the major LPG projects are likely to require monetization or repayment of their investments or loans (across one or more tranches) by that time.

To the extent LPG delivers on its potential for scaling and for socio-economic, environmental and climate benefit through 2030, as presented in the Feasibility Study, then LPG will be at a minimum an effective transitional solution until a fully renewable, clean, modern and effective cooking-energy solution emerges over the next decade and beyond. 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 extend well past 2030.

² GLPGP (2018)

II. Executive Summary

Overview

The LPG sector in Ghana is in the midst of major, Government-driven reform intended to make LPG significantly safer to handle and use, significantly more accessible and available to consumers, and significantly more bankable. This report and the companion Feasibility Study were developed during the planning process of this reform, which commenced in October 2017 and is anticipated to conclude by late 2019, with initial investment projects launched under a reformed national LPG ecosystem in at least one pilot province by the end of 2019 or in early 2020.

The Government of Ghana has set a policy goal of 50% of the population using LPG as their main cooking fuel, and for other uses, by 2030. The main reasons are to reduce pressure on Ghana'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 Ghana's people and accelerate Ghana's development.

Today, approximately 24.5% of Ghana's population uses LPG as its main cooking fuel.

Independent of the Government's policy goal for LPG use, the findings of the Feasibility Study indicate that unmet demand exists, and additional demand could be stimulated to exist by 2030, corresponding to 44% (low case) to 55% (high case) of the population using LPG by 2030.

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 tranches and key derisking actions and gating conditions are as follows:

Tranche	Time period	Major required derisking actions / gating conditions to proceed
1	2019-2022	<ul style="list-style-type: none"> Government implements the Branded Cylinder Recirculation Model (BCRM) and updates the corresponding pricing structure approximately as described in the Feasibility Study, applicable to at least those regions where investments will be made during Tranche 1
2	2023-2026	<ul style="list-style-type: none"> Acceptable results from Tranche 1 BCRM rolled out to remaining regions If demand does not develop at the rate expected during Tranche 1, one or both of (i) scale reduction of Tranches 2 and 3 and/or (ii) implementation of demand-incentivizing measures
3	2027-2030	<ul style="list-style-type: none"> Acceptable results from Tranche 2 Continuation of derisking actions and gating conditions from Tranche 2 If demand growth slows materially toward the end of Tranche 2, reduction in scale of Tranche 3 and/or increase in demand-incentivizing measures

Each tranche could be considered a standalone portfolio of linked projects. All Tranches reflect the risk associated with transition from the Consumer Controlled Cylinder Model (CCCM) to BCRM that does not go smoothly in practice, is delayed, or results in only a partial or piece-meal implementation of BCRM. Tranche one represents the highest risk, because it is connected directly with the transition and its projects will co-exist, as geographical neighbors, with regions still operating under CCCM for a period of time. Tranche two is the lowest risk: it involves the roll-out of BCRM to the rest of the country after whatever tranche one challenges that may arise have been resolved, and the measured national expansion of the LPG value chain. Tranche three is of intermediate risk, balancing the benefits of a presumably stable and effective national BCRM against the risk that tranche three demand, as viewed from the present day, is less certain to exist or be stimulated to exist at the projected levels compared with the earlier tranches.

During tranches two and three, the risk of governmental enforcement may become more important, and the level of that risk should be reassessed at the time.

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 such programs are described later in this report.

To expand and reengineer the supply chain to serve the projected demand effectively and efficiently, an estimated LPG sector investment of € 335 million will be required over ten years. The Ghana financial sector has constraints that will limit its ability to fund all these investments indigenously. International commercial funding sources have expressed guarded interest (or cautious optimism) about co-financing, but are wary of LPG-specific and country-specific risks, which manifest as reluctance to act as lead funders, especially with respect to the largest, most important, and most risky investment category: LPG cylinders.

To crowd in funding from these two groups in greater quanta and, potentially, with less onerous terms, development capital will have an important role to play. This would be both in the form of technical assistance grants that strengthen and facilitate the projects and help mitigate risks, and in the form of investment capital (equity/quasi-equity, loans) that helps attract commercial capital providers to the projects and gives them a greater level of confidence that they can achieve the financial returns they require on the time horizons they require.

In turn, addressing the overlapping but distinct requirements of these different classes of funders determines the options for how the financing for different classes of project may be structured.

Sector strategy

There are two main transitions to be accomplished in Ghana's LPG sector, rapidly and at scale:

1. Investment in a huge new national inventory of branded residential LPG cylinders by Ghana's numerous LPG marketing companies, together with refurbishing or scrapping the existing national inventory of unbranded cylinders;
2. Construction and operation of a network of new, regionally centralized cylinder refilling plants and associated LPG storage across the country's ten regions.

As of this writing there were 81 licensed and active LPG marketing companies in Ghana, operating through approximately 650 small roadside pumping locations. Under the Government's reforms, the filling function will be consolidated into an initial 8-10 major regional cylinder filling plants. Most of the existing small filling locations, which are largely independently owned and operated, will cease to be commercially viable under the Government's plan; those that cannot adapt their business models—that is, shift to a new role in the supply chain that offers growth prospects and cashflow potential—will likely go out of business. But they will be replaced by thousands of new, small-scale cylinder distribution enterprises and retail points operating under contract to the LPG Marketers.

In response to the desires of domestic interests, albeit in contravention of global best practices, the Government has determined that the Ghanaian LPG marketing companies will be the sole type of entity that can invest in, and will individually brand, the new national inventory of higher-safety LPG cylinders. The existing unbranded inventory held by consumers will be refurbished and brought into the new, branded cylinder recirculation system or scrapped, based on safety considerations.

The high fragmentation and relatively low level of potential free cashflow generation in this part of the supply chain creates an opportunity (and need) for horizontal consolidation among the LPG marketers. This is desirable from the standpoint of strengthening the LPG sector financially and operationally, rationalizing the brand mix for consumers, and making the sector easier to regulate. Vertical integration will not, in general, be permitted under Ghana's sector reforms. (In certain cases, creative corporates are devising and executing holding company strategies to bypass that limitation to a degree.) For consolidation to happen, the industry must first transition successfully to BCRM and develop a set of financially and operationally leading entities capable of rolling up the sector. It is thus beyond the scope of this report to evaluate or recommend a particular consolidation strategy; however, investor groups and implementers should bear in mind these motivations for consolidation as they fund and execute their business plans over time.

The pure-play LPG Marketers bear the highest investment risk. This is because their main assets will be LPG cylinders, which are mobile and mainly under the control of their customers and their distribution networks. They will have no other major LPG assets for diversifying LPG investment risk, and no major non-LPG assets. This risk profile affects the willingness of financing sources to provide capital, as well as the terms associated with the capital that is offered.

The companies best able to tolerate LPG cylinder risks are those which own major non-LPG assets as well: namely, oil-and-gas companies selling multiple products in addition to LPG. Ironically, these companies have proven, on average, to be the least effective at promoting LPG use among a wide demographic and geographic scope of households, because they tie most of their LPG selling to their petrol station networks. Pure LPG marketing companies have proved far more effective, on average, at penetrating the residential market in Ghana. (This is a common phenomenon throughout Sub-Saharan Africa.)

Some consolidation of marketers is likely to occur organically, eventually, but might also be stimulated through aggregation and structuring of cylinder investment for the sector, as described in this report. Sectoral financial structures for aggregated cylinder investments can also have other important benefits for financing, including in transaction costs, transaction size, risk management, and due diligence.

The second largest investment category is the filling plants, here called Bottling Plants (BPs). These act as quasi-utilities to refill LPG cylinders for the licensed LPG marketers. They have immobile assets (property, plant and equipment), superior cashflow generation capability, are far fewer in number, and represent much larger individual transaction sizes.

The Feasibility Study recommended that the cylinder investment responsibility be located with the BPs, which would become de facto regional LPG marketers; the “marketers” would then act as master distributors for the BPs. However, the direction of the Government reform and restructuring plan is that the BPs will be kept separate from the cylinder investing, branding and marketing functions. If done effectively, the organization of the filling function into a quasi-public utility creates a significant opportunity to realize economies of scale and to share risks. However, organizing it as a profit-maximizing function may not pass these scale and risk advantages onward to the marketing and distribution function, and it leaves the marketing function with greater fragmentation and a less bankable asset base (namely, only the cylinders).

To be awarded a regional license, a BP must provide a financing solution. As of this writing, at least three regional BP bids were accepted by the Government. Details of these were not made available. However, a pro-forma analysis and model were possible to construct through other means, and a useful role for complementary financing sources, risk mitigation sources and tools, and technical assistance grants were possible to define. These are presented, together with their rationales, in the body of this report.

Ecosystem strategy

The Feasibility Study recommends the Government implement BCRM thoroughly and enforce it rigorously. To minimize fragmentation among the cylinder investment modalities, it also recommends to consolidate cylinder investment, ownership, safety responsibility and branding with the new regional Bottling Plant operations, which will also make the cylinder investment more bankable by sharing cylinder risk (high) with filling plant risk (lower) and by directing a higher level of sector margins toward cylinder acquisition, safety and maintenance. However, it should be noted that, for reasons particular to the stakeholders in Ghana, it is likely that the cylinder investment and branding responsibilities will be allocated to LPG Marketers, with filling-related functions outsourced to the Bottling Plants by the Marketers.

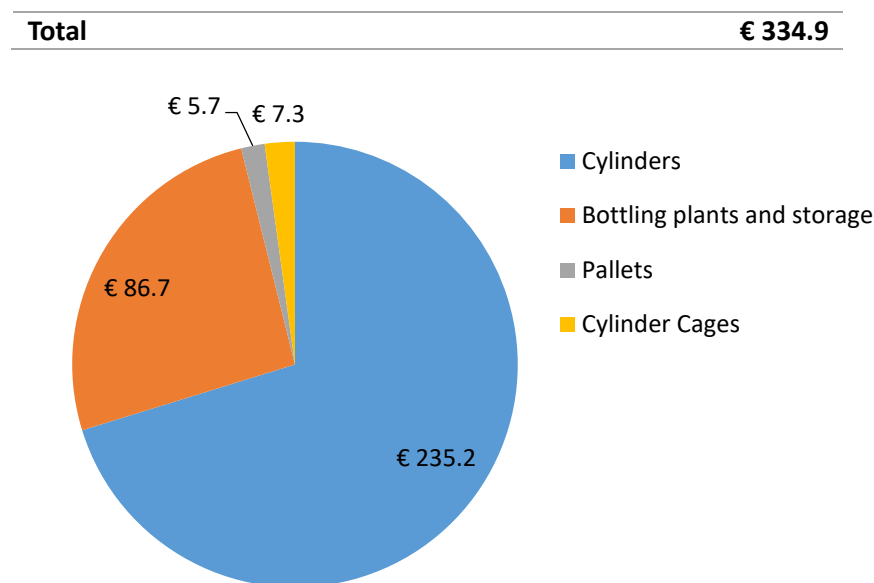
The Feasibility Study also recommends modifying the LPG pricing formula to generate a new revenue (cashflow) stream that would fund a discounting fund for aggregated procurement of cylinders by the LPG Marketers (or Bottling Plants), causing their net cylinder cost – and the cylinder deposit amount paid by consumers – to fall by a notional 40%. The recommended fund mechanism is also intended to provide risk mitigation for investors who would otherwise be reluctant to finance an individual Marketer based solely on the Marketer’s operating cashflow capability.

LPG investments and key assumptions

The total investment required to expand the LPG supply chain to satisfy a level of consumption within the aforesaid range of projected demand, as well as to achieve the Government’s policy goal, is estimated at € 335 million, excluding importation and production, allocated as follows:

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

Category	Capital Requirement (mm Euro)
Cylinders	€ 235.2
Bottling plants and storage	€ 86.7
Pallets	€ 5.7
Cylinder Cages	€ 7.3



Tranches for these investments are as follows:

Table 2. Investment financing tranches

	Tranche 1	Tranche 2	Tranche 3
	2019-2022	2023-2026	2027-2030
Cylinders	105,460 €	66,060 €	63,680 €
Bottling Plants/Storage	52,768 €	21,627 €	12,267 €
Pallets	3,789 €	938 €	938 €
Cages	4,865 €	1,210 €	1,210 €
Total Capital Investment	166,882 €	89,835 €	78,095 €

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 12 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.

The scale of investment is calibrated to fall between the lower bound and upper bound of projected demand, with the key difference between the lower bound (44% penetration) and upper bound (55%) being increased consumer preference for LPG.

Additionally, technical assistance measures of up to € 15.7 million could be employed to improve the success characteristics of both the investments and the LPG ecosystem in which the investments would be made, as well as to encourage additional demand. These are detailed in Chapter 0 beginning on page 160.

An LPG microfinance pilot program for Ghana was designed together with local implementing partners, described in the Feasibility Study (Chapter 18), but was not possible to implement during the work program for the Feasibility Study or for this report. Therefore, field data are not available to assess the potential effectiveness and scalability of an LPG microfinance initiative to unlock or accelerate additional LPG adoption or consumption. However, if a successful pilot program is presumed, using the Ghanaian planning data and benchmarks from other Clean Cooking for Africa Program countries where pilot programs were conducted, a large-scale Ghanaian microfinance program can be conceptualized which might benefit as many as 500,000 households across tranches one and two at a total cost of € 22 million.

These programs would be matched and scaled with the investment tranches, as follows:

Table 3. Technical assistance and microfinance tranches

	Tranche 1	Tranche 2	Tranche 3
	2019-2022	2023-2026	2027-2030
Technical assistance measures	11,825 €	2,585 €	1,320 €
Microfinance	7,356 €	14,662 €	- €
Total	19,181 €	17,247 €	1,320 €

Requirement for holistic investment

It is important to recognize that no single LPG project is viable in isolation, and no single LPG project will deliver a specific and precisely quantifiable set of benefits and impacts. Just as building a power plant is pointless without also building power transmission facilities, and building transmission facilities is pointless without also building power plants, investment in one part of the LPG supply chain is pointless without making corresponding, proportional investment in the rest.

It is the combination of investment all along the chain which creates the possibility of large-scale LPG transition for clean cooking, and delivers the corresponding benefits, stage by stage.

Key assumptions

Table 4. Key investment program characteristics and assumptions

Total new user population to be served by 2030	10 million, or 44% of the population (low case) 14 million, or 55% of the population (high case)
Total capital investment requirement to 2030	€ 335 million
Target leverage	75% notionally comprising 40% concessional, 35% non-concessional debt
New Bottling Plants	10
New cylinders in circulation	10.8 million
Potential technical assistance requirement ³	€ 15.6 million across all identified value-added activities

³ Includes both critical and optional elements. See Chapter 0 for details of program activities and structure.

Potential microfinance project (subject to successful piloting)	€ 22 million to stimulate demand among 500,000 additional households
Major impacts to 2030	11-21 million trees saved .50-.76 million MT of CO ₂ eq averted 12,000-19,000 lives saved Significant cost savings for households switching to LPG from charcoal
Key assumptions	<p>The Government successfully implements and enforces the BCRM market model, as outlined in the Feasibility Study</p> <p>End-user LPG pricing and supply chain margins remain regulated and increase by no more than approximately 12.5% to fund the expansion of the supply chain</p> <p>Relative stability of long-term LPG commodity input price⁴</p> <p>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 today⁵</p> <p>Historical demographic and economic trends affecting household fuel purchasing behavior will continue in force</p> <p>LPG asset costs will remain stable across the investment time horizon</p> <p>The Ghanaian inflation rate and foreign exchange rates will not dramatically change</p> <p>Adequate foreign currency supply will remain available to import LPG</p> <p>Key BCRM implementation decisions by Government that are still pending as of this writing are taken during 2019, allowing the first new bottling plant and associated BCRM distribution network to enter service by 2020</p>

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. It is expected that under BCRM the cylinder deposit amount in Ghana will set by law or regulation to 70% 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 will 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 4 (beginning on page 74), this causes the net amount needed for cylinder financing to

⁴ The price of domestically produced and imported LPG is the same

⁵ 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.

be closer to 30% of the capital cost of the cylinders than 100%. The aforesaid levy mechanism, if implemented, would effectively shrink this floor value to 18%, while reducing the deposit amount for the consumer from 70% of the cylinder cost to 42%.

In practice, the financing requirement for cylinders will fall somewhere between the hypothetical net (a floor value⁶) of € 70.6 million and the gross of € 235.2 million.

Financial analysis and main conclusions

This report uses a strawman approach to financial modelling of the investments, because company financials were not made available by prospective project sponsors for modeling individual investment projects and business expansions, and because the future margins available to companies under expected reforms to Ghana's regulated LPG pricing structure were not yet finalized by the Government as of this writing.

Based on the strawman scenarios presented herein, lender financial objectives (interest rates, debt service coverage) and equity quasi-equity returns on capital, as expressed collectively by interested Ghanaian and non-Ghanaian funding sources, can be achieved across the contemplated projects.

Concessional capital could be important to achieving these objectives. This is not because it has a lower cost of capital, but because involving capital from the global development system would deliver several key advantages identified by non-concessional capital providers: (i) it would reassure non-concessional capital providers about co-investing; (ii) use of guarantees and the like would reduce the riskiness of the investments; (iii) funding of value-adding technical assistance measures would improve the success probability of the investments, both individually and as a holistic set.

There is clear need for non-Ghanaian capital, because Ghanaian capital providers do not have the capacity, freedom (under regulatory limits on sectoral and other ratios for capital deployment), or the willingness (in view of alternative investment opportunities, such as government securities) to lead or complete the required financing on their own.

Finally, it is noteworthy that there is a demonstrated record, described in Part VI, that international financial organizations (MFIs, IFIs, et al.) have capital to be made available in Ghana, and have invested in LPG and similar activities, provided the Government successfully concludes its work in creating the needed enabling environment for such capital to be deployed for LPG projects and business expansions.

Impacts

A key motivation of the Ghana 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, Ghana's LPG transition and 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.

⁶ 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 growth (such as an exponential rate of growth), as some individual Marketers have projected regarding themselves, would amplify these timing effects.

As described in detail in the Feasibility Study, the low case and high case of expected impacts from the LPG investment projects against a business-as-usual scenario are as follows, covering the period 2020⁷-2030:

Environmental:

- **Averted deforestation:** 11 – 21 million trees saved annually relative to base case projections in 2030 and 127 – 221 million trees saved between 2020 and 2030.
- **Carbon dioxide equivalent (CO₂eq) emissions⁸ averted:** 0.50 – 0.76 million MT of CO₂eq emissions reduced annually in 2030 and 6.76 – 9.30 million MT of CO₂eq emissions averted cumulatively between 2020 and 2030.
- **Black Carbon equivalent (BCeq) emissions⁹ averted:** 1.0 – 1.7 million MT of BCeq emissions averted annually in 2030 and 10.4 – 16.6 million MT of BCeq emissions averted cumulatively between 2020 and 2030.
- **The economic value of averted CO₂eq emissions in terms of carbon financing:** € 30 – 41 million cumulatively between 2020 and 2030, using the 2018 prevailing price of carbon.

Health:

- **Averted premature deaths:** between 11,965 and 19,415 deaths could be averted cumulatively between 2020 and 2030 due to increased LPG usage.
- **Avoided Disability Adjusted Life Years (DALYs):** 423,774 – 688,042 DALYs
- **Value of labor time gained:** € 198 million - € 321 million

Consumer economics:

- **Average annual savings per household from switching to LPG from charcoal:** GHC 48 (€ 8.6) urban; GHC 66 (€ 11.9) rural
- **Average annual spending increase per household from switching to LPG from firewood:** GHC 146 (€ 26.3) urban and GHC 220 (€ 39.6) rural

National economics:

- **Cumulative tax revenue (assuming no rate or law changes):** Increase of tax revenue of GHC 76 million (€ 13 million) and GHC 162 million (€ 29 million) from 2020-2030
- **Trade balance (assuming no rate or law changes and constant local LPG production):** Decrease of the trade surplus¹⁰ by GHC 314 million (€ 56 million) and GHC 732 million (€ 132 million) as of 2030
- **Job creation:** 7,412 – 11,757 net new jobs in the LPG sector, but an unquantifiable reduction in the charcoal and woodfuel sectors

⁷ For purposes of the analysis, it is assumed that key governmental decisions, pending as of this writing, will be taken in 2019, with implementation of BCRM and initial associated expansion investments occurring in time to start taking effect in 2020.

⁸ CO₂eq emissions include carbon dioxide equivalent emissions from carbon dioxide, methane, and nitrous oxide. These were calculated using IPCC conform standards.

⁹ BCeq emissions includes black carbon equivalent emissions from black carbon, organic carbon, carbon monoxide, and total non-methane organic compounds.

¹⁰ Ghana ended a decade of trade deficits in 2017, positing a US \$1.5 billion trade surplus. Source: Statista (2018).

Major risks

The one thing that must go right, above all others, is the effective implementation and ongoing enforcement of the Branded Cylinder Recirculation Model (BCRM), as explained in detail in the Feasibility Study. Ghana's LPG companies and regulator must relearn how to operate effectively under BCRM, following a two decade-long gap in which a very different model took hold¹¹.

Among the most important additional risks are:

- Picking the winners. Choosing the right operational modality targets (individual firms) for investment, whether or not they are aggregated via intermediary financing vehicles. Additionally, there can be lack of alignment between winners chosen (directly or indirectly) by (i) NPA, (ii) the market, and (iii) investors. The present high level of fragmentation among LPG Marketers makes picking winners the more challenging, and the more important. Bringing relevant LPG industry and investment expertise and experience to bear in selecting capital recipients is thus essential.
- Government policy change. This can be the Government failing to follow through on BCRM implementation or, over time, on BRCM enforcement; or switching its support to a different solution for clean cooking in place of LPG (for example, attempting electric cooking for all) soon after major LPG investments are made. This is highly unlikely, but were it to occur, it would derail the investment program and could harm the LPG sector, its consumer beneficiaries, and its investors.
- Government decision-making. Connected with BCRM implementation risk is a prerequisite risk: the Government's failure to take, or substantial delay in taking, important but still-pending decisions, or the Government deviating materially in its decision-making from the guidance NPA provided as of this writing that was used in carrying out the Feasibility Study. A major, unexpected change in the Government's sector design or sector rules could invalidate the Feasibility Study findings and render some or all of the recommended investments unviable.
- Expanding the sector—nationally and regionally—at the wrong pace. The pace of expansion is a function of the rate of unlocking of demand, access to required financing by the operating modalities, their execution capability, and Government decisions (such as licensing requirements) which incentivize or mandate a certain minimum or maximum level of investment over time by different types of firm operating at different supply chain nodes. If these elements are not well synchronized, overinvestment (leading to inadequate profitability of affected firms) or underinvestment (leading to unmet demand and lost or deferred opportunity for impacts and for financial returns) can result, either sector-wide or within individual regions or individual firms, or all of these.

Other risks may emerge and become major in future, such as black market refilling (as had severely affected Kenya, where BCRM had been poorly enforced for many years), especially if BCRM is laxly enforced in Ghana in future, but these are not material now.

A comprehensive list of risks and mitigation options is presented in Chapter 17 beginning on page 136.

¹¹ The alternate model in question is the Consumer Controlled Cylinder Model (CCCM), discussed in the Feasibility Study.

Project details

The report's Project Annexes, beginning on page 169, present the details of each main project.

Conclusion

When the Government finalizes the key decisions regarding the future structure and rules for the LPG sector under BCRM, the substantial unmet LPG demand in Ghana presents a viable opportunity for investment over time to scale up the LPG sector substantially and thereby deliver significant social, environmental, and other benefits to the country.

To improve the odds and scale of success, development finance has a key role to play, both as an attractor of non-DFI funders and a provider of technical assistance, together with non-concessional finance.

Looking beyond the scope of this report, it will be critical that the major required investments are adequately defined with capable and bankable counterparties and financing structures.

Note that it was beyond the scope of this report to define in detail a full program of demand-side measures that could reduce the risk of unintentional overinvestment with respect to the later tranches.

III. LPG and 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 WHO12, 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)¹³, 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.

All of these goals are applicable to Ghana. Indeed, Ghana was the first country in the world to create and governmentally approve a Sustainable Energy for All Action Plan (in 2011), which included major focus on developing the Ghana LPG sector rapidly and sustainably.

¹² WHO (2016). Burning Opportunity: Clean Household Energy for Health, Sustainable Development, and Wellbeing of Women and Children Report. Geneva: World Health Organization.

¹³ 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.

IV. LPG Demand Potential to 2030

LPG consumption in Ghana has been rising modestly and steadily since 2010, with the proportion of households using LPG as their main source of energy for cooking growing from 18% in 2010¹⁴ to 22.3% in 2013¹⁵, and to 24.5% in 2017¹⁶. Table 5 summarizes key data points related to baseline LPG demand in Ghana in 2017.

Table 5. Summary of baseline LPG consumption in Ghana in 2017

Components of baseline LPG consumption	2017
Total LPG consumed in Ghana in 2017	358,900 MT
Total residential LPG consumed in cylinders by households in 2017	165,753 MT
Share of households consuming LPG as primary fuel in 2017 (GLSS 7)	24.47%
In urban households	37%
In rural households	9%
The annual per-capita consumption of LPG	5.5 kg
The annual LPG consumption per LPG user	22.6 kg

The demand forecast scenarios to 2030 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 276,060 MT by 2030, resulting in national per capita consumption of 7.12 kg per year.
- Scenario 2: Market reform and expansion scenario, reflecting policy and investment interventions as described in this report. 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. Total annual LPG consumption for household cooking is projected to grow to 404,415 MT by 2030, with 4.47 million households consuming LPG in 2030. This represents an LPG usage penetration of 46% of households (46% of the population), with a national per capita consumption of 10.44 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), as well as additional changes in preferences that result in additional households switching to LPG. Total annual LPG consumption for household cooking is projected to grow to 530,420 MT by 2030, with 5.3 million households consuming LPG. This represents an LPG usage penetration of 55% of households (55% of the population), with a national per capita LPG consumption of 13.69 kg per year.

¹⁴ Ghana Energy Commission (2013, 2017)

¹⁵ GLSS 6

¹⁶ GLSS 7

Scenario 3: Investment recommendations/government Policy Goal Scenario, which gives total projected consumption as per the investments needed to reach the Government's goal of 50% LPG penetration by 2030.

The scenario corresponding to the Government's goal (Policy Goal Scenario) falls between the lower bound (2A) and upper bound (2B) scenarios (including under increased pricing). Details for all three scenarios are presented in Chapter 21 of the Feasibility Study.

The scenarios all assume that LPG can expand on a commercial basis only in geographic areas where there is already some level of residential LPG present, for sake of conservatism and practicality: absent an adequate road network and an adequate cash economy, LPG expansion is unlikely to be commercially feasible. This assumption and rationale are discussed in detail in the Feasibility Study.

Also as discussed in the Feasibility Study, LPG consumption (by 2030 may be approximately 5.6% lower than modelled if an anticipated, recommended increase in the LPG end-user price of approximately 12.5% is put into effect under BCRM in order to cover incremental costs of expanding the LPG supply chain, and no offsetting measures are implemented. This level of price increase would apply until 2030, corresponding to the financial horizon of the LPG infrastructure investments. The resulting potential penetration is not forecast to decline materially, but the consumption (due to greater fuel-stacking) would grow to the lesser amounts of 381,880 MT (lower bound estimate) and 500,870 MT (upper bound estimate). After 2030, when the anticipated capital costs have been fully recovered, the price could be reduced by eliminating the price formula element associated with capital cost recovery. The effect of a 5.6% consumption reduction creates, for some impact measures, a somewhat proportional reduction of the measure. Direct modelling of the exact proportionality was not possible, because of a lack of necessary data. For other impact measures, the proportion of reduction is much less than 5.6%, due to the effects of non-linearity.

The following two figures depict the demand scenarios and demand drivers mentioned above, respectively:

Figure 1. Scenarios of forecasted residential LPG demand (2013-2030)
(from the Feasibility Study)

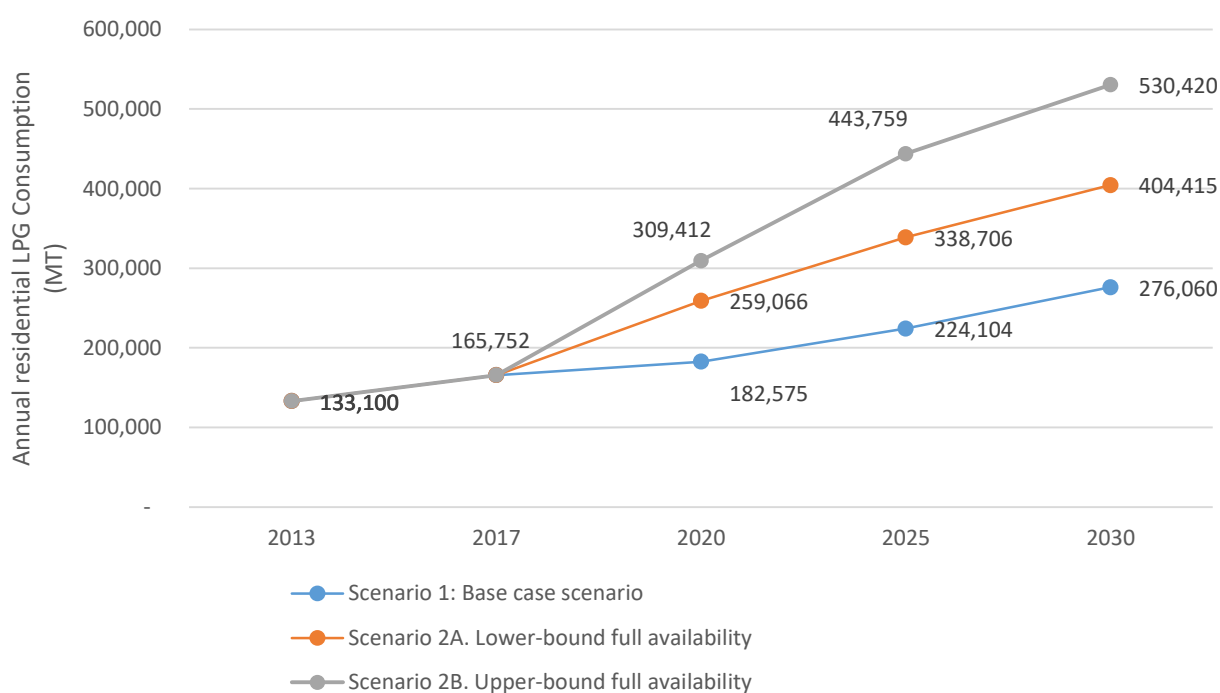


Figure 2. Percentage of households using LPG by 2030, by demand driver (LPG as primary cooking fuel)

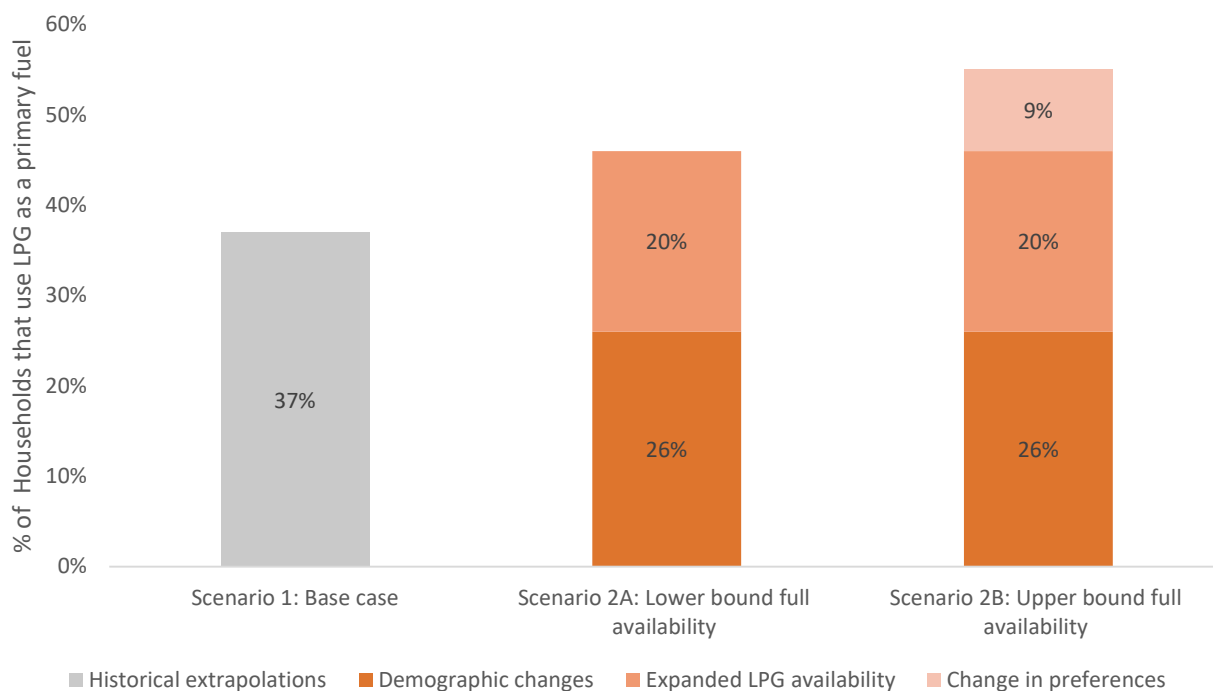
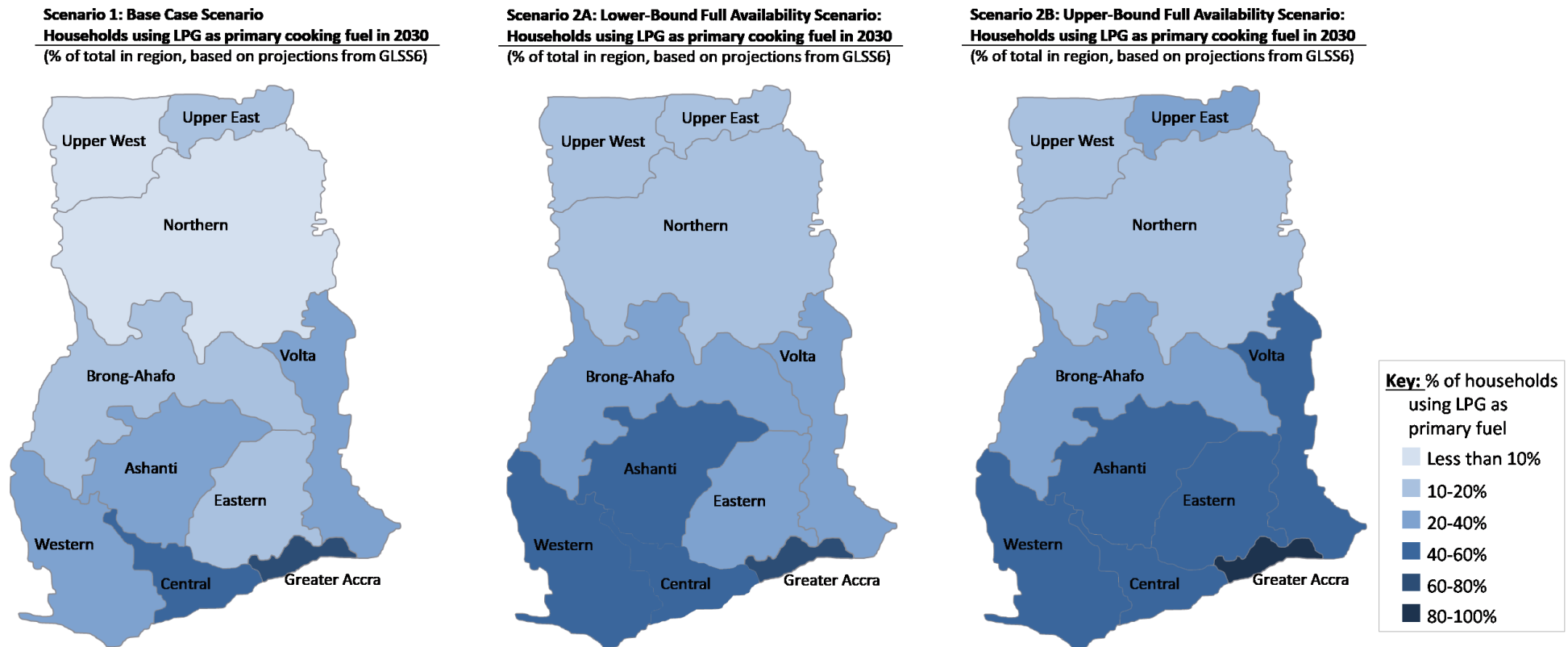


Figure 3¹⁷ below shows potential household LPG demand across Ghana's regions in 2030. While rural users will see a greater percentage increase in their total residential consumption as it grows from 14,748 MT in 2013 to between 102,973 MT and 126,732 MT in 2030, urban users will have a greater absolute increase from 118,352 MT in 2013 to between 310,442 MT and 403,688 MT in 2030, depending on the scenario.

¹⁷ In the base case scenario overall consumption grows as it has in the recent past, and usage deepens in areas already using LPG (Central) while changes in other areas are slow. In scenario 2A (lower bound), the base case is not considered. Instead, only demographic changes and changes in availability are considered. As Central already has availability, changes are minimal there. Changes are greater in areas that previously had no availability. Scenario 2B then builds on 2A, and deepens penetration in all regions due to increased preference-driven switching to, and use of, LPG.

Figure 3. Maps of scenarios of projected LPG demand in 2030



V. Critical Path LPG Infrastructure Investment Projects to 2030

This Part describes the key infrastructure projects to be undertaken (i) to serve projected LPG demand as well as (ii) to achieve the Government of Ghana's policy goal of 50% of the population using LPG for cooking by 2030. The Government's goal is consistent with the demand projection scenarios set forth in the Feasibility Study.

As noted in the Feasibility Study, key assumptions were required to be made about the results of ongoing Government deliberations about future pricing policy and other factors that could affect both future demand and the viability and bankability of investments to serve that demand. Accordingly, there is uncertainty inherent in the demand projections and in respect of the potential ease with which the corresponding supply chain expansion can be financed. It was beyond the scope of this report to attempt to model and evaluate all possible future scenarios. Rather, once specific details of such decisions are known, a refresh of the analyses herein (subject to the availability of additional resources to do so) should be performed to select with improved confidence, or to refine, the assumptions and analyses.

1. LPG Supply Chain

Existing Ghana supply chain nodes and participants

Production and importation

Production comes from three main sources:

1. The Ghana Gas Company, whose present volume sold into the Ghanaian market is about 70 KT per year out of a nameplate capacity of about 170 KT, towards which it is ramping its production. This production is approximately 30% butane, 70% propane.
2. The Tema Oil Refinery, whose production volume is approximately 23 KT. This production is approximately 70% butane, 30% propane.
3. Purchase of imports by the BDCs. Imported LPG is approximately 90% butane, 10% propane. Data on individual BDCs are presented later, in the BDC subsection.

As described in the Feasibility Study, importation will increase significantly its share as a source of supply, with ample global surplus expected to be available well beyond 2030 and relative import price stability for the long term.

Bulk Distribution Companies (BDCs)

A BDC is permitted under its license to import LPG (or to purchase it from the Ghana Gas Company or Tema Oil Refinery) and to sell LPG to OMCs and LPGMCs, but not to retailers. A BDC may sell LPG to bulk customers (such as industrial users), which must be registered as a bulk customer with the NPA.

There were a total of nine BDC's involved in LPG procurement in Ghana in 2017 as shown in Figure 4, with three dominating:

Figure 4. BDCs by market share (2017)

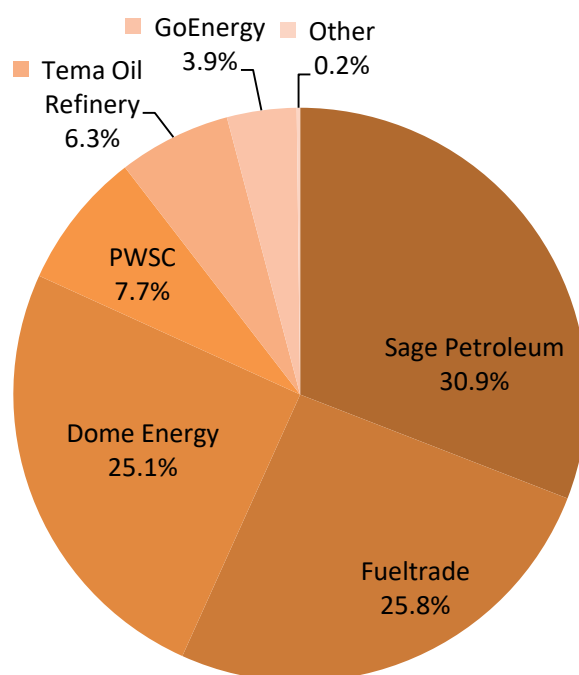


Table 6. BDC volumes and market shares (2017)

BDC	Volume (MT)	Market Share ¹⁸
Sage Petroleum	110,902	30.9%
Fueltrade Ltd.	92,758	25.8%
Dome Energy Resources Ltd.	89,918	25.1%
Petroleum Warehousing and Supply Co. Ltd.	27,813	7.7%
Tema Oil Refinery	22,765	6.3%
GoEnergy Company Ltd.	14,075	3.9%
Others:		
Blue Ocean Investments Ltd.		
Mobile Energy Resources Ltd.	701	.2%
XF Petroleum & Engineering Ltd.		
Total	358,932	100.0%

Sage Petroleum is the leading BDC by market share. It is the Ghana Gas Company's exclusive contract lifter of LPG. It is part of a corporate group with both OMC and BDC units. It sells to the licensed OMCs/LPGMCs.

Second is Fueltrade, which has no OMC affiliate.

Dome Energy procures propane for Genser Power for use in power generation.

GoEnergy, sixth, is a subsidiary of Ghana Oil (GOIL). In addition to importing LPG, also it buys from other BDCs.

¹⁸ Amounts do not add exactly due to rounding.

Oil Marketing Companies (OMCs) and LPG Marketing Companies (LPGMCs)

The OMCs and LPGMCs are the targets for investment capital to finance the expansion of the national inventory of LPG cylinders.

152 companies were licensed as Oil Marketing Companies (OMCs) or LPG Marketing Companies (LPGMCs) as of the end of 2017.

OMCs are typically larger, multistation, multifuel petroleum distribution companies that pursue a national marketing and retailing strategy. The market leader is GOIL, a partially state-owned company with approximately 8% market share in LPG and operations in nine of Ghana's ten regions.

The existence of a license does not guarantee LPG activity. Of these 152 licensed companies, only 81 reported any LPG sales volumes for 2017. Of those 81, 39 were self-reported as pure LPG players (LPGMCs). The top 10 (of the 81) had a combined LPG market share of 45%. By global standards, this is a highly fragmented market.

The following figure and table show the top market shares for 2017:

Figure 5. LPG marketers (OMCs and LPGMCs) market shares (2017)

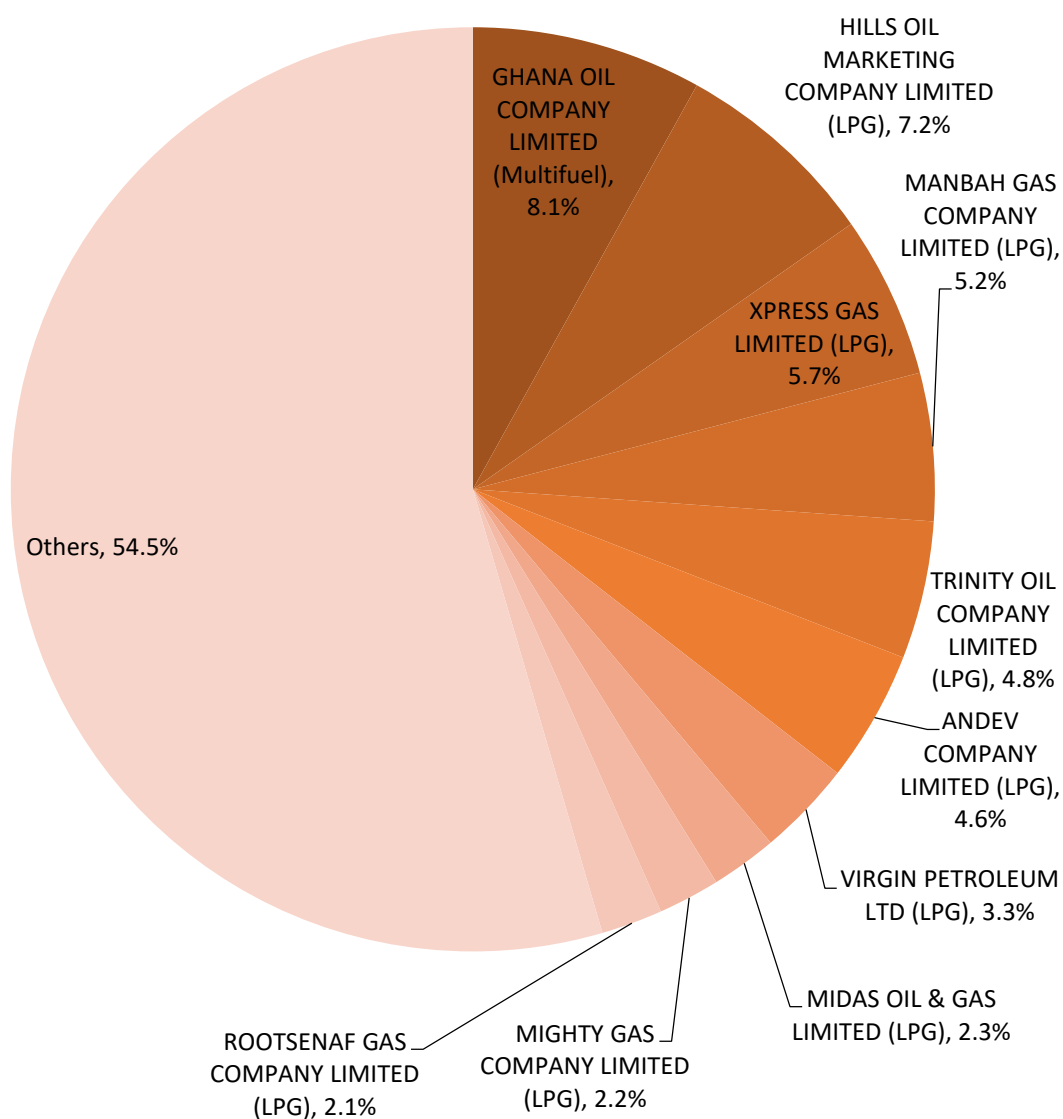


Table 7. LPG marketers (OMCs and LPGMCs), volumes and market shares (2017)

Company	LPG Sales (MT)	LPG Market Share	Type ¹⁹
Ghana Oil Company Limited	22,298.9	8.1%	Multifuel
Hills Oil Marketing Company Ltd.	19,939.1	7.2%	LPG
Xpress Gas Limited	15,696.8	5.7%	LPG
Manbah Gas Company Limited	14,303.2	5.2%	LPG
Trinity Oil Company Limited	13,341.6	4.8%	LPG
Andev Company Limited	12,713.7	4.6%	LPG
Virgin Petroleum Limited	9,216.4	3.3%	LPG
Midas Oil & Gas Limited	6,403.8	2.3%	LPG
Mighty Gas Company Limited	5,978.8	2.2%	LPG
Rootsenaf Gas Company Limited	5,936.6	2.1%	LPG
Others (71) ²⁰	150,874.0	54.5%	Multifuel: 41 LPG: 30
Total	276,702.8	100%	Multifuel: 42 LPG: 39

Transportation services

Transportation of LPG must be carried out under Ghanaian regulation by dedicated Bulk Road Vehicle (BRV) operators. As of this writing, Ghana has 193 LPG BRVs in operation. These earn a small unit margin for moving LPG in bulk from bulk storage facilities to the microstations.

Microstations and Retailers/Dealers

There are approximately 650 microstations in Ghana, approximately 80% of which the Government anticipates decommissioning for reasons of public safety and the remainder self-converting to LPG distribution or to the sale exclusively of autogas (LPG for vehicular use). Details about the microstations are provided in the Feasibility Study.

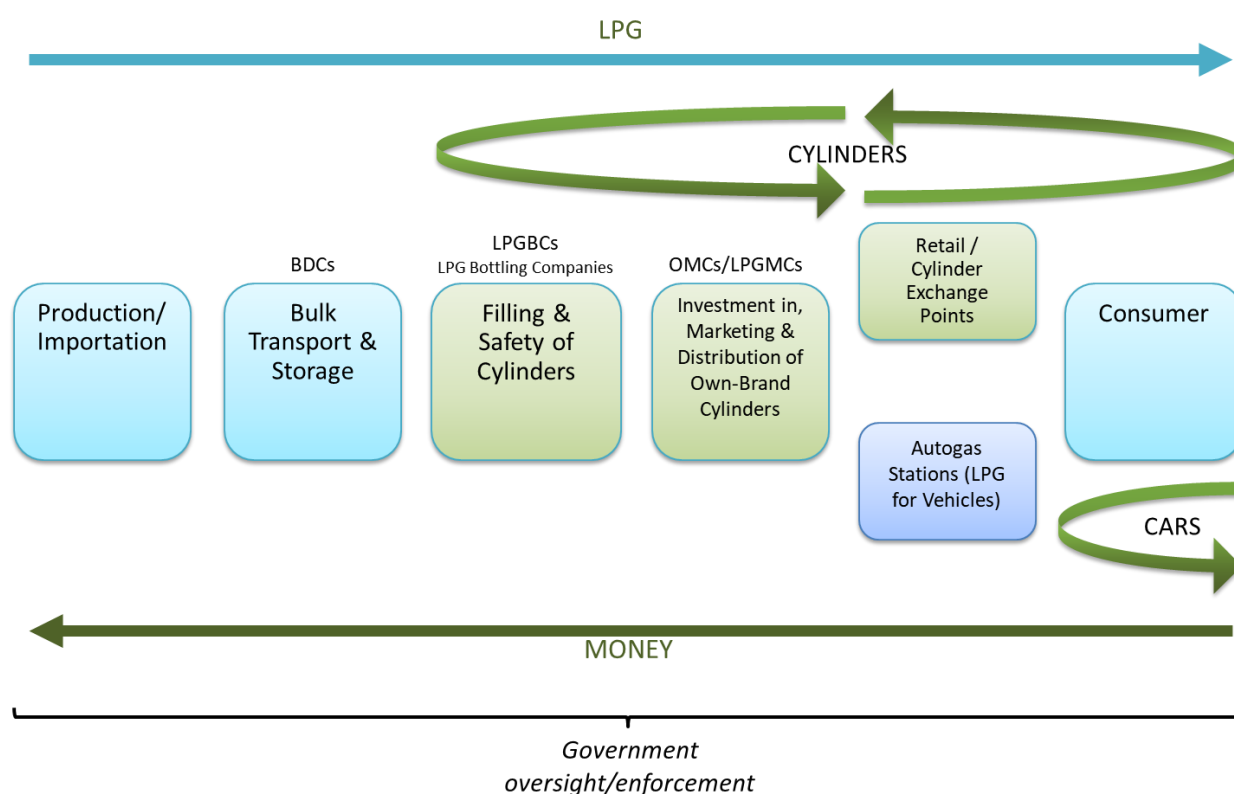
The future value chain under BCRM

The following figure shows the supply chain favored by the Government in its BCRM planning process and licensing program:

¹⁹ As reported by each company to NPA.

²⁰ Two OMCs that had some LPG activity in 2017 had no LPG activities in 2018, as of this writing.

Figure 6. LPG value chain, post-BCRM – OMCs/LPGMCs own cylinders/brands



The nodes are:

1. *Production/Importation*. Sourcing of LPG.
2. *Bulk Distribution Companies (BDCs)*. These companies obtain LPG from sources of importation and/or production, and sell it downstream, in bulk. They typically operate facilities for importation and storage, and may also have bulk transport facilities. The end-point for bulk deliveries is an autogas station for autogas sales; point for the cylinder market, the end-point is the new Bottling Plant node. BDCs are prohibited from selling LPG to consumers²¹.
3. *LPG Bottling Companies (LPGBCs)*. These new companies will build and operate the country's regional bottling plants. The Feasibility Study, and this report, recommend that the Bottling Plants be made responsible for cylinder investment, branding, filling and safety. The Government is however anticipated to locate these functions with the OMCs and LPGMCs, as described below.
4. *Oil Marketing Companies (OMCs), LPG Marketing Companies (LPGMCs)*. These companies are, respectively, licensed sellers of petroleum products generally, which can include LPG, and licensed sellers of LPG only, respectively. The Feasibility Study, and this report, recommend that the Bottling Plants be responsible for cylinder investment, branding, filling and safety. The Government is anticipated to locate these functions with the OMCs and LPGMCs, as shown in Figure 6 above.

²¹ An exception applies in the case of governmentally-registered bulk customers, such as industrial users of LPG.

5. *Retail / Cylinder Exchange Points.* Thousands of new retail points would be created by the LPG Marketers through expansion of their distribution networks. The existing microstations would be transitioned in one of two ways:
 - i) Licensed to sell LPG for vehicle use (autogas) only; or
 - ii) Licensed to operate as a distributor and/or cylinder exchange point operator for residential LPG cylinders.

The new retail points could be dry goods shops, food markets, energy products retailers— any sort of retail establishment located near to consumers that meets the requirements for safe storage and handling of LPG cylinders. A retail point with as few as a dozen cylinders in inventory can be viable, especially when selling other consumer products as well.
6. *Autogas Stations.* Microstations which sold LPG refills for both residential cylinder-owners and for vehicles (i.e., autogas) would, in some cases, be permitted by the NPA to continue operating their autogas business while closing down their non-autogas business.
7. *Consumer.* The consumer must trade in his/her old, generic cylinder for a new, branded one under BCRM. The details of the trade-in program terms and operation are still being determined by the Government as of this writing. A new LPG consumer obtains his/her branded cylinder from a retail point by making a cash deposit (this gives him/her the right to use a cylinder) and paying for the LPG it contains. When that cylinder becomes empty, the consumer returns it to the retail point and exchanges it for a full cylinder of the same brand, paying for the quantity of LPG in the replacement cylinder. If the consumer stops using LPG (such as to switch to natural gas or electricity for cooking), s/he may return the cylinder to the retail point and receive back his/her deposit.

Commissioning of Bottling Plants

The NPA has established general specifications, and a process, for proposals and bidding by the private sector to obtain licenses to become Bottlers (that is, to construct and operate the new regional bottling plants) starting in late 2019. Initial responses have been received for each plant, with some companies (such as GOIL) proposing to own and run multiple plants, and some plants receiving multiple competing responses from private sector companies.

The Government has instituted a Ghanaian ownership requirement. For BPs, this requirement is 100% equity ownership in the LPG Bottling Company by a Ghanaian citizen or Ghanaian corporate entity.

The license terms also require the license to have the capability to upgrade the plant to 750 MT of storage within five years and to have a minimum US \$1.2 million (or equivalent) of evidenced trade financing in the form of equity cash on account or a trade or credit facility with one or more reputable institutions. Licensees will have two years from the date of obtaining a construction permit to put their plant(s) into operation.

A discussion of planning for the BPs and other new assets, including cylinders, is covered in the next Chapter of this report.

As of this writing, the following prospective licensees and bidders for the BPs are publicly known, together with their status:

Table 8. Bottling Plant license applicants and status

Company	Status
Ghana Gas Company	Approved
Ghana Oil Company (GOIL)	Approved (bidding for three plants)
Quantum Terminals	Application in review
Puma Oil ²²	Application in review

GOIL intends to construct three BPs, at Tema, Kumasi and Talame. GOIL has announced it will spend an initial GHC 50 million (approximately € 9 million) toward their development and an expanded footprint of its LPG distribution centers.

Quantum intends to construct three BPs, at Tema, Atuabo and Kumasi. The Tema plant would have 900 MT of storage and throughput of 19,000 cylinders per day. Quantum would bring its own financing, through Arch Holdings as lead financial partner, with a preliminary cost estimate of US \$37 million. The Atuabo plant would commence construction in the first half of 2019, with 300 MT of storage and throughput of 2,000 cylinders per day (below the license requirement), at an estimated cost of US \$25 million. Details of the Kumasi plant have not been announced.

As of this writing, it was not yet clear whether the Government intends to issue licenses up front for all regions, or would issue them in conjunction with a particular rollout schedule of BCRM and new Bottling Plants, groups of regions by groups of regions.

Adoption and rolling out of BCRM will lead to many changes, including:

1. Reduced risk for the population, because refilling points will be regionalized in, notionally, 8-10 high-efficiency BPs located away from populated areas;
2. Reduced risk for the end-user when using LPG, because, through the recirculation of cylinders to the BPs, there will be rigorous inspection and repair of cylinders with every refill cycle, and unsafe cylinders will be systematically replaced by safe ones at no additional cost to the end-user; and
3. Clear responsibility will exist for the maintenance of the cylinder. If the BP companies were to be assigned the cylinder investment and branding function, then the cylinder maintenance responsibility would ideally be assigned to them as well. Each BP company would then invest in cylinders for its region, control its cylinder's brand, and obtain a stream of profits from refilling its cylinders over their lifecycles. However, if the Marketing companies were to be assigned the cylinder investment and branding function, then the cylinder maintenance responsibility would be assigned to them. Each Marketing company would then invest in cylinders for its chosen geographic footprint (which might span multiple regions), control its cylinder's brand, and obtain a stream of profits from the stream of exchanges of refilled for empty cylinders over the cylinders' lifecycles.

²² Puma is a midstream and downstream oil and gas company, majority-owned by the trader Trafigura of Singapore and by Sonangol of Angola.

The implementation of BCRM concerns not only the construction of BPs (none of which currently exist in Ghana), but also, in parallel, defining the enabling environment for the sector as whole, as discussed in the Feasibility Study.

From the perspective of lead times to develop critical infrastructure and put it into operation, the NPA has prioritized the specification and bidding for licenses to construct and operate the BPs. The BP license terms published by NPA allow for a two-year construction period once all permits have been obtained. Two years is a conservative estimate, based on best practices for LPG planning and construction in Sub-Saharan Africa. The NPA is hopeful that a first plant can be operational by 2020. (It should be noted, however, that mobilizing concessional financing, never a quick activity, may take longer than this lead time window and might, therefore, not come into play in the initial BP financings, but only later for (i) refinancings, (ii) later BPs, and (iii) later expansions of initial BPs.)

As described in the prior Chapter, the governmentally-determined business model for the BPs has not been finalized as of this writing. Thus, precise planning for the new infrastructure, business activities, and investments remains, temporarily, a moving target. Nonetheless, applications have been received and in some cases approved by NPA for licenses to construct and operate BPs from multiple companies, as detailed in Table 8 on page 39.

The following Chapters describe GLPGP's recommended scenario of the sizing and locations of the BPs and estimates of the costs and conditions for the construction thereof, to achieve the national LPG use goal in the context of BCRM. The estimates of costs have been built on the basis of international technical standards for construction of BPs²³. This Part also discusses the financial modalities and expectations for the LPG marketers under that scenario.

Governmental decisions are still pending; if decided differently from what is recommended and anticipated as of this writing, the scenario would need to be revisited using changed assumptions. For consistency with the Feasibility Study recommendations, this report maintains the primary investment focus on BPs that are permitted to, and do, invest in and brand cylinders. (The quantum of capital is the same whether the BP or the Marketer makes the cylinder investments, but the profit streams and risk allocations are different in the two scenarios.) However, the alternative scenario, in which the Marketer is the cylinder investor, is also included for reference and comparison (see Chapter 4).

Upon completion of these investment projects, Ghana would have a network of high-standard BPs with the capacity and capability to address the safety, productivity, and quality needs of refilling of cylinders at scale. The Marketers would have a corresponding, reliable, commercial model around which to plan and carry out business expansion, develop deeper and broader retailing footprints, and participate in sector-wide expansion financing.

The acquisition of cylinders, being a procurement task, is addressed below. 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 BPs.

23 Like the API, the ASTM E includes all relevant standards for the construction of LPG BPs.

Future importation, production and bulk storage capacity

The present national capacity and planned additions to capacity are adequate in the near and medium term for the forecasted increase in importation, production, and storage volumes under the growth scenario corresponding to the national LPG policy goals, and therefore these are not further analyzed in this report. Over time, if the anticipated consumption is exceeded, adding capacity to these categories of infrastructure may be necessary, and should in turn be duly studied and planned.

2. Investment Summary

This Chapter describes the recommended scenario of expansion and development of the critical LPG infrastructure needed to serve the latent and unmet residential demand as projected to 2030. The estimates of costs have been built on the basis of international technical standards.

Upon completion of these investment projects, Ghana 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 to serve the projected demand through 2030 and beyond.

This report, for consistency with the Feasibility Study, identifies as the preferable investment structure the consolidation of investment in cylinders (along with their branding and maintenance responsibility) into the BPs, whose risk profile and expected cashflows would create a stronger investment modality, stronger execution capability, and more easily overseen regulatory ecosystem, than locating the cylinder investment within the existing body of Marketers. However, because it is as likely, if not more likely, that the Government may ultimately choose the latter approach, the case of Marketers investing in the cylinders is also presents for reference and comparison. (The quantum of capital is the same whether the BP or the Marketer makes the cylinder investments, but the profit streams and risk allocations are different in the two scenarios.) 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 detail in the next two Chapters.

If the Government defines the Marketers to be the cylinder investors, then the Marketers must, in turn, plan and carry out business expansion driven by expanded cylinder inventories. In either case, they must develop deeper and broader retailing footprints in order to unlock the projected demand.

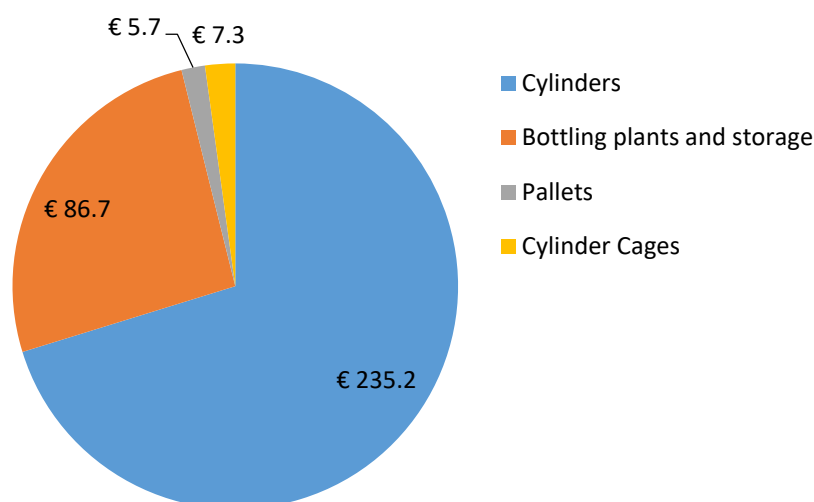
The acquisition of the cylinders themselves, being a procurement task, is addressed in detail in the Project Annexes, Chapter **Error! Reference source not found.** The quantity of cylinders in circulation and their velocity (rotation rate, in industry terms) along the value chain is related to the required capacities of the filling plants.

The total investment requirement is summarized in the following table:

Table 9. Capital investment requirements to 2030 for LPG sector scale-up

Category	Capital requirement (mm Euro)	Supply chain node
Cylinders	€ 235.2	Bottler or Marketer ²⁴
Bottling plants and storage	€ 86.7	Bottler
Pallets	€ 5.7	Bottler
Cylinder Cages	€ 7.3	Retailer
Total	€ 334.9	

²⁴ The final determination by Government of which node shall be required to invest in, brand and deploy cylinders into the market and maintain and ensure their safety has not been completed as of this writing. The 70% cylinder deposit paid by consumers can serve as a significant funding source toward the cylinder assets.



The BPs and marketers together represent 98% of this total, comprising cylinders, bottling plants and adjacent bulk storage, and pallets. Cylinder cages would be deployed for the management of cylinder inventory in the distribution and retailing part of the supply chain.

Tranches for these investments are as follows:

Table 10. Investment financing tranches

	Tranche 1	Tranche 2	Tranche 3
	2019-2022	2023-2026	2027-2030
Cylinders	105,460 €	66,060 €	63,680 €
Bottling Plants/Storage	52,768 €	21,627 €	12,267 €
Pallets	3,789 €	938 €	938 €
Cages	4,865 €	1,210 €	1,210 €
Total Capital Investment	166,882 €	89,835 €	78,095 €

The projected gross amount of required investment – € 335 million -- can be reduced over the 12-year period in three ways:

1. The cylinder investor (BP or Marketer) benefits by consumers paying a deposit for use of the cylinder. The percentage varies by country (in Cameroon it is 80% by law, and in Kenya can exceed 100%, set by the market; in Ghana it is anticipated to be 70% under BCRM). This deposit usually would be received by the cylinder-investing company within three months from its original purchase of the cylinders. These funds would be treated as a liability to the customer, who may recover the deposit upon cancelling service and returning the cylinder. Given a 70% deposit to be taken in, the net cost of the cylinders is reduced from € 235 million to € 71 million, with a somewhat proportional reduction in the amount of financing required. The quantum of financing would not fall in exact proportion due to factors including the rate of cylinder inventory growth year over year, deposit liability reserve levels, cylinder losses and scrap rates, and other factors, all of which affect the amount needed to grow and maintain the cylinder park year over year.
2. Based on detailed conversations, the Clean Cooking for Africa/GLPGP expert team anticipates that some Funders would offer terms for the financing of the cylinders which would help to minimize

the working capital component of any borrowing by the cylinder investors (BPs or Marketers). It is likely that the Funders would seek a minimum principal repayment schedule with increased amounts depending on the level of deposits collected and the speed with which they are paid. Nevertheless, any such financing terms would help to reduce the actual amount of borrowings by the Marketer.

3. The debt portion of the funding to purchase cylinders and to purchase or build other assets in this report is structured in three tranches. Were repayments to be made completely timely, the funds could in effect be rolled over to supply the actual funds for the second and, possibly even, the third tranche. The result is that, if the same Funders invest across the full investment time horizon, the Funders would not have to put up new funds in the latter portions of the 12-year period. Instead, they would, in effect, recycle the initial funds up to twice more. 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.

It is not possible in this report to completely estimate the terms of any particular financing transaction, as that depends on the reality of the financial marketplace at the time of the transaction and the prior steps taken by the Government to de-risk the environment. Nevertheless, it is clear that reuse of cylinder deposits and structured financing by Funders should allow cylinder investing modalities (BPs or Marketers) to reduce significantly the actual amount of funding sought. The result, in this case, would be somewhere between the € 335 million gross amount and a € 171 million net amount.

Additionally, technical assistance (TA) and demand-stimulating measures of up to € 15.7 million could help to improve the bankability and outcomes of these investments. These measures are described in Chapter 21 beginning on page 163.

An LPG microfinance pilot program for Ghana was designed together with local implementing partners, described in the Feasibility Study (Chapter 18), but was not possible to implement during the work program for the Feasibility Study or for this report. Therefore, field data are not available to assess the potential effectiveness and scalability of an LPG microfinance initiative to unlock or accelerate additional LPG adoption or consumption. However, if a successful pilot program is presumed, using the Ghanaian planning data and benchmarks from other Clean Cooking for Africa Program countries where pilot programs were conducted, a large-scale Ghanaian microfinance program can be conceptualized which might benefit as many as 500,000 households across tranches one and two at a total cost of € 22 million.

These programs would be matched and scaled with the investment tranches, as follows:

Table 11. Technical assistance and microfinance tranches

	Tranche 1	Tranche 2	Tranche 3
	2019-2022	2023-2026	2027-2030
Technical assistance measures	11,825 €	2,585 €	1,320 €
Microfinance	7,356 €	14,662 €	- €
Total	19,181 €	17,247 €	1,320 €

Combining the amounts shown in the prior two tables, the overall program costs by tranche are:

Table 12. Combined tranches: investments, microfinance, and TA measures

	Tranche 1	Tranche 2	Tranche 3
	2019-2022	2023-2026	2027-2030
Cylinders (Gross Amount)	105,460 €	66,060 €	63,680 €
Bottling Plants/Storage	52,768 €	21,627 €	12,267 €
Pallets and Cylinder Cages	8,654 €	2,148 €	2,148 €
<i>Subtotal: Capital Investment</i>	166,882 €	89,835 €	78,095 €
Technical Assistance (TA)	11,660 €	2,585 €	1,320 €
Microfinance	7,356 €	14,662 €	0 €
<i>Subtotal: TA and Microfinance</i>	19,016 €	17,247 €	1,320 €
Gross Financing Total	185,898 €	107,082 €	79,415 €
Less: Cylinder Deposits (Potentially)	(73,822 €)	(46,242 €)	(44,576 €)
Net Financing Requirement (Potentially)	112,076 €	60,840 €	34,839 €
Gross Financing Total to 2030			372,395 €
Net Financing Total (Potentially) to 2030			207,755 €

Concessional capital in a tranche-one critical mass of projects

As described in detail Part VIII beginning on page 159, it is recommended that concessional capital sources, such as DFIs, IFIs, and MDBs, consider participating at a level of 40% of the financing for the above hard assets and business projects as part of a blended capital stack, as well as to fund proposed technical assistance measures and microfinance programs, with tranche one serving as a self-contained, first financial cooperation project-of-projects.

Creating an initial mini-tranche / sub-tranche

Conceptually, a sub-tranche of tranche one could be created to reflect both a potentially slower roll-out of BCRM and associated investing and a reduced financing exposure for DFIs, IFIs, and MDBs. This mini-tranche might be considered if the roll-out of BCRM, and of the overall national BP and cylinder investment projects, are stretched out in time based on the pace of Governmental decisions, the level of responsiveness and adequacy of qualifications of additional BP bidders that must emerge to expand BCRM to all of Ghana's regions, and other factors. The recommended smallest sub-tranche is for a roll-out of investment projects in the three regions with the highest share of anticipated future demand and investment: Greater Accra, Ashanti, and Western. This mini-tranche would notionally comprise:

Table 13. Potential mini-tranche
(quantities other than BPs in 000s)

	% of New Cylinders ²⁵	New BPs	New Cylinders ²⁵	Capital Investment		
				Cylinder (Gross)	Cylinder (Potential Net)	BPs/Pallets
Greater Accra	25%	2	1,063	26,865 €	8,059 €	14,488 €
Ashanti	21%	1	937	23,674 €	7,102 €	7,886 €
Western	12%	1	499	12,621 €	3,786 €	6,712 €
Total Financing Requirement				63,160 €	18,948 €	29,086 €
Gross Financing Total					92,246 €	
Net Financing Total (Potentially)					48,034 €	

At this stage of BCRM pre-rollout and project preparation, this mini-tranche is hypothetical. It is presented for indicative and illustrative purposes to suggest how an initial subset of tranche one projects, limited in scope, scale, and geography, might be aggregated, either to fit with near-term DFI/IFI/MDB financing windows or to align with a stretched-out pace of BCRM roll-out across Ghana's regions, or both.

Potential transition-cost funding

One further possible use of concessional capital is in support of two elements of the BCRM transition:

1. A national cylinder trade-in program (up to € 8.8 million); and
2. A fund (up to € 5.6 million) to support business model transitions for LPG microstation operators whose business plans justify use of such financing to reposition their firms to undertake new supply chain roles, as permitted or required under BCRM and applicable NPA rules.

These are optional additions which are not technical assistance measures *per se*, and are not aligned in scope or purpose with a consumer-oriented microfinance program.

These additional items are further described in Chapter 21.

²⁵ Includes share of existing cylinder park to be scrapped and replaced.

3. Investments at the Sector Level

This Chapter describes the investments necessary over time to achieve the governmental policy goal of LPG adoption and use by 50% of the population for cooking by 2030 in aggregate, at the sector level. This investment stream is calibrated in four main ways, and may be recalibrated in future as needed:

1. *Demand.* The growth of the sector, target user population and usage volume of the policy-goal investment scenario fall within the lower and upper bounds of the demand assessments set forth in Part IV;
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 Annex Chapters 26 and 27.
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; and
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 4 examines the investment economics and returns at the firm level.

The discussion below builds on the consumption volumes associated with reaching 50% LPG penetration by 2030 (midway between the lower bound and upper bound of penetration of the demand projections, and coincidentally consistent with the governmental policy goal), calculations of the cylinder park associated with that penetration and consumption, capacities required of the regional BPs and storage facilities, and related capital expenditures needed to bring all of these about. (Both the current LPG receiving capacities in the marine terminals and the existing means of primary transport of the product are sufficient but may require to be redeployed, assuming that the other investments described in this report—cylinders, filling plants and storage, pallets, and cages—are timely made.)

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

1. The number of users;
2. The frequency of their refilling;
3. The mix of sizes of cylinders; and

4. How and how quickly the cylinders recirculate within the supply chain.

The investments are staged in a series of approximately linear steps over ten years, both to optimize returns and minimize execution risk, except that a significant boost to branded cylinder inventory is required at the very start in order to launch BCRM.

The number of users is projected in Part IV. As elsewhere in this document, a “user” is a member of a household that uses LPG for cooking. Because Ghana has no modern history with cylinder recirculation, this analysis utilizes industry standard operational parameters for modelling. These are detailed hereafter. The refill frequency is solved for through analysis of other operational, inventory and usage statistics, and is evolved over time to converge with industry 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 Ghana for households are 6kg and 14.5kg, with existing data about the mix of sizes.²⁶ That 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 0.414 14.5kge cylinders, or 12/29ths of a 14.5kg cylinder, the most common size of cylinder in Ghana. 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, (ii) regional variations in the key parameters are large enough to be material, and (iii) the national LPG expansion strategy²⁷ is based on implementing regionally centralized bottling facilities.

Calculation of operating projections per region

Population²⁸

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

²⁶ A final decision by Government regarding what cylinder sizes will be permitted under BCRM, and what if any alternate sizes in use in Ghana must be discontinued, is still pending as of this writing. The analysis in this Part is based on the latest guidance from NPA taken together with survey data about the existing national cylinder inventory, classified by cylinder size.

²⁷ Ministry of Energy (2017); NPA (2018)

²⁸ Sources given by NPA: www.theatlas.com/charts/HJ04buM3M
www.statsghana.gov.gh/docfiles/2010phc/Projections_Districts_2015_to_2020_submit.xlsx

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 duties²⁹).

LPG consumption for cooking

The consumption information provided by the NPA is limited to the list of liftings (loading of bulk trucks in the BDC facilities) by the OMCs and the LPG Marketing Companies (LPGMCs) and reported by the BDCs.

The reported volumes do not identify the destination of the lifting, whether LPG stations or bulk customers; it is a combination of all the segments. These volumes are translated to sales of LPG in the service stations for two segments of use: autogas (car fuel) and domestic cylinder use (mainly cooking).

Since the BCRM centralizes cylinder refills and separates them from automotive refills, the autogas volumes in each region must be separated from the residential volumes in order to determine required BP refill capacities as the residential market grows.

In the northern half of Ghana in 2017, the residential kg/capita was below 3kg, while it was 5.7kg/capita for the country as a whole, corresponding to a 24.5% LPG penetration rate nationwide.

Because the official desegregated LPG volumes per segment (cylinders, bulk customers and autogas) for 2017 could not be determined, it was decided to estimate the LPG volume for domestic use in cylinders in each region calculated from the LPG penetration rate reported in GLSS 7, applied to the projected average annual consumption by LPG users of 25kg/capita from the demand assessment.

The following table gives the estimate of LPG consumption in cylinders, summing to more than 165 KT in 2017, representing 5.7kg per capita.

Table 14. Population and residential LPG consumption by region in 2017

Region	Population	LPG penetration rate	LPG consumption			
			In residential cylinders (MT)	Autogas, bulk and cylinders (MT)	Autogas and bulk only (MT)	% of LPG volume in cylinders
Upper West	811,124	6.1%	1,237	2,611	1,375	47.4%
Upper East	1,216,680	6.6%	2,008	3,057	1,050	65.7%
Northern	2,925,831	3.4%	2,487	4,422	1,935	56.2%
Brong-Ahafo	2,723,050	11.4%	7,761	26,854	19,094	28.9%
Ashanti	5,533,011	23.2%	32,091	52,039	19,947	61.7%
Eastern	3,099,641	17.1%	13,251	24,471	11,220	54.1%
Western	2,954,789	24.4%	18,024	23,894	5,869	75.4%

²⁹ GLSS 7 survey data indicate that approximately 5% of Ghanaian households do not cook for themselves.

Volta	2,491,293	17.2%	10,713	26,858	16,146	39.9%
Central	2,479,279	23.1%	14,318	29,945	15,627	47.8%
Greater Accra	4,721,889	54.1%	63,864	87,758	23,895	72.8%
Total	28,956,587	22.9%	165,753	281,910	116,157	58.8%

Sources: NPA, GLSS 7

The proportion of LPG in cylinders is almost 59% of the overall distributed LPG volume of 282 KT, and the remaining 41% (116 KT) represents the autogas and the bulk customers segments.

The analysis of the dataset containing the lifting to the LPG microstations does not allow for direct estimation of the volume of the bulk customer and autogas segments.

An estimate for the bulk customers segment, from indicators in the liftings file, would be on the level of 15-16 KT (likely 10% of the cylinder segment, a very common ratio in African LPG markets).

The estimate for the autogas segment is thus around 100 KT, giving an average microstation output for LPG autogas around 225 MT³⁰ of LPG per year per station, consistent with what has been reported on the ground in interviews in LPG stations.

The change of model to BCRM will transform many of the current cylinder refilling microstations into a cylinder exchange activity in the same locations. The closing of LPG dispensing stations for BCRM implementation may affect the supply to LPG-fueled cars. To avoid supply disruption while implementing new safety rules for autogas dispensing, it is strongly recommended to focus, as much as possible, on locating the autogas dispensing pumps in service stations. A 5 MT buried tank in each could comply with the NPA safety regulations and would be adequate to supply the current number of autogas vehicles.

Projection of LPG consumption to 2030

It is 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, compared to the south, where LPG in Greater Accra has already exceeded 50% penetration of the population.

For 2018 and 2019, an LPG annual volume growth of 2% was assumed and, for the following years up to 2030, a linear interpolation.

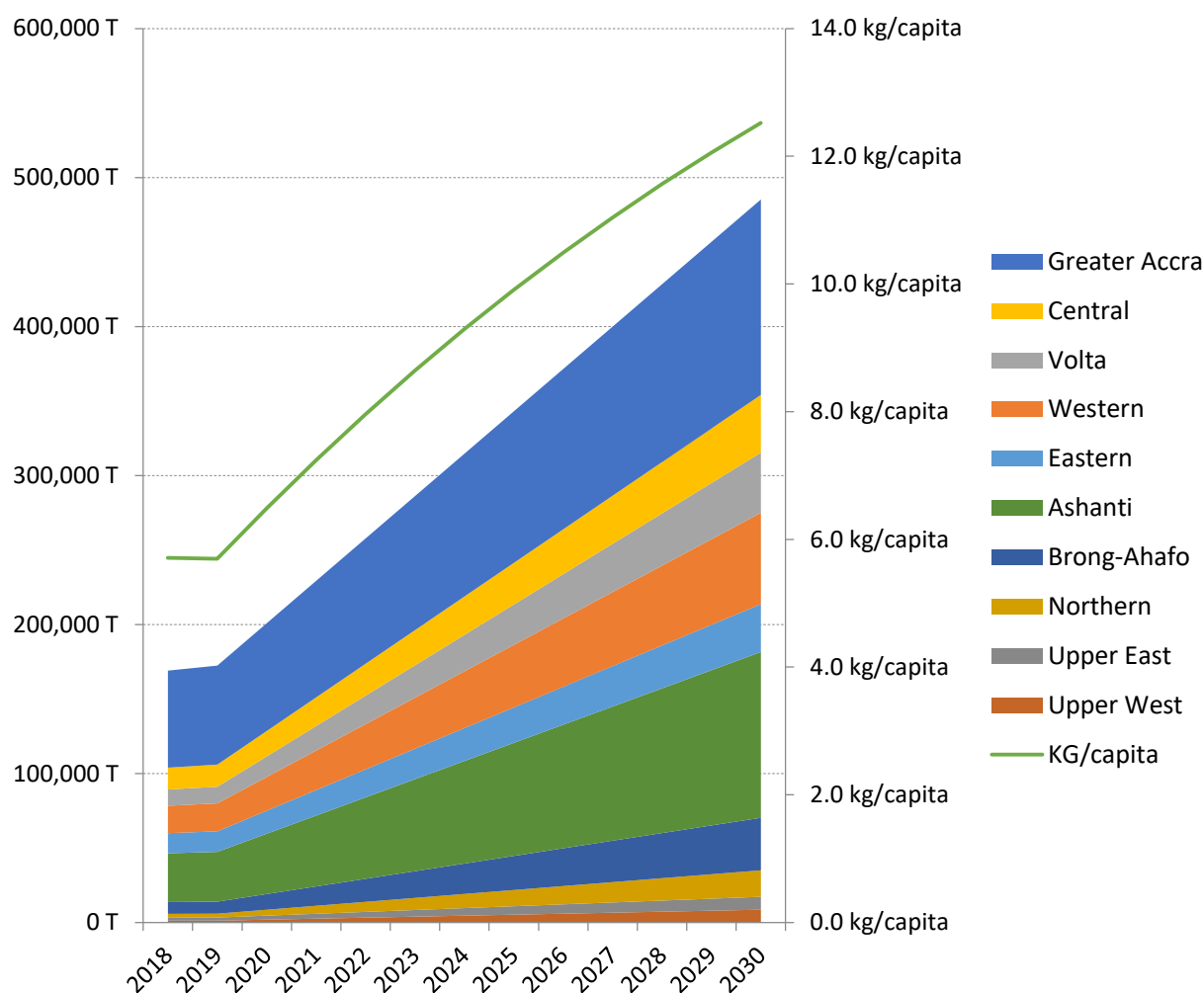
The penetration rate and consumption level per region were determined by applying the region-by-region growth projections for each from the demand analyses to the 2017 starting values. The consumption rate ramps, as in the lower bound demand scenario, to 22.6kg per capita per user, to give the projected LPG volume per region over time.

The projected volume and penetration data are summarized in Table 16 on page 53.

The following figure shows the total consumption per region that the investments in supply chain capacity will track (areas, left axis), and the corresponding national consumption per capita (users plus non-users) (line, right axis):

³⁰ The NPA station file of 2016 reports only 443 stations with sales volume, compared to the 645 officially registered. In the case that the 100 KT is sold through 645 stations, the average would be 155 MT per station per year.

Figure 7. Projection of consumption by region to 2030 for investment sizing
(Policy Goal Scenario)



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.

Summary of projected LPG volumes

LPG end-user pricing may be increased by the Government in connection with the launch of BCRM in order to cause the consumer to pay, in full or in part, for new supply-chain functions and for infrastructure capital cost recovery. The notional maximum extent of such a price increase is proposed to be € 0.123 per kg, which, if passed on fully to the end-consumer, is modelled to result in reduction in consumption volume of approximately 5.6% but negligible effect on the percentage of new households adopting LPG (and requiring 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.

Number of cylinders

In 2017, the NPA estimated that the total number of existing cylinders was 5.8 million, out of which roughly 60% were 14.5kg and 40% were 6kg, and minimal other sizes. The average rotation rate for 2017, were BRCM in effect in 2017, would be 2.85 in 14.5kg cylinders. The national result is consistent with other developing-stage LPG markets practicing BCRM (similar to Cameroon, for example). It is strongly influenced by the regions around Greater Accra, where the number of cylinders per household is higher compared to the other regions.

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 (25kg) from the demand projections.

These elements are shown in the following set of tables:

Table 15. LPG consumption by region (2017)

Region	Population ³²	LPG penetration rate	LPG consumption ³¹	
			In residential cylinders (MT)	As Autogas and in bulk (MT)
Upper West	811,124	6.1%	1,237	1,375
Upper East	1,216,680	6.6%	2,008	1,050
Northern	2,925,831	3.4%	2,487	1,935
Brong-Ahafo	2,723,050	11.4%	7,761	19,094
Ashanti	5,533,011	23.2%	32,091	19,947
Eastern	3,099,641	17.1%	13,251	11,220
Western	2,954,789	24.4%	18,024	5,869
Volta	2,491,293	17.2%	10,713	16,146
Central	2,479,279	23.1%	14,318	15,627
Greater Accra	4,721,889	54.1%	63,864	23,895
Total	28,956,587	22.9%	165,753	116,15T

Applying the region by region penetration projections from Part IV, and solving for an average penetration target of 50% nationally in 2030 for achievement of the governmental policy goal, the following regional breakdown of future regional consumption results for residential cylinders:

³¹ NPA (2018)

³² GLSS 7 (2018)

Table 16. Estimated cylinder filling volumes and penetration by region in 2017 and 2030

Region	LPG volume in cylinders (2017)	LPG volume in cylinders (2030)	Population (2030)	Penetration rate (2030)	Persons per cylinder (2017)	Persons per cylinder (2030)
Upper West	1,237 T	8,625 T	1,092,706	26.1%	22.8	5.0
Upper East	2,008 T	8,655 T	1,639,103	17.5%	21.1	7.4
Northern	2,487 T	17,786 T	3,941,688	14.9%	40.9	8.7
Brong-Ahafo	7,761 T	35,217 T	3,668,505	31.8%	12.2	4.1
Ashanti	32,091 T	111,272 T	7,454,090	49%	7.3	2.9
Eastern	13,251 T	32,163 T	4,175,895	26%	8.8	5.3
Western	18,024 T	61,281 T	3,980,687	51%	7.1	2.9
Volta	10,713 T	40,365 T	3,356,256	40%	8.8	3.4
Central	14,318 T	38,797 T	3,080,005	38%	7.3	3.5
Greater Accra	63,864 T	131,111 T	6,361,274	68%	3.2	2.2
Total	165,753 T	485,272 T	38,750,208	50%	7.2	3.4

It is possible that more than 50% of the population will cook with LPG, or that users will expand their LPG use to more than 25kg (the upper bound assumption) per year, 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 Ghanaian household that uses LPG for cooking, as discussed in Part IV, is 38 kg per year, if LPG is used exclusively for cooking all meals every day.

For purposes of this Part, incremental investment in LPG infrastructure through 2030 will result in the capacity for 50% 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.

Table 16 shows the estimated cylinder rotation rates for each region. The rotation rate under CCCM would be somewhat different from that under BCRM. Therefore, the methodology estimates the 2017 rotation rate were BCRM in effect, by layering in the effects of additional elements affecting the velocity of cylinders in the recirculation cycle that are different, or absent, under CCCM.

Table 17. Estimated cylinder rotation rates by region to 2030

Region	2017	2020	2022	2024	2026	2028	2030
Upper West	2.40	2.45	2.50	2.55	2.60	2.65	2.70
Upper East	2.40	2.45	2.50	2.55	2.60	2.65	2.70
Northern	2.40	2.45	2.50	2.55	2.60	2.65	2.70
Brong-Ahafo	2.40	2.45	2.50	2.55	2.60	2.65	2.70
Ashanti	2.90	2.92	2.93	2.95	2.97	2.98	3.00
Eastern	2.60	2.63	2.67	2.70	2.73	2.77	2.80
Western	3.00	3.02	3.03	3.05	3.07	3.08	3.10
Volta	2.60	2.63	2.67	2.70	2.73	2.77	2.80
Central	2.90	2.92	2.93	2.95	2.97	2.98	3.00
Greater Accra	3.00	3.02	3.03	3.05	3.07	3.08	3.10
National rotation rate	2.85	2.86	2.88	2.89	2.91	2.94	2.96

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 Ghana 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.

The foregoing data, in combination, predict cylinder inventory requirements (see Table 12). With an existing estimated national cylinder inventory of 4.0 million 14.5kg (5.0 million units), of which 2.0 million 14.5kg (2.49 million units) are expected to require scrapping and replacement due to their safety condition³³, the net cylinder investment requirement to 2030 is approximately 9.4 million 14.5kg cylinders (11.3 cylinder units). Translated into non-kg equivalents, they become 14 million distinct cylinders, assuming a constant proportion of 6kg and 14.5kg in the marketplace.

Table 18. Cylinder requirements to 2030, nationally and by region (000s of 14.5kg units)

Region	2017	2020	2022	2024	2026	2028	2030
Upper West	36	55	91	125	158	190	220
Upper East	58	76	107	137	166	194	221
Northern	71	112	186	257	325	391	454
Brong-Ahafo	223	297	427	552	672	788	900
Ashanti	763	957	1,284	1,608	1,928	2,245	2,558
Eastern	351	405	486	566	643	718	792
Western	414	517	690	861	1,030	1,198	1,363
Volta	284	361	494	624	750	874	994
Central	340	404	503	602	700	796	892
Greater Accra	1,468	1,653	1,912	2,167	2,420	2,670	2,917
Total 14.5kg	4,009	4,836	6,180	7,499	8,793	10,064	11,312
14.5kg	3,322	4,007	5,121	6,214	7,286	8,339	9,372
6kg	1,661	2,004	2,560	3,107	3,643	4,169	4,686
6kg+14.5kg	4,983	6,011	7,681	9,320	10,929	12,508	14,059

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 bottling plants over time.

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

The official number of existing cylinders in circulation in Ghana is not available, since the OMCs and LPGMCs have had, and still have, no responsibility for investment in cylinders and their maintenance. Moreover, the cylinders are generic, purchased directly by the end-user from a shop supplied by a wholesaler. 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

The implementation of BCRM will change the status of cylinder ownership and the responsibility for cylinder safety and maintenance. It is recommended that 100% of the existing generic cylinders be audited and tested. The safety testing of the entire cylinder park will require about 3 years.

³³ NPA (2017)

Without knowing the physical condition and safety integrity of the existing cylinders, based on private sector and governmental interviews it was assumed that 50% of the cylinders would not meet safety standards after testing in the BP or the cylinder factory, and therefore must be scrapped and replaced. It is also assumed that all cylinders of size different than 6kg and 14.5kg will be scrapped and replaced by new ones of those standard sizes, in order to harmonize all cylinders with the diameter of the conveyors in the BPs. It is also assumed that the valve must be harmonized to 3 or 4 maxima, also for the productivity of the BP.

Beyond the replacement of the 2.4 million total cylinders (2.0 million 14.5kg) to be scrapped by new ones, the remaining cylinders will have to be repaired and identified by the BP with proper brand and operational markings, like date of validation, date of next revalidation, and serial number.

For estimating the retesting and repairing cost, the calculation was based on the ratio used in the LPG industry for a cylinder park that is 30 years old, in well-maintained condition and transported with pallets (not in bulk onto the trucks):

- The number of cylinders to be repaired: 0.95% of the cylinder park;
- The number of cylinders to be retested annually: 10% of the cylinder park, if the safety procedures in the bottling plants are properly applied;
- In the case of no mark of year of construction, the cylinder is supposed to be scrapped and replaced;
- Every cylinder more than 40 years old must be scrapped;
- Every cylinder more than 10 years requesting a hot repair³⁴ must be scrapped.

These criteria have no influence on the rest of this analysis but need to be defined and known by the bidders.

Current cylinder size breakdown

The breakdown of the current cylinder park by sizes, provided by GCMC, the leading Ghana cylinder manufacturer, is as follows, noting that two sizes represent 90% of the park. Based on this, all calculations have been done on “14.5kg equivalent” (kge) basis, meaning that about 2.4 cylinders of 6kg are counted as one cylinder of 14.5kg:

Table 19. Cylinder park breakdown by size

Cylinder size	Percent of total
6kg	30%

³⁴ Hot repair describes a series of treatments in a specialized oven to reduce the deformations of steel plate due to shocks in transportation of the cylinders. Usually the oven of a cylinder factory is to be used for these treatments. Here, it is recommended that any old cylinder seen as requiring hot repair is scrapped, because the cost of the hot repair can be 60% of the cost of a new cylinder.

Cylinder size	Percent of total
14.5kg	60%
Others (3, 12.5, 45kg)	10%

The recommendation of the BCRM implementation committee is to only have 3 sizes: 3kg, 6kg, and 14.5kg. The 6kg and the 14.5kg can be filled on the same conveyor and move on the same carousels, while the 3kg has a lower diameter and must have its own conveyor and carousel.

The regional centralization of filling in BPs requires a harmonization of the diameter of the foot and shroud of the cylinder. In this study, the width of the conveyors, corresponding to the diameter of the cylinders, is assumed to be only for cylinders with a diameter between 300 and 310mm, which are the diameters of the 6kg and of the 14.5kg, together representing 90% of the sizes in the country. In case cylinders of 3kg are demanded in large numbers by some segments of end-users, either manual bottling lines would be added in investment Phase 1, or a small dedicated carousel will be added, likely in Phases 2 and 3. Any cylinder with a different diameter will have to be excluded and scrapped.

Calculation of the annual quantities of cylinders to be acquired

The total number of additional cylinders (7.3 million of 14.5kg) 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 650,000 cylinders per year.

Table 20. Projected 14.5kg cylinder quantities required to 2030 (in two-year increments)

Region	2020	2022	2024	2026	2028	2030
Upper West	19,459	35,704	34,304	32,984	31,740	30,564
Upper East	17,909	31,422	30,190	29,029	27,933	26,899
Northern	40,263	73,996	71,094	68,360	65,780	63,344
Brong-Ahafo	73,734	130,206	125,100	120,288	115,749	111,462
Ashanti	193,713	327,497	323,797	320,158	316,581	313,064
Eastern	53,324	81,352	79,344	77,408	75,543	73,745
Western	102,745	172,962	171,072	169,212	167,383	165,583
Volta	77,305	132,877	129,596	126,435	123,389	120,451
Central	63,108	99,875	98,746	97,637	96,546	95,473
Greater Accra	185,274	258,239	255,416	252,640	249,909	247,222
Total	826,833	1,344,130	1,318,659	1,294,153	1,270,553	1,247,806
Cumulative Total						7,302,134

Translated into non-kg, the 7.3 million of 14.5kg become 10.8 million cylinder units.

Cylinders to be scrapped and replaced at the launch of BCRM

At the launch of the BCRM, all existing cylinders in the hands of the end-users will have to be tested and certified for compliance with the safety requirements of LPG cylinders. The non-certified ones will be scrapped and replaced by new ones. In the absence of trusted data, since the current cylinders belong to the end-users, most of the stakeholders linked with the sector are estimating that about half of the existing cylinders would have to be scrapped and replaced.

Assuming 4.9 million existing cylinders (4 million 14.5kge), about 2.5 million cylinders (2 million 14.5kge) would have to be replaced equally over the first three years. (The process of safety auditing and hydrotesting of every cylinder will produce an exact count of the number to be scrapped and replaced.) The remaining 2.0 million will also be inspected and hydrotested and will receive essential maintenance including change of valve, repainting and branding.

Total number of cylinders for investment

The total number of 14.5kge cylinders for investment will be 7.3 million + 2.0 million, making 9.3 million of 14.5kge, or 11.8 million in non-kge.

This investment plan can self-adjust the pace of the investment downward, 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.

Annual cylinder quantities in the first three years

The following table shows the number of cylinders for investment in the initial phase, in 14.5kge:

Table 21. Annual cylinder quantities 2019-2021

Cylinder category	2019	2020	2021
New cylinders	413,417	413,417	672,065
Replacement of scrapped cylinders	666,667	666,667	666,667
Total for BCRM launch	1,080,084	1,080,084	1,338,732

Total cylinder investment

The total investment for all the cylinders to 2030 is € 235.2 million, comprised of:

- € 185.5 million for the additional 7.3 million 14.5kge cylinders, representing an annual investment flow of about € 15 million.
- € 49.7 million for the cylinders to be replaced during the first years of the launch of BCRM.

The following table details the staging of the entire cylinder investment:

Table 22. Total cylinder investment required to 2030
(€ mm, shown in two-year increments)

Category of cylinder	2020	2022	2024	2026	2028	2030
New 14.5kge cylinders	20.91 €	33.99 €	33.34 €	32.72 €	32.13 €	31.55 €
Replacement of scrapped cylinders	33.71 €	16.86 €				

Category of cylinder	2020	2022	2024	2026	2028	2030
Total investment ³⁵	54.62 €	50.84 €	33.34 €	32.72 €	32.13 €	31.55 €
Cumulative total						235.2 €

Investment in cylinders is an annual process, adjusted according to market trends. 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 illegal cross-filling or diversion of cylinders by competitors.

The estimated 11.47 million of 14.5kg cylinders in circulation by 2030 includes all cylinders in use, in stock, sitting idle, located with consumers, at distribution points, at the BPs, in transition (recirculation) in trucks, and in transition for maintenance. The total number of cylinders in the working stock grows from 506,000 in 2020 to 865,000 in 2030 and is included in the counts of existing cylinders not scrapped and additional cylinders purchased.

Table 23. Cylinder working stock levels by region to 2030
(in 14.5kg, shown in alternate years)

Region	2020	2022	2024	2026	2028	2030
Upper West	4,924	6,605	8,286	9,967	11,648	13,329
Upper East	6,767	8,272	9,776	11,280	12,784	14,288
Northern	10,002	13,483	16,965	20,447	23,928	27,410
Brong-Ahafo	26,564	32,782	39,000	45,218	51,436	57,654
Ashanti	101,976	119,818	137,660	155,501	173,343	191,185
Eastern	38,950	43,160	47,370	51,579	55,789	59,999
Western	56,996	66,739	76,481	86,224	95,966	105,709
Volta	34,779	41,472	48,166	54,860	61,553	68,247
Central	43,012	48,487	53,963	59,438	64,913	70,388
Greater Accra	182,245	197,059	211,873	226,688	241,502	256,316
Total	506,215	577,877	649,539	721,201	792,863	864,525
Net change	506,215	71,662	71,662	71,662	71,662	71,662

By comparison, the National LPG Policy Implementation Committee estimated that 12.4 million cylinders are expected to be needed to run the BCRM from the outset, based on 4 million households with two cylinders per household, 2 million held at the dealer level, 1 million en route to the BPs, 1 million at the BPs for refilling, and 0.4 million in maintenance. (These amounts do not include any scrappage of cylinders.)

The gap is explained by a difference in counting: one calculation sums all the cylinders, while the other uses a uniform size equivalence in order to apply a common rotation rate, in order to ensure consistency with the fuel consumption volumes generated by the cylinders in circulation.

³⁵ Based on quotations obtained and valid for September 2018, import audit services costs excluded. The cost of a 6kg cylinder is typically higher per kg than a 14.5kg cylinder, per kg.

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

- Import audit service is not included;
- The specifications of the cylinder (propane specs) are the basic-level ones, and could be improved;
- The valve (clip-on) is included and mounted;
- The unit price for 14.5kg cylinders: 25.3 € (139 Cedis³⁶).

Projected bottling capacity and number of bottling plants

The bottling capacity requirement is defined by the peak consumption in a year, increased by a safety factor. The peak of consumption is related to seasonality. There being no definitive information available on the consumption seasonality of the LPG in cylinder use in Ghana, the bottling 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 24. Theoretical maximum bottling capacity required to 2030 (MT)

Region	City	2020	2022	2024	2026	2028	2030
Upper West	Wa	2,300	4,600	5,750	6,900	9,200	10,350
Upper East	Bolatanga	3,450	4,600	6,900	8,050	9,200	10,350
Northern	Tamale	4,600	8,050	11,500	14,950	18,400	20,700
Brong-Ahafo	Sunyani	12,650	18,400	24,150	29,900	35,650	41,400
Ashanti	Kumasi	47,150	63,250	79,350	95,450	112,700	128,800
Eastern	Koforidua	18,400	21,850	26,450	29,900	33,350	37,950
Western	Sekondi	26,450	35,650	44,850	52,900	62,100	71,300
Volta	Ho	16,100	23,000	28,750	34,500	41,400	47,150
Central	Cape Coast	20,700	25,300	29,900	35,650	40,250	44,850
Greater Accra	Accra	83,950	97,750	110,400	124,200	138,000	151,800
Total		235,750	302,450	368,000	432,400	500,250	564,650

Bottling Plant capacities

The required total bottling capacity is estimated to be 557 KT per year, with one or two shifts of operations (labor) depending on the region, to serve the consumption corresponding to the national policy goal. This nameplate capacity allows for 16% of flexibility to cover all peak needs throughout the year.

In two regions (Greater Accra, Ashanti), a second bottling plant would be eventually required as the capacity of the first plant is outgrown. (The location of each second regional plant should be chosen to optimize transport logistics costs for the cylinders within the region.)

The investment projects are designed to cover expansion of bottling capacity across three phases, following step-wise the growth in the number of cylinders and associated refills required to achieve the national goal.

³⁶ Using an exchange rate of 5.5 cedis per Euro

The three phases of investment are:

1. Years 2019-2020: 8 BPs totaling 302 KT of bottling capacity
2. Years 2023-2024: 2 additional BPs and an increase to 429 KT of overall bottling capacity
3. Years 2028-2029: For the 10 BPs, an increase to 557 KT of bottling capacity

Location of the BPs

The following two tables show the number of BPs and their locations across the three phases and their capacity requirements, respectively.

Table 25. Bottling Plant regional rollout to 2029

Region	City	2019-20	2023-24	2028-29
Upper West	Wa			
Upper East	Bolatanga	1	1	1
Northern	Tamale			
Brong-Ahafo	Sunyani		1	1
Ashanti	Kumasi	1	2	2
Eastern	Koforidua	1	1	1
Western	Sekondi	1	1	1
Volta	Ho	1	1	1
Central	Cape Coast	1	1	1
Greater Accra	Accra	2	2	2
Total		8	10	10

Table 26. Bottling Plant capacity requirements by region to 2030

Region	City	2020 to 2022	2024 to 2026	2028 to 2030
Upper West	Wa			
Upper East	Bolatanga	46,000 MT	51,000 MT	74,000 MT
Northern	Tamale			
Brong-Ahafo	Sunyani		35,000 MT	49,000 MT
Ashanti 1	Kumasi	55,000 MT	55,000 MT	55,000 MT
Ashanti 2			23,000 MT	45,000 MT
Eastern	Koforidua	31,000 MT	50,000 MT	68,000 MT
Western	Sekondi	31,000 MT	44,000 MT	56,000 MT
Volta	Ho	22,000 MT	33,000 MT	45,000 MT
Central	Cape Coast	27,000 MT	34,000 MT	45,000 MT
Greater Accra 1	Accra	45,000 MT	52,000 MT	60,000 MT
Greater Accra 2		45,000 MT	52,000 MT	60,000 MT
Total		302,000 MT	429,000 MT	557,000 MT

In Phase 1, eight BPs will be located in the above-mentioned regions, sited according to current regional consumption of LPG. The three Northern regions (Upper West, Upper East and Northern) will be supplied by the bottling plant of the Brong-Ahafo region. A regional depot, comprising a large fenced area with guards and forklifts to load and unload pallets of cylinders, under the control of the BP of Brong-Arafo,

would be set to have a stock of cylinders to be dispatched to the marketing companies (OMCs/LPGMCs) and distributors.

In Phase 2, one BP will be constructed in the Northern region (Tamale) to supply the regions of Upper West and Upper East during Phases 2 and 3. If there is a strong acceleration of cylinder uptake and refill volume growth in these two regions, the construction of an additional BP there could be justified. The minimum recommended size of a BP is 20,000 MT of refilling per year, which ensures a minimum turnover (revenue) to cover a sufficient organizational structure of skilled staff needed to deliver on quality and safety in the refilling, inspection and maintenance of cylinders.

Bottling Plant investment

The total required investment across the three phases, starting in 2019, is estimated to be € 86.7 million, based on indicative costing analysis of the facilities. (Technical details are included in the Annex.) The BP investment represents about € 156 per tonne of bottling capacity, a reasonable productivity level for the investment by international LPG industry standards.

The investment per phase is:

- Phase 1: **€ 52.8 M** for 302,000 MT of bottling capacity
- Phase 2: **€ 21.6 M** for the additional 127,000 MT of bottling capacity
- Phase 3: **€ 12.3 M** for the additional 128,000 MT of bottling capacity

Due to the required high level of productivity, the plants have been designed and costed with automatic pallet loaders. The investment need includes 18,000 pallets at an indicative cost of € 5.7 million.

Also included are facilities for painting and re-testing of cylinders within the BPs during the implementation of BCRM, through the construction of a dedicated “cylinder maintenance hall.” This avoids transportation cost of cylinders to and from an external refurbishment plant, and provides an additional buffer stock of cylinders and pallets to cover cylinders’ downtime for maintenance.

Breakdown of the BP investment per region

Table 27. Summary of Bottling Plant investment by region and phase

Region	Phase 1	Phase 2	Phase 3	Total
Upper West (Depot)	50,000 €	-	-	50,000 €
Upper East (Depot)	50,000 €	-	-	50,000 €
Northern	50,000 €	8,286,117 €	1,659,000 €	9,995,117 €
Brong-Ahafo	7,109,867 €	20,000 €	428,750 €	7,558,617 €
Ashanti 1	7,098,923 €	- €	- €	7,098,923 €
Ashanti 2	- €	5,902,211 €	905,900 €	6,808,111 €
Eastern	6,671,705 €	49,640 €	837,500 €	7,558,845 €
Western	6,258,395 €	49,640 €	408,750 €	6,716,785 €
Volta	5,764,277 €	511,154 €	428,750 €	6,704,181 €
Central	6,192,179 €	47,292 €	428,750 €	6,668,221 €
Greater Accra 1	6,761,309 €	- €	408,750 €	7,170,059 €
Greater Accra 2	6,761,309 €	6,761,309 €	6,761,309 €	20,283,927 €
Total	52,767,964 €	21,627,363 €	12,267,459 €	86,662,786 €

About the cylinder depots in the northern regions

The € 50,000 for the Upper West, Upper East and Northern regions in Phase 1 is an estimate for the fencing of the plot of land, a forklift to load and unload pallets of cylinders, and a simple office with genset³⁷. These facilities will serve as a central dispatch depot, supplied by large carriers of palletized cylinders from the Brong-Arafo Bottling Plant in Phase 1, and from Tamale in Phases 2 and 3. The cost of primary transportation of cylinders in pallets from the BP to the regional cylinder depot is estimated at € 22-28€/tonne in the first instance, depending on the exact location of the depot.

Diameter of the cylinders

For the consistency and the productivity of the BP design and investment, all cylinders received to be refilled are supposed to have a harmonized diameter of 300-310mm, corresponding to the width of the cylinder conveyors, and the dimensions of the cylinder pallets. Since the BPs will be equipped with carousels and conveyors, the width of the conveyor is fixed and cannot be changed. The selection of standardized cylinders of 5kg, 6kg, 9kg, 12kg or 14.5kg would have to match the size of conveyor and pallet, unless there is a justification to build a separate carousel with adapted conveyors for the new cylinder diameter(s). This width assumption has been made to ensure bottling of the existing 6kg and 14.5kg cylinders only. The refilling head of the scale in the carousel will be adapted to the two existing valves to enable bottling: the clip-on valve and the “camping gaz” valve.

Concerning the “camping gaz” valve

The “camping gaz” valve is not an ideal choice of valve, but it has been disseminated in many markets. This valve requires a permanent safety control and periodic replacement, because leakages can occur very easily, such as from the presence of dust or sand from the handling of the cylinder. Prevention of problems is difficult, due to often-harsh conditions of use of this small cylinder on the ground.

Bottling Plant design

BP design, operation and outfitting are presented in the Annexes.

LPG storage capacity

The current total storage capacity of 22,690 MT could supply more than 544,000 MT/year of LPG for cylinder with a storage ratio of 24 (i.e., 24 fillings per year). Assuming the autogas and bulk customer segments remain at approximately the same level, this import storage capacity is sufficient to cover about a 600,000 MT market.

If the storage ratio were to be optimized to 36, the storage capacity could accommodate a total supply volume of more than 800,000 MT/year, including the current volume of autogas (approximately 100,000 MT/year) and bulk customers (approximately 16,000 MT/year).

³⁷ A genset is a device generating electricity from a diesel engine, typically used during electrical grid blackouts or in off-grid locations.

In conclusion, except for operational purposes and aiming at optimizing the investment cost of the import facility to get the lowest throughput cost per tonne, there is no necessity to increase the existing import capacity.

Projection of storage capacity of the BPs

The LPG storage capacity of a BP is calculated to address the risks of supply disruptions during the primary bulk transportation of LPG to the BP. 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 BP without difficulties corresponds with the vicinity of the BP from the depot where the truck is loading the LPG, taking into account the queueing of the truck, the change of driver, any labor working hours constraint, the break time for the driver, the traffic speed, the quality of the road, *etc.*

If the BP is located within a 50km distance, one or two daily round trips can easily be done, and the storage capacity can be reduced accordingly, because the risk of trucks being delayed is very low. The proximity of the BP with the 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 BP to have more

storage capacity, reduce any risk of supply disruption and avoid any scarcity situation due to the long transportation time;

- “36” for BPs less than one day transport from the source of the product, and
- “52” for any BP located near the import terminals and/or refineries, where the product is located.

The following tank rotation rates were used to calculate the storage capacity of each BP:

Table 28. Standard tank rotation rates for each Bottling Plant

Region	Rotation Rate
Upper West	24
Upper East	24
Northern	24
Brong-Ahafo	36
Ashanti	52
Eastern	52
Western	52
Volta	52
Central	52
Greater Accra	52

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

- It will not be possible to change the capacity of the storage 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 8. Examples of spherical and bullet tanks



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

Table 29. 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

The final projection of the storage capacities of the BPs is as follows:

- In Phase 1, 7,750 MT, corresponding to a rotation rate of 39. This rotation is possible because the biggest part of the volumes are located close to the loading depots.
- In Phase 2, the storage capacity will be 10,500 MT, with rotation rate of 41.

- In Phase 3, the storage capacity will be 14,000 MT, with a rotation rate of 40.

These rotation rates ensure an excellent return on the storage investment.

Table 30. Projected storage capacity by region by investment phase

Region	City	Phase 1	Phase 2	Phase 3
Upper West	Wa			
Upper East	Bolatanga		2,000 MT	3,000 MT
Northern	Tamale	1,250 MT		
Brong-Ahafo	Sunyani		1,250 MT	1,500 MT
Ashanti 1	Kumasi	1,250 MT	1,250 MT	1,250 MT
Ashanti 2			500 MT	1,000 MT
Eastern	Koforidua	1,000 MT	1,000 MT	1,500 MT
Western	Sekondi	1,000 MT	1,000 MT	1,250 MT
Volta	Ho	500 MT	750 MT	1,000 MT
Central	Cape Coast	750 MT	750 MT	1,000 MT
Greater Accra 1	Accra	1,000 MT	1,000 MT	1,250 MT
Greater Accra 2		1,000 MT	1,000 MT	1,250 MT
Total		7,750 MT	10,500 MT	14,000 MT
Average rotation rate		39.0	40.7	39.8

Strategic reserve storage capacity

The consumption of LPG for cooking in 2030 in line with the national policy goal will be approximately 485,000 MT per year, or 40,000 MT per month. The existing LPG storage capacity (22,690 MT + 36,000 MT), plus storage at the new BP sites of 14,000 MT, for a total of about 73,000 MT, will store over 50 days' consumption of LPG at the 2030 volume. 30 days' consumption is a usual rule in the LPG industry, especially when the country is surrounded by, and importing from, producing countries.

Any storage capacity above that level 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.

Cylinder refill distribution network investment

The responsibility for the implementation of the distribution network of the cylinder refills and the means of transportation of refills/cylinders will be defined in the forthcoming licensing rules. It is expected that the OMCs and LPGMCs will have the primary role of transitioning and further developing the distribution and retail-point networks throughout the country.

Primary transportation of bulk LPG to the BPs

The estimated cost of primary transportation of LPG to the BPs from the main supply points (Atuabo and Tema) is 23 €/MT in Phase 1 and close to 30 €/MT in Phase 3, when the northern volumes will have grown. (This cost will be covered via the national LPG pricing structure described in Chapter 10 of the Feasibility Study.)

Bulk transportation

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

The positioning of the BP 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).

As a general rule, it is more economical and professional to have BP capacity above 20KT/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 20KT/year, it was assumed to have a cylinder depot supplied by the BP of a neighboring region, as shown in Table 25 on page 60. This rule must be weighed against the cost of cylinder secondary transport.

It is recommended that the rollout of the BPs, as much as possible, be based on economic criteria, rather than on administrative sequencing³⁸. 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.

The growth in number of BPs from 8 to 10, and the increased capacity projection for 305,000 T/year to 557,000 T/year, are shown in Table 25 and Table 26 on page 60, respectively.

Estimate of the cost of primary bulk transportation

The calculation of the cost of primary transportation of bulk LPG from the depots to the BP varies from 23€/MT in 2020 to 30€/MT in 2030, taking into account the growth of volume in the northern regions, which are located farther away from supply. This calculation could also help define the transportation cost in the price structure to set the perequation fee for primary bulk transportation. (See the Feasibility Study for details.) 30€/MT is recommended to make uniform the ex-BP price nationwide, via a transportation differential.

Table 31. Bulk transport costs by region to 2030

(€ mm, except €/MT values)

Trip	Distance	2020	2022	2024	2026	2028	2030	€/MT (2030)
Atuabo-Bolgatanga	880 km							
Atuabo-Wa	760 km	1.10 €	1.68 €	1.93 €	2.46 €	3.00 €	3.53 €	100.6 €
Atuabo-Tamale	720 km							

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.

³⁸ As of this writing, it is not yet known in what sequence of regions the Government intends to license regional BPs.

Trip	Distance	2020	2022	2024	2026	2028	2030	€/MT (2030)
Atuabo-Sunyani	410 km			1.17 €	1.45 €	1.73 €	2.02 €	57.3 €
Tema-Kumasi	275 km	1.55 €	2.10 €	2.64 €	3.19 €	3.73 €	4.28 €	38.4 €
Tema-Koforidua	100 km	0.22 €	0.26 €	0.31 €	0.36 €	0.40 €	0.45 €	14.0 €
Tema-Secundi	250 km	0.79 €	1.06 €	1.33 €	1.60 €	1.87 €	2.14 €	34.9 €
Tema-Ho	170 km	0.33 €	0.45 €	0.58 €	0.71 €	0.83 €	0.96 €	23.8 €
Tema-Cape Coast	180 km	0.43 €	0.54 €	0.65 €	0.76 €	0.87 €	0.98 €	25.1 €
Tema-Accra	30 km	0.30 €	0.35 €	0.40 €	0.45 €	0.50 €	0.55 €	4.2 €
<i>Price km.tonne 0.07 €/MT</i>	Total	4.72 €	6.45 €	9.01 €	10.97 €	12.93 €	14.89 €	30.0 €
	€/MT	23 €/T	25 €/T	29 €/T	30 €/T	30 €/T	31 €/T	

65% of the cost of transportation is generated from Tema, 35% from Atuabo.

These calculations can potentially be adjusted downward, as soon as there is substantial market growth, allowing transporting companies to find synergies in logistics by reducing the time a truck remains idle.

Primary transport capacity

There are about 300 Bulk Road Tankers (BRTs) in Ghana including the 193 officially registered with the NPA for LPG transport differential. (The Ghanaian licensing term for these tankers is Bulk Road Vehicle, or BRV.)

Those 193 BRTs are large enough to ensure the transport of the projected volume for 2030. 157 BRTs cover the exact need of primary transportation for 2030 (485 KT).

The calculation is based on one BRT of 24 MT average capacity transporting 3,120 MT per year, assuming an average round trip of two days, working five days per week.

Determining the number of cylinders in the 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 BP: 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 (bottling plant and trucks) are optimally used.

Determining the number of pallets and cages (display racks)

As in most well-developed LPG markets, the cylinder should be transported in pallets to ensure safety (for example, 2 cylinders cannot be in contact when in transportation, per ADR³⁹ rules). It is recommended that all the transportation of cylinders from and to the BPs be executed in pallets for safety reasons. Thus pallets will be used in the BPs, on the cylinder trucks and in the warehouse. Standard pallets contain 35 cylinders of 300mm diameter cylinders (applicable to both 14.5kg and 6kg). To achieve high throughput, the BPs have been designed with an automatic pallet loader. The 14,000 pallets represent an additional investment of € 5.7 million by the BP.

Pallets have a positive side-effect of increasing productivity at the BP, because the discharging of a cylinder truck with a forklift accelerates offloading, reduces safety problems, and ensures good control over the accurate counting of cylinders.

The cylinders in the retail network will be presented in cages or display racks (see Figure 9 below). The cages will be placed outside the retail shop, petrol station, dedicated gas-seller, *etc.*, preferably in the shade.

These cages will be designed to ensure the following functions:

- Store the cylinders, preferably in a vertical position;
- Protect the cylinders against shock and severe weather;
- Make the cylinder delivery easy for the deliveryman and the seller;
- Protect against theft.

About 300,000 cylinders, corresponding to 4 days' consumption, will be stored in the cages. The estimated cost of a cage is around 20 €/cylinder. A 20-cylinder cage would cost around 400 €. The cage investment is made by the retailer.

Figure 9. Examples of cylinder cages



The following table sets forth the number of pallets and cages to be added:

³⁹ The RID/ ADR is an international agreement of safety rules concerning the transportation of hazardous goods, including LPG in cylinders and in bulk. These rules are applicable and followed in most countries.
www.unece.org/trans/danger/publi/adr/adr2017/17contentse0.html

Table 32. Quantities of new cylinders, pallets, and cages to 2030
(shown in alternate years)

Number	2020	2022	2024	2026	2028	2030	Total
14.5kg cylinders	826,833	1,344,130	1,318,659	1,294,153	1,270,553	1,247,806	7,302,134
Pallets	8,373	1,185	1,185	1,185	1,185	1,185	14,300
Cages	213,143	30,173	30,173	30,173	30,173	30,173	364,010

The pallet requirement by region are as follows:

Table 33. Quantities of new pallets to 2030 by region
(shown in alternate years)

Region	2020	2022	2024	2026	2028	2030
Upper West	81	28	28	28	28	28
Upper East	112	25	25	25	25	25
Northern	165	58	58	58	58	58
Brong-Ahafo	439	103	103	103	103	103
Ashanti	1,687	295	295	295	295	295
Eastern	644	70	70	70	70	70
Western	943	161	161	161	161	161
Volta	575	111	111	111	111	111
Central	711	91	91	91	91	91
Greater Accra	3,015	245	245	245	245	245
Total	8,373	1,185	1,185	1,185	1,185	1,185
Cumulative						14,300

Main elements of investment

The following tables break out the investment for each type of asset by region and by investment stage.

Table 34. Total Bottling Plant investment requirement by region and investment phase

Region	Phase 1	Phase 2	Phase 3	Total
Upper West (Depot)	50,000 €	- €	- €	50,000 €
Upper East (Depot)	50,000 €	- €	- €	50,000 €
Northern	50,000 €	8,286,117 €	1,659,000 €	9,995,117 €
Brong-Ahafo	7,109,867 €	20,000 €	428,750 €	7,558,617 €
Ashanti 1	7,098,923 €	- €	- €	7,098,923 €
Ashanti 2	- €	5,902,211 €	905,900 €	6,808,111 €
Eastern	6,671,705 €	49,640 €	837,500 €	7,558,845 €
Western	6,258,395 €	49,640 €	408,750 €	6,716,785 €
Volta	5,764,277 €	511,154 €	428,750 €	6,704,181 €
Central	6,192,179 €	47,292 €	428,750 €	6,668,221 €
Greater Accra 1	6,761,309 €	- €	408,750 €	7,170,059 €
Greater Accra 2	6,761,309 €	6,761,309 €	6,761,309 €	20,283,927 €
Total	52,767,964 €	21,627,363 €	12,267,459 €	86,662,786 €

Table 35. Total cylinder, pallet and cage investment requirement by region and investment phase (€ mm)

Asset type	2020	2022	2024	2026	2028	2030	Total
Additional cylinders (14.5kge)	20.91 €	33.99	33.34	32.72	32.13	31.55	184.63 €
Cylinders to replace scrapped existing cylinders	33.71 €	16.86					50.57 €
<i>Subtotal Cylinders</i>	54.62 €	50.84	33.34	32.72	32.13	31.55	235.20 €
Pallets	3.32 €	0.47	0.47	0.47	0.47	0.47	5.66 €
Cages	4.26 €	0.60	0.60	0.60	0.60	0.60	7.28 €
Total	62.20 €	51.92	34.42	33.80	33.20	32.62	248.15 €

Pallets are a BP investment, cages a Retailer investment.

Limitations of underlying data

Due to the lack of availability of certain key data, like the market volumes of LPG in cylinders, per region, and the size and condition of the national cylinder inventory, the calculations in this Chapter were based upon assumptions which may, upon further detailed investigation, require updating for improved accuracy. It was beyond the scope of this reporting effort to perform a detailed audit and field survey for bottom-up calculation of key values and ratios.

Total investment

Set forth in Table 30 are the components of the total investment for the cylinders, BPs, pallets and cages of € 335 million, or about € 8.6 per capita in 2030. Total investment in cylinders of € 235.2 million represents about 70% of the total investment, consistent with a usual 60% ratio benchmark when taking into account the adequate prior investment in import terminals and bulk depot capacity.

Table 36. Summary of investment to 2030, by asset type

Asset type	Amount (€ mm)	Per capita (2030)
10 Bottling Plants	86.7 M €	2.2 €/capita
Additional cylinders	184.6 M €	4.8 €/capita
Cylinders to replace scrapped existing cylinders	50.6 M €	1.3 €/capita
<i>Subtotal Cylinders</i>	<i>235.2 M €</i>	<i>6.1 €/capita</i>
Pallets	5.7 M €	0.1 €/capita
Display racks/cages	7.3 M €	0.2 €/capita
Total⁴⁰	334.9 M €	8.6 €/capita

Note: The cost of additional vehicles (BRVs and cylinder trucks) is excluded from the overall investment plan, because vehicular services for bulk LPG distribution are adequate through 2030, and there is no constraint on the use (or acquisition and financing) of cylinder-transport vehicles.

The investment cost to develop LPG for clean cooking in Ghana comes to under € 9/capita, excluding potentially useful technical assistance measures. This comprises a complete change of value chain model to BCRM from CCCM, the replacement of about 50% of the existing cylinders, and investment in new

⁴⁰ Amount does not add exactly due to rounding.

cylinders to reach 50% penetration of the population. One may extrapolate this figure to about € 20/capita for a 100% penetration rate, inclusive of the import terminal.

Measured on a per-household basis, the € 8.6/capita value is approximately € 34 per Ghanaian household, with the investment spread over twelve years. (The useful life of the assets is at least 20 years, and potentially up to 50 years.) Adding the cost of a typical basic Ghanaian LPG stove (€ 37), the cost per household comes to approximately € 70. LPG stoves have a useful life of about 10 years. This € 70 value is consistent with infrastructure and equipment costs experienced by other LMICs executing major LPG scale-up programs.

Overview of investment project assumptions and methodology

The assumptions and methodology are based on what the NPA has indicated to GLPGP, as described in detail in the Feasibility Study and as follows:

1. 8-10 BPs will be constructed in 8-10 different locations that must be identified by the NPA. (In this report, 10 BPs are used.) The locations will then define the areas the consumption of LPG is attached to, in reference to the projected refilling volumes.
2. The approximately 650 LPG microstations, active and inactive, will be divided into those permitted to pump autogas, and under what conditions, and those others permitted to transition into retail points (cylinder exchange points, or CEPs). It is essential that no disruption or shortage of refill supply occur at the start of the implementation.
3. The OMCs and LPGMCs will own and/or contract with the CEPs. The OMCs/LPGMCs will be licensed to develop cylinder distribution networks for BCRM. In parallel, it is possible that the closure of some LPG microstations for cylinder business and the transformation of others into a CEP could result in compensation to the owners⁴¹. The present study does not evaluate this possibility or estimate its economic effects, because any such compensation possibility as of this writing is entirely hypothetical, and subject to ongoing debate among the government and stakeholders.
4. Investment in the cylinders and branding should ideally come from the BP companies. This must be confirmed by the NPA. Nevertheless, the trending NPA guidance as of this writing is that the cylinder investment and branding will be done by the (much larger and more fragmented set of) LPG Marketers. Because there are many more Marketer companies than BP companies, and because Marketers investing in cylinders would have only cylinders as their main asset, the results of having cylinder investment and branding by the Marketers are expected to be (i) reduced bankability for the cylinder investment, (ii) greater investment risk for investors whose funds go to cylinder acquisition, (iii) greater regulatory burden with respect to oversight of cylinder handling, brand and property rights protection, and safety.
5. The specification of the LPG must be precisely defined in regulation, because it affects the mass balance of the BP and the quality and efficiency of combustion in car engines (autogas). For other purposes, such as for industrial users (bulk customers), it may be necessary or desirable to use

⁴¹ As of this writing, such compensation has been lobbied for by certain of the affected businesses, and the Government has not determined that compensation will be provided.

more propane. The fuel specification for autogas typically requires 50-60% propane for best performance. LPG for domestic cylinders is ideally butane, which contains more heat per kilogram than propane and can be safer to handle than propane, because butane liquefies under much lower pressure than propane. The current standard in Ghana specifies a maximum LPG vapor pressure that corresponds to approximately 70% propane content⁴².

It is recommended to segregate, if possible, the specification of LPG into 3 types:

- 60% minimum propane for autogas (potentially up to 80% propane)
- 80% minimum butane for domestic cylinders (potentially up to 100% butane)
- 90% maximum propane for industrial use (potentially up to 95% propane)

Segregation into three different mix specifications could have three different prices structures, one per mix. This recommendation aims at ensuring a low safety risk for households and proper frames of use of the propane and butane produced by Ghana. A more detailed calculation of the availability of propane and butane can be performed to adjust these specifications, as a follow-on topic of study⁴³. In particular, it is probable that Ghana will need to emphasize butane importation in its sourcing, given relatively higher propane content from domestic sources.

Methodology

The methodological approach used is to estimate the projected filling volume per Bottling Plant from 2017 to 2030, described earlier in this Chapter and introduce appropriately sized plants in multiple phases.

A central assumption had to be made about whether BPs or Marketers would become the cylinder investment and ownership entities in the supply chain. For the reasons referenced above and for consistency with the Feasibility Study, it has been assumed for plant-sizing purposes that BPs are the cylinder investment and ownership entities. In practice, that means that the geography of new cylinder deployments will be synergistic with bottling plant sites and sizes. (Marketers, if investing in cylinders, may not necessarily choose to deploy them optimally for purposes of supply chain efficiency, but would instead deploy them out of self-interest, which might or might not be optimal for the national system as a whole.) If the Government determines otherwise, the investment in cylinders and the associated economics (income, costs, investment returns and risks) related to the cylinder investment shift from the BPs to the OMCs and LPGMCs. Aggregated at the sector level, the associated cashflows simply shift among the nodes. At the firm level, the effect is pronounced, reflecting a different business model for both the BP node and the Marketer node in the supply chain.

The steps are:

1. Utilize the demand data and projections by region described in Part IV, cross-checked with the 2016 and 2017 sales of every LPG microstation for residential use and combined with relevant

⁴² The Ghana standard is a maximum of 9 Barg (bars of pressure relative to atmospheric pressure) at 37.8°C. *Source:* Ghana Standards Authority. LPG produced by the Tema Oil Refinery is approximately 5.5 Barg (roughly 30% propane/70% butane) and by the Ghana Gas Company, 7.5 Barg (roughly 50% propane). Imported LPG is according to its purchase specification.

⁴³ A high LPG propane content requires propane-rated facilities due to the higher pressure required for propane liquefaction. This report does not consider the implications to infrastructure costs and specifications of a potential high-propane LPG subsector that would serve vehicular and industrial users.

- 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 governmentally-defined policy goal of 50% of the population using LPG for cooking by 2030 (this creates a mid-case scenario, referred to as the Policy Goal Scenario, between the upper and lower bounds presented in Part IV);
 3. Project the step-wise capacity required of the sector through 2030 in adequate anticipation of consumption year by year, while maintaining high 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 capacity required at each regional BP to serve the consumption in its region over time, concluding with 50% adoption and use by 2030 in accordance with the policy goal⁴⁴;

By calculating the annual bottling volume per BP, the required capacity of the BP's main elements (scales, storage, etc.) can be defined from the rules defined by the NPA, taking into account good operational practices and adequate capacity buffer to absorb peaks of consumption.

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

Note: This report does not consider the future of the Autogas segment.

⁴⁴ 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.

4. Investments at the Firm Level

This Chapter examines the economics of the sector-level investments at the firm level. The two relevant supply chain nodes are BPs and marketers (OMCs/LPGMCs).

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 Ghana, this was not possible, because (i) key governmental decisions about the business models of, and margins available to, multiple main LPG supply chain nodes requiring investment had not yet been made, through the time of this writing; (ii) businesses were, in general, unwilling to share proprietary internal business information, except to a recognized financing source interested to discuss a transaction; (iii) businesses were, in general, concerned about violating applicable competition law by disclosing internal financial or operating data that could eventually be viewed by the public; (iv) for smaller firms in marketing, retailing and distribution, standardized financial statements often did not exist; (v) for OMCs, LPG financial data typically were aggregated with data about non-LPG operations, and not practical to extract; and (vi) the NPA requested formally that bilateral discussion with Ghanaian companies be kept to a minimum during the NPA's uncompleted national planning process for LPG sector reform. The NPA's concern is especially understandable in light of the highly public, politicized disagreement between members of the association of smaller LPG microstation owners, GLIPGOA, and the NPA about the economic, legal and operational path forward for the microstations under BCRM.

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 nodes.

This choice involved making certain assumptions about future unit margins, potential costs of capital (i.e., financial return requirements), and key operating parameters affecting the cash flow generation potential and growth rates capacity of the different types of firms. Details behind the key assumptions are described in Chapter 10 (Pricing) and Chapter 18 (Consumer Empowerment) of the Feasibility Study.

Where possible, the pro forma cases have 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.

The critical types of firm examined in this Chapter with respect to future investment are:

- BPs
- Marketers (LPGMCs and the LPG-specific activities of OMCs treated on a stand-alone basis).

These two types of firm represent 98% of the investment requirement to 2030.

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

- *Bulk Road Vehicles and Cylinder Trucks.* The existing fleet of Bulk Road Vehicles (BRV) is adequate to transport all future expected LPG volumes to 2030, assuming business-as-usual growth in

autogas. Truck service to carry cylinders is not growth-constrained, and access to vehicle financing is not a barrier to capacity growth.

- *Production and Importation.* The sole expected source of significant additional domestic production is the potential addition of supply and production capacity at the Ghana Gas Company (GGC), which has adequate recourse to its own financing for this. However, even if GGC expands its LPG output, total supply will be dominated increasingly by importation. Growth in importation is not constrained operationally or financially today, and has the existing growth capacity to achieve the usage desired by the Government and forecasted in this report.
- *Bulk Storage and Importation.* With the addition of labor shifts and/or faster rotation of fuel inventory, such facilities can increase their capacities and capacity utilization rates to meet the tonnage required through 2030 without significant new investment.
- *Retail (Cylinder Exchange) Points.* The anticipated main source of new retailing facilities, which includes cylinder cages, 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

The following examinations of prospective firm-level economics are based on representative models of

1. A BP with 10% market share that invests in and owns cylinders;
2. A BP with 10% market share that does not invest in cylinders;
3. A marketer (LPGMC or the LPG unit of an OMC viewed on a standalone basis) with a 5% market share that invests in and owns cylinders.

Cases 1 and 2 are mutually exclusive, and cases 1 and 3 are mutually exclusive.

For Marketers, the only major capital investment they would need to make under BCRM is in cylinder inventory, if the Government's decision turns out to allocate the main cylinder functions to the marketers, as is expected as of this writing. Therefore, the case of a marketer without any cylinder investment has not been evaluated.

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 models. These data were in line with the models.

The models do not reflect the use of an LPG volume-based capital recovery levy fund to support the cylinder investment. If this levy were implemented in Ghana, it would shift a notional 40% of the capital cost of all new cylinders to this fund, which would have three effects: (i) reduce the net investment required of BPs (or Marketers) and their financing sources in cylinders proportionally, (ii) reduce the up-front cylinder deposit cost paid by consumers, and (iii) improve the financial returns of BPs (or Marketers) with respect to their cylinder assets. The fund would pay for the shifted 40% through an increase of € 0.03 per kg of LPG in the national pricing formula over 12 years, expiring in 2030. Use of an LPG capital recovery

levy is currently being contemplated by the Government. This approach is discussed in Chapter 5 beginning on page 93.

Each 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.

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

Bottling Plant with cylinder investment

This pro-forma BP is modelled on the basis of a 10% share of the bottling-node volume in the supply chain, including investment in 10% of the national cylinder requirement in each year. It is thus a composite (at 1/10th scale) of the notional 10 new BP businesses to be created with the roll-out of BCRM.

Revenue is made from the permitted unit margin under the national price formula for filling of cylinders. In this case, the unit margin comprises both a filling fee component (€ 70 per tonne) and a cylinder investment and maintenance fee component (€ 50 per tonne). The total, €120 per tonne, is less than the total of the maximum allowed unit margin amounts shown in the pricing formula recommended in the Feasibility Study (Chapter 10), which sum to € 150 per tonne⁴⁵. This is done for two reasons: (i) it demonstrates that an adequate profit and financial return can be created by a BP at a lower level of revenue per tonne than the permitted maximum; (ii) it demonstrates that there is enough spare margin available to the BP, while still generating adequate profit and financial returns, that the BPs can afford to pay for a cylinder capital cost recovery levy applied to their LPG volumes instead of the consumer paying. The potential workings and benefit of such a levy is discussed in detail in Chapter 5.

Assumptions

The following are the main financial and operating assumptions:

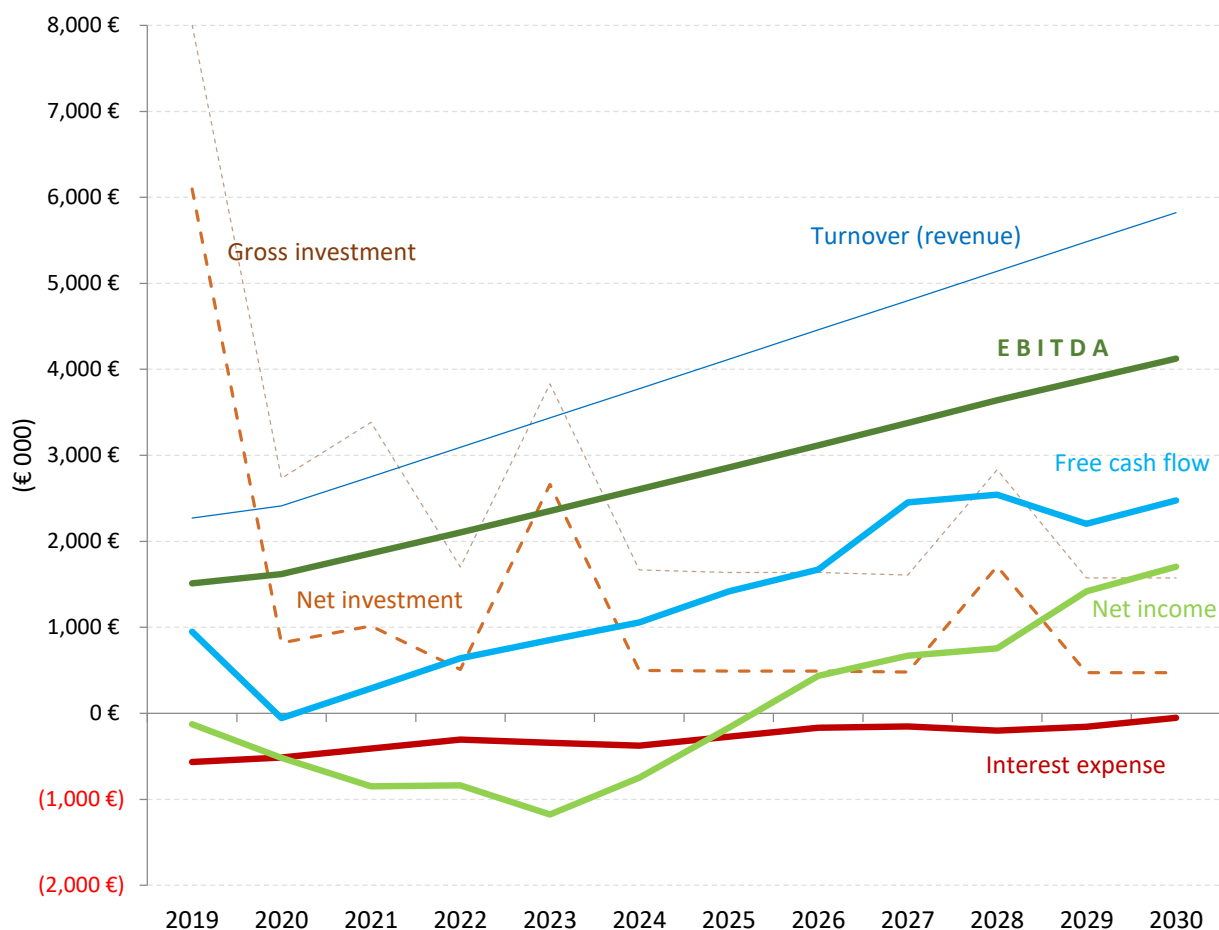
Item	Value
Market share of the firm	10%
Cost of cylinder (14.5kg)	25.3 €
Cylinder deposit (as % of cost)	70%
Net cylinder cost to marketer	30%
BP margin per tonne (includes cylinder margin)	120 €/t
Annual rate of margin increase	0%
Company income tax rate	20%
Tranches of capital increase (loans and equity)	3
Blended cost of debt	8.93%
Loan tenors	3-8 years

⁴⁵ The relevant margin elements from the price formula shown in Chapter 10 of the Feasibility Study for this BP are "Bottling Plant Margin" (€ 70) and "Cylinder Investment and Maintenance" (€ 80). All other elements apply to other nodes in the supply chain.

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 10. Bottling Plant with cylinder investment: financial performance



The selected metrics are as follows:

Gross investment	Value at purchase of invested assets
Net investment⁴⁶	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 ⁴⁷ , interest expense and taxes
Free cash flow	Net income adjusted for non-cash charges

⁴⁶ 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.

⁴⁷ 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. Bottling Plant with cylinder investment: 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 & Deployed (000 units)	108	108	134	67	66	66	65	65	64	64	62	62	931
Price of Cylinder	25	25	25	25	25	25	25	25	25	25	25	25	
Gross Capital Cost of Cylinders	2,731	2,731	3,383	1,700	1,667	1,667	1,637	1,637	1,607	1,607	1,577	1,577	23,522
	<i>Y1-3 includes replacement of scrap cylinders</i>												
Cylinder Deposits Received	765	765	947	476	467	467	458	458	450	450	441	441	6,586
Net Cylinder Cost	819	819	1,015	510	500	500	491	491	482	482	473	473	7,057
Investment in BP Facilities (PP&E)	5,277				2,163					1,227			8,666
Tonnage (KT)	19	20	23	26	29	31	34	37	40	43	46	49	396
BP margin/tonne	120	120	120	120	120	120	120	120	120	120	120	120	1,440
Total BP margin	2,270	2,411	2,752	3,093	3,434	3,776	4,117	4,458	4,799	5,141	5,482	5,823	47,557
TURNOVER (REVENUES)	2,270	2,411	2,752	3,093	3,434	3,776	4,117	4,458	4,799	5,141	5,482	5,823	47,557
Personnel costs (per tonne)	25	24	24	23	23	22	22	21	21	20	20	20	
Non-personnel operating costs (per tonne)	15	15	15	15	15	15	15	15	15	15	15	15	
OPEX/tonne	40	39	39	38	38	37	37	36	36	35	35	35	
Total OPEX	757	792	892	988	1,081	1,171	1,258	1,342	1,422	1,499	1,599	1,698	14,500
EBITDA	1,513	1,618	1,860	2,105	2,353	2,605	2,859	3,117	3,377	3,641	3,883	4,125	33,057
Depreciation	(1,074)	(1,620)	(2,297)	(2,637)	(3,187)	(2,974)	(2,755)	(2,406)	(2,387)	(2,498)	(1,952)	(1,940)	(27,725)
OPERATING INCOME (EBIT)	439	(2)	(437)	(532)	(833)	(369)	104	711	990	1,144	1,931	2,185	5,331
Interest Expense	(566)	(514)	(410)	(307)	(342)	(377)	(273)	(168)	(153)	(199)	(157)	(52)	(3,518)
OPERATING PROFIT BEFORE TAXES	(126)	(516)	(847)	(838)	(1,175)	(746)	(169)	543	837	944	1,775	2,133	1,814
Income Tax	0	0	0	0	0	0	0	(109)	(167)	(189)	(355)	(427)	(1,246)
Tax Holiday	no	no	no	no	no	no	no	no	no	no	no	no	
NET INCOME (NI)	(126)	(516)	(847)	(838)	(1,175)	(746)	(169)	434	670	755	1,420	1,706	567

Capital infusions are structured into three tranches. The first two tranches are concurrent. The third tranche is split, with new money for cylinders in 2027 and for a plant expansion in 2028:

<i>(in 000s)</i>	Tranche 1	Tranche 2	Tranche 3
Cylinders	2019	2023	2027
Debt	1,107 €	694 €	669 €
Concessional Debt	1,265 €	793 €	764 €
<i>Debt amortization in years</i>	2-5	6-9	10-12
Equity	791 €	496 €	478 €
Total	3,164 €	1,983 €	1,910 €
Plant	2019	2023	2028
Debt	1,847 €	757 €	429 €
Concessional Debt	2,111 €	865 €	491 €
<i>Debt amortization in years</i>	2-8	6-12	11-12
Equity	1,319 €	541 €	307 €
Total	5,277 €	2,163 €	1,227 €

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. Bottling Plant with cylinder investment: debt coverage, FCF, TV and equity IRR
(values in € 000s except as noted)

Total Debt Service	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	TOTALS
<i>Total Principal</i>	6,330	0	0	0	3,109	0	0	0	1,433	920	0	0	11,792
<i>Principal Repayments</i>	0	1,159	1,159	1,159	1,159	1,169	1,169	1,169	603	709	1,169	1,169	11,792
<i>Total Interest</i>	566	514	410	307	342	377	273	168	153	199	157	52	3,518
Total Debt Service	566	1,672	1,569	1,465	1,501	1,546	1,442	1,337	757	909	1,326	1,222	15,310
EBITDA	1,513	1,618	1,860	2,105	2,353	2,605	2,859	3,117	3,377	3,641	3,883	4,125	33,057
<i>EBITDA Coverage of Debt Service</i>	3	1	1	1	2	2	2	2	4	4	3	3	
EBITDA after Debt Service	948	(54)	291	640	853	1,059	1,417	1,780	2,621	2,733	2,557	2,903	17,747
Taxes	0	0	0	0	0	0	0	(109)	(167)	(189)	(355)	(427)	(1,246)
Cashflow after Debt Service & Taxes	948	(54)	291	640	853	1,059	1,417	1,671	2,453	2,544	2,202	2,477	16,501
Operating Cash Flow	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	TOTALS
Net Income	(126)	(516)	(847)	(838)	(1,175)	(746)	(169)	434	670	755	1,420	1,706	567
+ Depreciation & Amortization	1,074	1,620	2,297	2,637	3,187	2,974	2,755	2,406	2,387	2,498	1,952	1,940	27,725
+ Non Cash Charges	0	0	0	0	0	0	0	0	0	0	0	0	0
Free Cashflow from Operations	948	1,105	1,450	1,798	2,011	2,227	2,586	2,840	3,057	3,253	3,371	3,646	28,293
- Principal Debt Repayments		1,159	1,159	1,159	1,159	1,169	1,169	1,169	603	709	1,169	1,169	11,792
Cashflow after Debt Service (FCF)	948	(54)	291	640	853	1,059	1,417	1,671	2,453	2,544	2,202	2,477	16,501
										Tax Adjusted EBITDA		3,300	
										Terminal Multiple		5.0x	
										Terminal Value		16,499	
- Equity Fundings	2,110				1,036					784			3,931
Net FCF to Equity (Net of Investment)	(1,162)	(54)	291	640	(184)	1,059	1,417	1,671	2,453	1,760	2,202	18,976	29,069
Total Equity Fundings	3,931												3,931
IRR to all Equity Classes	47%												

The equity IRR, based on the notional capital stack, is a healthy 47%, including a terminal value of approximately € 16.5 million in 2030.

If unit margins are higher than the € 120 used for this analysis, the equity rate of return increases significantly, and if less leverage is used, it falls significantly, as shown in Table 39:

Table 39. Bottling Plant with cylinder investment: IRR sensitivity to margins and capital mix

IRR to all Equity Capital		
		47%
Revenue/t	120 €/t	47% <i>Modelled amount</i>
	150 €/t	121% <i>Amount in price formula</i>
	160 €/t	174%
	165 €/t	214%
	170 €/t	269%

IRR to all Equity Capital		Equity % of Capitalization			
		47%	20%	25%	50%
Revenue/t	120 €/t	57%	47%	28%	
	150 €/t	261%	121%	47%	
	160 €/t	694%	174%	54%	
	165 €/t	2338%	214%	58%	

The sensitivity tables suggest that if the BPs could raise enough equity, the equity sources could be satisfied with the returns to equity at a significantly reduced amount of leverage. However, raising 50% of the required capital in the form of equity, for example, is not a given. 25% equity has been used as a target in this report because it is the minimum equity funding level typically sought by lenders.

Bottling Plant without cylinder investment

This pro-forma BP is modelled on the basis of a 10% share of the bottling-node volume in the supply chain, excluding investment in 10% of the national cylinder requirement in each year, which in this case must be done by the companies in the marketer node. It is thus a composite (at 1/10th scale) of the notional 10 new BP businesses that are to begin their construction starting in 2019, if the marketers (OMCs and LPGMCs) are assigned all responsibilities for cylinder investment and management, excepting filling and maintenance, which the BPs would perform.

Revenue is made from the permitted unit margin under the national price formula for filling of cylinders, set here to € 70 per tonne per the recommended pricing formula of Feasibility Study Chapter 10.

Assumptions

The following are the main financial and operating assumptions:

Item	Value
Market share of the firm	10%
BP filling margin per tonne	70 €/t
BP cylinder maintenance margin per cylinder	€ 5

Annual rate of margin increase	0%
Company income tax rate	20%
Tranches of capital increase (loans and equity)	3
Blended cost of debt	8.93%
Loan tenors	3-8 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 11. Bottling Plant without cylinder investment: financial performance

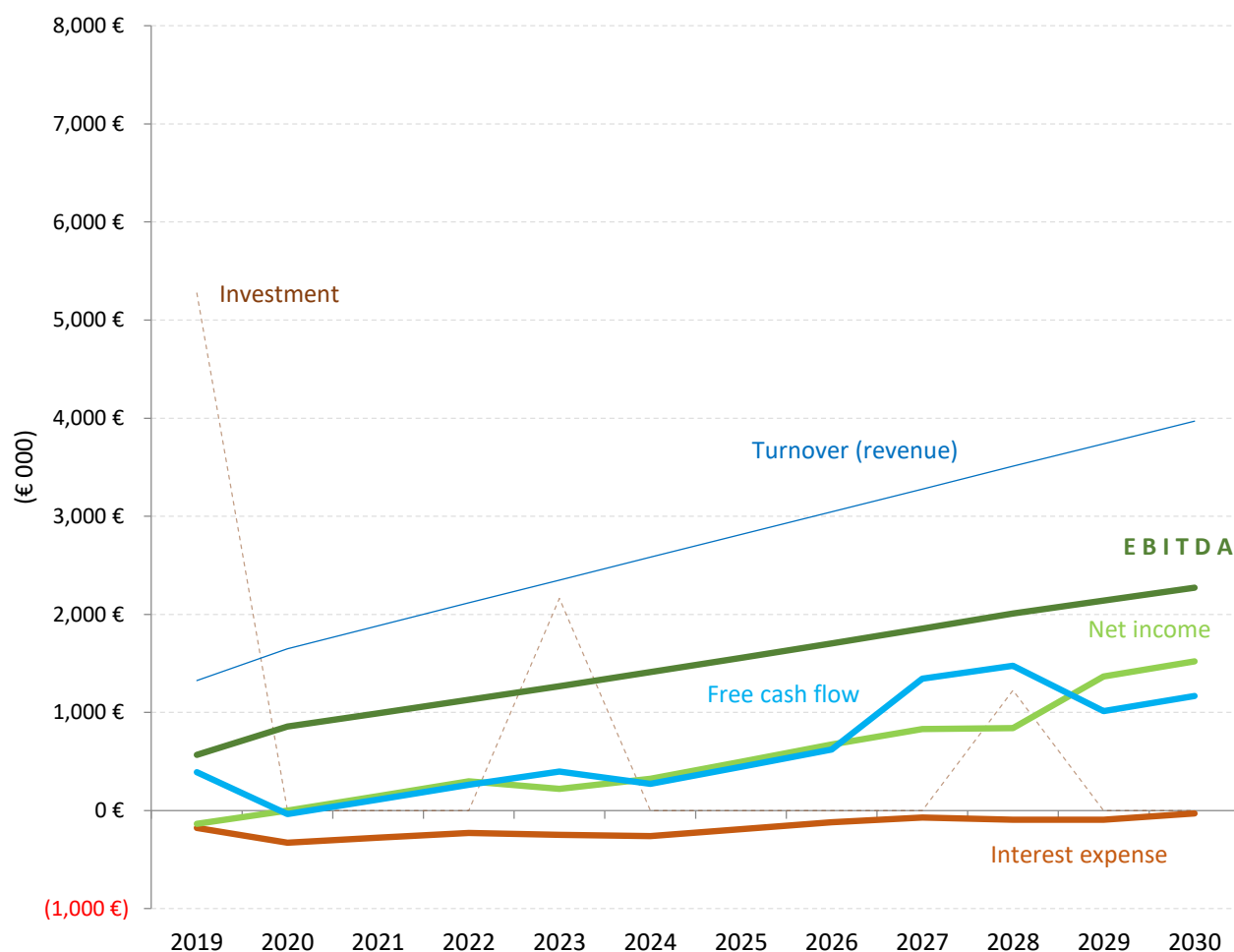


Table 40. Bottling Plant without cylinder investment: pro-forma financial data
(values in € 000s except as noted)

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	TOTALS
Investment in BP Facilities (PP&E)	5,277				2,163					1,227			8,666
Tonnage (KT)	19	20	23	26	29	31	34	37	40	43	46	49	396
Filling Fee (€ per tonne)	70	70	70	70	70	70	70	70	70	70	70	70	
LPG Filling Service Income	1,324	1,406	1,605	1,804	2,003	2,202	2,402	2,601	2,800	2,999	3,198	3,397	27,741
Maintenance Service Income		243	278	312	346	380	413	446	478	510	542	574	4,521
TURNOVER (REVENUES)	1,324	1,649	1,883	2,117	2,349	2,582	2,814	3,046	3,278	3,509	3,740	3,970	32,263
<i>Personnel costs (per tonne)</i>	25	24	24	23	23	22	22	21	21	20	20	20	
<i>Non-personnel oper. costs (per tonne)</i>	15	15	15	15	15	15	15	15	15	15	15	15	
<i>OPEX/tonne</i>	40	39	39	38	38	37	37	36	36	35	35	35	
Total OPEX	757	792	892	988	1,081	1,171	1,258	1,342	1,422	1,499	1,599	1,698	14,500
EBITDA	568	857	991	1,128	1,268	1,411	1,556	1,705	1,856	2,010	2,141	2,272	17,763
<i>Depreciation</i>	(528)	(528)	(528)	(528)	(744)	(744)	(744)	(744)	(744)	(867)	(339)	(339)	(7,375)
OPERATING INCOME (EBIT)	40	329	463	601	524	667	812	961	1,112	1,143	1,802	1,933	10,388
<i>Interest Expense</i>	(177)	(328)	(278)	(227)	(249)	(261)	(190)	(118)	(72)	(93)	(93)	(31)	(2,117)
OP PROFIT BEFORE TAXES	(137)	1	186	373	275	406	623	843	1,039	1,050	1,709	1,902	8,271
<i>Income Tax</i>	0	(0)	(37)	(75)	(55)	(81)	(125)	(169)	(208)	(210)	(342)	(380)	(1,682)
<i>Tax Holiday</i>	no	no	no	no	no	no	no	no	no	no	no	no	
NET INCOME (NI)	(137)	1	148	299	220	325	498	674	831	840	1,367	1,522	6,589

Capital infusions are structured into three tranches:

<i>(in 000s)</i>	Tranche 1	Tranche 2	Tranche 3
PP&E	2019	2023	2028
Debt	1,847 €	757 €	429 €
Concessional Debt	2,111 €	865 €	491 €
<i>Debt amortization in years</i>	<i>2-8</i>	<i>6-12</i>	<i>11-12</i>
Equity	1,319 €	541 €	307 €
Total	5,277 €	2,163 €	1,227 €

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:

The equity IRR, based on the notional capital stack, is 35%, including a terminal value of approximately € 9.1 million in 2030. This is materially below the values for the case of a Bottling Plant making cylinders investments (47%, € 16.5 million).

If unit margins are higher than the € 70 used for this analysis, the equity rate of return increases significantly, and if less leverage is used, it falls significantly, as shown in Table 42:

Table 42. Bottling Plant without cylinder investment: IRR sensitivity to margins and capital mix

IRR to all Equity Capital	
	35%
Revenue/t	70 €/t
	72 €/t
	74 €/t
	76 €/t
	78 €/t

IRR to all Equity Capital		Equity % of Capitalization		
	35%	20%	25%	50%
Revenue/t	70 €/t	41%	35%	22%
	72 €/t	45%	38%	24%
	74 €/t	49%	41%	25%
	76 €/t	55%	45%	27%
	78 €/t	60%	49%	29%

Marketer (LPGMC / OMC) with cylinder investment

This pro-forma LPG marketer is modelled on the basis of a 5% share of the marketing-node volume in the supply chain, including investment in 5% of the national cylinder requirement in each year. A pure-LPG business model—no other petroleum-sector products—is assumed. A 5% share is selected as representative for two reasons: (i) a practical limit on the number of cylinder brands in a country is 20; the market can be expected to consolidate towards this limit organically over time, or through Government limiting the number of licenses available for cylinder brands; and (ii) below this size level, it is unlikely that an individual entity will be directly bankable due to management and/or business information limitations.

Revenue is made from the permitted unit margin under the national price formula for investment in and maintenance of cylinders, for recovery of transportation costs, and marketing margin (in aggregate, € 150 per tonne⁴⁸), as shown in the recommended pricing formula of Feasibility Study Chapter 10.

Assumptions

The following are the main financial and operating assumptions:

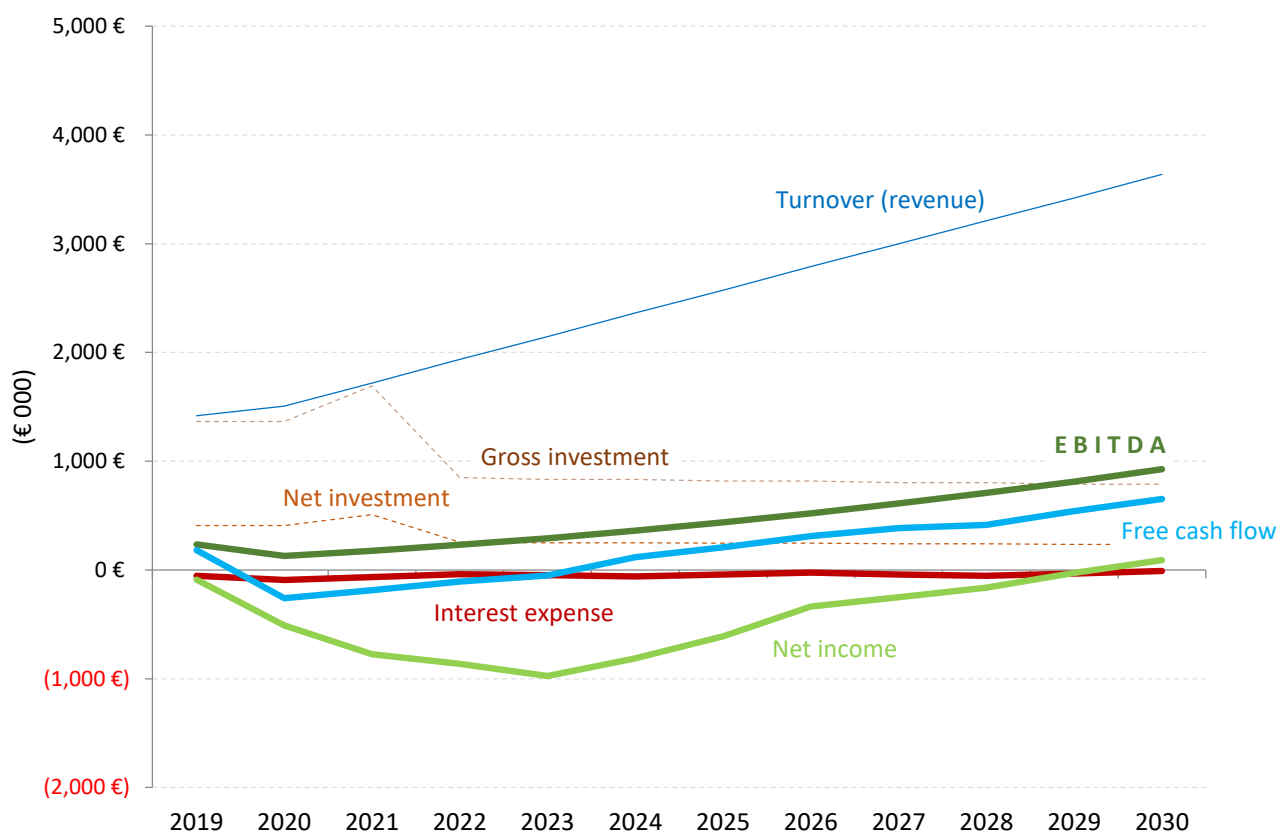
Item	Value
Market share of the firm	5%
Cost of cylinder (14.5kge)	25.3 €
Cylinder deposit (as % of cost)	70%
Net cylinder cost to marketer	30%
Total margin per tonne (includes cylinder margin)	150 €/t
Fees payable to BP:	
Bottling fee	€ 70/t
Maintenance fee (per 14.5kge cylinder)	€ 5/cylinder
Annual % of cylinder inventory requiring maintenance (starting in year 2)	10%
Distributor transportation fee	€ 10/t
Annual rate of margin increase	0%
Company income tax rate	20%
Tranches of capital increase (loans and equity)	3
Blended cost of debt	8.93% ⁴⁹
Loan tenors	4-5 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:

⁴⁸ The relevant margin elements from the price formula shown in Chapter 10 of the Feasibility Study for this LPGMC/OMC are “Cylinder Investment and Maintenance” (€ 80), “Cylinder Transport Cost” (€ 20), and “Marketer Margin” (€ 50). All other elements apply to other nodes in the supply chain.

⁴⁹ It may turn out in practice, when specific transactions are negotiated, that the cost of debt will be higher for pure cylinder investors, compared to the case of BPs investing in both fixed PP&E and cylinders. It was not possible for financing sources to pre-estimate a “cylinder risk premium” for Ghana, based on conversations held, given the lack of recent operating history of BCRM-based companies in Ghana. Therefore, it is possible that debt service costs might be slightly higher than modelled herein.

Figure 12. Marketers with cylinder investment: financial performance



As in the case of the BP with cylinder investment, “Net Investment” is the gross investment less the cylinder deposits received via the distribution network. Net income is rendered highly negative by the depreciation of the cylinder assets.

Comparing this chart to the similar chart for the BP that makes cylinder investments (Figure 11 on page 82), it is evident how much lower the profitability ratio and cash flow generation capability are of the LPG marketing company, despite a higher margin per tonne assumed in the Marketer modelling and despite excluding any possible “cylinder risk premium” in the cost of debt. This is a mean reason why it is recommended to co-locate the cylinder investment (and branding) with the Bottling Plants.

Table 43. Marketer with cylinder investment: 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 & Deployed (000 units)	54	54	67	34	33	33	32	32	32	32	31	31	466
Price of Cylinder	25	25	25	25	25	25	25	25	25	25	25	25	
Gross Capital Cost of Cylinders	1,366	1,366	1,691	850	834	834	819	819	803	803	788	788	11,761
	<i>Y1-3 includes replacement of scrap cylinders</i>												
Cylinder Deposits Received	956	956	1,184	595	584	584	573	573	562	562	552	552	8,233
Net Cylinder Cost	410	410	507	255	250	250	246	246	241	241	236	236	3,528
Tonnage (KT)	9	10	11	13	14	16	17	19	20	21	23	24	198
Margin/tonne	150	150	150	150	150	150	150	150	150	150	150	150	1,800
Total margin	1,418	1,508	1,718	1,935	2,145	2,363	2,573	2,790	3,000	3,210	3,420	3,638	29,715
TURNOVER (REVENUES)	1,418	1,508	1,718	1,935	2,145	2,363	2,573	2,790	3,000	3,210	3,420	3,638	29,715
<i>Opex per tonne</i>													
<i>Bottling Plant filling charge</i>	70/t	70/t	70/t	70/t	70/t	70/t	70/t	70/t	70/t	70/t	70/t	70/t	
<i>Distributors transportation of refills</i>	10/t	10/t	10/t	9/t	9/t	8/t	8/t	7/t	7/t	6/t	6/t	5/t	
<i>Commercial costs (sales, training, technicians, etc.)</i>	20/t	20/t	19/t	18/t	17/t	16/t	15/t	14/t	13/t	12/t	11/t	10/t	
<i>Other OPEX</i>	25/t	25/t	24/t	23/t	22/t	21/t	20/t	19/t	18/t	17/t	16/t	15/t	
<i>Total OPEX/tonne before cylinder maintenance</i>	125/t	125/t	123/t	120/t	118/t	115/t	113/t	110/t	108/t	105/t	103/t	100/t	
<i>Total OPEX before cylinder maintenance</i>	1,181	1,256	1,403	1,548	1,680	1,811	1,929	2,046	2,150	2,247	2,337	2,425	22,014
<i>Bottling Plant cylinder maintenance</i>		122	139	156	173	190	206	223	239	255	271	287	2,261
Total OPEX	1,181	1,378	1,541	1,704	1,853	2,001	2,136	2,269	2,389	2,502	2,608	2,712	24,275
EBITDA	236	130	176	231	292	361	437	521	611	708	812	926	5,440
<i>Depreciation</i>	(273)	(546)	(885)	(1,055)	(1,221)	(1,115)	(1,006)	(831)	(822)	(816)	(806)	(800)	(10,175)
OPERATING INCOME (EBIT)	(37)	(416)	(708)	(824)	(930)	(754)	(569)	(310)	(211)	(108)	6	125	(4,735)
<i>Interest Expense</i>	(53)	(93)	(66)	(40)	(46)	(58)	(42)	(25)	(40)	(53)	(32)	(11)	(559)
OP PROFIT BEFORE TAXES	(90)	(509)	(775)	(863)	(976)	(812)	(610)	(335)	(251)	(161)	(26)	115	(5,294)
<i>Income Tax</i>	0	0	0	0	0	0	0	0	0	0	0	(23)	
<i>Tax Holiday</i>	no	no	no	no	no	no	no	no	no	no	no	no	
NET INCOME (NI)	(90)	(509)	(775)	(863)	(976)	(812)	(610)	(335)	(251)	(161)	(26)	92	(5,317)

Capital infusions are structured into three tranches:

<i>(in 000s)</i>	Tranche 1	Tranche 2	Tranche 3
Cylinders	2019	2023	2027
Debt	554 €	347 €	334 €
Concessional Debt	633 €	397 €	382 €
<i>Debt amortization in years</i>	<i>2-5</i>	<i>6-9</i>	<i>10-12</i>
Equity	395 €	248 €	239 €
Total	1,582 €	991 €	955 €

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:

The equity IRR, based on the notional capital stack, is 24%, including a terminal value of approximately € 3.7 million in 2030. This rate of return is just adequate to satisfy equity providers. An increase in costs or decrease in volume or unit margins compared to the projections could make the investment unattractive to equity Funders, based on guidance received from the Ghanaian and international financial sectors.

The sensitivity of the return to equity with respect to changes in unit margin and in leverage is shown in the following table:

Table 45. Marketer with cylinder investment: IRR sensitivity to margins and capital mix

IRR to all Equity Capital		
		24%
Revenue/t	140 €/t	10%
	145 €/t	17%
	150 €/t	24%
	155 €/t	33%
	160 €/t	44%
		<i>Amount in price formula</i>

IRR to all Equity Capital		Equity % of Capitalization		
	24%	20%	25%	50%
Revenue/t	140 €/t	11%	10%	7%
	145 €/t	18%	17%	13%
	150 €/t	26%	24%	18%
	155 €/t	36%	33%	24%
	160 €/t	51%	44%	30%

5. Investment Plan Overview

Key financing topics

This Part of the report will discuss:

1. The investment funding needs;
2. Preferred structuring options using Blended Capital;
3. Factors to consider in structuring to access these Funders' capital on optimal terms;
4. Prospective Funders (Ghanaian and foreign); and
5. Risk mitigation options for the Funders.

This is an evolving process, because regulatory and other related frameworks for the new Ghanaian LPG operational paradigm and ecosystem are still being refined locally, and specifications of the investment projects remain subject to change by the Ghanaian authorities.

Summary of assets and projects requiring financing

The GLPGP Clean Cooking for Africa expert team, working with NPA and other Ghanaian governmental ministries and agencies, LPG industry participants, and financial sector entities, identified the following € 335 million of capital expenditures over the 2019-30 period to serve projected unserved and underserved LPG demand, also reaching the 50% national usage goal:

Table 46. Capital investment requirements to 2030 for LPG sector scale-up

Category	Capital requirement (mm Euro)	Supply chain node
Cylinders	€ 235.2	Bottler or Marketer ⁵⁰ / consumer
Bottling plants and storage	€ 86.7	Bottler
Pallets	€ 5.7	Bottler or Marketer ⁵⁰
Cylinder Cages	€ 7.3	Retailer
Total	€ 334.9	

The financing would cover 9.3 million LPG cylinders of 14.5kg equivalence, 10 bottling plants with appropriate storage capacity, palletization assets for moving the cylinders safely and effectively, and cages for retail cylinder display and management. The cylinders would be funded in three tranches spaced over the 2019-30 period, with interest only the first year and equal principal repayments in the remaining years. The BPs would be built and then enlarged in three tranches starting in 2019, 2023 and 2028. The palletization assets' cost, after an initial \$1.3 million in 2020, would be spread over the remaining years.

⁵⁰ The final determination by Government of which node shall be required to invest in, brand and deploy cylinders into the market and maintain and ensure their safety has not been completed as of this writing. The consumer, through cylinder deposits, is also a significant source of funding for the acquisition of cylinders by the BPs or by the Marketers.

As previously explained, importation and production facilitates and bulk storage and transportation capacity are adequate to support the expected sector growth through 2030, and therefore do not require financing attention for expansion at this time.

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 BPs or Marketers, as the case may be, to borrow internally against the cylinder deposits obtained from their end-customers. It is anticipated that Ghana will set the cylinder deposit amount in the BCRM price regulations to 70% of the cost of the cylinder to its Marketer or BP, as the case may be. The funds provided by the customers are, in principle, a liability of the cylinder-owning company, to be returned to the consumer when s/he cancels service and returns the cylinder to the company. In practice, BPs or Marketers could redeploy most of the consumer deposit funds internally. This makes the consumer, in effect, a major financing source for the sector's cylinders. As modelled and discussed in Chapter 4 (beginning on page 74), this causes the net amount needed for cylinder financing to be closer to 30% of the capital cost of the cylinders than 100%.

In practice, the financing requirement for cylinders will fall somewhere between the hypothetical net (a floor value⁵¹) of € 71 million and the gross of € 235 million.

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.

Investment and financing tranches

The investments are grouped into three financing tranches, corresponding to years 1-4, 5-8, and 9-12.

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.

The tranche amounts are as follows:

⁵¹ 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 growth (such as an exponential rate of growth), as some individual Marketers have projected regarding themselves, would amplify these timing effects.

Table 47. Investment financing tranches

	Tranche 1	Tranche 2	Tranche 3
	2019-2022	2023-2026	2027-2030
Cylinders	105,460 €	66,060 €	63,680 €
Bottling Plants/Storage	52,768 €	21,627 €	12,267 €
Pallets	3,789 €	938 €	938 €
Cages	4,865 €	1,210 €	1,210 €
Total Capital Investment	166,882 €	89,835 €	78,095 €

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 enforce BCRM effectively and evenly throughout the sector, and (iii) the level of demand growth. 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 such programs are described later in this report.

Creating an initial mini-tranche / sub-tranche

In case the timeline of BCRM rollout and of BP and cylinder project preparation is stretched out, or to accommodate limited near-term DFI/IFI/MDB financing windows, it is conceptually feasible to define a subset of the BP and cylinder investments from tranche one as a self-contained initial sub-tranche. Details of this approach are presented for illustrative purposes in Chapter 20 beginning on page 159.

Capital recovery and affordability mechanism

An added element in the proposed Investment Plan 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 (either BPs or marketers, based on pending final market structure determinations to be made by the Government) and reduce substantially the cylinder deposit amount to be paid by the consumer.

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 BPs (or 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 second benefit, potentially decreasing significantly the size of the deposit required of consumers to acquire a new LPG cylinder. This mechanism is similar (but in a positive sense) to the ELSA levy used to clean up the balance sheets of Ghanaian banks which were deeply exposed to non-performing petroleum sector loans in recent years.

This mechanism, which (if paid by the consumer) would increase LPG pricing by approximately 3% on average over 12 years, and might increase consumer adoption but also might depress consumption. This is discussed in greater detail in the Feasibility Study. Unfortunately, quantification of the net effect was not feasible to calculate with the data available. The countervailing reduction in overall consumption from such a price increase would be approximately of 1.4%, based on the price sensitivity analysis from Part IV of the Feasibility Study. As an alternative to charging the consumer, this amount could be deducted from the

margins provided to the BPs (assuming the BPs are made responsible for the cylinder investment), because the BPs' cashflows, as modelled, would be sufficient to absorb it without materially harming their bankability.

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 Bottlers (or 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 Bottlers 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 Bottlers (or marketers)⁵², 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; and
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.

As of this writing, the Government had not made a determination to proceed with such a levy. Ultimately, the modalities and Funders will have to make business decisions about whether (and when) to proceed with recommended investments, based on a view of whether (and when) the Government might implement the recommended levy.

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).

⁵² Each node of the supply chain downstream of the cylinder investor (Bottler or marketer) 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.

Which financing vehicles are actually used would be determined by the structuring preferences and investing requirements of the specific Funders that participate in financing the Investment Plan.

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 Ghanaian and non-Ghanaian 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 9% 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.

Identification of prospective funding sources

To focus efforts efficiently on targeting the largest and most accommodative mix of blended capital from pivotal funding groups like DFIs, IFIs and MDBs as leads, coupled with risk mitigation, the Clean Cooking for Africa/GLPGP team (Team) conducted face-to-face discussions and phone calls, and researched comparable activities of the targeted organizations.

Domestically, Ghana provides a broad range of private sector financial resources – approximately US \$16.5 billion in banks, and US \$5-6 billion in pension funds, mutual funds, and insurance companies. Ghana also has access to sizable external Funders, public securities markets on which new securities can be listed which feature advanced securities regulation and oversight providing investor confidence, national investment promotion agencies with clear roles and reporting mechanisms, and key governmental agency initiatives. There are numerous Ghanaian funding precedents that may be good references for structured LPG investment. GLPGP has chosen two, as discussed below, that are especially important as being instructive on mixing various Funders and risk mitigation mechanisms: Energy Sector Levy Bonds (ESLA Bonds) and the Produce Buying Corporation shelf (PBC Shelf) securities issuances.

Moreover, the present Minister of Finance is a former investment banker and has put in place initiatives to attract both domestic and foreign capital sources for national private and public sector development. The Ministry of Finance (MoF) has created domestic investment vehicles, such as a US \$250 million (targeted US \$1 billion) Ghana Infrastructure Investment Fund (GIIF). The Ghana Investment Promotion Center (GIPC) has a mandate to attract \$10 billion for investment into Ghana in 2018 alone, and is consequently supportive of initiatives like the LPG investments discussed here.

It is noteworthy that international MDBs, such as the IBRD, IDA, AfDB, AsDB, EBRD and IADB, committed almost US \$84 billion in 2014. European DFIs, such as BIO, CDC, COFIDES, DEG, FINNFUND, FMO, IFU, Norfund, OeEB, PROPARCO, SBI, Sifer, SIMEST, SOFID, and SWEDFUND committed \$6.8 billion in 2015, and OPIC a further \$4.4 billion. IFIs contributed additional funds. So, funding and Funders are available if the targeted recipient is right.

Critical path of financing steps

Based on research and analysis, the following steps are recommended to be taken by the Government and its advisors⁵³, together with key private sector partners as applicable:

1. Confirm the Government's support for the proposed, or some amended version of the national LPG investment plan (Investment Plan), including confirmation by the NPA, MoF and Ministry of Energy (MoE);
2. Select the appropriate funding structure(s) to optimize access to Funders at the most attractive overall terms for the modalities;
3. Identify the leading Funders which can "crowd in" others.
4. 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.
5. Strengthen the "bankability" of the financing with sufficiently strong backstops, such as levies, guarantees and risk mitigation tools.
6. Secure operational approval from relevant ministers and agencies (including NPA, MoE and MoF) as to the structuring and financing path chosen.

No set of Funders can ultimately be chosen until an Investment Plan (or plans) has been fully developed for specific projects by specific entities with necessary approvals from the Government, with 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.

Between the marketers and the Bottlers, the Bottlers may be the best-positioned supply-chain node to buy the cylinders, and around which to design the funding mechanism. This is based on (i) their size and economic scale relative to most marketers, thereby being most likely to generate consistent cash flows and a mix of fixed and mobile (cylinder) assets that can be attractive to Funders, and (ii) their ability to ensure that cylinder investments that unlock consumption are synchronized with bottling investments for regilling the cylinders. This has been suggested by banks, pension funds and other potential institutional investors, and is supported by the comparative pro-forma economics of companies at each of these nodes in Chapter 4.

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.

Main structuring options

1. 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

⁵³ Which may continue to include GLPGP

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.

2. 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 have statutory limits of 15% of portfolio (especially, pensions) on how much they can allocate into investment funds. Although this is being reviewed by the National Pensions Regulatory Authority (NPRA) and exceptions can be made, it is a probable limiting factor for the foreseeable future. It might also be the case, as with the GILF, that MoF could co-invest if MoF determines that doing so meets important national objectives. Investment Funds also involve a longer implementation process, especially in terms of capitalization. However, they are otherwise an attractive option because they offer exposure to many Funders who can only invest in investment funds (sovereign funds, international pensions, some family offices, etc.). They also open up DFIs' fund investment units to participate.

Four Options

1. The following four options are prioritized as follows. They match funding structures with appropriate Funders and risk mitigation sources:
 - a) **“SPV-G (Ghana)” Listed.** For example, a cylinder-focused SPV for Ghana. 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 BPs (or Marketers), and would recover that 40% from the levy over time. This involves active outside oversight, such as through an escrow agent and specialist⁵⁴, 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.
 - b) **LPG (Vertical) SPVs-listed or Non-listed.** For example, an LPG sector SPV for Ghana. 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 Ghana Securities and Exchange Commission (SEC) if this SPV

⁵⁴ Such as Clean Cooking for Africa/GLPGP

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-G.

- c) **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 Adenia, Databank, Injaro, and Petra. Institutions such as Adenia and Injaro also carry the added credibility of having DFIs and IFIs as backers. This should be commenced by targeting logical initial players involved in building out financial inclusion, innovative finance, capital markets and solutions for private/public sector financing. These should include, but not be limited to, AfDB, CDC, DBSA, DEG, FMO (already a financial sector investor in Ghana via Fidelity Bank), IFC, Norfund, OPIC, and Swedfund. These institutions are active in financial institutions/innovations and also infrastructure plays.
 - d) **Investment Funds (LPG infrastructure Development Fund (LID) and the LPG First Cost 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 Ghana, 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. GLPGP has been exploring the LID Fund with local fund managers like Injaro and Adenia. Both manage major DFI and other non-Ghanaian capital, so they would be good groups with which to consider building and operating the Investment Fund(s). 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 Stanbic or Databank, which have asset management activities.
2. These funding mechanisms could also be used to reposition the Ghanaian microstation owners who need—and can justify—external funding to migrate to other roles in the value chain. This could be done through the creation of an NBFI with units/shares/debt eventually listed on the GSX. This will appeal to DFIs and IFIs trying to facilitate the broadening of local capital markets in Ghana. Such a listing might even go as far as the London Stock Exchange AIM where African growth stocks from Ghana and elsewhere have listed. Creation of an NBFI would require that the underlying entities can be made sufficiently bankable when taken as a group.

3. In general, the following summarize the main advantages, risks/issues and mitigants for these four options:

Primary Advantages

- a) They are potentially appealing to the Government because MoF, GIPC, and BoG are all trying to encourage more domestic and foreign institutional investment into Ghana's infrastructure and critical social and business sector development.
- b) They will appeal to DFIs and IFIs who are trying to promote capital flows into Ghana 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 NBFi or parent company, investing as limited partners in an Investment Fund), 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 institutional investors such as pension funds, mutual funds, insurance companies, private investment houses and foreign investors.
- d) Statutory rules governing pensions and insurance companies favor (after Ghana Government securities) corporate debt and listed investments. Private securities have more restrictions.
- e) For insurance companies, a listed instrument, and particularly if issuing debt, does not require a 15% discount reserve for performance as would be the case with equity.
- f) 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.

Primary Risks/Issues and Mitigants

- a) SPV or NBFIs may at first sound complicated, but Ghanaian investors understand them well, based on established precedents. Ghana has numerous SPVs that have attracted Funders' institutional capital into sector enterprises such as cocoa and the energy sector bond restructurings. Ghana also has numerous NBFIs and Investment Funds.
- b) Numerous public listings have taken place. The listing process requires a filing with the Ghana Stock Exchange (GSX) and SEC. It also requires the creation of a more detailed Offering Document which meets all listing standards. This can take about 90 days depending on the focus of the SEC and the GSX, once the issuer of the securities has completed and filed the appropriate documentation.
- c) The local market providers of banking advice, accounting, listing, legal, structuring and administration are professional and are appropriately experienced, having

created complex vehicles such as the ESLA Bonds and PBC Shelf Registration. Regulators too, are well versed. GLPGP has already engaged with certain service providers (bankers/advisors like Databank, Stanbic, Barclays, and PwC) and senior leadership at GSX, SEC, NPRA, NIC, MoF, GIPC, BoG, and other regulatory bodies, which have shown broad interest in seeing such innovative financial solutions brought to the local capital markets. This goodwill can be a magnet to attract both domestic and foreign capital into developing Ghanaian capital markets further.

Important drivers in choosing among alternatives for financing the investments

Important requisites for choosing financing approaches and sources include:

1. Ghana's targeted LPG-related funding needs all along the value chain (from importation to consumer) should be well defined, in particular, the BPs and Marketers once detailed decisions by the Government about their scope of responsibilities and their margins are taken.
2. The funded entities or modalities in the LPG value chain behind the ultimate repayment responsibilities should be able to demonstrate "bankability".
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. ESLA and PBC issuances provide good precedents that have appealed to Funders, given their cash flow predictability as well as managerial, operational and financial transparency, and 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.
9. 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 has been cautious due to its own IMF-imposed debt ceilings, but its IMF oversight may be easing soon, which will open up the Government's ability to become more directly involved in the financing. For example, the Government through MoF might reach out to the World Bank Group's International Bank for Reconstruction and Development (IBRD) for funds to be arranged to finance the Investment Plan. (Only governments can approach IBRD directly to initiate such discussions.) The Government may also consider approaching climate finance facilities such as the NAMA Facility of GCF. The purposes of such requests to Funders that normally only fund public sector projects would have two purposes: (i) for them to consider financing for LPG investments to be made by the state sector, and (ii) for them to consider financial support to the Ghana financial sector in order to increase its ability to participate in LPG investments into the Ghana private sector.

Funder issues to be addressed in financing the investment plan

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 Ghana LPG sector development funded by such entities, the four options are appropriately suited to take advantage of the structural expectations and realities in Ghana's capital markets.
4. GLPGP determined from its face-to-face discussions and market research with leading Ghanaian 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 have both more regulatory and investment preference for listed or Government-supported instruments (e.g., ESLA Bonds, PBC Shelf, GoG Bonds and Treasury Securities).

ESLA Bonds, PBC Shelf Registration, and other benchmark financings

In addition to GoG bonds, there are two relatively recent and good market proxies for local and foreign investor appetites for structures in Ghanaian capital markets. Analysis of such proxies has been factored into the structuring and pricing considerations for the Ghana LPG-related vehicle(s) through the discussions held with prospective Funders.

ESLA Bonds

First are the ESLA Bonds. A distressed situation in the oil and gas sector led to Ghanaian banks with a major exposure (12-15 billion Cedis) to non-performing loans from local companies. A levy (ESLA) was created by the Government to create a support mechanism for the energy sector and used by the MoF as a back-stop for bonds that would be issued on behalf of stranded energy entities, that could not repay their bank debt. ESLA Bonds were swapped mainly to banks and other energy sector debtholders for existing Ghanaian

Energy SOEs' debt that was underperforming and hindering the banks' abilities to lend more into the broader economy. An SPV raised 6.5 billion Cedis worth of bonds to pay the banks, turning that portion of the non-performing loans into performing. This was issued in two tranches – 7-year and 10-year initially only to local institutions. The 2017 ESLA Bonds were priced at roughly GHC (Cedis) 19% to 20% with 7 to 10-year maturities for local investors. Investors preferred the 7-year maturities because they were priced closely to the coupon on the 10-years (both 19% to 20%). The MoF and BoG had to encourage bank buyers of the bonds to take more of the 10-year paper as well. What is demonstrative in this example, and helpful for GLPGP-related entities, is that the MoF is actively working to encourage local institutional investors to take longer-term views of their investment securities. This is to build out the yield curve options for funding longer term projects in Ghana.

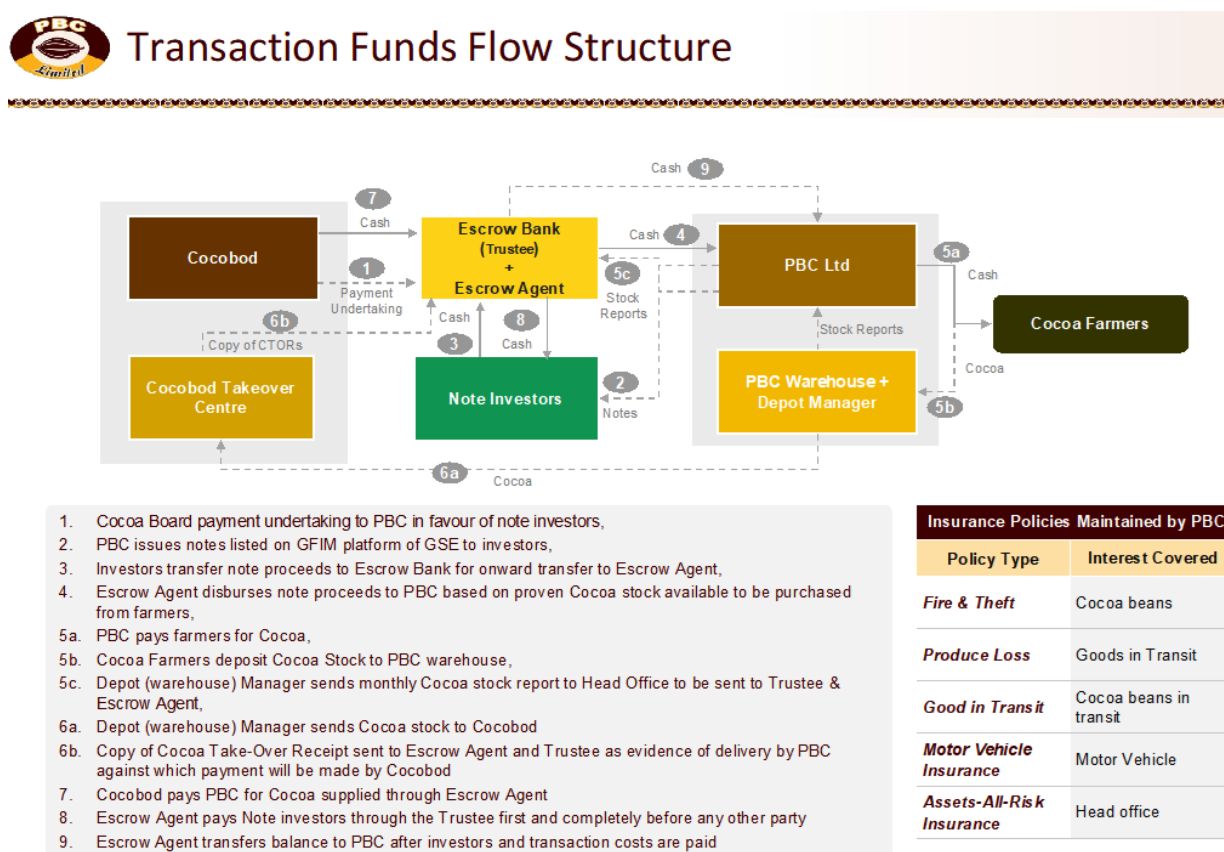
This recent example, and the current experience of levies already embedded in the market price formula of Ghana's LPG, demonstrates there is successful, large-scale experience in Ghana with a levy approach. The public and media understand the levy concept as well. Consequently, the approach of using a levy to back-stop a discounted cylinder acquisition cost to the consumer (as well as to industry) might have broad popular appeal. It directly benefits consumers through a lower initial deposit cost for cylinders instead of what may be seen as their having to pay for the mistakes of others (banks). This may also incentivize technological change, by switching a part of the cost burden for LPG switching from new LPG users to the entire LPG using population, or (under an alternative and broader levy approach), to the general population. For levies, the proceeds go into the Bank of Ghana's Consolidation Fund, unless exempted. MoF should be asked where the Reimbursement Fees' funds would be kept, separate and ring-fenced, to pay off the aggregate cylinder discount.

PBC Shelf Registration

Second is the US \$100M PBC Shelf issuance of Notes for financing of investments in the Ghana cocoa sector. Each phase of drawdown issuance is priced (through a standardized pre-approved pricing amendment filed with the GSX and SEC). This enables the pricing on each tranche to be made in a manner to attract the local institutional investors. Each tranche varies on the issuance based on the then-current capital market's conditions.

Figure 13 illustrates the structural flows used by PBC in its 2017 US \$100M shelf listing and issuance. The GLPGP SPV or NBF I can replicate this structure in the areas that are appropriate to create appeal to local Funders. In this example, see steps 4 to 9. Specifically, the Escrow Agents and Escrow (Trustee) Banks created a level of comfort for investors that their investment/funding would be disbursed based on the PBC's demonstrated need to buy cocoa plus off-take to buyer Cocobod. Bond issuance cash flows are sent to the PBC via an Escrow Bank, which is also responsible for making distributions to investors. The Trustee (it could be GLPGP for the Investment Plan) and Escrow Bank validate relevant business agreements. Clean Cooking for Africa/GLPGP, as an expert in LPG matters, could be considered as potential Trustee/Manager of this process while the SPV, NBF I or Investment Fund could be the equivalent of the PBC Shelf.

Figure 13. PBC shelf issuance transaction funds flow



Other Benchmarks

Other helpful precedents emerged from discussions with, and research into, the largest and most accommodative mix of blended capital from pivotal funding groups like DFIs, IFIs and MDBs as leads, coupled with risk mitigation through face-to-face discussions, phone calls, and research. These include identification and discussions of activities in the Ghanaian markets or in other emerging markets that could be instructive. Examples include:

- FMO's lead funding ~\$16 million investment in the \$60 million Bangladesh-based LPG company Omera, in the form of debt and equity. This has since been up-sized.
- Over 5 LPG funding exposures in the form of loans and technical assistance.
- Ghana Cenpower: FMO led and mobilized \$163 million in addition to [?] the IFC debt, and facilitated a senior finance facility of \$447 million insured by the Export Credit Insurance Corporation. FMO invested in this project along with the Africa Finance Corporation (AFC) – an African-based multilateral finance institution which has committed approximately \$3 billion to sectors like infrastructure, power, energy, transportation, and telecommunications. FMO, AFC and the IFC (all Master Cooperation Agreement (MCA) partners) could possibly partner on GLPGP funding.
- IFC's role in energy-related entities in Ghana such as Quantum.
- CDC, Development Bank of South Africa, and Ghana Infrastructure Investment Fund have invested jointly in the multi-hundred million USD building of the extension of the Accra Airport – Kotoka.

The logic for targeting marquee leaders in the blended capital and risk mitigation mix is that they will enable mobilizing scale, and then serve as the catalyst for followers who ideally could lower the overall blended cost of funding, be patient capital, and be well matched to the potential repayment abilities of the LPG supply chain players that underlie the cash flows of the funding mechanisms (SPVs, NBFI, Investment Funds etc.). This lead Funder approach is similar to typical syndicate and other “book-building efforts” in project finance and other finance efforts. GLPGP has concluded that the financial markets of Ghana have substantial options and a rich history of working with outside capital providers, and are a regional hot spot for attracting such investment.

It is important to note that Ghana does not have a history of structured LPG investing; prior to the market shift to CCCM, major LPG investments were made from the balance sheets of large oil-and-gas corporates. During CCCM, the LPG distribution network expanded through numerous small bank loans made to microstation operators that were secured, in part, by their LPG storage tanks and potentially by other business assets and by personal guarantees. The proposed new vehicle(s) are intended to facilitate greater professionalization of LPG investing, broader participation in both number and types of Funders, and greater quanta of capital being available to deploy.

Environmental/carbon finance

The potential carbon-market value from implementing what is described in this report is potentially €3-4 million per year. 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 consumer would benefit from a reduced cylinder deposit cost, by way of passthrough from the lower net cost to the service providers. One way this transfer might be accomplished, if carbon monetization were assured, is through utilization of a levy-like mechanism, which would leverage Ghana’s ample petroleum levy experience.

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).⁵⁵

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.

⁵⁵ 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.

VI. The Investment Opportunity for Funders

The Ghanaian LPG sector represents an opportunity for impact-oriented institutional Funders and donors to deploy resources efficiently to meet the need of € 335 million of new assets, based on in-depth country level analysis through the Clean Cooking for Africa/GLPGP expert team, demand assessment and impact assessments integrated with discussions with governmental agencies and financial entities. They can do this at scale and make an impact in the areas of cleaner cooking fuel sources, related health impacts, reduction of carbon output from charcoal or wood-based fuels, prevention of deforestation, and also create new areas of domestic SME development along the LPG value chain. Their investment, risk mitigation and technical assistance (TA) resources can serve as a catalyst to mobilize complimentary commercially-oriented capital into blended funding for the LPG sector. This could be both foreign and domestic sources. If structured correctly and provided the right business and regulatory environments, the blended sources of growth capital, risk mitigation and TA may realize their return objectives – financial and impact. The analyses in this document suggest that this can be the case.

6. Evolution to a More Bankable LPG Industry

Increasing LPG penetration to 50% of the population by 2030 will be facilitated by the adoption of the comprehensive Government-mandated regulatory and operational frameworks as discussed and recommended in the Feasibility Study. Adopting the frameworks, in particular the new, recommended strong form of BCRM, will create a more robust and more sustainable economic model for operators such as the LPG Marketers and planned Bottling Plant entities in the supply chain. With such frameworks in place, companies will be more inclined to make investments in critical operational assets, because loss of revenues due to events such as cylinder cross-filling will be substantially reduced or eliminated, and only legally established filling relationships, as regulated by the Government’s agencies such as NPA, will prevail.

The investment needs are not the only consideration, but must be balanced against the needs and expectations of capital providers. The Government’s regulatory frameworks to protect the economic flows of assets like cylinders will make these operational modalities more justifiably “bankable” to institutional Funders such as DFIs, IFIs, MDBs, and private and other funding and risk mitigation sources that are a critical link in the evolution of the sector.

Modeling of the potential returns to Funders indicates that, through 2030, investments in the two key areas of cylinders (Bottlers or Marketers) and filling/storage facilities (Bottlers) can generate hard currency-equivalent returns of approximately 8% to 10% on debt and more than 30% on equity. For investors and Funders looking at debt, debt-linked instruments, and instruments with equity-like characteristics, there are three ways to take exposure to the LPG sector. These are framed as straw-man financial scenarios below, and are described more fully later in this Chapter:

- a. Bottling Plant companies investing in both filling/storage plant and equipment (P&E) (€ 86.7 million) as well as making all the cylinder investments (investment before cylinder deposits of € 235.2 million), and forecasted IRR forecasted of 47%;
- b. LPG Marketers investing in cylinders with gross asset value of €235.2mm in aggregate through 2030, with a forecasted IRR of 30%;

- c. Bottling Plant companies investing in filling/storage P&E only (€ 86.7 million) through 2030, with a forecasted 35% IRR.

These returns are attractive from a PE vantage point, as the return threshold for emerging markets institutional investors is usually 20% minimum. As the Government is requiring Ghanaian-only equity ownership in the new LPG operators going forward, foreign capital sources are needed to complement in-country financial institutions in order to fund the full scale of investment. Foreign technical assistance funding, investment funding and risk mitigation resources will bring more scalable capital and risk mitigation sources to the investment equation. This will enhance longer-term scalability potential and attractiveness to both domestic and foreign investors/Funders. In order to protect the returns associated with such exposures, guarantee structures from groups such as those noted below are available. KfW or DEG, for example, might lead such a process for funding and risk mitigation. The approach regarding mobilizing non-Ghanaian sources of funding and risks protection is to use concessional funding through groups such as KfW/DEG, DFIs, MDBs, and IFIs, and use these entities to crowd in both additional non-concessional sources of capital and Ghanaian sources of capital – mainly pension funds and banks in particular that are used to lower risk investments. The blending of domestic and foreign concessional and non-concessional resources is an important catalyst to the Ghana Investment & Implementation Plan's realization. Foreign backers will lower the risk of capital losses if guarantees can be structured, in addition ensure ample capital is available, to make LPG investments of that scale economically viable, and return capital appropriately given the country level and firm-level risks. This is a proven approach.

The logic for targeting marquee leaders in the blended finance and risk mitigation mix is that they will enable mobilizing funding to scale, provide TA grants and guarantee structures, and then be the catalyst for followers. Ideally this approach could lower the overall blended costs of funding, be patient capital, and be well matched to the potential repayment abilities of the LPG supply chain players that underlie the cash flows of the funding mechanisms. This packaging of lead institutions to provide grant funding, TA, capital, and guarantees is an approach similar to typical syndicate and other "book-building efforts" in project finance and other financings. Grants for TA and operational development of the resource mobilizing entities envisioned by GLPGP are not atypical and an important caveat in this instance.

7. Methodology

The approach to executing GLPGP's mandate has been an interdisciplinary one. Detailed studies have been undertaken regarding the market demand for LPG, technical investment needs, impact potential, and blended financing options to implement investments. GLPGP has based the Investment and Implementation analysis and the investment funding and risk mitigation recommendations on the expressions of interest, preference, and practical requirements for investing from blended finance and risk mitigation sources, taking into consideration possible structures with which they are comfortable and the key characteristics of the local supply chain actors that would be the beneficiaries of the financing. The Clean Cooking for Africa/GLPGP expert team analyzed both domestic and international sources for meeting the capitalization and risk mitigation needs, in order to create both local and foreign based solutions to facilitate implementation. The view which emerged from such discussions and analysis is that foreign capital would also catalyze the limited sources of interested capital that may exist in the local market. Then, structuring options were created, designed to attract both local and foreign sources of capital.

Importantly, Ghana has approximately US \$22 billion in its institutional capital markets from banks, and investors ranging from pensions to insurance companies. While they are familiar with complex structures, they invest conservatively and tend to aggregate into perceived "safe haven" instruments like treasuries and investments/loans to large corporations. This limits the capital that is allocated to SMEs and growth companies. For a growth company like an LPG Bottler or Marketer, the domestic funders are, effectively, non-concessional Funders. In the mix of blended capital, if these local sources are crowded-in, they will need risk mitigation to participate at scale. This said, they have been proven to respond to guaranteed structures with the right SPV cash flow mechanisms, such as the \$100 million PBC SPV-linked financings as well as the multi-billion dollar ESLA Bond structures mentioned in Chapter 5. These two situations however were with large-scale operating players as the underlying credits.

The funding recommendations herein are anchored on an analysis of realistic options for implementing the Investment and Implementation Plan. GLPGP has utilized market-based analysis such as the needs of existing LPG Marketing companies and Bottlers – critical players in the value chain, that would need to be financed to be a part of the Ghana's LPG solution. In Ghana, the GLPGP team has met with senior capital markets officers at the Ministry of Finance and the National Investment Corporation (Agency) to corroborate the recommendations. In addition, pension and insurance regulatory bodies have also been consulted. Finally, major institutional funders including DFI representatives, investment banks, commercial banks, insurance companies, mutual funds, pensions, private debt/equity, and others have been approached to understand their appetites for investing in various types of opportunities. Outside of Ghana, the team has also discussed appetite with groups such as AfDB, DBSA, DFID/CDC, FMO, IFC, KfW, POPARCO, OPIC, and USAID among others. We have also discussed providing combinations of capital and risk mitigations with groups such as PIDG, GuarantCo and Africa Finance Corporation. On the private funding side, numerous funds have been approached on a confidential basis.

The firm-level funding recommendations herein are based on a composite of the industry. This is based on LPG consumption forecasts, market-based pricing of key financial influencers of the LPG operators, NPA-allowed operator value chain margins in key areas like costs of LPG, refill prices, cylinder policy and availability, regulatory operating framework (BCRM for example) and investment needs to fill the demand potential and other components – as explained in this and other related documents. This has enabled GLPGP to then build the industry profile (operational DFI and related financial composite) based on actual

market information and the demand assessment performed as part of the Feasibility Study. This approach is the strawman (composite) approach.

Ideally, specific company disclosures would be provided for each modality, but in the absence of having detailed information provided by a largely privately-owned and fragmented sector, the alternative of a the strawman (composite) approach was utilized. The potential social impact, risk and return expectations of potential Ghanaian and international Funders were assessed to evaluate the likelihood of satisfying the Investment Plan's financing needs versus the potential to fund these needs. The structuring analysis considered the best mix of concessional and commercial capital – blended capitalization, risk mitigation through guarantees, and supplemental needs such as grants for ensuring that operating entities and regulatory bodies have the capacities to meet the requirements to attract capital and be sustainable. For example, TA grants could be used to enable existing Marketing companies to analyze and reposition in the changing industry.

The recommended plan requires financing 9.5 million LPG cylinders of 14.5kg equivalence (kge), including 2 million existing cylinders that would have to be scrapped and replaced; 10 bottling plants (BPs) with appropriate storage capacity; pallets for efficient movement of the cylinders; and cages to display the cylinders in retail locations as detailed in Chapter 3.

Conclusion

This interdisciplinary approach has established that there is indeed an attractive underlying case for both owners and Funders to consider in terms of development impact, financial returns and social impact presented by investing in the LPG sector. To realize this potential, considerable investment must be attracted into the Bottling and Marketing modalities. Importantly, because the investment needs are over time, capital providers and proprietors can participate in stages and naturally hedge risks – somewhat of a testing of stages of funding. These investments were modelled in Bottlers and Marketers over three tranches. Related funding options from 2019 to 2030 were also accessed. Then, the best approach to driving capital and risk mitigation resources from interested parties was determined, considering both direct and indirect investment mechanisms, with the objective that institutions are enabled to deploy meaningful amounts of capital with a justifiable level of expended time and effort. Direct Funding (grants, debt, equity, risk mitigation tools) are both non-domestic and domestic institutional resources structured through a technical assistance supported initiative to groom and support pipeline recipients to meet the requirements of institutional resource providers. This should complement capital providers by enhancing the viability of various investment opportunities and options.

8. Structuring Ghanaian LPG Investment and Implementation

The approach to mobilizing blended financing around Ghanaian LPG value chain Bottler and Marketer modalities should be phased to identify and galvanize the best syndication of lead Funders and risk mitigation sources first. Because of the conservatism and investment scale limitations expressed regarding LPG by local financing sources, funding and risk mitigation sources should first be tapped from outside Ghana as leads that are used to catalyze participation from Ghanaian institutions such as banks, pensions, insurance companies and private investment institutions. This approach is a proven one and DFIs, for example, serve this lead role well. Their mandates and abilities, depending on the institution, are designed to provide some or all of the continuum of project development technical assistance monies and resources, capital ranging from working capital to longer-term hard asset financing – debt, equity, hybrid instruments, and pass-through or fund investments.

To be most effective as a way to stimulate the LPG sector, it is important to prioritize the firm level investees or recipients of capital by working first with the top tier players in terms of market share and impact potential. This will serve to stimulate interest from both sources of funding and risk mitigation and also from other sector followers. GLPGP has confidentially approached selected leading players and the belief is that, although some have on-going smaller operational funding needs covered by local banks, the larger capital investments associated with the BPs and the new cylinder investments, in order to grow under BCRM, will require investments beyond their existing funding capabilities. In order to receive new licenses from the NPA, Bottlers have been required to demonstrate that they can fund. A small (and insufficient) number have indicated in general that they can mobilize funds, as of this writing. Even for the Bottlers who have come forward with funding strategies, their ability to fund at interest rates as attractive as that which can be mobilized utilizing global and domestic blended capital sources is doubtful. This is because the blended mixes will utilize risk and capitalization structures that can better minimize risk. They can incorporate syndicated scale with pre-arranged tranches as per DFIs or IFIs – using the IFC-sponsored MCA for example; instruments such as OPIC's private placement insurance for 144A debt placements – essentially providing a US Government guarantee to investors in, for example, an SPV; first-loss tranches from impact investors and institutions with such offerings; investment structures that can be more accommodative to the structural needs of the companies – for example, using convertible instruments that can lower immediate coupons in exchange for future upside through royalties – structures domestic banks do not typically utilize to fund clients; operational and political risk guarantees; FX guarantees; and other advantages. In addition, DFIs, MDBs, and IFIs can offer tenors out to fifteen years – thereby lowering the cash-flow burdens with debt servicing over shorter tenors. Domestic banks are limited by risk metrics, capital adequacy ratios and provisioning, and capital pricing constraints that understandably limit their ability to do these things. Unless a Bottler is a blue-chip client, it is even difficult to finance beyond three to five years. The Government of Ghana (GoG) had to push banks to swap their bad loan exposures to Ghanaian energy companies into seven and ten-year GoG bonds. For these reasons, it would make sense for Bottlers to work to be part of the blended finance structured funding solutions, recommended herein. Importantly, this approach can still incorporate their local bank funding, but in conjunction with funding through a blended capital initiative.

As noted, the LPG sector in Ghana will evolve towards 10 regional Bottling Plants under new NPA rules and regulations, and these Bottlers will supply the Marketers and their distribution channels to the end consumers. As it is still early in the implementation of NPA's new frameworks around BCRM, Bottling and/or Marketing companies are expected to need to invest in the approximately 9.5 million incremental

cylinders by 2030. This has a €235.2 million estimated price tag, although consumer cylinder deposits will cause the net financing need to be a materially smaller quantum. For a Bottler or Marketer with even 5% market share, this would entail a gross capital expenditure of € 11.8 million minimum to keep its relative market share of LPG sales, if the market rankings and cylinder rotation rates stay relatively constant. In a constant, let alone changing, market where certain Marketers may soon be positioning for survival in some cases or for opportunities to grow rapidly in others, this is a large investment amount, and outside Funders, domestic or foreign, if interested, will seek risk mitigation.

Recommended technical assistance measures and associated costs are set forth in Chapter 21 beginning on page 160.

Conclusion

This interdisciplinary approach has established that there is an underlying case for both owners and Funders to consider in terms of development impact, financial returns and social impact presented by investing in the LPG sector in Ghana. To realize this potential, considerable investment must be attracted into the Bottling/Marketing modalities. Importantly, because the investment needs are over time, capital providers and proprietors can participate in stages and naturally hedge risks—that is, testing of stages of funding. These investments for the Bottlers and Marketers – namely for key investment areas as noted in cylinders and bottling plants/storage—have been modelled using the Strawman approach. We have also accessed the related funding options from 2019 to 2030. We then have determined that the best approach to driving capital and risk mitigation resources from interested parties is through a combination of direct and indirect channels. This enables institutions to deploy meaningful amounts of capital, thereby justifying their time and efforts. Direct Funding (grants, debt, equity, risk mitigation tools) are both non-domestic and domestic institutional resources structured through a TA supported initiative to develop capacity and capability in pipeline recipients to meet the requirements of institutional resource providers. This should complement capital providers by enhancing the viability of various investment opportunities and options.

9. Structuring Firm-Level Investments

In order to target and structure firm-level funding opportunities and assess their risks – crudely speaking “to pick potential winners” – it is key to note the sector’s evolving macro-operational dynamics. This makes firm-level risks a dynamic assessment. Funders will therefore price their capital at the sovereign, sector, and operator risk levels. These risks can all be insured by risk guarantees and insurance from both private and public institutions, but they too have to have an appetite and the pricing has to be affordable to operators. As noted, Ghana’s LPG sector is fragmented and, with the evolving new NPA-mandated BRCM, reclassifications of licenses and operational statutes, the sector winners are not certain. The expectation is that there will be a meaningful reduction in the number of Marketers, based on the NPA’s evolving guidelines. The NPA has already stipulated its decision to have 10 regional, core Bottlers in Ghana, all of which will be new: new assets, new operations, new managements. Only those that can currently demonstrate adequate operational, competitive, financial, and managerial potential are likely to be deemed bankable. However, compared to Bottlers, Marketers are likely to be more difficult to appropriately assess for their potential and risks at this stage and going forward. The much smaller competitive pool of Bottlers--10 players with regional rights—make them the more attractive modality. In addition, they have major core assets (even if they also invest in cylinders, should NPA assign them that role also) that are fixed, which provides more comfort to Funders.

Structuring the firm-level capitalization should therefore be based top-down (mainly regulatory/demand) and bottom-up (operational firm/industry-level). The view is that this approach will break the Ghanaian LPG sector into two main tiers of targets in the Bottler and Marketer verticals:

- 1) *Tier 1 Entities* – Those that are well-positioned to adapt to the new regulatory paradigm. These would have economic scale, strong operational outlooks, and management and are most likely “bankable” in the immediate term – with some advisory services to prepare for outside resourcing; and
- 2) *Tier 2 Entities* – Those with a chance and interest in growing with the new market realities, but are still smaller or uncertain. As suggested in meetings with NPA and country research, they are typically smaller scale, less dynamic proprietorships and will need more time and assistance to be “bankable”.

For more conservative debt Funders, structuring funding around Bottlers may be easier than Marketers due to the scale and fixed assets base. Outside of investment in cylinders, which are portable assets, they will have € 86.7M in plant and storage capacity that can stand as fixed asset collateral for Funders. Marketers, on the other hand, have the primary investment need in the area of cylinders, if NPA assigns that role to them. The eventual Marketer firm count is still undetermined by NPA as of this writing, as some players will be rendered inoperable by NPA, and some will choose to consolidate. This makes investing directly in smaller Marketers potentially riskier, so interested Funders will want to have risk diversification. This would be analogous to a portfolio diversification strategy by owning a range of companies in a sector to mitigate competitive risks – or to a closed-end country fund.

In light of the mix between larger-scaled Bottlers and presumably some Marketers that will take on larger scale in the new NPA LPG regime, based on being designated as adequately prepared to continue operations as marketing entities, the recommendation is to take two paths to funding the LPG value chains:

- a. **Direct Structured Funding** to Bottlers and Marketers that can be made bankable with the correct engagement or advisory work from GLPGP;

b. **Indirect Funding** to Marketers and, in cases where it makes sense, to Bottlers.

This can be done effectively by providing direct and indirect conduit/surrogate investment structures which enable institutional players to build positions in the LPG sector, in both lower risks areas such as Bottlers, and in the evolving areas like Marketers. In addition to advising LPG entities on positioning for direct funding and risk management sources, the recommendation therefore is to create LPG-targeted funding vehicle(s) that can serve as funding conduits that LPG-targeted institutional Funders and investors can use to achieve larger scale exposure to parts of the value chain. These could be in the form of Ghana Stock Exchange-listed SPVs, private SPVs, an LPG focused Non-Bank Financial Institution, or investment funds. *Figure K* envisions any one of these options in the Ghana LPG Vehicle spot. These can be €100 million or more, that then enables DFIs and other non-Ghanaian Funders as well as important domestic Ghanaian Funders and investors, such as the pensions and banks, to put their minimum sizes of capital to work. This would typically be in the range of €1 million (for Ghanaian entities) to €5 million to €25 million easily for non-Ghanaian institutional and investors and Funders such as DFIs, IFIs, and MDBs and impact interested private sector investors and Funders such as PE (debt and equity funds), pensions, foundations, family offices etc.

In reference to Figure 14 below and *Tier 1 Entities*, these will be funded directly largely by non-domestic sources followed by domestic banks and domestic institutional investors. These would most likely include the 10 Bottlers because of their scale and competitive strength, given that they will be allotted exclusive territories under the BCRM. The LPG Vehicles and LPG On-Lending through financial institutions will be made available to invest in *Tier 1 & 2 Entities*. The participation of the LPG Vehicles serves the purpose of providing a pooled solution to appealing *Tier 1 & 2 Entities* that, perhaps because of scale, cannot draw the attention of capital sources directly.

10. Projecting the Performance of Firm-level Investments

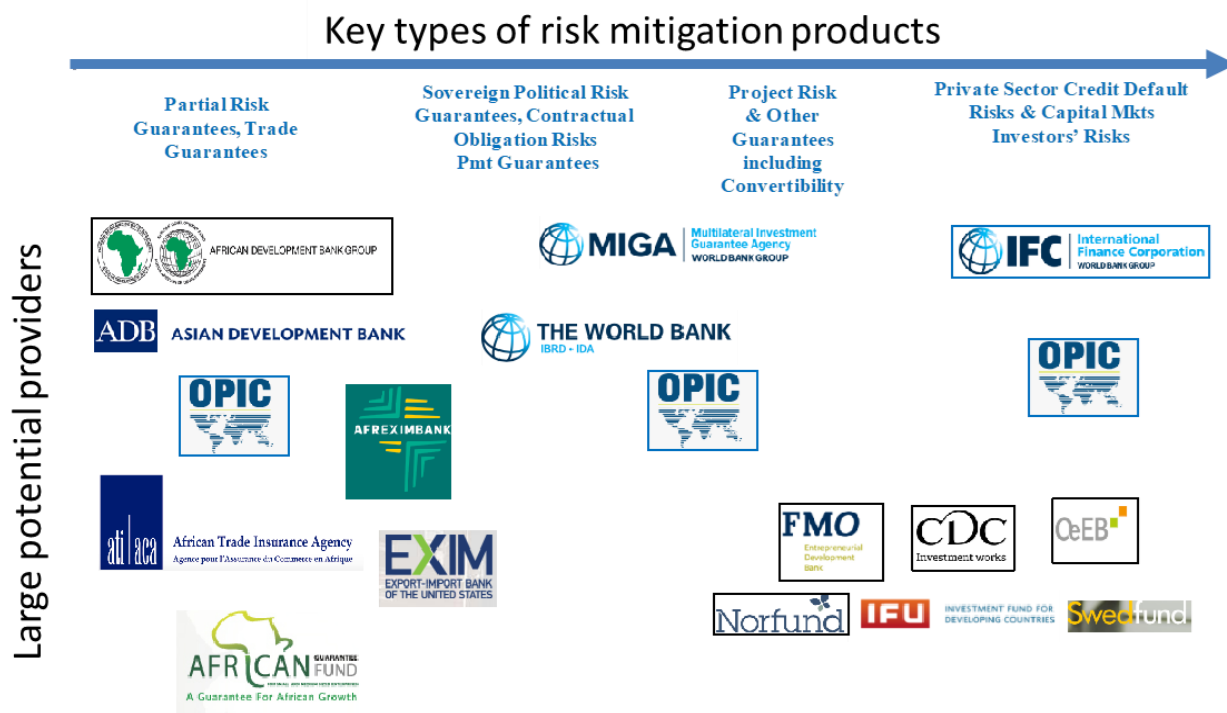
To test the potential appeal for outside capital to fund the firm-level investments, GLPGP modeled the investment requirements, the timing, and the returns to Funders using the Strawman approach and has concluded that, through 2030, investments in cylinders, bottling and storage can generate hard currency equivalent returns of approximately 8% to 10% on debt and more than 30% on equity.

These returns are attractive from a PE vantage point as the minimum return thresholds for emerging markets institutional investors is usually 20%. From the perspective of the preference of Funders into an SPV, options B and C would most likely be the more attractive because Bottlers have hard assets, a unique NPA-blessed operating radius, and essentially captive customers in the form of Marketers. Option A of funding the more sustainable Marketers so that they can invest in new cylinders is also attractive in terms of IRR. The issue, though, is whether bigger Marketers can mobilize enough resources on their own to fund the required cylinder investment for the overall sector growth. This is also a question for the NPA as it decides who will have the right to buy and own cylinders – Bottlers or Marketers.

To protect the returns associated with such exposures, guarantee structures from groups such as those noted below in Figure 15 are available. For example, for KfW or DEG there are potential roles for lead funding and for risk mitigation. (For a more detailed discussion of DFI participation needs and opportunities, see Chapter 20, which begins on page 159.) Foreign backers will lower the risk of capital losses if guarantees can be structured in addition to the availability of ample capital to make LPG investments of the scale to be economically viable in order to return capital. This is a proven approach.

As can be seen from the representative cases in the Supplementary Annexes, partnerships of DFIs and the IFC have backed multiple loans to LPG operators across the value chain in developing markets. This makes the IFC a suitable target to approach for non-concessional capital while also serving as an organizer of co-funders, as they so often do through their syndication services, that can include concessional capital. Partners who are members of the IFC's MCA would create an efficient syndication club that could provide packages for LPG investment, once the right funding candidates are identified on a large one-off basis or on aggregated levels. Certain DFIs and MDBs still have reservations about fossil fuel sources. Fortunately, major groups like the IFC and FMO are comfortable with the LPG sector and can therefore serve as catalytic blended capital sources as they did with Omera Petroleum in rounds of funding. In addition, larger private impact investment groups may also find the health, environmental, SME, infrastructure and economic inclusion developmental and impact results to be compelling.

Figure 15. Large providers of risk mitigation offerings



11. Capital Target Size and Capital Structure

The recommended approach for targeting and mobilizing non-Ghanaian sources of funding and risk protection is to use concessional funding through development-oriented groups like KfW/DEG and DFIs, for example, to then crowd-in non-concessional capital sources, both foreign – IFC, for example -- and Ghanaian. Ghanaian sources can include large institutions such as pension funds and banks in particular. In reality, non-concessional capital will most likely not look at large scale investment in the LPG sector without the cushion from concessional capital. This includes TA for operators and GoG sector administrators; risk mitigation sources – first-loss, contractual, operational, and political risks; and more patient capital which will provide longer tenors, flexibility in amortization and cash repayment timing, and lower interest rates. In addition, if each of the 10 Bottlers were required to provide equity of 1/10th of the overall gross cylinder and bottling investments as noted below under a BCRM scheme, this would be approximately €334.8M/10 (pro-rated 10% share of market) or €33.5M each. This might be doable if it is over several years but the cost of funding and the commensurate returns to these Bottlers and their outside domestic and foreign Funders would be increased with lower costing concessional capital. In addition, TA monies could also enhance their operational and financial structure optimization and profitability. To this end, of the debt, we modelled a blend of 47% non-concessional and 53% concessional to achieve appropriate return hurdles that could be met by the projected cash flows of the sectors' Marketing and Bottling Companies. The capitalization envisioned is as follows:

Capitalization % Assumed	% of Capitalization
Non-Concessional Debt	35%
Concessional Debt	40%
Equity (or Quasi-Equity)	25%
Total Capitalization	100%

Below are side-by-side scenarios to show the impact of the extreme case of no concessional capital. Interest rates would be higher as more commercial sources would be required to participate and capital would then become more expensive. In addition, non-concessional (public such as IFC and private such as banks) Funders would be the sole basis of the weighted cost of capital. Arguably one of the best credit risks in Ghana is the Sovereign Bond. On May 10, 2018 Ghana raised US \$2 billion Eurobond priced as follows: (1) 10-year @ 7.625% and (2) 30-year @ 8.627%. The original US \$1.5 billion was reportedly oversubscribed by approximately seven times so it was raised by \$500 million to US \$2 billion. This suggests that corporate entities funded in Ghana will pay a risk premium to this benchmark. The insurance premium by non-Ghanaian debt investors is currently running at 200bps to 300bps according to active investor sources confidentially approached by GLPGP. In addition, the Funders will expect an arbitrage spread for backing the private sector. This could put non-concessional debt rates at the 12% to 13% which would be at approximately a 300 to 500 basis point spread range over the Ghana Sovereigns. This kind of relative corporate to sovereign spread is not atypical in emerging markets' debt.

Table 48. Base case capitalization for LPG investment vehicles

IRR to all Equity	
	47%
120€/t	47%
150€/t	121%
160€/t	174%
165€/t	214%
170€/t	269%

Debt Breakdown	%	Int Rates
Non-Concessional	47%	10.00%
Concessional	53%	8.00%

Overall Int Expense	
	35,178

The scenario in Table 48 is the Base Case capitalization blend for the LPG vehicles in Ghana. Note the interest expense is €35 million.

Table 49. Extreme case capitalization for LPG investment vehicles

IRR to all Equity	
	39%
120€/t	39%
150€/t	88%
160€/t	121%
165€/t	143%
170€/t	171%

Debt Breakdown	%	Int Rates
Non-Concessional	100%	12.50%
Concessional	0%	8.00%

Overall Int Expense	
	49,223

The scenario in Table 49 is the Extreme Case capitalization – without any concessional capital for the LPG vehicles in Ghana. The interest rate is averaged at 12.5% as explained above – the 12% to 13% range for riskier corporates. Note the interest expense is €49 million. The IRRs to the equity backers also fall although they are arguably still attractive. The reality is that this scenario, no matter how reasonable IRRs might still be, cannot be funded without concessional capital from DFIs and MDBs among others. The size alone of capitalization and the risks of the underlying operating investments would limit the exposures for a non-blended capital stack.

Note that these scenarios assume that the capital investment into cylinders is net of the consumer cylinder deposits. To the extent that the cylinder deposits cannot be fully repurposed toward the acquisition of additional cylinders, the interest expenses in both cases will rise, and the IRR to equity will fall.

It is envisaged that mobilizing up to €335 million (the hypothetical floor, net of cylinder deposits, being €170 million) would be done in phases to match the timing of blocks of deployments of investments by the Bottling and Marketing operators. In the case of Table 50 below, this will be done in three phases to match the needs for timing of the Bottlers. In the case of Marketers, if they invest in cylinders under the forthcoming NPA rules, this would be done through the arrangement of on-lending lines or similar blocks of debt commitments that could be administered to meet the funding of Table 51 below. Importantly, operators should be expected to provide equity to bolster outside equity and debt commitments. The equity tranches are expected to be 25% of the overall funding. This is unlikely to be satisfied by most operators by themselves, according to views obtained through confidential discussions. So, this quantum will likely have to be structured as preferred equity (or quasi-equity) with a predictable stream of cash returns for outside investors (such as impact investors and DFIs). This is an area where the scale that can be created by SPVs makes SPVs an important conduit to aggregate streams of multiple operators' returns, and dividend them out. Guarantees will also be essential at these levels.

Table 50. Total bottling plant investment by region and phase

Region	Phase 1	Phase 2	Phase 3	Total
Upper West (Depot)	50,000 €	- €	- €	50,000 €
Upper East (Depot)	50,000 €	- €	- €	50,000 €
Northern	50,000 €	8,286,117 €	1,659,000 €	9,995,117 €
Brong-Ahafo	7,109,867 €	20,000 €	428,750 €	7,558,617 €
Ashanti 1	7,098,923 €	- €	- €	7,098,923 €
Ashanti 2	- €	5,902,211 €	905,900 €	6,808,111 €
Eastern	6,671,705 €	49,640 €	837,500 €	7,558,845 €
Western	6,258,395 €	49,640 €	408,750 €	6,716,785 €
Volta	5,764,277 €	511,154 €	428,750 €	6,704,181 €
Central	6,192,179 €	47,292 €	428,750 €	6,668,221 €
Greater Accra 1	6,761,309 €	- €	408,750 €	7,170,059 €
Greater Accra 2	6,761,309 €	6,761,309 €	6,761,309 €	20,283,927 €
Total	52,767,964 €	21,627,363 €	12,267,459 €	86,662,786 €

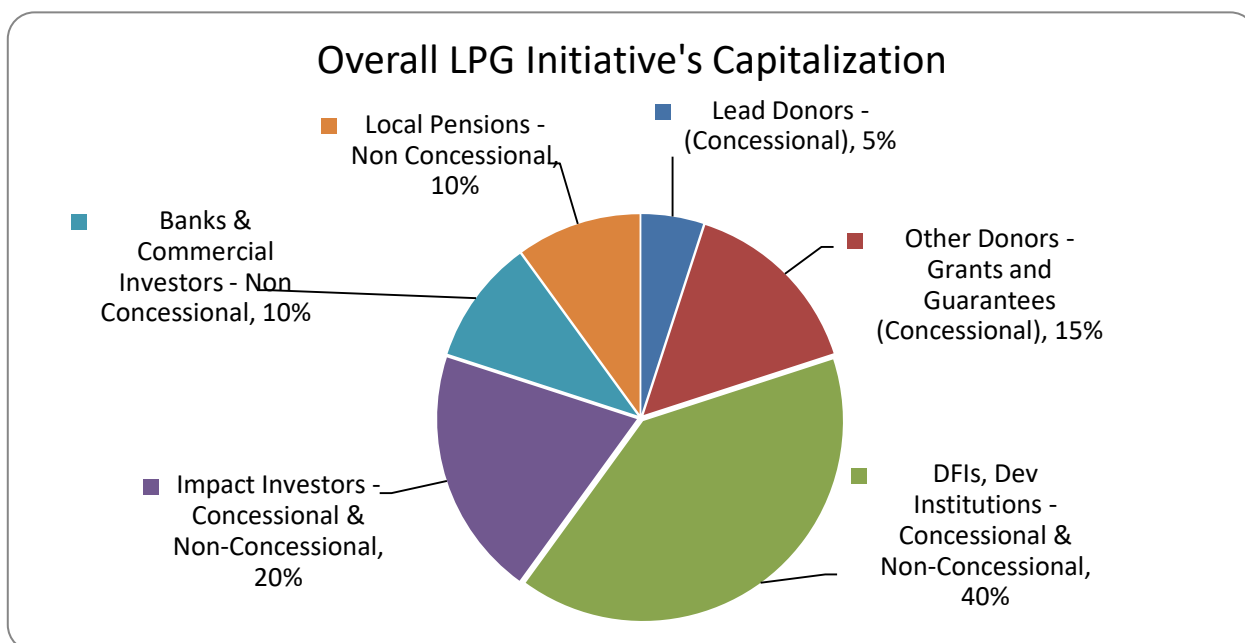
Table 51. Total cylinder, pallet and cage by investment phase (€ mm)

Asset type	2020	2022	2024	2026	2028	2030	Total
Additional cylinders (14.5kge)	20.91 €	33.99	33.34	32.72	32.13	31.55	184.63 €
Cylinders to replace scrapped existing cylinders	33.71 €	16.86					50.57 €
<i>Subtotal Cylinders</i>	54.62 €	50.84	33.34	32.72	32.13	31.55	235.20 €
Pallets	3.32 €	0.47	0.47	0.47	0.47	0.47	5.66 €
Cages	4.26 €	0.60	0.60	0.60	0.60	0.60	7.28 €
Total	62.20 €	51.92	34.42	33.80	33.20	32.62	248.15 €

12. Operationalization of the Investment and Implementation Process

The LPG financing mechanisms' costs (Figure 14, page 116) would be funded by a 2% to 3% management fee charged to the investors. In the early years, it is envisioned that lead donors will need to provide working capital grants and loans until the Vehicles get to assets under management that can cover expenses each year. This will include design grants and other grants. The expected size of such funding will be discussed with prospective grant and support sources. In later years, higher costs of a larger staff will be offset by the management fee being applied to a larger capital base. Figure 16 shows that the vehicles will be financed through multiple tranches to mobilize as much capital as possible. In reality, the timing of tranches will pick up momentum but after the first tranche is closed. GLPGP has based its estimations of the composition of the capital stack from team experience, knowledge of market trends, and research including sources like the OECD and Convergence. What actually occurs will be based on the marketplace when funding happens.

Figure 16. Overall target capitalization of LPG investment projects - 2019 to 2030



Overall Funding - Gross Assets 334.8 €

(Euros mm)

Overall	Assumed Ratios of Capitalization	Capitalization
5%	Lead Donors - (Concessional)	16.7 €
15%	Other Donors - Grants and Guarantees (Concessional)	50.2 €
40%	DFIs, Dev Institutions - Concessional & Non-Concessional	133.9 €
20%	Impact Investors - Concessional & Non-Concessional	67.0 €
10%	Banks & Commercial Investors – Non-Concessional	33.5 €
10%	Local Pensions – Non-Concessional	33.5 €
100%	Size of Vehicle Funding	334.8 €

Overall Funding - Net of All Cylinder Deposits		170.2 €
<i>(Euros mm)</i>		
Overall	Assumed Ratios of Capitalization	Capitalization
5%	Lead Donors - (Concessional)	8.5 €
15%	Other Donors - Grants and Guarantees (Concessional)	25.5 €
40%	DFIs, Dev Institutions - Concessional & Non-Concessional	68.1 €
20%	Impact Investors - Concessional & Non-Concessional	34.0 €
10%	Banks & Commercial Investors - Non Concessional	17.0 €
10%	Local Pensions - Non Concessional	17.0 €
100%	Size of Vehicle Funding	170.2 €

The LPG capitalization targets are based on:

- **Investment Needs:** The projected investment needs of the Ghana plan;
- **Availability of Scalable Capital:** The availability of resources at scale of each Funder category to participate;
- **Probability of Success:** The potential to successfully access such resources based on past investment and funding records and to blend them into a capital stack;
- **Add-On Impact:** The additionality/multiplier effect that can be facilitated by mixing catalytic donor grants and capital with other concessional and non-concessional sources;
- **Returns and Risks:** The return expectations and risk tolerance of capital sources and LPG's ability to meet these; and
- **Benchmarking:** Market benchmarks for such funding, by targeted groups.

The sector investment needs the ability for operators to stretch them out, and the size of capital commitment assumed by each Bottler or Marketer involved going forward are captured in the table below.

Table 52. Overall target capitalization of LPG investment projects - 2019 to 2030

<i>(Euros mm)</i>	2019-22	2023-26	2027-30	Totals
Total Cylinders	105.5 €	66.1 €	63.7 €	235.2 €
Bottling Plants & Storage	52.8 €	21.6 €	12.3 €	86.7 €
Pallets	3.8 €	0.9 €	0.9 €	5.7 €
Cages	4.9 €	1.2 €	1.2 €	7.3 €
Gross Capital Investment	166.9 €	89.8 €	78.1 €	334.8 €
<i>Max. Potential Funding from Cylinder Deposits</i>	73.8 €	46.2 €	44.6 €	164.6 €
Potential Net Capital Investment (Floor)	93.1 €	43.6 €	33.5 €	170.2 €

Table 53. Target capitalization by prospective capital source - 2019 to 2030
(prior to any borrowing against, or internal use of, cylinder deposit funds)

TARGETED CAPITALIZATION OF LPG VEHICLE (Euros 000)

<i>(Euros mm)</i>					
% of Cap	Target Capitalization of	2019-22	2023-26	2027-30	Totals
	Sponsored Vehicle - Gross Capital Amounts				
5.0%	Lead Donors - (Concessional)	8.3 €	4.5 €	3.9 €	16.7 €
15.0%	Other Donors - Grants and Guarantees (Concessional)	25.0 €	13.5 €	11.7 €	50.2 €
21.2%	DFIs, Dev Institutions - Concessional	35.4 €	19.0 €	16.6 €	71.0 €
18.8%	DFIs, Dev Institutions - Non-Concessional	31.4 €	16.9 €	14.7 €	62.9 €
10.6%	Impact Investors - Concessional	17.7 €	9.5 €	8.3 €	35.5 €
9.4%	Impact Investors - Non-Concessional	15.7 €	8.4 €	7.3 €	31.5 €
10.0%	Banks & Commercial Investors - Non-Concessional	16.7 €	9.0 €	7.8 €	33.5 €
10.0%	Local Pensions - Non-Concessional	16.7 €	9.0 €	7.8 €	33.5 €
100.0%	<i>Size of Vehicle Funding</i>	166.9 €	89.8 €	78.1 €	334.8 €

(with 100% borrowing against, or internal use of, cylinder deposit funds)

TARGETED CAPITALIZATION OF LPG VEHICLE - NET (Euros 000)

<i>(Euros mm)</i>					
% of Cap	Target Capitalization of	2019-22	2023-26	2027-30	Totals
	Sponsored Vehicle - Net of Consumer Deposits				
5.0%	Lead Donors - (Concessional)	4.7 €	2.2 €	1.7 €	8.5 €
15.0%	Other Donors - Grants and Guarantees (Concessional)	14.0 €	6.5 €	5.0 €	25.5 €
21.2%	DFIs, Dev Institutions - Concessional	19.7 €	9.2 €	7.1 €	36.1 €
18.8%	DFIs, Dev Institutions - Non-Concessional	17.5 €	8.2 €	6.3 €	32.0 €
10.6%	Impact Investors - Concessional	9.9 €	4.6 €	3.6 €	18.0 €
9.4%	Impact Investors - Non-Concessional	8.7 €	4.1 €	3.2 €	16.0 €
10.0%	Banks & Commercial Investors - Non-Concessional	9.3 €	4.4 €	3.4 €	17.0 €
10.0%	Local Pensions - Non-Concessional	9.3 €	4.4 €	3.4 €	17.0 €
100.0%	<i>Size of Vehicle Funding</i>	93.1 €	43.6 €	33.5 €	170.2 €

Given that there is the probability that all the steps to be taken starting in 2019, set forth in this report dated December 2018, and in the immediate following years, will not be accomplished on such a timely basis, and that this might jeopardize the timeline of the recommended investment projects and their financing, it would be worthwhile for the reader to consider the 2019-2030 target years of activity to be Years 1-12.

Marketers in Ghana may borrow internally against the cylinder deposits obtained from their end-customers. It is anticipated that the Government will define via new regulation that the cylinder deposit amount will be 70% of the cost of the cylinder to the cylinder-owning company, and that the cylinder-owner must treat these funds on its books as a liability to the depositor. (In some other BCRM countries, a portion of the deposit amount must be treated as taxable income instead.) The funds provided by the customer are to be returned to the customer when s/he cancels service and returns the cylinder to the brand owner. The internal reuse of these deposit funds makes the consumer, in effect, a major financing source for cylinders. As presented in the tables above, this effect causes the net amount needed by Bottlers or Marketers for financing of new cylinders to be closer to 30% 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.

Thus, the financing requirement for cylinders, in practice, will fall somewhere between the hypothetical net (representing a floor value) of € 70.6 million and the gross of € 235.2 million.

The scenarios below show the potential average capital burden under the scenarios of (i) the planned 10 NPA-designated BPs investing in cylinders, (ii) the Marketers investing in cylinders instead of the BPs, assuming a notional 20 Marketers ultimately making such investment. The full investments for larger players like BPs may be partly self-fundable but, for smaller Marketers, the quantum, as referenced in Table 54 as the “Average Size of Investments”, could be difficult without the existence of LPG-related funding mechanisms. Importantly, BPs’ equity according to governmental requirements must be 100% Ghanaian, so foreign funding of investment needs will have to be at the debt or preferred stock levels for outside capital. The LPG funding mechanisms can serve the purpose of aggregating the project level investments into a pool that can then be efficiently funded and de-risked. Since these levels will require interest payments, it is important to utilize the least costly funding for the debt component.

Table 54. Average size of Investments by operator type - 2019 to 2030
(with BPs investing in the cylinders)

Bottling Plant with cylinder investment (10% average market share)			
(Euros mm)	2019-22	2023-26	2027-30
Total Cylinders	10.5 €	6.6 €	6.4 €
Bottling Plants & Storage	5.3 €	2.2 €	1.2 €
Pallets	0.4 €	0.1 €	0.1 €
Gross Capital Investment	16.2 €	8.9 €	7.7 €
<i>Max. Potential Funding from Cylinder Deposits</i>	7.4 €	4.6 €	4.5 €
Potential Net Capital Investment (Floor)	8.8 €	4.2 €	3.2 €

(with Marketers investing in the cylinders)

Bottling Plant without cylinder investment (10% average filling share)			
(Euros mm)	2019-22	2023-26	2027-30
Bottling Plants & Storage	5.3 €	2.2 €	1.2 €
Pallets	0.4 €	0.1 €	0.1 €
Capital Investment	5.7 €	2.3 €	1.3 €

Marketer with cylinder investment (5% average market share)			
(Euros mm)	2019-22	2023-26	2027-30
Total Cylinders	5.3 €	3.3 €	3.2 €
Gross Capital Investment	5.3 €	3.3 €	3.2 €
<i>Max. Potential Funding from Cylinder Deposits</i>	3.7 €	2.3 €	2.2 €
Potential Net Capital Investment (Floor)	1.6 €	1.0 €	1.0 €

Operationally, the IFC has an active syndication process which brings in other qualified funding partners. This Funders’ group is a highly capital and resource intensive club of IFIs and DFIs some of which like FMO and the IFC, are themselves involved in LPG-related projects. The MCA syndicate grouping below is facilitated through the members’ respective capital markets teams – an area in which the IFC is very active and is therefore a good target for GLPGP’s funding approaches. This process was further institutionalized in October 2009, when the IFC created along with DEG, FMO, and PROPARCO, the MCA syndication format shown in Table 55. The MCA details how the IFIs and DFIs will work in a pre-arranged standardized manner, to co-finance projects when the IFC is the mandated lead arranger. This is done through the IFC’s Parallel

Loans Program whereby the IFC is the lead arranger for loans, and can also act as administrative agent. In this situation, participants (DFIs, IFIs, etc.) 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. When appropriate, this 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 targets that could be approached for the various blended capital funding structures and associated risk mitigation instruments are signatories.

Table 55. IFC Master cooperation agreement syndicated/parallel loans signatories

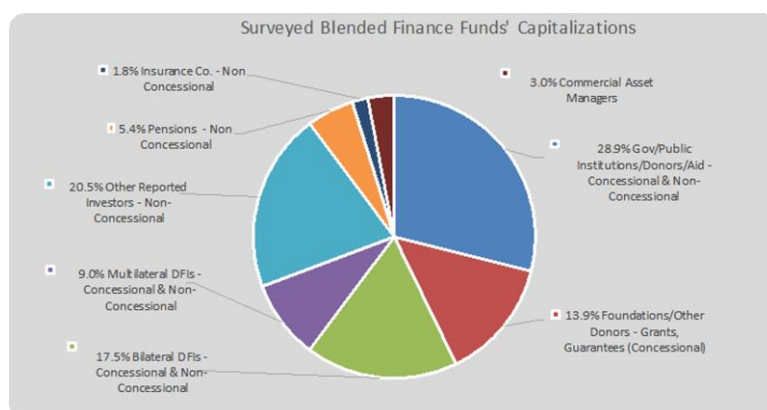
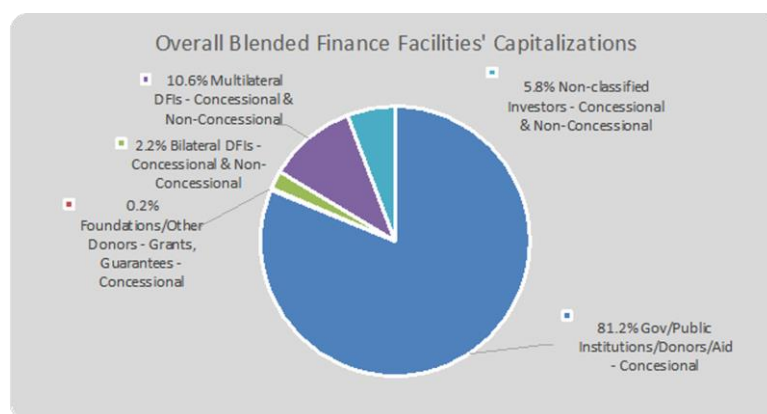
1. International Finance Corporation
2. France's Société Promotion et de Participation pour la Coopération Economique (Proparco)
3. Germany's Deutsche Investitions-und Entwicklungsgesellschaft mbH (DEG)
4. Netherlands' Nederlandse Financierings-Maatschappij Voor Ontwikkelingslanden NV (FMO)
5. Development Bank of Japan (DBJ)
6. Austria's The OPEC Fund for International Development (OFID)
7. Belgium's Societe Belge d'Investissement pour les Pays en Developpement SA/Investment Co. for Dev. Countries (BIO)
8. Black Sea Trade and Development Bank (BSTDB)
9. Oesterreichische Entwicklungsbank (OeDB) or Development Bank of Austria
10. Eurasian Development Bank
11. Arab Petroleum Investments Corp (APICORP)
12. United States' Overseas Private Investment Corporation (OPIC)
13. Islamic Corporation for the Development of the Private Sector (ICD)
14. Export Development Canada (EDC)
15. United Kingdom's Commonwealth Development Corporation (CDC)
16. Portugal's Sociedade para o Financiamento do Desenvolvimento (SOFID)
17. Banque Ouest-Africaine de Developpement (BOAD) or West African Development Bank
18. Swedfund
19. Compañia Española de Financiación del Desarrollo (COFIDES)
20. International Investment Bank (IIB)
21. Hungarian Export-Import Bank (HEIB)
22. Swiss Investment Fund for Emerging Markets (SIFEM)
23. Finnish Fund for Industrial Cooperation Ltd (Finnfund)
24. Instituto de Credito Oficial (ICO)
25. Japan International Cooperation Agency (JICA)
26. Cassa Depositi e Prestiti (CDP)
27. PTC India Financial Services Ltd (PFS)
28. Indian Renewable Energy Development Agency (IREDA)
29. Easter and Southern African Trade and Development Bank (PTA Bank)
30. Africa Finance Corporation (AFC)

13. Building the Blended Capital Stack

In addition to discussions with potential funding and risk mitigation providers, GLPGP has used research, such as the OECD's July 2019 report *Blended Finance Funds and Facilities – 2018 Survey Results*, to verify the trends in successfully capitalizing blended funding vehicles. This data is captured in the two charts below. This report provides an in-depth analysis of the collective investment vehicles used in blended finance structures. The SPVs and NBFIs structures recommended by GLPGP fit this classification. Specifically, of the estimated \$60.2 billion in blended funding vehicles, broken down as investment funds (structured and non-structured) and special facilities such as funding mechanisms like on-lending vehicles or SPV conduits, the concessional capital portion is larger than the non-concessional portion. This is consistent with GLPGP's structuring recommendations. GLPGP's view is that the non-Ghanaian institutions like government donors, MDBs, DFIs, development-oriented institutions, like IFC or SIDA, can be instrumental in catalyzing both domestic and foreign capital. The OECD data proves this out.

Table 56. Blended capital sources - concessional vs. non-concessional shares (2018)
(OECD 2019)

C/NC %s	Assumed Blended Capital Sources
100%	Lead Donors - (Concessional)
100%	Other Donors - Grants and Guarantees (Concessional)
53%	DFIs, Dev Institutions - Concessional
47%	DFIs, Dev Institutions - Non-Concessional
53%	Impact Investors - Concessional
47%	Impact Investors - Non-Concessional
100%	Banks & Commercial Investors - Non Concessional
100%	Local Pensions - Non Concessional

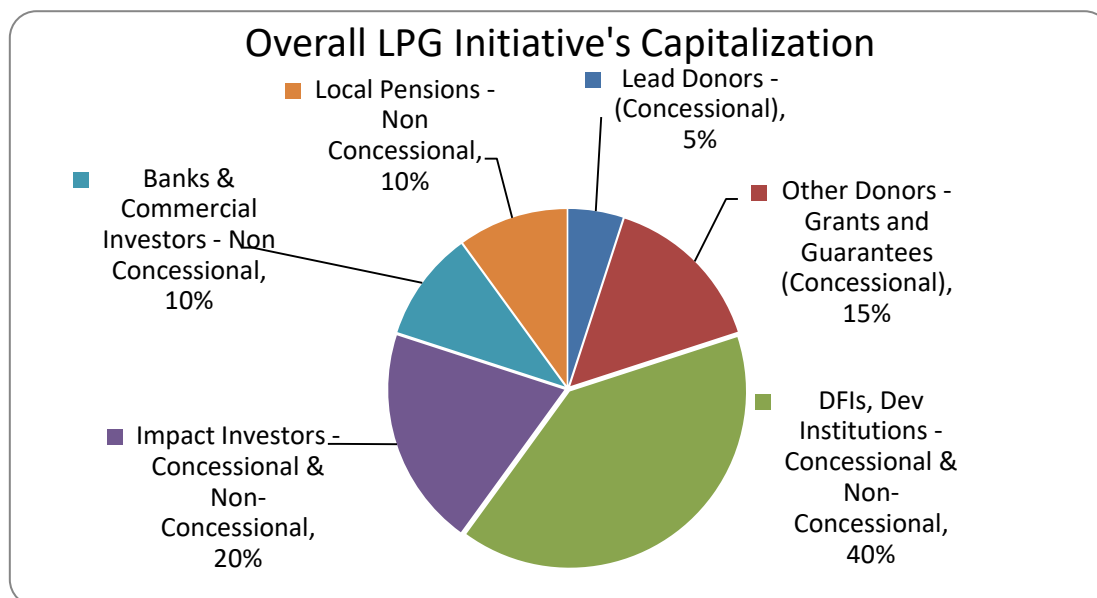


The adjacent two charts, recreated from the OECD report, demonstrate most the range of types of institutions that GLPGP can approach for the proposed funding mechanisms. As GLPGP has proposed hybrid vehicles, SPVs, NBFIs, On-lending Facilities, and Investment Funds, as possible ways to efficiently fund the LPG sector, the information from the OECD report corroborates the appeal of such approaches for important blended finance sources.

The specific level of potential participation from various categories of capitalization partners, will vary from region to sectors being targeted by the blended funding vehicles. In Africa, DFIs, MDBs, and other development-oriented entities are key players in catalyzing both direct funding to entities (businesses

and project), and also to large-scale funding mechanisms like facilities and funds. GLPGP's capitalization mix therefore reflects this. This is reflected in Figure 17 below.

Figure 17. Capitalization of LPG investment in Ghana - 2019 to 2030
(in two-year intervals; in Euro)



Cumulative Capitalization of Sponsored Vehicle

	2020	2022	2024	2026	2028	2030
5.0% Lead Donors - (Concessional)	5,748,398 €	2,595,694 €	2,802,062 €	1,689,694 €	2,273,567 €	1,631,195 €
15.0% Other Donors - Grants and Guarantees (Concessional)	17,245,195 €	7,787,082 €	8,406,186 €	5,069,082 €	6,820,701 €	4,893,584 €
21.2% DFIs, Dev Institutions - Concessional	24,373,208 €	11,005,743 €	11,880,744 €	7,164,303 €	9,639,924 €	6,916,265 €
18.8% DFIs, Dev Institutions - Non-Concessional	21,613,977 €	9,759,809 €	10,535,754 €	6,353,249 €	8,548,612 €	6,133,291 €
10.6% Impact Investors - Concessional	12,186,604 €	5,502,871 €	5,940,372 €	3,582,151 €	4,819,962 €	3,458,132 €
9.4% Impact Investors - Non-Concessional	10,806,989 €	4,879,905 €	5,267,877 €	3,176,625 €	4,274,306 €	3,066,646 €
10.0% Banks & Commercial Investors - Non-Concessional	11,496,796 €	5,191,388 €	5,604,124 €	3,379,388 €	4,547,134 €	3,262,389 €
10.0% Local Pensions - Non-Concessional	11,496,796 €	5,191,388 €	5,604,124 €	3,379,388 €	4,547,134 €	3,262,389 €
100.0% Size of Vehicle Funding	114,967,964 €	51,913,880 €	56,041,243 €	33,793,880 €	45,471,339 €	32,623,890 €

Capitalization Summary & Coverage

	2020	2022	2024	2026	2028	2030
Concessional	59,553,405 €	26,891,390 €	29,029,364 €	17,505,230 €	23,554,154 €	16,899,175 €
Non-Concessional	55,414,559 €	25,022,490 €	27,011,879 €	16,288,650 €	21,917,185 €	15,724,715 €
Coverage of Concessional to Non-Concessional Capital	107.47%	107.47%	107.47%	107.47%	107.47%	107.47%

Assumed Number of Funders

	2020	2022	2024	2026	2028	2030
Concessional	3	3	3	3	3	3
Non-Concessional	5	5	5	5	5	5
Average Funding per Grouping						
Average Concessional Funder	19,851,135 €	8,963,797 €	9,676,455 €	5,835,077 €	7,851,385 €	5,633,058 €
Average Non-Concessional Funder	11,082,912 €	5,004,498 €	5,402,376 €	3,257,730 €	4,383,437 €	3,144,943 €

Specific roles for DFIs to increase impact and reduce risk

DFIs are active in areas that overlap with the LPG investments for Ghana. This makes them likely to be lead Funders and risk mitigation providers for selected initiatives. The sectors such as SMEs and Financial Institutions/Innovations, Infrastructure, and Manufacturing could appeal to DFIs, especially when coupled with the positive social and environmental impacts from the investments. If, for example, SPVs are created to fund the build-out of the LPG sector and to fund related SMEs and MSEs, this will align well with certain DFI windows, because those are target areas. GLPGP recommends targeting DFIs and IFIs that are already

active in Ghana as a start. These include AfDB, CDC, DEG, FMO, IFC, Norfund, OPIC, and Swedfund. To go to the IBRD, the Government must make the approach and this then creates a semblance of Ghana officially taking on more debt vis-à-vis its debt ceiling restrictions.

DFIs are well-positioned to help facilitate the national LPG build-out. 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, discussed more fully in Part VIII beginning on page 159:

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;
8. Provide technical assistance funding to help the Government develop capacity to suppress black market activities and ensure BCRM compliance and the LPG sector to improve management capability and project bankability and prepare projects to sufficient investment readiness;
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 this report 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 Ghana, with BCRM well-implemented.

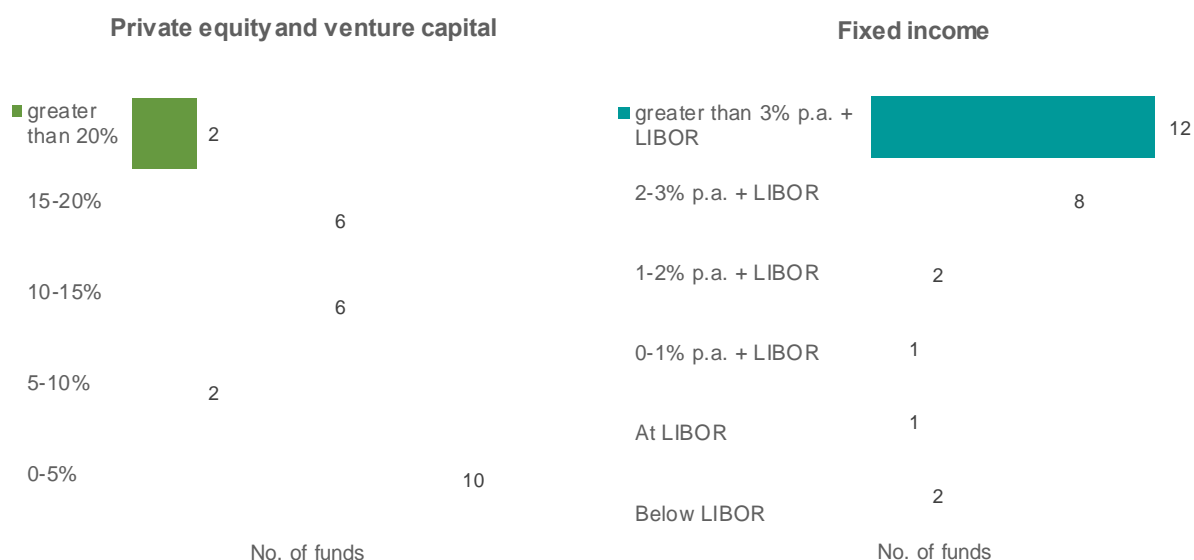
DFIs' development of LPG-specific investment funds

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: the LPG Infrastructure and Distribution (LID) Fund and the First Costs Financing (FCF) Fund. They 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.

14. Pricing the Blended Capital Stack

In addition to evaluation of the level of participation in the blended finance, GLPGP also compared its cost of capitalization assumption against Pricing Trends (See *Relative Pricing of Types & Sources of Concessional and Non-Concessional Funding* in the Annexes), case reviews and conversations with active funders like DFIs. This was supplemented with analysis of the OECD's report on returns. Equity and private debt for Ghana are seeking minimum returns (hard currency) of 20% (equity) and 15% upwards (debt). The summary analysis from the OECD report, shown below in Figure 18, demonstrates that the 8% to 10% ranges for concessional and non-concessional debt, are good approximations for early analysis of the financial outlook for LPG Bottlers and Marketers, once funded with blended capital. OPIC for example would price at 300 to 600 basis points above comparable maturity US treasuries. As of this writing, this would put OPIC costs, before other fees, at roughly 5% to 8%. In addition, 46% (12 of 26) of fixed income players in blended capital, are expecting greater than 3% per annum over Libor, as shown in the Figure.

Figure 18. Financial return expectations



Note: Based on 22 private equity funds, 4 venture capital funds and 26 fixed income funds. In fixed income, percentages are per annum (p.a.). LIBOR is the London inter-bank offered rate, which represents a benchmark interest rate at which global banks borrow from one another.

15. Targeting Initial Investors and Risk Mitigation Sources

GLPGP has initiated exploratory discussions with AfDB, DFID/CDC, FMO, IFC, OPIC, PIDC, PROPARCO, SIDA, and USAID among others about new financial commitments in line with the scope of the envisioned funding mechanisms. The IFC and DFIs often work together as joint sponsors across investments from project grants, debt, equity, guarantees, first loss provisions etc. and therefore are a good starting point to marshal resources. They also have experience in using through similar structures such as the IFC's MCA platform of over 30 financial institutions globally – mainly DFIs, IFIs, and MDBs which have pre-packaged syndication agreements that sometimes facilitate faster transaction funding through a range of exposures at various levels of the capital structure. In the area of LPG, FMO and the IFC, two groups being explored, are active in sizable exposures in projects in developing markets.

On the official Ghanaian side, GLPGP has approached the MoF-backed Ghana Infrastructure Investment Fund, which has co-invested with DBSA and DFID/CDC, and has a targeted asset base of US \$1 billion to invest in Ghanaian infrastructure. As such, GLPGP has also presented the opportunity to mobilize capital investment into Ghana to the top of the MoF and also the Ghanaian investment promotion authorities as GIPC. The GoG is anxious to mobilize assistance for the capitalization of an NPA and MoE-approved Ghana LPG plan. The Ghanaian Executive Branch is keen to see a growing and safe LPG sector for Ghanaians with the vision of 50% penetration by 2030.

The recommendation is to target marquee funding and risk mitigation leaders in GLPGP's blended finance and risk mitigation mix. They will enable GLPGP to mobilize scale and then serve as the catalyst for followers who ideally could lower the overall blended costs of funding, be patient capital, and be well matched to the potential repayment abilities of the LPG supply chain players that underlie the cash flows of the funding mechanisms (SPVs, NBFI, Investment Funds, etc.). This lead Funder approach is similar to typical syndicate and other "book-building efforts" in project and other finance efforts.

FMO's logic on the LPG funding, as captured below, matches well with the end ambitions of the goals of the GLPGP-led Ghana LPG plan in the evolution of the Ghanaian market. According to FMO, in additional press releases, they have up-sized their investment in Omera Petroleum Limited three times. This could make them an attractive target. Importantly, similar assets are being funded to those targeted in the technical plans by GLPGP.

For illustration, below is FMO's case excerpt describing the Omera Petroleum investment:

Figure 19. LPG DFI investment case: FMO in Bangladesh

Who is our client

Omera Petroleum Limited (OPL) in Bangladesh is developing an LPG project to import, store, bottle and distribute liquefied petroleum gas throughout Bangladesh. OPL sources its LPG on the global market. The company will mainly target domestic use as it is considered one of the safest, eco-friendly and healthy cooking fuels. OPL is one of the subsidiaries of a strong and reputable energy player in Bangladesh and benefits from its sector and market experience and an established brand.

Funding objective

FMO has financed and invested in the development and construction of 4 LPG plants with a local capacity of 100,000 tonnes/year. Total project costs amount to approximately US\$60 million. Through the Infrastructure Development Fund FMO is providing US\$9.5 million senior debt and approximately US\$5.5 million equity. The funding will be used for the construction of the main terminal, the three satellite plants and the distribution network. The main terminal is located in Mongla (close to one of the country's principal seaports) where the LPG is delivered and then redistributed to the three satellite bottling plants located in Dhaka, Bogra and Chittagong and further on to private and commercial users.

Why we fund this project

LPG can be used for cooking, heating, electricity generation, transportation (autogas), refrigerating and many other industrial and commercial applications. Given the lack of natural gas in rural and urban areas in Bangladesh due to the fast growing economy, households are looking for alternatives for cooking. LPG is a more expensive alternative for cooking compared to charcoal and kerosine but the health and environmental benefits easily outweigh the cost, for those who can afford it. By engaging in this transaction, FMO contributes to the positive impact that LPG has on the health and productive time consumption on local Bangladeshis, especially women and children. OPL is expected to reach close to 250,000 households, representing 1.2 million people. The local banking sector was not able to meet the full financing needs of OPL and by doing this transaction FMO-IDF filled the gap. The additional equity will provide sufficient buffer to the debt providers. OPL is also able to benefit from FMO's name and experience as an international finance institution, which may help in attract potential future investors and financiers.

In addition to FMO's involvement, the IFC has also been actively involved in LPG including an August 2018 \$20M loan to Omera Petroleum. As with GLPGP's suggested LPG investments for Ghana's Master Plan targets, this loan is slated for capital expenditures including cylinders, transport barges, storage tanks, trucks, and filling machinery.

For additional cases, see Annex Chapters 28 and 29 beginning on page 198.

16. Implementation Schedule

The following table lays out the major activities and milestones of the investment projects from 2019-2030, based on the NPA-directed timetable (to the extent defined as of this writing) and based on industry norms for project completion.

All activities assume prior completion by NPA of all prerequisite decision-making. In case of delay to the start of the activities, the timeline can be assumed to be pushed outward by the amount of the delay.

Table 57. Timeline of major financing and implementation events

Major Project / Program Activities	Tranche 1				Tranche 2			Tranche 3				
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Introduction of BCRM in at least one province	■											
BRCM national rollout		■	■									
Bottling investment tranche	■				■					■		
Cylinder investment tranche	■				■				■			
Bottling plant capacity additions	■	■		■		■		■		■		■
Deployment of cylinders	■	■	■	■	■	■	■	■	■	■	■	■
Cylinder trade-in program	■	■	■									
Existing microstations transition ⁵⁶	■	■	■									
Management/engineering/finance assistance activities	■	■	■	■	■	■	■	■	■	■		
Capacity-building activities	■	■										
Microfinance program	■	■	■	■	■	■	■	■	Further expansion on commercial basis			
Distribution training /women's SME empowerment	■	■			■				■			
Education and awareness program	■	■			■							
Follow-on studies for LPG ecosystem enhancement	■	■			■							

Lightly shaded cells indicate an expansion (for microfinance) or optional extension or recurrence (for BCRM rollout and cylinder trade-in, and for training, respectively) of the activity.

⁵⁶ This presumes that the Government determines that such operators will be permitted (licensed) to continue carrying on a subset of their LPG activities under BCRM, and that they apply for, and justify, the use of funding to transition their businesses.

Note: Because delays affecting implementation and/or financing have occurred and are occurring, and because there could shift this schedule outward, it may be useful to view the schedule as covering years 1-12, rather than necessarily years 2019-2030, which are utilized here for consistency with the Feasibility Study data and findings. As of this writing, the NPA has not determined (i) the order in which Ghana's regions will be converted to BCRM and the associated Bottling Plants brought on line, (ii) the corresponding start or end dates of an eventual cylinder trade-in program, or (iii) how certain existing LPG microstation operators will (or will not) be permitted to, and be supported to, transition to new supply chain roles.

17. 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 Ghana applicable to LPG, for financing, and overall, is a critical consideration. The regulatory scorecard presented in Part V of the Feasibility Study is a useful assessment tool regarding the supportiveness of the LPG regulatory environment and gaps to be diligenced and hedged against. Uncertainty regarding timing of the finalization and implementation of new regulations is a contributor to regulatory risk as well. 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 implement BCRM effectively, as recommended in the Feasibility Study. Implementing BCRM adequately is fundamental to the growth capability and sustainability of the LPG value chain; without this, any significant investment would be unwise. This can only be accomplished by Government.
2. Failure to implement BCRM timely. This would push the schedule outward. The projects and impacts could still be achieved if there are BCRM delays, but their achievement in full would probably occur only after 2030. This risk is discussed in more detail below.
3. Failure to enforce safety requirements adequately for cylinders and cylinder handling. If BCRM enforcement is not adequate, particularly in this critical area, the sustainability and long-term bankability of the sector will face higher risk. Government has not enforced BCRM-oriented regulations for two decades, and its failure to enforce them well historically led to the encroachment and later the total dominance of the CCCM model. As the LPG sector grows—particularly in the more remote regions of the country—the task will grow more challenging. This can, and should, 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 (see Chapter 0). 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.

4. **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 are adequate. Use of qualified locally-familiar counsel and accountancies will facilitate such diligence.

Investing Environment Risks. Ghana 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 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.

Pricing and Levy Risks. The LPG investments presented in this report are potentially viable under Ghana[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.

As described in Chapter 11 of the Feasibility Study, there is risk to smooth BCRM implementation from the potential objection and/or potential non-cooperation of existing microstation operators whose business operations and/or business models could be adversely affected by changes in their roles brought about by new governmental regulations and standards. The Government has already undertaken public relations efforts to attempt to mitigate this risk, and has signaled to the microstation operators the Government's insistence that the proposed and contemplated changes to their businesses are essential for purposes of improved public safety and of effective scale-up of (and associated investment in) the LPG sector. This risk can be further mitigated by ongoing constructive dialogue between Government and concerned microstation operators, potentially combined with assistance measures for transition or repurposing of affected operators' current LPG businesses.

Timing Risks for Governmental Decisions. The actions and investments described in this report are time-sensitive with respect to achieving intended scale and impacts by 2030 at a manageable rate of growth, and delays in governmental decision-making (in particular, in finalization of the parameters and specifications for, and in implementation of, BCRM) can increase the risk of national under-performance against policy goal targets and on the financial parameters of the recommended investments. Timing risk added by such delay can be mitigated through increased utilization of concessional capital, which could permit acceleration of the scale-up of the sector by increasing its economically sustainable growth rate; by use of funding structures and mechanisms such as those described in Chapter 5 (Investment Plan Overview) (beginning on page 93) which could decrease investment lead times and increase the rate of transaction flows through project aggregation and risk-pooling; and by continued or renewed technical assistance support (such as the support funded up through the time of this writing by the Clean Cooking for Africa Program) to the Government to assist it in its analytical and decision-making processes.

Country Development Risk. Part of the feasibility assessment in this report and the Feasibility Study 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.

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 Ghana, 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 (such as provided by the Ghana Gas Company) with diverse sources and buffer storage will serve as mitigants to these disequilibriums. MIGA and USAID offer programs to insure commodity price risks and these may also be employed, where justifiable.

Consultancy IHS Markit has forecast that global LPG supply will be in surplus at least through 2030, and potentially to 2050, creating relative price stability during the expected investment horizon. See Annex Chapter 31 (Note Regarding Long-Term LPG Pricing and Availability) beginning on page 208 for further discussion.

Additionally, commercial quantities of price-competitive bio-LPG have been introduced into the 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. Additionally, the Ghana Gas Company, which already sells domestically produced LPG into the Ghana market under long-term contracts, may (but is not obligated to) choose to sell such LPG domestically on a cost-plus basis should international reference prices rise significantly, as an additional form of hedge.

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 an impacts risk, 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.

Subsidy Challenges. Ghana phased out its general subsidy on LPG fuel, essentially ending subsidy performance risk associated with the Government's ability to make timely subsidy reimbursements to LPG projects and companies. If the Government later 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.

Cylinder Risk Allocation among Bottlers and Marketers. If the NPA determines to allocate cylinder responsibilities (investment, branding, safety, maintenance, liability) to OMCs or LPGMCs rather than to BPs, it is likely to increase overall risk in the sector, for the following reasons:

- The small number of BP companies (8-10 plants owned by no more than 8-10 companies, and probably fewer than eight companies) allows each one (such as the Ghana Oil Company Limited and the Ghana National Gas Company Limited (an SOE)) to operate at a greater economic scale

and, therefore, to have a stronger balance sheet, greater longevity/commercial staying power in the face of other risks, and reduced counterparty risk for investors and lenders. With the average market share of the current set of OMCs and LPGMCs being 1-2%, they are on average on the opposite end of the spectrum of risk from the BP entities.

- The funding mechanism for cylinders is critical to a scaling-up of LPG usage. Bottlers, with a more physically rooted investment (the bottling plant), compared to the more mobile cylinders, are a more stable and bankable investment from the Funders' point of view, not only as offering better collateral but also more consistent cash flows based on the anticipated LPG pricing structure. (They are the only fillers and earn the fillers' margin, compared to marketers, which are in a more competitive marketplace, and may lose out on revenue due to cross-filling or dynamic pricing by competitors.) Combining cylinder investment into the BPs creates a beneficial portfolio effect on the risks of their assets: the €235 mm of higher-risk cylinder investment is blended with the € 92 mm of lower-risk bottling plant investment, and relatively stable bottling services cashflows hedge potential volatility and risk of cylinder-driven cashflows. (Cylinders are higher-risk than plants because the cylinders are mobile, and therefore more difficult to track, repossess and/or liquidate.) The addition of cylinders to the bottling plants by the JBs then would offer better and more integrated add-on collateral compared to further stand-alone collateral in the case of ownership by marketers.
- In setting up the most efficient LPG supply chain for Ghana, it makes sense to have cost-effectiveness the driver for the portion from importation through storage to filling, being more generic, which then allows the remaining aspects, such as distribution and retail, to the more competitive marketer relationships. Competition among the marketers is best when focused on working toward securing and maintaining end-customers, not potential short-cuts in filling. Thus, BP cylinder ownership and branding potentially improves the overall function and cost-efficiency of the chain, potentially leading to greater LPG adoption and usage over time.
- Cross-filling and cylinder diversions, which represent important operational and safety risks for competing cylinder brand-owners that can reduce profitability and increase liability exposure, would occur far less with regional brands under BPs, because each plant would tend not to be exposed to cylinders from a different plant and brand. Multiple marketers within one region, with multiple brands, would be exposed to much greater cross-filling and cylinder-diversion risk.
- Having the BPs responsible for quality-checking of the cylinders during the refilling process is likelier to happen, and be rigorously done, if the BPs have the financial stake in own their own cylinders.
- With a small number (8-10) of BPs involved in cylinder procurement, it is easier to pool cylinder acquisition for economic advantage, and to supervise cylinder deployment and safety.
- The establishment of a revised LPG price structure gives a unique opportunity for change, such as allocation of the cylinder functions and responsibilities to the BPs, to optimize the supply chain.

For the foregoing reasons, it is advantageous as a risk-mitigant for operations, safety, economics and investment/financing, for the small number of BPs to have the cylinder investment task and the benefits and responsibilities of cylinder ownership, in favor of the large pool of marketers. (Through holding

company structures, a marketer that is also a BP can exploit both supply chain nodes from a risk management as well as cost and profit optimization standpoint.)

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.
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 (in particular, those with negligible individual market shares) 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 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 microfinance schemes on a pilot basis and to support sensitization activities could address that gap. As microlending scales up, the average credit quality of consumers who have not yet taken LPG loans may 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 in other countries, 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.

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. The proper level of involvement by concessional capital may also be affected by the monetary/currency environment. In a beneficial trend, Ghana, while having experienced higher than usual inflation (and currency depreciation) in recent years, is not hyperinflationary and has begun to rein in these adverse trends. Currency hedging will be employed under both project level and SPV/Fund level risk management policies.

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. Accordingly, changes in currency exchange rates between USD/Euros and the Cedi may adversely affect the U.S. Dollar/Euro value of investment vehicles and the income, interest and dividends or other distributions it receives, gains and losses realized on the sale of investments and the amount of distributions, if any, to be made.

Because imported LPG is priced in Dollars, and project companies' turnover (revenue) is in local currency, there is currency risk for the supply chain. In recent years, the Ghana inflation rate and the rate of currency devaluation against the USD have moved in tandem, causing LPG priced in local currency to avoid dollar-driven real price inflation. (LPG has experienced meaningful nominal price inflation in Cedis, as have all other goods – and wages – in Ghana.)

Currency hedging and derivative products should 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, affordability and accessibility. These potential issues can be mitigated by the work that Clean Cooking for Africa/GLPGP will continue to do in Ghana (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. As recommended in this report and the Feasibility Study, the Government should also institute an equipment-discounting levy on national LPG consumption to be used to lower significantly the consumer deposit amount paid on new cylinders.

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 same⁵⁷. 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 de-risk 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.

Price and Cost Structure Risks to Firms. If the Government allocates unit margins throughout the supply chain nodes in a way that ends up not adequately covering the costs at a given node, for whatever reason, the risk of viability of the adversely affected firms is increased. This risk can be addressed in two main ways: (i) The Government should carefully match its pricing formula to the costs and financial requirements (of equity-holders and lenders) at each supply chain node, to ensure adequacy at each node and to optimize the overall financial performance of the supply chain (taking into account the analysis of Chapter 4, and balancing affordability for consumers against industry profit objectives); (ii) Utilizing the ISLE indicators and consulting with industry and other stakeholders on an ongoing basis, the Government should periodically revise its allocation of unit margins as necessary to ensure the viability and performance of the value chain overall as the sector scales up, and as its conditions change.

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. There can be no assurance that management and operation companies can successfully manage such complexity. It is recommended that Government, supported by

⁵⁷ The Clean Cooking for Africa/GLPGP LPG expert team may play such a role in the latter.

Clean Cooking for Africa/GLPGP experts (and relevant complementary experts), lead the consolidation of industry plans into a master investment plan, to help ensure 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 as with all private equity and long-term debt investments. The investors will be provided with distributions as appropriate and the critical mass of projects created will make this a potential portfolio for an exchange listing (as discussed earlier in this Part of the report) or 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.

Long Term Investment. An investment in the vehicles is a medium- to long-term investment. The aim of facilitating the creation of sustainable LPG platforms dictates 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.

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.

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 the Feasibility Study report are wrong, it will result in overinvestment in infrastructure, but there are nonetheless choices

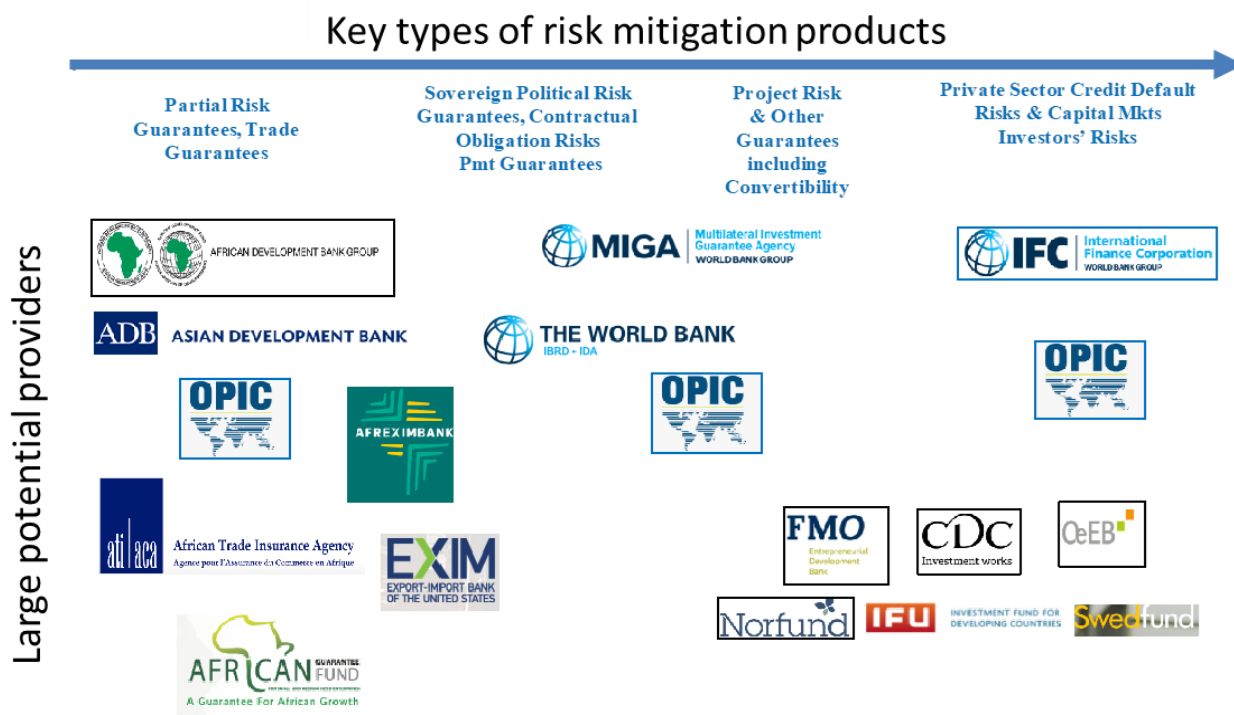
available to address this. For example, a) to run at lower capacity or b) to run at normal capacity but resell surplus LPG acquired into other markets (e.g., to regional traders, or to regional petrochemical producers) at a discount. Also, most LPG infrastructure can be scaled up in steps, rather than 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

DFIs, MDBs, IFIs, private companies and others provide the risk mitigation tools profiled below in Figure 20. 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 figure⁵⁸ provides several examples as points of reference:

Figure 20. 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.

⁵⁸ Self-reported institutional data analyzed by GLPGP.

18. Structuring Risk Mitigation with Guarantees on Investments

Guarantees will be important in mobilizing both domestic and non-domestic Funders into blended capital structures for the LPG sector. Guarantees would strengthen the comfort of parties to invest in the LPG Vehicles or directly into underlying LPG operating entities. According to the Convergence's database as of July 2019, approximately one-third of blended finance transactions (35%) have used a development guarantee, and these transactions represent a total capital flow of \$77 billion. The guarantees LPG Investment Vehicles or operating companies such as Bottlers and Marketers will need fit this classification. As this Part references Convergence's database updates from July 2019, their characterization is consistent with GLPGP's: *"Credit guarantees cover all or a portion of scheduled repayments of private sector loans or bonds against the risk of default and are commonly used to mobilize private investment for project finance, financial intermediation and policy-based finance. Political risk guarantees cover private lenders against the risk of a government, or a government-owned agency, failing to perform its obligations vis-à-vis a private sector project. Risks may include currency inconvertibility, regulatory risks (adverse changes in law), and various forms of breach of contract. Guarantees may be full (i.e., cover the full value of scheduled repayments) or partial (i.e., cover a portion of the full value), although partial guarantees are considerably more common."*

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 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 projects, 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 Ghana.

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." 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. Ghana just became a larger membership-contributing partner for AFC. This entitles Ghana 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

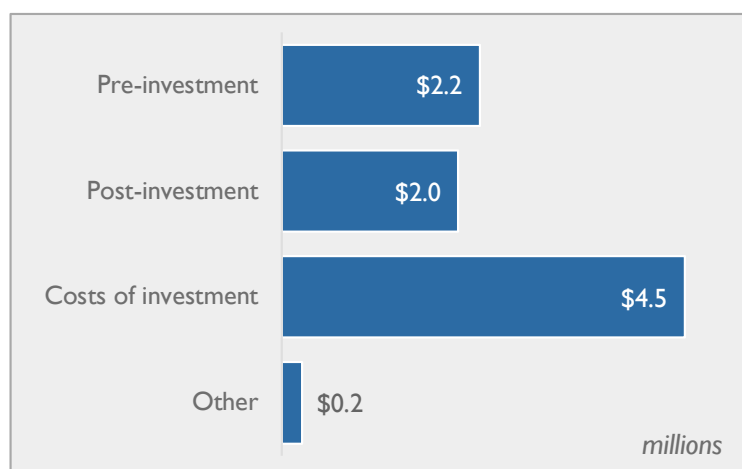
across debt, equity, quasi-equity, and grants. In addition, like AfDB, FMO and other DFIs, it could be approached to provide credit for an NBFi.

19. Technical Assistance for Project Preparation and Financing

In the use of blended finance and risk mitigation tools for the Ghanaian LPG sector, technical assistance (TA) can play an important facilitating and knowledge-deepening role in: 1) governmental level sector oversight and development; 2) project/company preparation for funding; 3) managerial and operational strengthening; 4) on-going budgetary support for the LPG advisory services; and 5) monitoring and reporting budgets as agreed for items such as impact measurements and reporting. According to Convergence Blended Finance's February 2019 analysis, 34% of all blended finance transactions have an associated technical facility. They have utilized TA as a concessional form of resources.

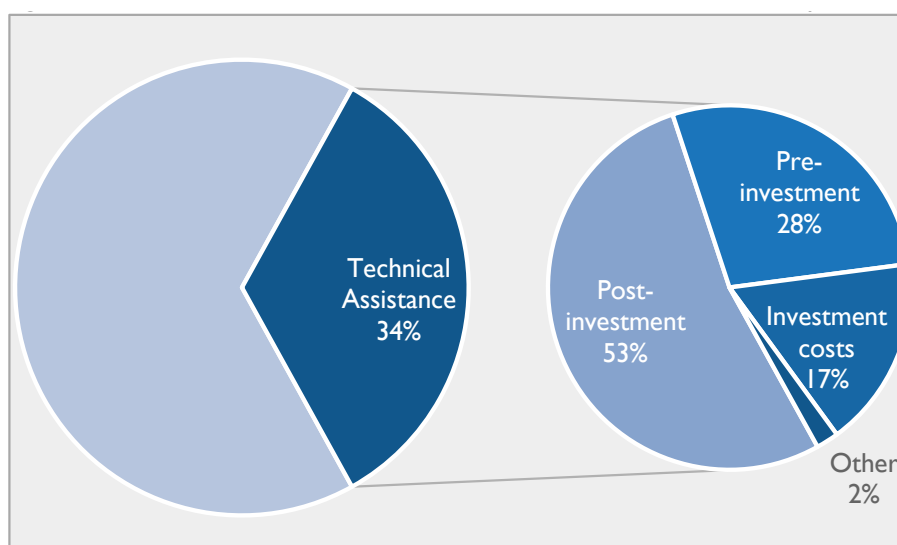
According to data in Convergence's 2019 brief, *Blending with Technical Assistance: "on average technical assistance facilities have been capitalized to 12% of deal size"*. Figure 21 below shows the average breakdown of this assistance. GLPGP has also interviewed select Funders and a common theme for those interested in possibly funding the opportunities in LPG is the readiness of the projects at the onset, and the ability of such entities/projects to perform to the expectations of backers in the future. The ongoing TA averages \$4.5 million for investments but this is less typical than pre-investment preparation and post-investment work. The IFC, by example, has indicated in an interview with GLPGP that it is often concerned with the management capabilities of the projects in sectors like LPG. TA can help alleviate some of this uncertainty.

Figure 21. Average size of technical assistance facility by type



Source: *Convergence Blended Finance February 2019*

Figure 22. Breakdown of blended finance deals with a technical assistance facility

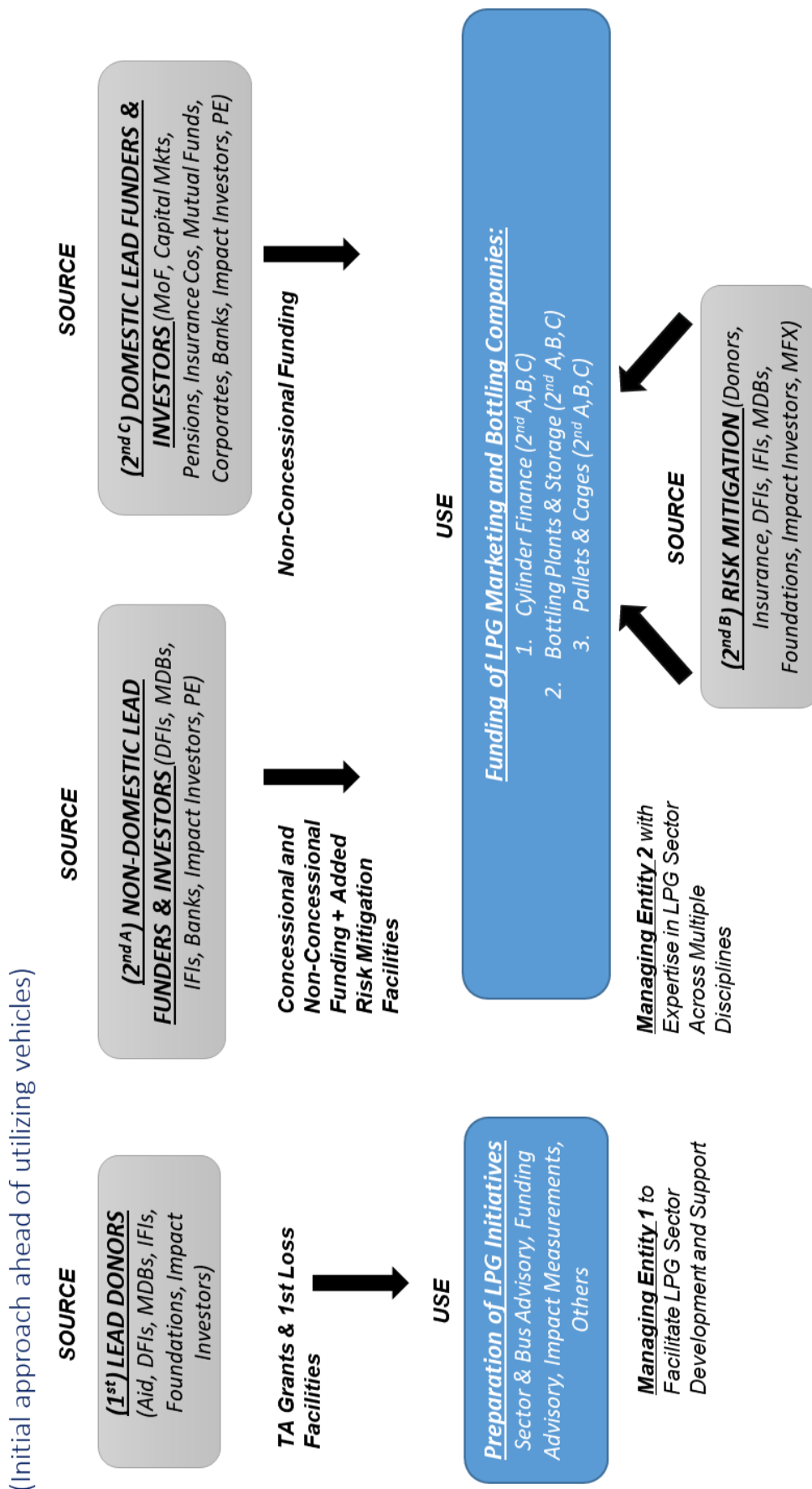


Source: *Convergence Blended Finance February 2019*

According to Convergence, “Technical assistance is one tool for accelerating commercial sustainability and deepening development impact for projects and social enterprises aligned to the SDGs in developing countries. Technical assistance can be as effective as concessional capital in managing risks and supporting returns in blended finance transactions to mobilize additional commercial capital.”

The Value Chain Capitalization Stages discussed in Figure 23 envision tapping into TA providers as a first step in the next stages of implementation. Institutions like the EU, KfW, AfDB, DFIs and others could jump start the next steps of implementation with grants. These are captured in the section Source 1st below in *Figure B* followed by parallel stages Source 2^{nd A}, 2^{nd B}, and 2^{nd C}.

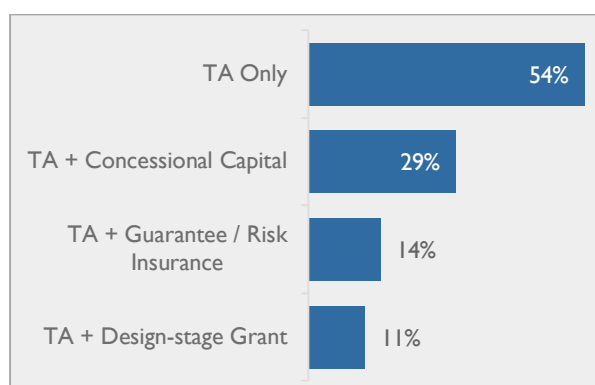
Figure 23. Value chain capitalization stages: grants, concessional and non-concessional



LPG sector development TA is an integral part of the blended capitalization initiatives proposed in the schematic above. If targeted efficiently, for example, to strengthen operations and management of a group of LPG Marketers targeted for funding, this component can de-risk projects from the perspective of both proprietors and outside financial backers. This is how it is envisioned in the Ghanaian context.

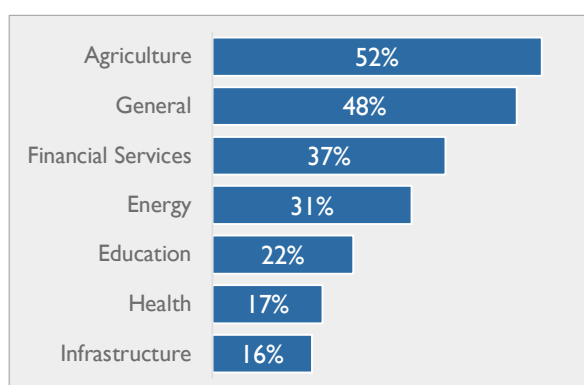
The blending of capitalization for Bottlers and Marketers has a range of uses for TA from pipeline development, preparation, and funding, to on-going sector support initiatives from contracted advisors and donors themselves. In the Ghana context, EU market assessment, impact work, technical study, project identification and funding option grants have been provided. The next logical step is to engage LPG market design-stage grants and implementation grants – for example, to develop the funding mechanisms and pipeline candidates in the critical value chain verticals. This will ultimately be matched with both concessional capital and non-concessional capital. Groups that GLPGP would suggest approaching for finance such as the IFC, which has funded several LPG projects around the world, are noted by [Convergence](#) to be among the top providers of investment-related TA. This is done, as noted, to de-risk and also to make projects and investments more likely of achieving their expected impact and financial results. The two following Figures present a synopsis of the role of TA in the context of the 34% of all blended finance transactions where TA was used.

Figure 24. Percentage of deals with technical assistance



Source: *Convergence Blended Finance February 2019*

Figure 25. Percentage of deals with technical assistance, by sector

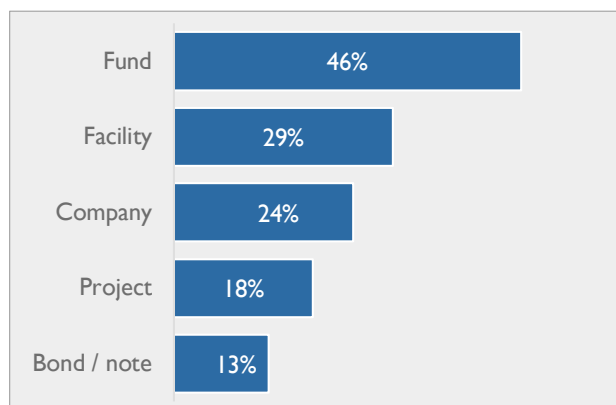


Source: *Convergence Blended Finance February 2019*

The conclusion from the Figures above is that, in terms of sector applicability, TA has been used in numerous blended funding initiatives across sectors to stimulate capitalization and sector development. This can be readily applied to LPG, as the IFC has done, for example. According to [Convergence](#), as of February 2019, 38% of TA has targeted Sub-Saharan Africa. This also bodes well for the LPG blended capital

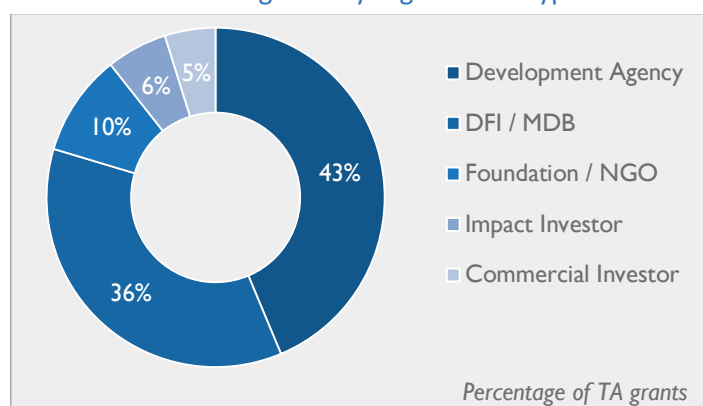
goals being proposed herein as the notion of TA support for both direct and indirect funding approaches should be well appreciated by the Funders that are being targeted. Importantly, the deal types using the blended finance, as broken down below in Figure 26, match well to the capitalization staging and structures being recommended.

Figure 26. Percentage of deals with technical assistance



Source: Convergence Blended Finance February 2019

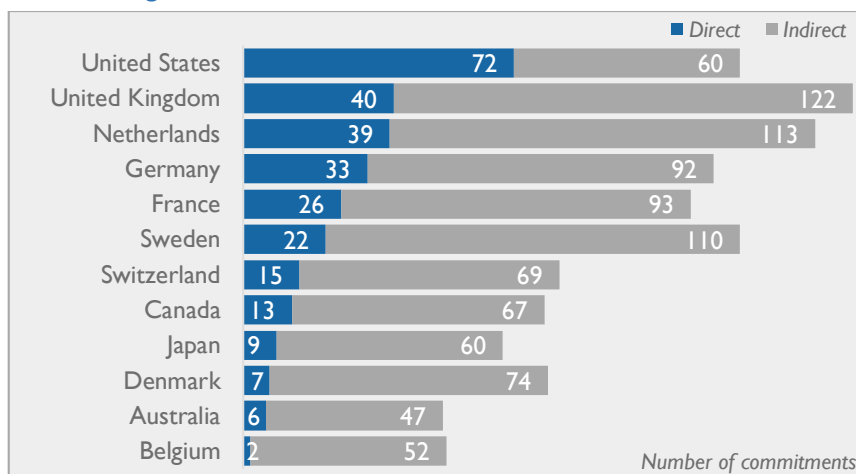
Figure 27. Percentage of technical assistance grants by organization type



Source: Convergence Blended Finance February 2019

TA is typically deployed through donor funds or aid agencies associated with the major pools of blended capital such as DFIs, MDBs and other like-minded institutions. GLPGP is targeting many of the groups. Figure 27 shows the respective roles of parties that should be targeted by GLPGP in structuring TA grants for Ghana. Importantly many of these institutions are also active potential Funders. As such they are also being targeted for investment in LPG in Ghana. As an example, the IFC is active in LPG loans across the value chain and also a top TA provider. They have attached TA to several of these projects, although the specifics are not public.

Figure 28. Most active donor governments in blended finance



Source: Convergence Blended Finance May 2019

According to Convergence database, donor governments have participated in approximately half (56%) of blended finance transactions captured – with the remaining transactions supported primarily by development finance institutions (DFIs), development banks, and philanthropic organizations. Donor governments have committed various types of financial resources (e.g., grants, guarantees) to blended finance solutions, both directly and indirectly (e.g., indirectly through multilateral organizations or funds). Based on current data, the top donor governments, by number of commitments, have been the United States, the United Kingdom, the Netherlands, Germany, France, and Sweden.⁵⁹

⁵⁹ Convergence Blended Finance (2019)

VII. Environmental, Health, Social and Economic Impact Potential

This Part⁶⁰ summarizes the impact potential of the investments, if successfully implemented to serve the projected LPG demand in Ghana to 2030. For a complete treatment of the impact potential and the modelling methodology and assumptions utilized, please refer to the Feasibility Study.

Introduction: impact scenarios

The impact assessment utilizes the demand forecast scenarios presented in Part VI of the Feasibility Study, and summarized in Part IV of this report, 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.

The impacts are presented holistically, because they are necessarily the result of a holistic program of investment. It is not practical nor useful to attempt to allocate impacts to any one investment project or to any one company’s business expansion plan, because it is only from the combination of linked investments and implementations all along the LPG supply chain that the impacts are created.

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.
- Scenario 2: Market reform and expansion scenario, reflecting policy and investment interventions as described in this report. This scenario comprises two sub-scenarios:
 - 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.
 - Scenario 2B: Upper-bound with sufficiency of availability, incorporating the same demand drivers as Scenario 2A (demographic changes and expanded LPG availability), as well as additional changes in preferences that result in additional households switching to LPG.
- Scenario 3: Investment recommendations/government Policy Goal Scenario, which gives total projected consumption as per the investments needed to reach the Government’s goal of 50% LPG penetration by 2030.

Because the Policy Goal Scenario falls between the lower bound (2A) and upper bound (2B) scenarios (including under increased pricing), the ranges of values presented in this Chapter’s introduction are based

⁶⁰ The contents of this Part were developed with Dalberg Global Development Advisors under engagement to GLPGP.

on the lower bound and upper bound cases. Details for all three scenarios are presented in Chapter 21 of the Feasibility Study.

The detailed methodology and data sources for modelling these impacts is discussed in the Feasibility Study.

Environmental impacts

Ghana's greenhouse gas emissions profile is dominated by emissions from land-use change and forestry (53% of total emissions) and energy (25% of total).⁶¹ One of the contributing factors to land-use change and fuel combustion is the use of biomass as fuels. 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 study, the environmental impacts from increased LPG use and correspondingly decreased charcoal and firewood use (without major increase to charcoal exports) were calculated as⁶²:

- **Averted deforestation:** 11 – 21 million trees saved annually relative to base case projections in 2030 and 127 - 221 million trees saved between 2020 and 2030
- **Carbon dioxide equivalent (CO₂eq) emissions⁶³ averted:** 0.50 – 0.76 million MT of CO₂eq emissions reduced annually in 2030 and 6.76 – 9.30 million MT of CO₂eq emissions averted cumulatively between 2020 and 2030
- **Black Carbon equivalent (BCeq) emissions⁶⁴ averted:** 1.0 – 1.7 million MT of BCeq emissions averted annually in 2030 and 10.4 – 16.6 million MT of BCeq emissions averted cumulatively between 2020 and 2030
- **The economic value of averted CO₂eq emissions in terms of carbon financing:** € 29.6 – € 40.6 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)⁶⁵, 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

⁶¹ USAID (2016); FAO (2015)

⁶² These values are subject to the effect of a possible 5.6% LPG reduction in the growth of LPG consumption to 2030, if LPG pricing is increased to end-users, without any offset mechanisms, by an anticipated 12.5%.

⁶³ CO₂eq emissions include carbon dioxide equivalent emissions from carbon dioxide, methane, and nitrous oxide. These were calculated using IPCC conform standards.

⁶⁴ BCeq emissions includes black carbon equivalent emissions from black carbon, organic carbon, carbon monoxide, and total non-methane organic compounds.

⁶⁵ IMHE (2016)

decreased charcoal and firewood use) were estimated by calculating (1) Deaths averted, and (2) Disability-Adjusted Life Years (DALYs)⁶⁶ saved due to reduced exposure to HAP from reparable fine particulate matter (PM_{2.5}).⁶⁷ Impacts on both adults and children were estimated.

Overall, relative to base case projections, between 11,965 and 19,415 deaths could be averted cumulatively between 2020 and 2030 due to increased LPG usage, based on the scenario. In addition, 423,774 – 688,042 DALYs could be saved depending on the LPG adoption scenario, relative to base case projections⁶⁸. This could result in a total economic value of labour of working age adults (from deaths averted and DALYs saved) of € 198 million – € 321 million, relative to base case projections, based on prevailing wage rates.

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.⁶⁹ 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), pursue education and/or have more leisure time.⁷⁰ LPG offers a significant time saving advantage 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.⁷¹ 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.

In all the demand projection scenarios (based on primary fuel use only), the firewood using households that were forecasted to transition to LPG were almost exclusively purchasers of firewood, not collectors. Therefore, negligible time savings would be created among firewood-collectors in Ghana. No data were available to estimate the reduction in time previously spent purchasing charcoal daily or nearly daily (to the extent incremental to other shopping time) caused by purchasing LPG on a multi-week cycle instead.

Note that there may be additional time saved when taking into consideration (i) the time saved from cooking with LPG, and (ii) time saved cleaning (as pots, stoves, and the household cooking space are not blackened by LPG). However, these effects were excluded from this analysis due to lack of available data.

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.

⁶⁶ 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.

⁶⁷ 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.

⁶⁸ All scenarios include assumed rates of growth of the adoption of improved biomass cookstoves by charcoal and firewood users, detailed in the Feasibility Study (Annex Chapters 28 and 29).

⁶⁹ Gates, Melinda (2016)

⁷⁰ Oxfam International (2017)

⁷¹ Brooks N. et al. (2016); Nautiyal S. (2013)

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 Ghanaian households.⁷² Yet, LPG could save households costs in the long run, because LPG is more cost-efficient at delivering heat to pots than charcoal in Ghana. In Ghana, the KITE household survey estimated that spending on fuel comprised 9% (rural) to 16.2% (urban) of average household income in 2015.⁷³ Since the GLSS 6 does not contain data on household fuel consumption and expenditure, the total fuel cost savings from using LPG was estimated from the KITE (2015) study data. Because this study, while multiregional, was on a small scale, comprising only 200 households, extrapolation from the KITE data should be done with due caution. The average annual cost of cooking per household shows that, on average, LPG provides cost savings for households purchasing charcoal but not for households purchasing firewood.⁷⁴

Under the market reform and expansion demand scenarios (referred to as lower and upper-bound full availability scenarios), the annual cost savings to consumers, assuming no changes in the relative prices of fuels, could increase between GHC 279 million and GHC 460 million in 2030, relative to base case projections. For the households switching from charcoal to LPG, this equates to an annual per household cost saving of GHC 48 (€ 8.6) and GHC 66 (€ 11.9) for urban and rural households, respectively. The absolute savings are greater for rural households due to the higher price of charcoal in rural areas relative to urban areas. For households switching from purchased firewood, this results in an annual per household increased expenditure of GHC 146 (€ 26.3) and GHC 220 (€ 39.6) for urban and rural households, respectively. This increase would amount to 3.2% and 8.2% of urban and rural annual household income in 2015, respectively. These values should be used with caution, because the KITE (2015) survey data are from a relatively small sample size, and some respondents' answers to its income questions were found to be inconsistent with the range of answers to similar questions posed in GLSS 6.

Macroeconomic impacts

Quantitative impacts

Increasing LPG usage within the country could affect the (1) tax revenue, (2) trade balance for the country's economy, and (3) total number of jobs across various fuel value chains. Ghana's LPG supply is imported in part, and LPG is taxed, and these are expected to continue in a reformed LPG market.

LPG, including imported LPG, is VAT-exempt, while charcoal and firewood are subject to 12.5% VAT in Ghana. However, LPG is subject to a set of hydrocarbon-sector taxes that amount to approximately 20% of the current LPG end-user price. Assuming that the VAT rates and status regarding 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 from VAT. Displacement of charcoal and firewood consumption by increased LPG consumption will increase national tax revenue between GHC 76 million (€ 13 million) and GHC 162 million (€ 29 million) in 2030, relative to the base case scenario.

⁷² Maxwell et al. (2018); Asante et al. (2018)

⁷³ KITE (2015)

⁷⁴ KITE (2015)

In 2016, Ghana imported 177,900 MT of LPG and produced 114,200 MT domestically. To meet the latent demand of LPG under conditions of full availability, LPG production and/or LPG imports will need to increase. Assuming domestic production capacity of LPG is constant at 2016 production capacity values and charcoal exports do not rise,⁷⁵ increased LPG consumption would require an increase in LPG imports, which will impact the national trade balance. Increased LPG consumption could also decrease the national trade balance by between GHC 314 million (€ 56 million) and GHC 732 million (€ 132 million) in 2030 relative to base case projections.

Serving the projected increased LPG consumption could create between 4,680 and 11,748 direct jobs, net, within the LPG value chain by 2030 relative to base case projections, based on Government and industry estimates. Most of these jobs would be in the distribution and retailing of LPG. The shift to LPG for cooking is also likely to lead to job losses in the charcoal and wood value chains. This analysis was unable to quantify potential job losses in the charcoal and wood value chains due to lack of data.

Unquantified 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.

Other impact types

It is important to note that the assessment excluded a few potential avenues for impact that, if possible to include, would likely have increased the amounts of the positive findings. One example is the impact of the time saved by cooking with LPG and cleaning the LPG stoves and cookware and cooking space – relative to other fuels and stoves. These types of impact could not be quantified due to a lack of reliable data.

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.

Proportionality

If the amount of LPG demand served by 2030 is more or less than projected, then the impacts will be higher or lower in approximate proportion. Some impacts are not entirely linear with the adoption/consumption of LPG in displacement of woodfuels. Impacts also depend on what fuels are being displaced by LPG in what quantities. For a more detailed discussion, please refer to the Feasibility Study.

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.

⁷⁵ Ghana Energy Commission (2017)

VIII. Progressing the Clean Cooking for Africa Program in Ghana

This Part summarizes recommendations and notional budgeting for a next major phase of engagement by the Clean Cooking for Africa Program in Ghana, in connection with the investments, project implementation, and other supportive measures.

There are two main ways in which the Program should evolve:

- a) Facilitating the mobilization and deployment of blended capital (including technical assistance (TA) funding) to those projects which require it or would be strengthened thereby;
- b) Extending and expanding work with the Government, the LPG sector and other relevant stakeholders to improve the overall LPG ecosystem in Ghana.

This Part presents an overview of Program development recommendations, including (i) potential DFI participation and (ii) technical assistance measures and follow-on studies to help improve and expand the LPG ecosystem further.

20. DFI Investment Participation

DFIs are an important source of capital for LPG sector reform and expansion, not only by reducing the cost of capital, which may be desirable, but also by providing the needed reassurance to other Funders that crowds in adequate non-concessional capital and by providing TA resources, both of which may be vital and transformative.

As mentioned previously, DFI roles can include some or all of the following:

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;
5. Provide risk mitigation tools, such as guarantees and private bond placement insurance;
6. Provide hedging tools to help mitigate LPG price volatility and address currency risk;
7. Use financial influence in the country overall to ensure/support governmental performance of obligations;
8. Provide TA funding to help the Government develop capacity to suppress black market activities and ensure BCRM compliance, and the LPG sector to improve management capability and project bankability and prepare projects to sufficient investment readiness;
9. Provide TA 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., 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.

Although DFIs may wish to consider co-funding of individual LPG projects, in order to achieve breakthrough impacts from large-scale LPG transition away from solid fuels for cooking, it is important that critical investments occur across the entire LPG supply chain, and across multiple operating and project entities, in a coordinated fashion. DFIs can take a lead, where the private sector has not yet been willing to do so, in the establishment of blended capital financing vehicles for aggregation of related LPG projects in a given country (or across multiple countries), as described in detail elsewhere in this report.

Quantum target for concessional capital

In Ghana, the recommended share of the total capital investment to 2030 attributed to concessional capital is 40%. On a gross asset cost basis, this represents financing of € 66.7 million in tranche one, € 35.9 million in tranche two, and € 31.2 million in tranche three. On a net basis, the hypothetical minimum required would be reduced by approximately half, taking into account the potential effect of the consumer cylinder deposits: € 37.2 million in tranche one, € 17.4 million in tranche two, and € 13.4 million in tranche three.

Additionally, technical assistance (TA) and microfinance program funds of up to € 11.8 million in tranche one, € 2.6 million in tranche two, and € 1.3 million in tranche three could be deployed to improve the odds of success and, thereby, expand (or de-risk) the impact potential of the investments. (Microfinance should first be piloted based on the design specified in the Feasibility Study in the sections of the country where BCRM will first be rolled out, with the expansion program design, scope and budget adjusted based on the pilot findings.)

Treating tranche one investments and TA/microfinance costs as a portfolio of interrelated investments for concessional capital sources, the financing requirement for tranche one would be:

Investments (net/floor – gross)	€ 37.2 – 66.7 million
Technical assistance measures	up to € 11.8 million
Microfinance scale-up programs, If pilot programs successful	up to € 7.4 million
Total	€ 56.4 – 85.9 million

Of this, the investment portion (€ 37.2 – 66.7 million) would be repaid, with applicable interest, at the end of tranche one, and could then be recycled into tranche two, and then again into tranche three, both of which are smaller investment quanta than tranche one.

This allows concessional capital sources to treat tranche one as an immediate project portfolio for impact investing, with the opportunity to reinvest repaid funds into later tranches based on the results achieved with each prior tranche, and taking into account the conditions, gating factors, evolving risks, and new information available at the start of each later tranche.

It would also be possible to focus an initial investment on a particular set of provinces where BCRM is initially rolled out; however, as of this writing, the Government has not determined the sequence of provinces for the BCRM roll-out. It is recommended that the sequencing be prioritized based on the size of

the unmet LPG demand in each region, such that commercial risk is at its lowest during the first phase of the roll-out, rather than on an administrative basis.

Beyond TA and microfinance, two supplementary and optional areas that could be appropriate for concessional capital are the following:

Funding for a cylinder trade-in program	up to € 8.8 million
Microstation operator transition fund	up to € 5.6 million
Subtotal	up to € 14.4 million
Total of investments, TA, microfinance	€ 56.4 – 85.9 million
Grand Total	€ 70.8 – 100.3 million

These supplementary and optional uses of concessional funding are described in the next Chapter.

What is critical overall is how the presence, and tools, of concessional capital sources in the capital stack improve the attractiveness and risk appearance of the LPG sector and its investments to non-concessional capital sources.

Combining the investments with the proposed microfinance and technical assistance programs and activities, a notional DFI led Clean Cooking Program for Ghana would comprise in a range of approximately € 60-85 million in tranche one, as shown above excluding the optional transition assistance measures, and € 70-100 million in tranche one including them.

In time for tranche two, the program would determine whether, and how much, to re-deploy its repaid capital (plus usable interest payments) for the expansion projects and measures in that tranche. Of this, in case access to concessional funding is limited, priority (or preference) should be given to the near- and medium-term CapEx and TA requirements, because the first wave of new LPG demand that can be served will be exclusively, or almost exclusively, pent-up, unmet demand that would not require microfinance support to be unlocked. (See the Feasibility Study for a detailed discussion of the stages of demand.)

Creating an initial mini-tranche / sub-tranche

Conceptually, a sub-tranche of tranche one could be created to reflect both a potentially slower roll-out of BCRM and associated investing and a reduced financing exposure for DFIs, IFIs, and MDBs. This mini-tranche might be considered if the roll-out of BCRM, and of the overall national BP and cylinder investment projects, are stretched out in time based on the pace of Governmental decisions, the level of responsiveness and adequacy of qualifications of additional BP bidders that must emerge to expand BCRM to all of Ghana's regions, and other factors. The recommended smallest sub-tranche is for a roll-out of investment projects in the three regions with the highest share of anticipated future demand and investment: Greater Accra, Ashanti, and Western. This mini-tranche would notionally comprise:

Table 58. Potential mini-tranche
(quantities other than BPs in 000s)

	% of New Cylinders ⁷⁶	New BPs	New Cylinders ²⁵	Capital Investment		
				Cylinder (Gross)	Cylinder (Potential Net)	BPs/Pallets
Greater Accra	25%	2	1,063	26,865 €	8,059 €	14,488 €
Ashanti	21%	1	937	23,674 €	7,102 €	7,886 €
Western	12%	1	499	12,621 €	3,786 €	6,712 €
Total Financing Requirement				63,160 €	18,948 €	29,086 €
Gross Financing Total					92,246 €	
Net Financing Total (Potentially)					48,034 €	

At a notional 40% DFI/IFI/MDB share of the capital stack, the concessional capital portion would be in the range of € 19.2 million (net floor) to € 36.9 million, a reduction of about 45% from the full tranche one; funding for related TA/microfinance activities could be reduced in approximate proportion.

At this stage of BCRM pre-rollout and project preparation, this mini-tranche is hypothetical. It is presented for indicative and illustrative purposes to suggest how an initial subset of tranche one projects, limited in scope, scale, and geography, might be aggregated, either to fit with near-term DFI/IFI/MDB financing windows or to align with a stretched-out pace of BCRM roll-out across Ghana's regions, or both.

⁷⁶ Includes share of existing cylinder park to be scrapped and replaced.

21. Technical Assistance and Microfinance Programs and Activities

The following table describes a set of useful technical assistance (TA) and transition-support activities which emerged from the Feasibility Study, with recommended budgeting for each. Time-limited items involving governmental decision-making presently underway, that is expected to conclude during 2019—for example, regarding modifications to the national LPG price formula—are excluded. Each item is notionally planned to occur and conclude within 1-2 years, but could optionally be extended beyond this with additional funding.

Descriptions of selected items are presented after the table.

Table 59. Recommended technical assistance, optional transition support, and indicative budgets

Item	Indicative budget (€ 000)	By tranche (€ 000)		Prospective executing parties
Financial and management capability building (associated with the investments) (at 10% of BP/storage CapEx)	8,700	1	5,300	GLPGP / Clean Cooking for Africa expert team, DFIs, IFC
		2	2,200	
		3	1,200	Selected financial consultancies
LPG microfinance program (2 pilot phases; includes sensitization)	150	1	150	GLPGP, NPA, XpressGas, Planters Capital Other local partners to be added in expansion phases
Public education and awareness campaign ⁷⁷	750	1	750	NPA, GLPGP, communications consultancy
SME distributor training	200	1	200	GLPGP training team, selected LPGMCs/OMCs
Women's LPG entrepreneurship training and financing	3,600	1	3,600	GLPGP training team, selected LPGMCs/OMCs
Follow-on studies (see Feasibility Study, Part XII)	900	1	750	GLPGP / Clean Cooking for Africa expert team
		2	150	
Subtotal	14,300			
TA program management / overhead (10%)	1,430			
Total—TA	15,730			
Optional, supplementary transition measures				
Cylinder trade-in program				NPA, licensed LPG Marketers and their retail networks
Vouchers	8,300	1	8,300	
Program costs	500	1	500	Optionally: Ghanaian Army ⁷⁸ Support/advisory: GLPGP / Clean Cooking for Africa expert team ⁷⁹

⁷⁷ This element is separate and distinct from the targeted consumer education activities included in the microfinance program.

Item	Indicative budget (€ 000)	By tranche (€ 000)	Prospective executing parties
Transition fund for LPG microstation operators (who can justify such financing) ⁸⁰	5,600	1 5,600	NPA / Ministry of Finance
Total—transition measures	14,400		

Description of selected TA and transition support items

LPG microfinance	A program was designed by GLPGP together with the NPA and local operating partners (LPGMC, MFI) but could not be executed during the relevant grant period. As BCRM is rolled out, this program should be piloted and, based on the results, expanded into a broader, national program to accelerate LPG adoption, to mitigate the risk of delayed or incomplete demand development and delayed or reduced achievement of anticipated environmental, social and health impacts.
SME distributor training	Training in good and safe LPG business and operating practices under BCRM (per experience outside Ghana, the cost would be US \$450 per distributor; Ghana target of 500 distributors).
Women's entrepreneurship	Training and coverage of business start-up costs for women to become LPG retail entrepreneurs under BCRM (per experience outside Ghana, the cost (including inventory) would be US \$24,000 per woman, spent over two years; Ghana target of 150 women).
Follow-on studies	A set of recommended follow-on study topics is outlined in the Feasibility Study, Part XII, including: <ul style="list-style-type: none"> • Development of pro-poor/pro-rural LPG interventions and programs; • Bulk Road Vehicles; • Autogas (LPG for transport use); • Importation strategies and opportunities for regional coordination; • Opportunities to reduce costs through bulk transport of LPG by rail; • The LPG-to-power subsector; • Pay-as-you-go business models in context of Ghana price regulation; • Geographic targeting of cylinder exchange points and depots;

⁷⁸ The Army was the lead implementing agency in the highly successful national refrigerator exchange program, the "Rebate and Turn In" program, that contributed to the elimination of old refrigerators that used environmentally damaging coolant. Funding was provided in part by UNDP and GEF. See www.undp.org/content/undp/en/home/ourwork/ourstories/in-ghana--a-victory-for-energy-efficiency.html

⁷⁹ To be expanded as necessary or desired

⁸⁰ TA financing to the existing LPG microstation operators should only be considered for operators which the Government has determined will not be shut down for reasons of public safety, which are presently solvent, and which can present on a preliminary basis a viable business plan for recovering profitability under a revised business model that complies with new NPA rules and regulations for such stations, fully compliant with BCRM.

- Segmentation of LPG standards (propane-butane mix) for residential, autogas, and industrial use; and
- Potential for bio-LPG production and use.

Cylinder trade-in program

Approximately 2 million old LPG cylinders presently in the possession of households must be traded in and either scrapped or refurbished. While the costs of cylinder refurbishment, etc., are already factored into the cylinder investment requirement, as of this writing there is no budget or source of budget for incentivizing consumers to trade in their old cylinders—for which they paid cash at one time—for new branded cylinders that require a deposit to be made. Costs for both consumer trade-in vouchers (notionally GHC 25⁸¹) and for designing and overseeing

Transition of LPG microstation operators

Each affected operator will have on average about USD 100,000 of assets which may become stranded, based on what business model the operator chooses to pursue after the national BCRM transition takes place. Approximately 20% of operators are expected to be permitted to continue operations, per the latest NPA evaluation data. These would each notionally lose half their existing business (either the cylinder refill half or the Autogas half). Notionally, therefore, concessional funding equivalent to 50% of their stranded asset value would allow for the reinvestment (or first loss coverage) involved in adapting their business model to a BCRM-compliant one, and under this model, restoring revenues to their earlier level over time. The budget item shows, notionally, 650 x 20% x USD 50,000, converted to Euro. Microstation operators would be required to apply formally for such funding and present a viable business plan and, potentially, appropriate security, in respect of it. Additionally, the operators would be encouraged, as part of applying, to consolidate or merge to form larger entities, both to enhance their bankability and to reduce the number of applications relative to the amount of financing provided.

Microfinance

The objective of the above-mentioned pilot program—which should only be started with BCRM in effect—would be to demonstrate the extent to which microloans that reduce the up-front cost to consumers of LPG equipment (cylinder, stove, etc.) stimulate adoption, how much consumption results per new user, the income potential to MFIs from LPG microlending, and the repayment characteristics. If the results justify expansion, then the objectives of a proposed national-scale program to follow would be to stimulate LPG

⁸¹ As part of the detailed design of a trade in program, a specific voucher value must be determined based on consumer surveying and/or focus groups, and then tested in a pilot province for effectiveness. Too large a voucher amount wastes money by over-incentivizing; too small an amount leaves an excess of non-compliant, potentially unsafe cylinders in the hands of consumers and distributors.

switching and use by 500,000 households (with minimal cannibalization of households that would have switched without it) over tranches one and two.

The following table describes the notional scope and budget for such a national LPG microfinance program.

Table 60. Recommended microfinance and consumer education program and indicative budget

Item	Indicative budget (€ 000)	By tranche (€ 000)		Prospective executing parties
LPG microfinance expansion program (includes consumer sensitization)	21,860	1	7,200	GLPGP, NPA, Ecobank, Planters Capital, LPG Marketers Other local partners to be added
		2	14,660	

Including the pilot phase from the TA activities above, the total microfinance program would have an indicative budget of € 22 million.

The design of the Ghanaian microfinance pilot program, as developed and planned with relevant Ghanaian program partners and stakeholders, is described in the Feasibility Study (Chapter 18).

22. Program Structure

A broadened and extended program would include establishing a managerial organization comprising the following key categories of expertise:

Category of expertise	Key responsibilities	Potential sources
LPG sector development, project planning and preparation	<p>Ongoing policy and regulatory reform/enhancement advisory</p> <p>Technical assistance delivery: ongoing national planning (where required), project preparation, management capability development, cross-project coordination, investment technical and economic evaluation / due diligence, engineering support, training programs / SME capacity building</p> <p>Research and M&E support</p>	GLPGP / Clean Cooking for Africa expert team ⁸²
Financing and investment	<p>Structuring of financial vehicles / funds</p> <p>Mobilization and deployment of capital</p> <p>Investment and credit decision-making</p> <p>Investment management and fund operation (as GP or similar), including compliance and reporting</p> <p>Monetizations / exits</p> <p>Financial TA to project entities</p>	<p>DFI</p> <p>Regional investment bank</p> <p>GLPGP finance team (for LPG-specific expertise)</p>
Communications and education	<p>Develop educational and awareness campaigns regarding LPG benefits, safe use, etc.</p> <p>Deploy and extend SME training programs in LPG marketing, distribution, retailing</p>	<p>Communications consultancies</p> <p>GLPGP sensitization/training teams</p>

⁸² To be expanded as necessary or desired

Category of expertise	Key responsibilities	Potential sources
LPG microfinance / pro-poor programs	Program design Coalition development Supervision, M&E Pilot program Expansion program Transition to pure commercial basis; transfer to 100% local/regional partners	DFI microfinance group GLPGP microfinance team Regional pro-poor commercial bank
LPG/clean cooking M&E	Monitor and evaluate the program and its results, including social, economic, environmental and climate impacts	Independent evaluator, such as a university or research institute with staff having relevant experience

Ultimately, in Ghana as well as any other LMIC, the government must take active responsibility for ensuring the LPG ecosystem is and remains sufficient with respect to safety and bankability, and the leading LPG companies must drive and execute major LPG projects and business expansions. The Clean Cooking for Africa Program, appropriately extended and expanded, could help both the public sector and the private sector identify and exploit opportunities to accomplish more, faster, in transitioning the national market to LPG from harmful biomass for cooking.

IX. Project Annexes

This part presents the project technical details not described elsewhere. For the economic and financial details, see Chapters 4 and 10, and for the aggregate impacts of the projects, see Part VII.

23. Project 1: Bottling Plants and Storage

Bottling Plant Project Overview

The information in this subsection is reproduced for ease of reference from Chapter 3. The Chapter then continues with a presentation of the technical and other details of a standard BP, to be replicated regionally as presented in Table 62 on page 170.

Projected bottling capacity and number of bottling plants

The bottling capacity requirement is defined by the peak consumption in a year, increased by a safety factor. The peak of consumption is related to seasonality. There being no definitive information available on the consumption seasonality of the LPG in cylinder use in Ghana, the bottling 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 61. Theoretical maximum bottling capacity required to 2030 (MT)

Region	City	2020	2022	2024	2026	2028	2030
Upper West	Wa	2,300	4,600	5,750	6,900	9,200	10,350
Upper East	Bolatanga	3,450	4,600	6,900	8,050	9,200	10,350
Northern	Tamale	4,600	8,050	11,500	14,950	18,400	20,700
Brong-Ahafo	Sunyani	12,650	18,400	24,150	29,900	35,650	41,400
Ashanti	Kumasi	47,150	63,250	79,350	95,450	112,700	128,800
Eastern	Koforidua	18,400	21,850	26,450	29,900	33,350	37,950
Western	Sekondi	26,450	35,650	44,850	52,900	62,100	71,300
Volta	Ho	16,100	23,000	28,750	34,500	41,400	47,150
Central	Cape Coast	20,700	25,300	29,900	35,650	40,250	44,850
Greater Accra	Accra	83,950	97,750	110,400	124,200	138,000	151,800
Total		235,750	302,450	368,000	432,400	500,250	564,650

Bottling Plant capacities

The required total bottling capacity is estimated to be 557 KT per year, with one or two shifts of operations (labor) depending on the region, to serve the consumption corresponding to the national policy goal. This nameplate capacity allows for 16% of flexibility to cover all peak needs throughout the year.

In two regions (Greater Accra, Ashanti), a second bottling plant would be eventually required as the capacity of the first plant is outgrown. (The location of each second regional plant should be chosen to optimize transport logistics costs for the cylinders within the region.)

The investment projects are designed to cover expansion of bottling capacity across three phases, following step-wise the growth in the number of cylinders and associated refills required to achieve the national goal.

The three phases of investment are:

4. Years 2019-2020: 8 BPs totaling 302 KT of bottling capacity
5. Years 2023-2024: 2 additional BPs and an increase to 429 KT of overall bottling capacity
6. Years 2028-2029: For the 10 BPs, an increase to 557 KT of bottling capacity

Location of the BPs

The following two tables show the number of BPs and their locations across the three phases and their capacity requirements, respectively.

Table 62. Bottling Plant regional rollout to 2029

Region	City	2019-20	2023-24	2028-29
Upper West	Wa			
Upper East	Bolatanga		1	1
Northern	Tamale	1		
Brong-Ahafo	Sunyani		1	1
Ashanti	Kumasi	1	2	2
Eastern	Koforidua	1	1	1
Western	Sekondi	1	1	1
Volta	Ho	1	1	1
Central	Cape Coast	1	1	1
Greater Accra	Accra	2	2	2
Total		8	10	10

Table 63. Bottling Plant capacity requirements by region to 2030

Region	City	2020 to 2022	2024 to 2026	2028 to 2030
Upper West	Wa			
Upper East	Bolatanga		51,000 MT	74,000 MT
Northern	Tamale	46,000 MT		
Brong-Ahafo	Sunyani		35,000 MT	49,000 MT
Ashanti 1	Kumasi	55,000 MT	55,000 MT	55,000 MT
Ashanti 2			23,000 MT	45,000 MT
Eastern	Koforidua	31,000 MT	50,000 MT	68,000 MT
Western	Sekondi	31,000 MT	44,000 MT	56,000 MT
Volta	Ho	22,000 MT	33,000 MT	45,000 MT
Central	Cape Coast	27,000 MT	34,000 MT	45,000 MT
Greater Accra 1	Accra	45,000 MT	52,000 MT	60,000 MT
Greater Accra 2			52,000 MT	60,000 MT
Total		302,000 MT	429,000 MT	557,000 MT

In Phase 1, eight BPs will be located in the above-mentioned regions, sited according to current regional consumption of LPG. The three Northern regions (Upper West, Upper East and Northern) will be supplied by the bottling plant of the Brong-Ahafo region. A regional depot, comprising a large fenced area with guards and forklifts to load and unload pallets of cylinders, under the control of the BP of Brong-Arafo,

would be set to have a stock of cylinders to be dispatched to the marketing companies (OMCs/LPGMCs) and distributors.

In Phase 2, one BP will be constructed in the Northern region (Tamale) to supply the regions of Upper West and Upper East during Phases 2 and 3. If there is a strong acceleration of cylinder uptake and refill volume growth in these two regions, the construction of an additional BP there could be justified. The minimum recommended size of a BP is 20,000 MT of refilling per year, which ensures a minimum turnover (revenue) to cover a sufficient organizational structure of skilled staff needed to deliver on quality and safety in the refilling, inspection and maintenance of cylinders.

Bottling Plant investment

The total required investment across the three phases, starting in 2019, is estimated to be € 86.7 million, based on indicative costing analysis of the facilities. (Technical details are included in the Annex.) The BP investment represents about € 156 per tonne of bottling capacity, a reasonable productivity level for the investment by international LPG industry standards.

The investment per phase is:

- Phase 1: **€ 52,8 M** for 302,000 MT of bottling capacity
- Phase 2: **€ 21,6 M** for the additional 127,000 MT of bottling capacity
- Phase 3: **€ 12,3 M** for the additional 128,000 MT of bottling capacity

Due to the required high level of productivity, the plants have been designed and costed with automatic pallet loaders. The investment need includes 18,000 pallets at an indicative cost of € 5.7 million.

Also included are facilities for painting and re-testing of cylinders within the BPs during the implementation of BCRM, through the construction of a dedicated “cylinder maintenance hall.” This avoids transportation cost of cylinders to and from an external refurbishment plant, and provides an additional buffer stock of cylinders and pallets to cover cylinders’ downtime for maintenance.

Breakdown of the BP investment per region

Table 64. Summary of Bottling Plant investment by region and phase

Region	Phase 1	Phase 2	Phase 3	Total
Upper West (Depot)	50,000 €	-	-	50,000 €
Upper East (Depot)	50,000 €	-	-	50,000 €
Northern	50,000 €	8,286,117 €	1,659,000 €	9,995,117 €
Brong-Ahafo	7,109,867 €	20,000 €	428,750 €	7,558,617 €
Ashanti 1	7,098,923 €	- €	- €	7,098,923 €
Ashanti 2	- €	5,902,211 €	905,900 €	6,808,111 €
Eastern	6,671,705 €	49,640 €	837,500 €	7,558,845 €
Western	6,258,395 €	49,640 €	408,750 €	6,716,785 €
Volta	5,764,277 €	511,154 €	428,750 €	6,704,181 €
Central	6,192,179 €	47,292 €	428,750 €	6,668,221 €
Greater Accra 1	6,761,309 €	- €	408,750 €	7,170,059 €
Greater Accra 2	6,761,309 €	6,761,309 €	6,761,309 €	20,283,927 €
Total	52,767,964 €	21,627,363 €	12,267,459 €	86,662,786 €

About the cylinder depots in the northern regions

The € 50,000 for the Upper West, Upper East and Northern regions in Phase 1 is an estimate for the fencing of the plot of land, a forklift to load and unload pallets of cylinders, and a simple office with genset⁸³. These facilities will serve as a central dispatch depot, supplied by large carriers of palletized cylinders from the Brong-Arafo Bottling Plant in Phase 1, and from Tamale in Phases 2 and 3. The cost of primary transportation of cylinders in pallets from the BP to the regional cylinder depot is estimated at € 22-28€/tonne in the first instance, depending on the exact location of the depot.

Bottling Plant process design

Painting, washing, cold repair, hot repair, retesting cylinders

To comply with BCRM, the empty cylinder brought by a new customer to the Marketer will be repainted in the Marketer's color. The quantity of cylinders to paint and to retest will be so numerous that it will be easier, and most cost-effective, to paint and retest the cylinders in the Bottling Plant. It will be the same for the cylinders requesting a cold repair (shroud or foot repair).

We can assume that, at the beginning of the CRM implementation, a significant number of cylinders would have to be hot repaired; they will be repaired in a central cylinder manufacturing or specialized refurbishing company.

Palletization

There is no doubt of the need of the palletization system in the bottling process: efficiency of bottling, and optimization of batch changes, will keep the cylinder in good condition.

The pallets will be used all across the whole supply chain except in the dealer shop where the cylinders will be presented in racks.

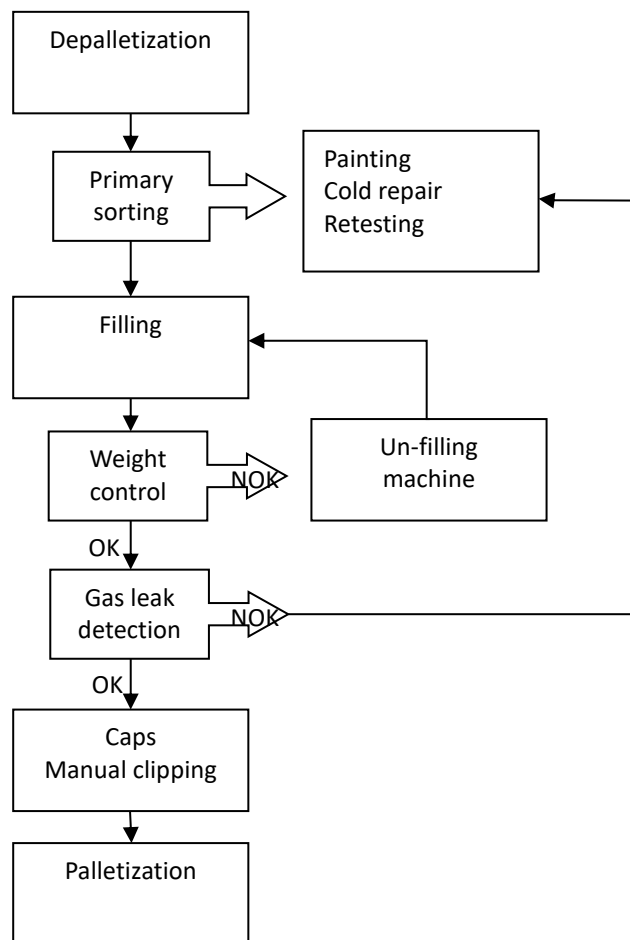
Bottling process

As specified in the "NPA Guidelines for LPG bottling plants", the cylinder bottling plant will be equipped with gas leak detection, weight control and a capping machine.

The cylinder bottling process schema will be as follows:

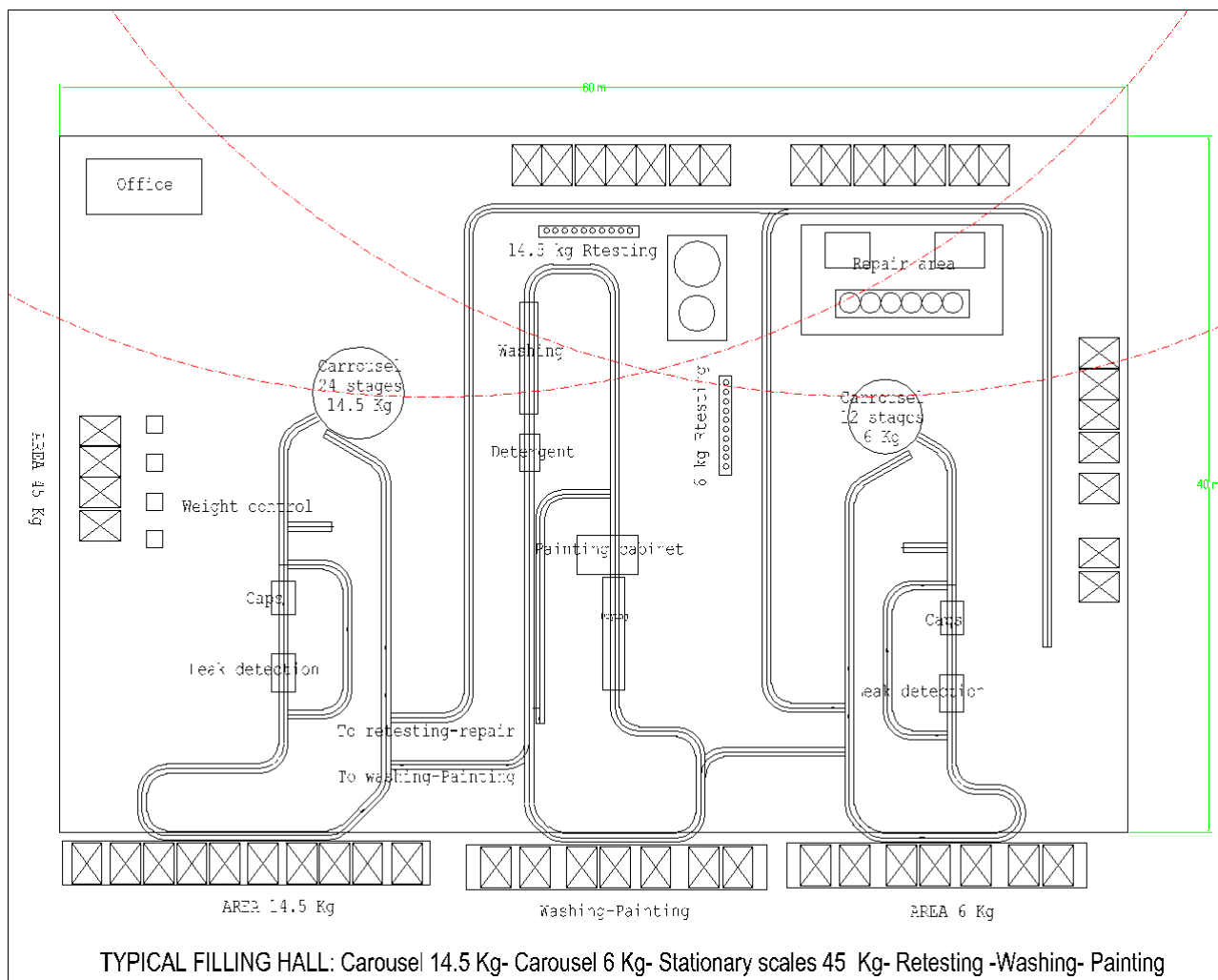
⁸³ A genset is a device generating electricity from a diesel engine, typically used during electrical grid blackouts or in off-grid locations.

Figure 29. Bottling Plant process flow diagram



Bottling Plant layout and equipment

Figure 30. Bottling Plant filling hall layout



TYPICAL FILLING HALL: Carousel 14.5 Kg- Carousel 6 Kg- Stationary scales 45 Kg- Retesting -Washing- Painting

Table 65. Bottling Plant equipment by site

BOTTLING PLANT EQUIPMENT		Short Term			Middle Term			Long Term		
Upper West Wa	Volumes projected	14.5 Kg	6 Kg	LC	14.5 Kg	6 Kg	LC	14 000 T	6 Kg	LC
								8 400 T	4 200 T	1 400 T
		Cylinders in Entrepot			Cylinders in Entrepot			New Bottling plant		
	14.5 kg filling	Forklift						Automatic Paletization		
	6 Kg Filling							1 carousel 12 stages 10 scales		
	Large capacity Filling							Manual paletization		
Other							4 scales in lines			
							Manual Paletization			
							1 stationary sale			
							Maintenance			

BOTTLING PLANT EQUIPMENT		Short Term			Middle Term			Long Term		
Upper East Bolatanga	Volumes projected	-			14 000 T			14 000 T		
		14.5 Kg	6 Kg	LC	14.5 Kg	6 Kg	LC	14.5 Kg	6 Kg	LC
				8 400 T	4 200 T	1 400 T	8 400 T	4 200 T	1 400 T	
		Cylinders in Entrepot			New Bottling plant					
	14.5 kg filling	Forklift			Automatic Paletization 1 carousel 24 stages 16 scales					
	6 Kg Filling				Manual paletization 4 scales in lines					
Large capacity Filling				Manual Paletization 1 stationary sale						
Other				Maintenance						
BOTTLING PLANT EQUIPMENT		Short Term			Middle Term			Long Term		
Northern Tamale	Volumes projected	13 000 T 27000 2 shift			35 000 T			50 000 T		
		14.5 Kg	6 Kg	LC	14.5 Kg	6 Kg	LC	14.5 Kg	6 Kg	LC
		7 800 T	3 900 T	1 300 T	21 000 T	10 500 T	3 500 T	30 000 T	15 000 T	5 000 T
		New Bottling plant								
	Painting	Automatic Paletization Washing Painting								
	14.5 kg filling	Automatic Paletization+forklift 1 carousel 24 stages 16 scales			4 add scales			4 add scales		
	6 Kg Filling	Manual paletization 4 scales in lines			Automatic Paletization 1 carousel 12 stages 10 scales			4 add scales		
Large capacity Filling	Manual Paletization 2 stationary sale			Add 2 stationay scales						
Other	Maintenance									
BOTTLING PLANT EQUIPMENT		Short Term			Middle Term			Long Term		
Brong-Ahafo	Volumes projected	12 000 T 19 000T 2 shifts			35 000 T			46 000 T		
		14.5 Kg	6 Kg	LC	14.5 Kg	6 Kg	LC	14.5 Kg	6 Kg	LC
		7 200 T	3 600 T	1 200 T	21 000 T	10 500 T	3 500 T	27 600 T	13 800 T	4 600 T
		New Bottling plant								
	Painting	Automatic Paletization Washing Painting								
	14.5 kg filling	Automatic Paletization+forklift 1 carousel 24 stages 16 scales			4 add scales			4 add scales		
	6 Kg Filling	Manual paletization 4 scales in lines			Automatic Paletization 1 carousel 12 stages 10 scales			2 add scales		
Large capacity Filling	Manual Paletization 2 stationary sale			Add 2 stationay scales						
Other	Maintenance									

BOTTLING PLANT EQUIPMENT		Short Term			Middle Term			Long Term		
Ashanti n°1 Kumasi	Volumes projected	25 000 T			35 000 T			45 000 T		
		14.5 Kg	6 Kg	LC	14.5 Kg	6 Kg	LC	14.5 Kg	6 Kg	LC
		15 000 T	7 500 T	2 500 T	21 000 T	10 500 T	3 500 T	27 000 T	13 500 T	4 500 T
		New Bottling plant								
	Painting	Automatic Paletization Washing Painting								
	14.5 kg filling	Automatic Paletization+forklift 1 carousel 24 stages 16 scales			4 add scales			4 add scales		
	6 Kg Filling	Automatic Paletization 1 carousel 12 stages 8 scales			4 add scales					
Large capacity Filling	Manual Paletization 4 stationary scale									
Other	Maintenance									
BOTTLING PLANT EQUIPMENT		Short Term			Middle Term			Long Term		
Ashanti n°2 Kumasi	Volumes projected	25 000 T			35 000 T			45 000 T		
		14.5 Kg	6 Kg	LC	14.5 Kg	6 Kg	LC	14.5 Kg	6 Kg	LC
		15 000 T	7 500 T	2 500 T	21 000 T	10 500 T	3 500 T	27 000 T	13 500 T	4 500 T
		New Bottling plant			New Bottling plant					
	Painting	Automatic Paletization Washing								
	14.5 kg filling	Automatic Paletization+forklift 1 carousel 24 stages 16 scales			4 add scales			4 add scales		
	6 Kg Filling	Automatic Paletization 1 carousel 12 stages 8 scales			4 add scales					
Large capacity Filling	Manual Paletization 4 stationary scale									
Other	Maintenance									
BOTTLING PLANT EQUIPMENT		Short Term			Middle Term			Long Term		
Eastern Koforidua	Volumes projected	25 000 T			40 000 T			53 000 T		
		14.5 Kg	6 Kg	LC	14.5 Kg	6 Kg	LC	14.5 Kg	6 Kg	LC
		15 000 T	7 500 T	2 500 T	24 000 T	12 000 T	4 000 T	31 800 T	15 900 T	5 300 T
		New Bottling plant								
	Painting	Automatic Paletization Washing Painting								
	14.5 kg filling	Automatic Paletization+forklift 1 carousel 24 stages 24 scales								
	6 Kg Filling	Maunal Paletization 4 scales in line			Automatic Paletization 1 carousel 12 stages 10 scales			2 add scales		
Large capacity Filling	Manual Paletization 4 stationary scale						1 staionnary scale			
Other	Maintenance									

BOTTLING PLANT EQUIPMENT		Short Term			Middle Term			Long Term		
Western Sekondi	Volumes projected	22 000 T 28 000T 2 shifts			40 000 T			50 000 T		
		14.5 Kg	6 Kg	LC	14.5 Kg	6 Kg	LC	14.5 Kg	6 Kg	LC
		13 200 T	6 600 T	2 200 T	24 000 T	12 000 T	4 000 T	30 000 T	15 000 T	5 000 T
		New Bottling plant								
	Painting	Automatic Paletization Washing Painting								
	14.5 kg filling	Automatic Paletization+forklift 1 carousel 24 stages 24 scales								
	6 Kg Filling	Maunal Paletztation 4 scales in line			Automatic Paletztation 1 carousel 12 stages 10 scales			2 add scales		
Large capacity Filling	Manual Paletization 4 stationary scale						1 stationary scale			
Other	Maintenance									
BOTTLING PLANT EQUIPMENT		Short Term			Middle Term			Long Term		
Volta Ho	Volumes projected	14 000 T 20 000T 2 shifts			30 000 T			42 000 T		
		14.5 Kg	6 Kg	LC	14.5 Kg	6 Kg	LC	14.5 Kg	6 Kg	LC
		8 400 T	4 200 T	1 400 T	18 000 T	9 000 T	3 000 T	25 200 T	12 600 T	4 200 T
		New Bottling plant			New Bottling plant					
	Painting	Automatic Paletization Washing Painting								
	14.5 kg filling	Automatic Paletization+forklift 1 carousel 24 stages 12 scales			8 add scales			4 add scales		
	6 Kg Filling	Maunal Paletztation 4 scales in line			Automatic Paletztation 1 carousel 12 stages 10 scales					
Large capacity Filling	Manual Paletization 4 stationary scale									
Other	Maintenance									
BOTTLING PLANT EQUIPMENT		Short Term			Middle Term			Long Term		
Central Cap coast	Volumes projected	18 000 T 22 000T 2 shift			30 000 T			39 000 T		
		14.5 Kg	6 Kg	LC	14.5 Kg	6 Kg	LC	14.5 Kg	6 Kg	LC
		10 800 T	5 400 T	1 800 T	18 000 T	9 000 T	3 000 T	23 400 T	11 700 T	3 900 T
		New Bottling plant								
	Painting	Automatic Paletization Washing Painting								
	14.5 kg filling	Automatic Paletization+forklift 1 carousel 24 stages 16 scales			4 add scales			4 add scales		
	6 Kg Filling	Maunal Paletztation 4 scales in line			Automatic Paletztation 1 carousel 12 stages 7 scales			5 add scales		
Large capacity Filling	Manual Paletization 4 stationary scale						1 staionnary scale			
Other	Maintenance									

BOTTLING PLANT EQUIPMENT		Short Term			Middle Term			Long Term		
Greater Accra n°1 Accra	Volumes projected	32 500 T			40 000 T			40 000 T		
		14.5 Kg	6 Kg	LC	14.5 Kg	6 Kg	LC	14.5 Kg	6 Kg	LC
		19 500 T	9 750 T	3 250 T	24 000 T	12 000 T	4 000 T	24 000 T	12 000 T	4 000 T
		New Bottling plant								
	Painting	Automatic Paletization Washing Painting								
	14.5 kg filling	Automatic Paletization+forklift 1 carousel 24 stages 16 scales			Add 8 scales					
	6 Kg Filling	Automatic Paletization 1 carousel 12 stages 10 scales								
Large capacity Filling	Manual Paletization 4 stationary scale									
Other	Maintenance									
BOTTLING PLANT EQUIPMENT		Short Term			Middle Term			Long Term		
Greater Accra n°2 Accra	Volumes projected	32 500 T			40 000 T			40 000 T		
		14.5 Kg	6 Kg	LC	14.5 Kg	6 Kg	LC	14.5 Kg	6 Kg	LC
		19 500 T	9 750 T	3 250 T	24 000 T	12 000 T	4 000 T	24 000 T	12 000 T	4 000 T
		New Bottling plant								
	Painting	Automatic Paletization Washing Painting								
	14.5 kg filling	Automatic Paletization+forklift 1 carousel 24 stages 16 scales			Add 8 scales					
	6 Kg Filling	Automatic Paletization 1 carousel 12 stages 10 scales								
Large capacity Filling	Manual Paletization 4 stationary scale									
Other	Maintenance									

Technical specifications

WORKS

The following works would be performed:

Civil works

- Earthworks and levelling
- Construction of administrative and technical buildings
- Construction of filling hall
- Construction of concrete blocks for piping, concrete slabs for pump room, unloading facilities
- Construction of internal road
- Construction of sewerage, drink water, electrical network system
- Fence height 2.5 meters and 2 gates
- The Power supply by National Electrical company (High voltage), construction will include transformer High voltage/low voltage

Storage

- Installation of storage including standard foundation (capacity depending of the type of bottling plant).
- Sprinkling system

Fire fighting

- Installation of fire water system, pumps, jockey pump, fire hydrant, water canon, fire pipes and accessories based on sprinkling system at 10 liters/m²/minutes during 2 hours (capacity depending of capacity of the storage)
- Installation of fire water tank (capacity depending of capacity of the storage)

LPG network

- Installation of 2x30m³/h LPG pumps (one spare)
- Installation of LPG compressor for bulk truck unloading
- Construction of 1 LPG bulk trucks unloading bay
- Installation of air compressors, air dryers
- Installation of electrical diesel generator
- LPG pipes and accessories
- Installation of gas and flame detector system

Bottling hall equipment depending of the capacity of the bottling plant

- 14.5 Kg cylinder line
- 6 kg cylinder line
- Large cylinder capacity line
- Washing and painting line
- Maintenance line

CLIMATIC CONDITIONS

- To be adapted to location of the site
- Ambient temperature max: XX°C
- Ambient temperature mini: XX°C
- Average temperature: XX°C
- Relative humidity max: XX%
- Relative humidity mini: XX%
- Atmosphere: humid and very corrosive

PRODUCT

LPG with 80% Butane minimum

Butane density: 580 kg/m³ (worst case to be considered for normal load calculations)

APPLICABLE RULES AND STANDARDS

- GUIDELINES APPLICABLE FOR THE CONSTRUCTION, THE OPERATING AND THE SAFETY OF LPG FILLING PLANTS - (Installations with Liquid LPG Transfer into Cylinders)
- ASME BPVC Section VIII Div 1 for pressure vessel (or equivalent)
- API5L last revision for pipes and accessories (or equivalent)
- NFPA 58 last revision for firefighting (or equivalent)
- NFPA 15 for fire pump installation (or equivalent)
- IS-5571 and IS-5572 (Part-I) for electrical area classification (or equivalent)
- NFPA 70 for electricity in unclassified area (or equivalent)
- NFPA 780, for Standard for the Installation of Lightning Protection (or equivalent)

DESIGN LIFE

The design life of the LPG plant including all mechanical, associated piping, electrical, instrumentation and civil/structural works shall be 30 years with due note taken of the operating and maintenance regime and environmental conditions.

SITE DETAILS

The bottling plant consists of the following:

Gas equipment:

Installations of 1 x XXXX MT LPG aboveground pressure vessel

LPG pumping station (LPG pumps and compressor)

Technical building (Diesel generator, fire water pumps, air compressor)

LPG unloading road tankers facility equipped with loading arm

Filling hall

14.5 kg

- Chain conveyors (including derivation, stops, sorting post, walkway, etc.)
- Carousel XX stages including tangential entrance and exit
- X Scales on carousel, equipped with automatic filling gun for 20 mm compact valve
- On line automatic weight control
- Manual refilling
- Electronic gas leak detection
- Sleeves shrinking machine
- Palletiser 9 stages, including stacker-unstacker in option
- Assistance management computer (in option)
- Pressure regulator set

6 kg

- Chain conveyors (including derivation, stops, sorting station, walkway, etc.)
- X scales in lines
 - or alternative Carousel XX stages including tangential entrance and exit
 - X Scales on carousel, equipped with automatic filling gun for 20 mm compact valve
- On line automatic weight control
- Manual refilling
- Electronic gas leak detection
- Sleeves shrinking machine
- Palletiser x stages (in option)
- Assistance management computer (in option)
- Pressure regulator set

Large capacity

- Stationary filling scales, equipped with manual clamps for shellgas valves
- Leak detection, type "water bell"

Washing-Painting-maintenance

- Chain conveyor (including branches, stops, walkway, sorting stations, etc.)
- Unfilling system 14.5 kg, including X-station and unfilling unit
- Unfilling system 6 kg, including X station
- 14.5 retesting machine, including X stages and test unit
- 6 Kg retesting machine, including X stations
- Paint booth online
- Washing tunnel
- Foot and shroud Straightener machine
- Valves Screw / unscrew machine
- Manual gasing
- Online tare scales

Utilities

- Gas and flame detection system
- Water fire fighting system
- Power, control and lighting distribution
- Industrial and potable water system
- Sewer and septic tank
- Compressed air network
- Lightning protection

Other facilities

- Guard house
- Administrative building containing offices, canteen, cloakroom, wash room,
- Trucks parking (outside the site)
- Comprehensive fire protection system complete with xxxx m3 fire water storage, fire pumps (at least 2) to cool the storage at 10 l/m²/min during at least 2hours able to supply the entire fire fighting power +30%(If one of the pumps is out of order, the remaining pumps will ensure the entire fire fighting flow), fire water main ring, fire monitors, Fire water spray system, fire hydrant, extinguishers
- Staff/visitors parking (outside the site)
- Fencing with 2 gates, driveways and drainage,
- Associated civil works,
- Electrical installation works inclusive of power supply, power and lighting distribution system, back-up power, voltage protection for key equipment

LPG STORAGE FACILITIES

The storage tanks will comply with ASME BPVC Section VIII Div 1, Rules for Construction of Pressure Vessels and the Engineering Equipment.

The LPG sphere (s) or bullet should be constructed according to the following basic data:

- Design Pressure: 17 bar
- Test Pressure: 25 bar
- Design temperature (Maximum): +55°C
- Design temperature (minimum): -10°C
- Shell & Head steel material: ASTM SA516 G70 or P355NL1 or equivalent
- Steel Plates steel material: Normalized

- Corrosion allowance (minimum): 1.0mm
- Applicable heat treatment: ASME Section VIII division1
- Lifting lugs: Suitable for (un)loading
- Joint Efficiency: 1
- Nozzle of tank flange type: ANSI-Class 300 flange & neck

Each storage vessel (sphere or bullet) shall be equipped with the following:

a. Tank Instruments

- Pressure gauge
- Temperature equipment,
- Level indicator with transmitter,
- High level switch (HL: 90% and HHL: 95%),
- Pressure relief valves: At least two pressure relief valves designed, sized and tested in accordance with API RP 520 (Part 1) and RP 521 to provide adequate flow capacity to protect the tank during fire exposure.

b. Shut-off valves (from the shell side)

Liquid Outlet Line:

- Internal safety valve (hydraulically operated with fusible plugs), Fail Closed or external automatic valve,
- Remotely Operated Ball Valve (pneumatically operated), Full Bore, Fail Closed
- Ball Valve Full Bore

Liquid Inlet Line and liquid return line:

- Check Valve
- Remotely Operated Ball Valve (pneumatically operated), Fail Closed
- Ball Valve manually operated

Vapour Balance Line:

- Excess Flow Valve
- Ball Valve manually operated, automatic recommended

Liquid drain line:

- Remotely Operated Ball Valve (pneumatically operated), Fail Closed
- Dead Man Ball Valve and Globe Valve manually operated connected by piping of sufficient volume to remove any accumulated water

LPG PUMPING STATION

The LPG pumping station is a shelter located in vicinity to the LPG storage tanks.

Pumping station includes:

- LPG filling hall pumps

Two (2) LPG pumps designed as duty pumps to transfer LPG from storage tanks to filling hall (1 working and 1 spare).

Each pump is has a nominal flow rate of 30m³/h and shall have individual by-pass valve back to the tanks for over pressure protection.

The loading pumps may also used to transfer LPG from one tank to another (back-up of the compressor).

Each pump will be provided with:

- LPG strainer installed in suction line
 - Check valve at pump outlet line
 - Isolation ball valves (full bore in suction line)
 - Delivery pressure gauge
 - Delivery flow switch
 - By-pass valve
 - LPG vapor/liquid purging system
- LPG Compressor

One (1) LPG compressor is used to transfer LPG from semi-trailer to the storage tanks (unloading). The flow rate of the compressor is 75m³/h.

The compressor will be provided with:

- LPG strainer intake line
 - Intake pressure gauge
 - Intake pressure switch
 - Outlet pressure gauge
 - Outlet pressure switch
 - Temperature gauge
 - Oil pressure switch and pressure indicator
 - Liquid trap with electric level switch
- Bulk truck unloading

The LPG plant will be equipped with 1unloading bay for LPG road tankers or semi-trailer.

Each Loading / unloading operations shall be manually controlled.

Each bay should be equipped with:

- Double loading arm: One 3'' for liquid line provided with safety breakaway coupling, and one of 2'' for vapor line provided with safety breakaway coupling as well
- Opening/close of corresponding manual valves
- Check valves
- Road tankers grounding indicator and control relay to ensure safety during LPG transfer
- Control stations to start/stop LPG pumps or LPG compressor
- Dead-man push button station to make sure that the operation is focused on loading operations and to deal with the possibility of a consciousness lost
- Emergency push button to allow unloading local operator to stop the process
- Fire alarm manual activation
- Fire and gas detection
- ESD valve on the liquid line

UTILITY SYSTEMS

- Fire water system

Fire water system will be designed according to NFPA 58 and shall consist of below equipment:

- Fire water pumps with a least one equipped with thermal motor driven
- Jockey pumps with electrical motor driven
- Firewater network to cover fire protection to all plant facilities: main fire water pipe able to insure the entire flow of fire fighting water.
- Fire water storage tank: capacity in accordance of the requested fire fighting flow

The firewater network shall be permanently pressurized by means of a jockey pump alone.

In case of main power failure, jockey pumps shall be assisted by the emergency generator.

Pumps shall be basically started:

- Automatically in case of fire alarm or pressure lost in the firewater network
- Manually from control room or pumps room.

Firewater pumps shall be stopped manually only through the push button station located in pumps room.

The firewater network shall consist of:

- A pipe network
- Manual valves to split and isolate the network in sections
- Automatic spray system with double supply. One side by deluge valve, the other by manual valve
- Water monitors
- Hydrants
- Hose reels

A fixed water deluge system shall be installed over the LPG storage tanks, the truck, unloading areas, filling hall and the LPG pumps and compressor.

- Service water supply for industrial purpose

Service water shall be made available to the service water consumers within the plant.

Suitable system shall be to boost/reduce the water pressure as required to meet the water pressure requirements of the respective utilities.

- Potable water for building services

Potable water service shall be made available to the service water consumers within the plant.

Suitable system shall be to boost/reduce the water pressure as required to meet the water pressure requirements of the respective utilities. Water tanks located in the buildings roofs are allowed.

- Drainage

Drainage and sewerage shall be designed in accordance with the relevant requirements of the Environmental local Regulations and Standards. Industrial drainage is not applicable.

Drainage system shall be designed taking into consideration the type of effluents, the segregation and disposal. Clean storm water from roofs of buildings shall be directed to local soak ways through appropriate gravity lines. Roads and parking shall be sloped to provide run off to adjacent areas, without causing erosion.

Areas around buildings and unpaved areas shall be sloped away from paved areas, where applicable.

Storm water drainage of the entire plant shall be done through soak away pits, which shall be constructed along the drainage network.

INSTRUMENT/COMPRESSED AIR

The air requirement shall be designed with adequate provision and installed in the technical building.

- The air system shall consist of:
 - One (1) air compressors (including spare)
 - One (1) air tank (receiver)
 - Two (2) air dryer (including spare)
 - A plant wide instrument air/plant air distribution system consisting of distribution headers, instrument air manifolds and other accessories engineered to ensure availability of instrument air/plant air to all consumers within the plant.

ELECTRICAL DESIGN

- Power

Electric power required to feed the plant shall be provide by a new transformer. One Diesel generator shall be foreseen to feed the plant in case of power failure.

- Grounding

Grounding system shall be provided. It shall be designed as per the requirement of IEEE-80 standard (Guide for safety in AC Substation Grounding or BS 7430, last edition-Code of practice for earthing) or equivalent.

For earthing of electrical systems, equipments and structures each installation shall have one common earth grid connected to at least two groups of earth electrodes. The earth grid shall comprise earthing conductors made up of wires of stranded copper.

- Lightning protection

Lightning protection for storage tank, building and structures shall be provided.

Design and installation shall be as per BS 62305-Protection against lighting or equivalent.

- Illumination of the plant

The plant lighting includes the normal lighting and the emergency lighting to selected areas of the plant during emergency condition. A multiplying factor of 0.8 shall be used in the calculation to allow for the fact that the luminaries become dirty.

The lighting distribution system of the plant shall consist of:

- Normal AC Lighting: It shall be ON at all times in indoors areas/as required

In outdoor area:

- Emergency AC Lighting: These lighting fixtures shall be normally ON along with normal AC system. In case of failure of main supply these lights will be automatically fed by the emergency generator.
- Critical Battery-Back-up Lighting: In case of the failure of main supply these lights shall be energized by battery back-up until emergency generator starts. These fixtures shall be located at strategic locations to enable safe movement of opening personnel and access to important control point failure of complete AC supply.

BUILDINGS

- Administrative building

The administrative building shall include the following services:

- Administrative rooms (4 offices including meeting room)
- Control room
- Lunch area
- Cloakroom
- wash room and toilets
- Guard room

- Technical building

The building shall include following services:

- Diesel generator room
- Fire fighting pumps rooms
- Air compressor set

Extinguishers for fire fighting, emergency lights, emergency exits, power supply, etc. are to foreseen.

- Guard house

A guard house will be built at the entrance of the bottling plant.

- Fence and gates

The depot must be enclosed with an industrial fence not less than 2.5 m in height.

The fence must have no less than two exits which are not next to each other and are always freely accessible. Two gates should be built, one used as safety gate. They should be outwards opening and has a width of 7m minimum.

DIESEL ELECTRIC GENERATOR

The electric generator should have below specifications:

- Engine
 - Cooling system: closed cooling system.
 - Governing type: electronic
 - Air filter type: replaceable element
 - Exhaust system: industrial type silencer (85Dba at 1 m).
 - Fuel system: Gas oil
- Electric Generator
 - Voltage: 400V Tri
 - Earthing system: TT
 - Frequency: 50Hz
 - Protection: IP23
 - Output rating: To be specified
- Control panel

It will be equipped with all the necessary generating set instrumentation and protection devices.

- Instrumentation
- Voltmeter and ammeter
- Combined frequency and tachometer
- Hours run counter
- Positions voltmeter and ammeter phase selector switch
- Led charging alternator failure
- Shutdowns with individual warning leds :
 - High coolant temperature
 - Low coolant level
 - Low lube oil pressure
 - Emergency stop

Controls:

- Key switch (off – run – preheat – start)
- Lock down stop button
- Led test
- Automatic start
- Sound protection
- Sound attenuated Canopy: Yes

PRODUCT TRANSFER

The installation shall allow following product movements:

INDEPENDENT OPERATIONS

The installation permits the following operations independently:

- Unload the bulk truck in the storage
- Make tank to tank transfer (in case of many tanks)

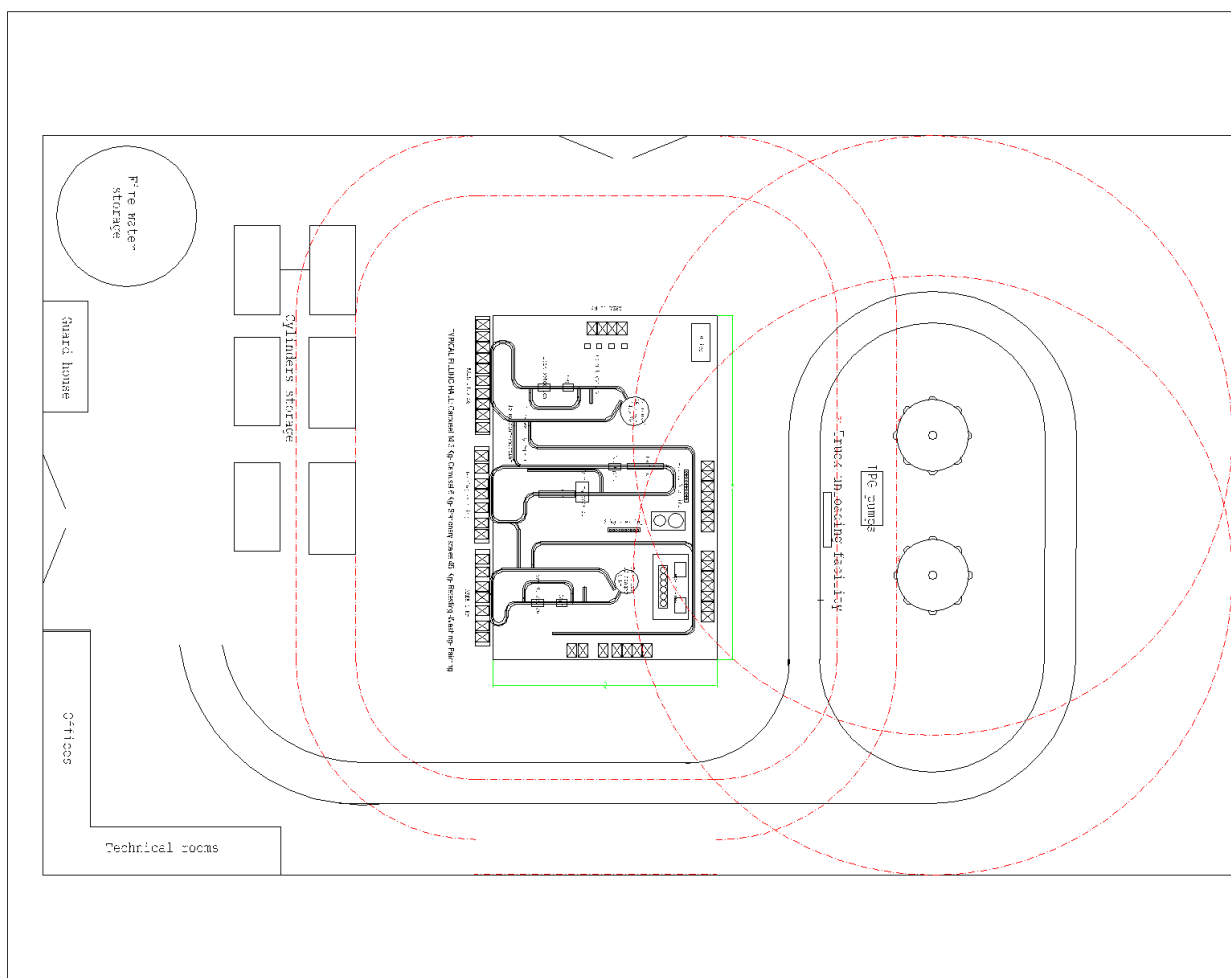
- Supply Filling hall

SIMULTANEOUS OPERATIONS

The installation shall permit the following simultaneous operations:

- Unload the bulk truck in the tank(s) / supply filling hall
- Supply filling hall / transfer product from one tank to another if more than 2 tanks exist.

Figure 31. Bottling Plant site layout



Bottling Plant costing

Table 66. Standard Bottling Plant costing details
(1,000 MT storage with 32.5 KT annual throughput capacity)

NEW BOTTLING PLANT	Quantity Short Term	Quantity Middle Term	Quantity Long Term	Per Unit	SHORT TERM (€ 000)	MIDDLE TERM (€ 000)	LONG TERM (€ 000)
Storage 1000 T- Yearly Capacity 32.5KT/y							
Engineering and project management					150 €		
Supervision					150 €		
Civil works					867 €		
STORAGE including civil works, sprinkler system, instrumentation	1000 MT	0 MT	0 MT	1500 €/T	1,500 €	- €	- €
LPG NETWORK incl 2 x30m³/h pumps, 1 compressors 691					700 €		
1 double Loading arm					50 €		
FIRE FIGHTING NETWORK					450 €		
COMPRESSED AIR NETWORK					80 €		
ELECTRICITY					450 €		
Gas and flame detection					100 €		
FILLING EQUIPMENT						34 €	
-14.4 kg Filling line+ palettization					440 €		
-6 kg Filling line					229 €		
- 6kg Palettization					110 €		
-Large Capacity Filling					17 €		
-Washing and Painting line+ Maintenance+palettization					618 €		
FORKLIFT	1			50,000 €	50 €	- €	- €
Installation-supervision filling hall machine: 6%					48 €		
Transport-packaging filling hall machine 8%					64 €		
TRANSPORT	1			150,000 €	150 €		
3rd party control	1	1	1	20,000 €	20 €		
Commissioning 4%					168 €	- €	- €
Contingency (5%)				- €	210 €	- €	- €
GRAND TOTAL (land, tax, TVA, cumtom duties excluded)					6,620 €	34 €	- €

The sizing, stages, and costing of the individual plants is shown in the following two tables:

Table 67. Bottling Plant capacities to 2030 by region and by expansion phase

Region	City	2020 to 2022	2024 to 2026	2028 to 2030
Upper West	Wa			
Upper East	Bolatanga	46,000 MT	51,000 MT	74,000 MT
Northern	Tamale			
Brong-Ahafo	Sunyani		35,000 MT	49,000 MT
Ashanti 1	Kumasi	55,000 MT	55,000 MT	55,000 MT
Ashanti 2			23,000 MT	45,000 MT
Eastern	Koforidua	31,000 MT	50,000 MT	68,000 MT
Western	Sekondi	31,000 MT	44,000 MT	56,000 MT
Volta	Ho	22,000 MT	33,000 MT	45,000 MT
Central	Cape Coast	27,000 MT	34,000 MT	45,000 MT
Greater Accra 1	Accra	45,000 MT	52,000 MT	60,000 MT
Greater Accra 2		45,000 MT	52,000 MT	60,000 MT
Total		302,000 MT	429,000 MT	557,000 MT

Table 68. Cost summary of Bottling Plants by region and by expansion phase

Region	Phase 1	Phase 2	Phase 3	Total
Upper West (Depot)	50,000 €	-	-	50,000 €
Upper East (Depot)	50,000 €	-	-	50,000 €
Northern	50,000 €	8,286,117 €	1,659,000 €	9,995,117 €
Brong-Ahafo	7,109,867 €	20,000 €	428,750 €	7,558,617 €
Ashanti 1	7,098,923 €	- €	- €	7,098,923 €
Ashanti 2	- €	5,902,211 €	905,900 €	6,808,111 €
Eastern	6,671,705 €	49,640 €	837,500 €	7,558,845 €
Western	6,258,395 €	49,640 €	408,750 €	6,716,785 €
Volta	5,764,277 €	511,154 €	428,750 €	6,704,181 €
Central	6,192,179 €	47,292 €	428,750 €	6,668,221 €
Greater Accra 1	6,761,309 €	- €	408,750 €	7,170,059 €
Greater Accra 2	6,761,309 €	6,761,309 €	6,761,309 €	20,283,927 €
Total	52,767,964 €	21,627,363 €	12,267,459 €	86,662,786 €

Construction timing

An individual greenfield bottling plant can be constructed and made operational in a 12-18 month period from the time of the decision to proceed. Timing variabilities include permitting and necessary land and roadworks preparation specific to the plant.

The latest modular bottling plant designs from companies such as Makeen Energy (the industry leader) bring the standard lead time down to 12 months and below.

24. Project 2: Cylinder Procurement

Implementation of the cylinder investment is a procurement project. Because LPG cylinders must comply with Ghanaian standards, it is possible to aggregate the cylinder purchasing requirements of the LPG Marketers (or Bottlers) to conduct procurements which minimize pricing and optimize terms for the sector as a whole.

Additionally, if the Government institutes the proposed cylinder discounting levy, recommended to be € 0.03 per kg of LPG consumed nationally, the Marketers (or Bottlers) can benefit from a discount of 40% on the cost to acquire each cylinder (which savings would also be passed on to the consumer).

The total new cylinder requirement to serve the projected demand in Ghana is:

Table 69. Projected 14.5kge cylinder quantities required to 2030 (in two-year increments)

Region	2020	2022	2024	2026	2028	2030
Upper West	19,459	35,704	34,304	32,984	31,740	30,564
Upper East	17,909	31,422	30,190	29,029	27,933	26,899
Northern	40,263	73,996	71,094	68,360	65,780	63,344
Brong-Ahafo	73,734	130,206	125,100	120,288	115,749	111,462
Ashanti	193,713	327,497	323,797	320,158	316,581	313,064
Eastern	53,324	81,352	79,344	77,408	75,543	73,745
Western	102,745	172,962	171,072	169,212	167,383	165,583
Volta	77,305	132,877	129,596	126,435	123,389	120,451
Central	63,108	99,875	98,746	97,637	96,546	95,473
Greater Accra	185,274	258,239	255,416	252,640	249,909	247,222
Total	826,833	1,344,130	1,318,659	1,294,153	1,270,553	1,247,806
Cumulative Total						7,302,134

Translated into non-kge, the 7.3 million of 14.5kge become 10.8 million cylinder units.

When scrapping and refurbishment of existing cylinders is included, the following totals result for BCRM launch:

Table 70. Annual cylinder quantities for BCRM launch 2019-2021

Cylinder category	2019	2020	2021
New cylinders	413,417	413,417	672,065
Replacement of scrapped cylinders	666,667	666,667	666,667
Total for BCRM launch	1,080,084	1,080,084	1,338,732

Total cylinder investment

The total investment for all the cylinders to 2030 is € 235.2 million, comprised of:

- € 185.5 million for the additional 7.3 million 14.5kge cylinders, representing an annual investment flow of about € 15 million.
- € 49.7 million for the cylinders to be replaced during the first years of the launch of BCRM.

The following table details the staging of the entire cylinder investment:

Table 71. Total cylinder investment required to 2030
(€ mm, shown in two-year increments)

Category of cylinder	2020	2022	2024	2026	2028	2030
New 14.5kge cylinders	20.91 €	33.99 €	33.34 €	32.72 €	32.13 €	31.55 €
Replacement of scrapped cylinders	33.71 €	16.86 €				
Total investment ⁸⁴	54.62 €	50.84 €	33.34 €	32.72 €	32.13 €	31.55 €
Cumulative total						235.2 €

Investment in cylinders is an annual process, adjusted according to market trends. 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 illegal cross-filling or diversion of cylinders by competitors.

Cylinder cost

Based on an indicative global procurement exercise, a blended cylinder cost of € 25.3 was achieved per 14.5kge unit.

⁸⁴ Based on quotations obtained and valid for September 2018, import audit services costs excluded. The cost of a 6kg cylinder is typically higher per kg than a 14.5kg cylinder, per kg.

X. Supplementary Annexes

25. Statistics of Licensed LPG Sector Actors in Ghana

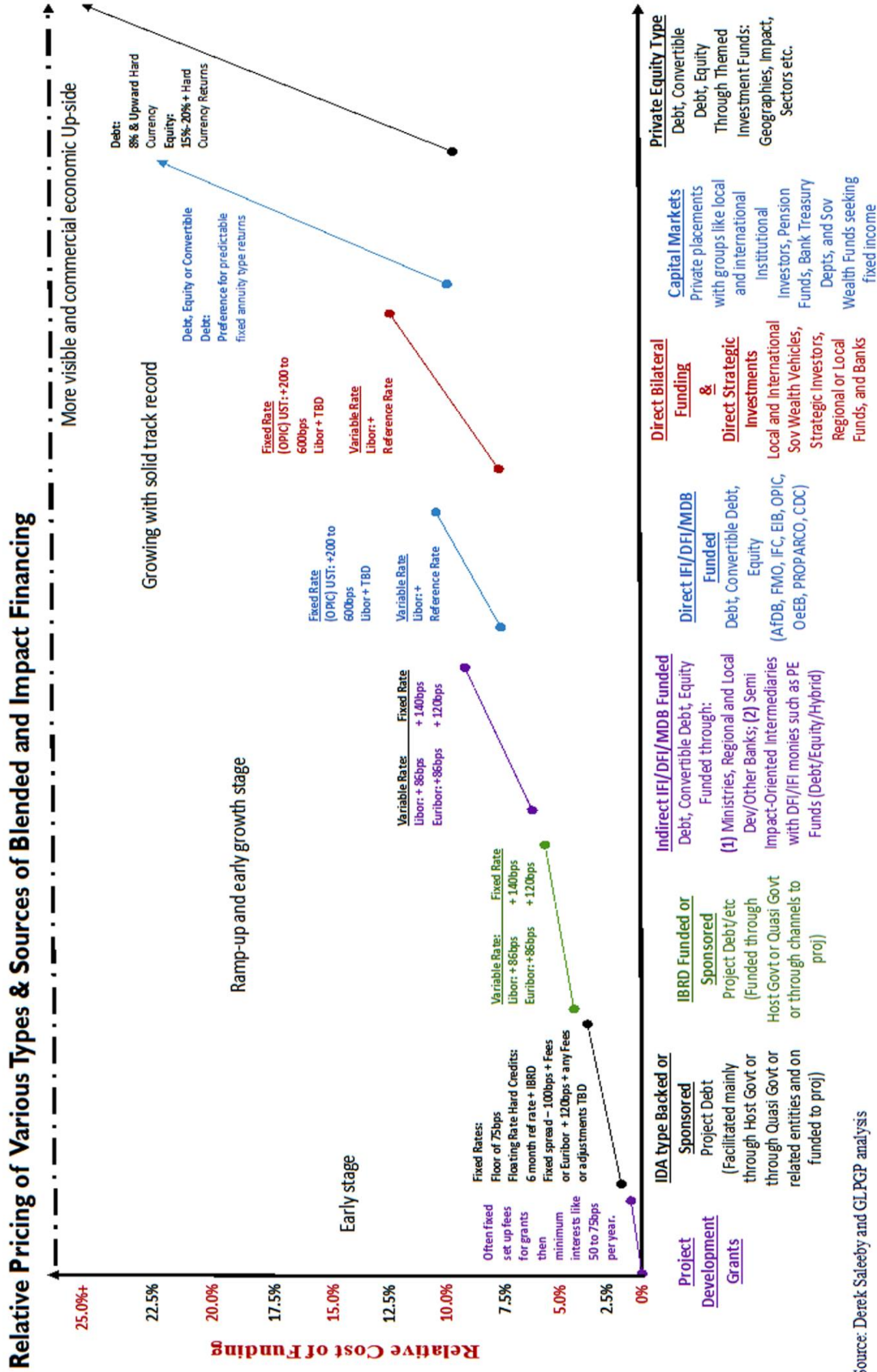
Table 72. Ghanaian LPG companies

Company	LPG Sales Volume in 2017 (MT)	LPG Market Share	LPG as % of Total Sales Volume
Ghana Oil Company Ltd	22,298.9	8.1%	3.6%
Hills Oil Marketing Company Ltd	19,939.1	7.2%	100.0%
Xpress Gas Ltd	15,696.8	5.7%	100.0%
Manbah Gas Company Ltd	14,303.2	5.2%	100.0%
Trinity Oil Company Ltd	13,341.6	4.8%	100.0%
Andev Company Ltd	12,713.7	4.6%	100.0%
Virgin Petroleum Ltd	9,216.4	3.3%	100.0%
Midas Oil & Gas Ltd	6,403.8	2.3%	100.0%
Mighty Gas Company Ltd	5,978.8	2.2%	100.0%
Rootsenaf Gas Company Ltd	5,936.6	2.1%	100.0%
World Gas Company Ltd	5,637.3	2.0%	100.0%
Lonestar Gas Company Ltd	5,409.7	2.0%	100.0%
Royal Energy Company Ltd	5,366.6	1.9%	100.0%
Joekona Company Ltd	5,099.2	1.8%	100.0%
Lucky Oil Co. Ltd	4,935.2	1.8%	43.7%
Yokwa Gas Ltd	4,628.9	1.7%	100.0%
Anasset Company Ltd	4,546.9	1.6%	100.0%
Trade Cross Ltd	4,481.3	1.6%	100.0%
Annandale Ghana Ltd	4,317.9	1.6%	100.0%
Total Petroleum Ghana Ltd	4,283.3	1.5%	1.3%
Dukes Petroleum Company Ltd	4,168.9	1.5%	12.4%
Radiance Petroleum Ltd	4,041.9	1.5%	9.4%
Superior Oil Company Ltd	3,975.5	1.4%	53.7%
Coegan Ghana Ltd	3,883.7	1.4%	100.0%
Louis Gas Company Ltd	3,545.4	1.3%	100.0%
Quantum Petroleum Ltd	3,518.8	1.3%	11.6%
Shakainah Ventures Ltd	3,454.4	1.2%	100.0%
Gasol Petroleum Ltd	3,436.8	1.2%	26.5%
Seam Oil Company Ltd	3,405.1	1.2%	26.5%
Maxx Energy Ltd	3,355.8	1.2%	26.5%
Lambark Gas Company Ltd	3,218.2	1.2%	100.0%
Patrick K.A Bonney & Co. Ltd	3,158.7	1.1%	100.0%
Nextbons Gas Ltd	3,119.6	1.1%	89.9%
Engen Ghana Ltd	2,968.8	1.1%	8.7%
Kaysens Gas Company	2,943.8	1.1%	100.0%
Alive Gas	2,825.2	1.0%	100.0%
Top Oil Company Ltd	2,700.0	1.0%	4.2%
Star Oil Co. Ltd	2,645.4	1.0%	3.0%
Kan Royal Service Station & Trading Ltd	2,585.6	0.9%	13.9%
Frimps Oil Co. Ltd	2,517.8	0.9%	3.9%
Glory Oil Co. Ltd	2,176.2	0.8%	5.1%

Company	LPG Sales Volume in 2017 (MT)	LPG Market Share	LPG as % of Total Sales Volume
Laminin Bee Ventures Ltd	2,161.5	0.8%	100.0%
Go-Gas Ventures Ltd	1,823.7	0.7%	100.0%
Ki Energy Ltd	1,808.9	0.7%	100.0%
Shelleyco Petroleum Ltd	1,727.6	0.6%	100.0%
Agapet Ltd	1,685.4	0.6%	5.2%
Pacific Oil Ghana Ltd	1,603.3	0.6%	6.0%
Triple A Lp Gas Ltd	1,599.1	0.6%	100.0%
Central Brent Petroleum Ltd	1,565.8	0.6%	100.0%
T- Tekpor Energy	1,527.3	0.6%	100.0%
Baffour Gas Company Ltd	1,524.0	0.6%	100.0%
Ap Oil & Gas Ghana Ltd	1,307.2	0.5%	8.5%
Cent Eastern Gas Ltd	1,144.4	0.4%	100.0%
Riema Company Ltd	1,098.2	0.4%	100.0%
Oando Ghana Ltd	1,061.5	0.4%	17.3%
So Energy Gh Ltd	1,051.9	0.4%	4.2%
Dabemens Gas Co.	1,035.8	0.4%	100.0%
Rural Energy Resources Ltd (Runel)	1,020.0	0.4%	20.5%
Thomcof Energy Ltd	943.5	0.3%	25.6%
Champion Oil Co. Ltd	888.2	0.3%	2.9%
First Gas Company Ltd	856.7	0.3%	100.0%
Maxx Gas Ltd	833.0	0.3%	100.0%
Norgaz Petroleum Ltd	705.5	0.3%	100.0%
Benab Oil Company Ltd	675.4	0.2%	4.7%
Orient Energy Ltd	666.7	0.2%	14.4%
Da Oil Co. Ltd	622.1	0.2%	100.0%
Petroleum Solutions Ltd	553.5	0.2%	1.1%
Puma Energy Ghana Ltd	417.3	0.2%	0.2%
Jusbro Petroleum Co. Ltd	413.7	0.1%	3.7%
Crown Petroleum Gh. Ltd	380.9	0.1%	3.7%
Rich Oil Company Ltd	315.7	0.1%	2.7%
Fraga Oil Gh. Ltd	282.7	0.1%	3.1%
Cash Oil Company Ltd	246.3	0.1%	1.3%
Union Oil Ghana Ltd	231.8	0.1%	0.7%
Plus Energy	212.6	0.1%	2.9%
Ev. Oil Co. Ltd	201.0	0.1%	1.9%
Petrobay Oil Ltd	191.2	0.1%	1.1%
Venus Oil Company Ltd	61.1	0.0%	0.8%
Unique Oil Company Ltd	32.3	0.0%	1.5%
Kings Energy Ltd	23.3	0.0%	0.3%
Zen Petroleum Ltd	22.5	0.0%	0.0%
TOTAL	276,702.8	100.0%	

Highlighting indicates a company reporting only LPG sales during 2017.

26. Pricing of Types and Sources of Concessional and Non-Concessional Funding

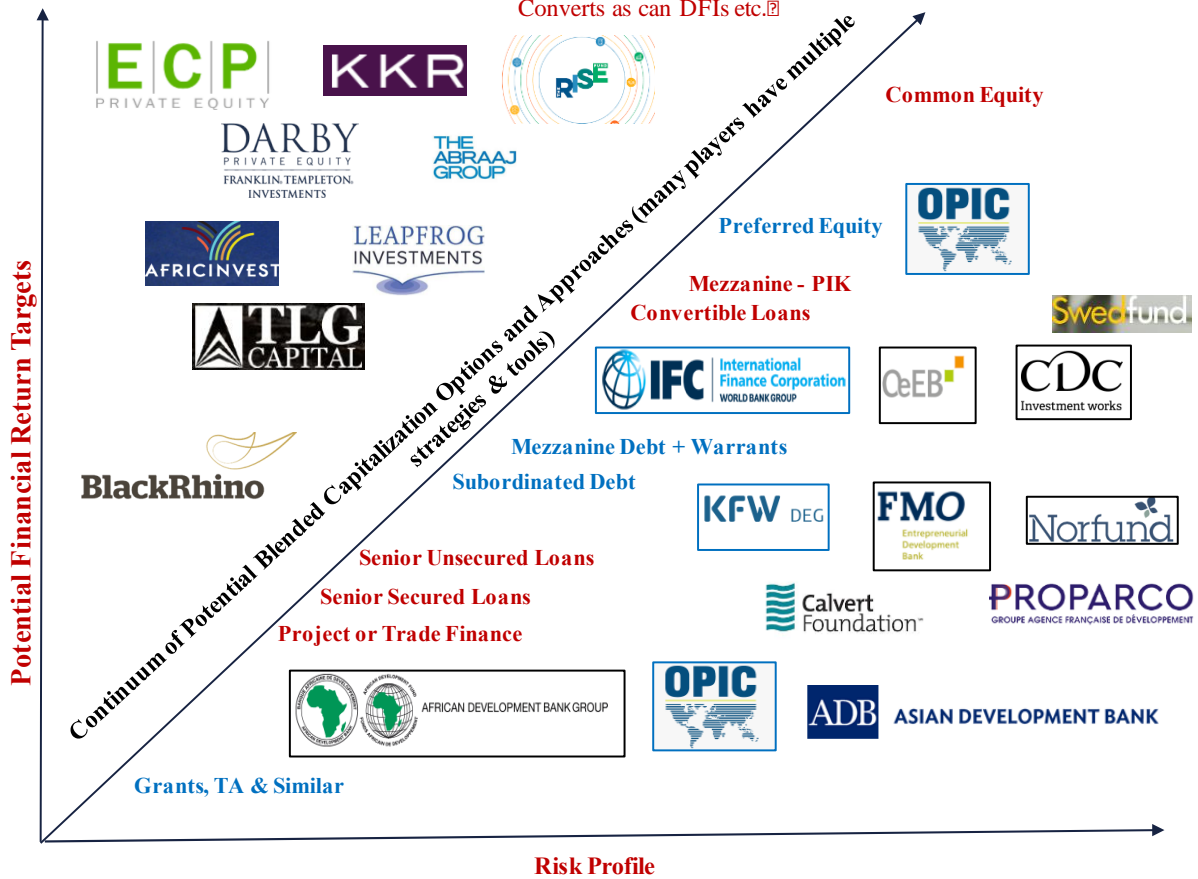


Source: Derek Saleeby and GLPGP analysis

Note: This analysis does not factor in credit guarantees, insurance, export credit, trade finance etc. It is based on most current costing benchmarks presented by the entities mentioned or from market proxies/knowledge as in the case of private equity and capital markets.

27. Risk / Return Expectations of Potential Blended Funding Sources

Note that many funders below use similar instruments to fund, but have differing relative return requirements. OPIC's preferred returns may be lower than Abraaj. TLG Africa can do Sr. Secured but also Mezzanine and Converts as can DFIs etc.



28. Financing Case Studies: DFIs, IFIs, MDBs, Guarantors and Other Funders

Backing LPG Related investments in Ghana, Cameroon, and Kenya

The purpose of mentioning the below cases is to demonstrate the combination of DFI and other blended funding sources that have worked in LPG and, therefore, could be approached by GLPGP. The first DFI-backed IPP project was the AES-SONEL LPG-fired power project in Limbe, Cameroon, which was built and commissioned in December 2003 and led by the Emerging Africa Infrastructure Fund (EAIF), a subsidiary of Private Infrastructure Development Group (PIDG). PIDG was established in 2002 by donor groups and members from Australia, Germany, IFC, Netherlands, Norway, Sweden, Switzerland and UK, and was the catalyst for funding the 4 case studies. Our team has approached PIDG and is seeking their willingness to engage in GLPGP's initiatives once more structural clarity is established in Ghana's LPG's funding targets. They can similarly crowd in some of their DFI backers.

These case studies represent three LPG-focused projects in Ghana, Cameroon, and Kenya which are power projects. However, they acted as catalysts in mobilizing foreign capital and expertise in each country, and established various forms of infrastructure for further development of the LPG sector in each country, such as import terminal and storage facilities.

Ghana's LPG Power Project and Import Storage Facility

Quantum Group Limited (QTL) is building an LPG-fueled power project in Tema, Ghana and essential import terminal and infrastructure for LPG and petroleum liquids. Sage Petroleum, a subsidiary of QTL, will import the LPG and petroleum liquids products and own 20% of the Bridge Power Project. The IFC has been a lender to Quantum-related entities, although now they are at odds.

Ghana's LPG storage company Quantum Terminals Group lists a bond on the London Stock Exchange

GuarantCo-backed London Listed Bond

On November 29th, 2018 Ghana's LPG storage company Quantum Terminals Group (also discussed below) listed a 75% partially guaranteed bond on the London Stock Exchange denominated in Ghanaian Cedis. This is part of a larger Cedis 140 million financing program. The initial placement of approximately Cedis 40 million is guaranteed 75% by GuarantCo – a PIDG entity. This guarantee enabled various investors to take positions in this placement.

Bridge Power

Sage to Supply LPG for the Bridge Power Project

The Bridge Power Project (sponsored by the Early Power Limited) is a greenfield development project in Ghana for the rapid deployment of a 400 MW (net at site conditions) generation facility to be fueled initially by LPG with diesel as the backup fuel. There is a 20-year power purchase agreement with the

Electricity Company of Ghana. The project is owned 20% by Sage Petroleum, 20% by GE, and 60% by Endeavor Energy.

The Project will run on imported LPG as the primary fuel and diesel as a secondary fuel. It is estimated that by year 5 of operation natural gas will be available for the project and this will then become the primary fuel with LPG left in place as a secondary fuel.

As part of this project, Quantum, through its associated companies, will build storage spheres and construct a pipeline from the Tema Jetty to connect to the existing LPG storage and transportation infrastructure at the Tema Oil Refinery. This will ensure that in addition to supplying LPG to fuel the Power Plant, Sage will also be in the position to supply LPG to the local market.

Quantum LPG Terminal

Quantum to build LPG storage and associated infrastructure

The Quantum LPG Terminal Project is a greenfield development project in Atuabo, Ghana near the Jubilee Oil Fields. They are building three 500 cubic meter storage tanks, three loading gantries and associated infrastructure to increase the availability of LPG in Ghana. The cost of the tank farm was \$19 million, which required hard and local currency for the Project so Standard Chartered Bank provided the US\$10.8 million project loan (57%) which had a local currency guarantee for 50% of the proceeds by GuarantCo, a subsidiary of PIDG. The project completed in Nov-2014.

Quantum is building a 55,000 MT storage tank farm (100,000 MT expansion capability) at Tema which will serve the petroleum liquids storage requirements of Sage Petroleum, its trading subsidiary. The project is estimated to cost \$33 million (51.5% QTL equity and 48.5% banks). In addition, QTL is building a 23,000 cubic meter storage tank farm for LPG storage for the power project at a cost of \$65 million (~23% QTL equity and ~77% from power project). QTL will receive leasing fees from the power project for usage of storage tanks. The development impact was:

Indicators	Development Impact
Private Sector Investment	\$117 million (72% LPG)
Fiscal Benefits	Project increased government revenue through Corporate Tax, Withholding Taxes, Import and Stamp Duties
People Benefiting	2 million
Additional Benefits	Reducing reliability on wood and charcoal-fueled cooking, carbon dioxide emissions, slowing deforestation and contributing to Ghana's fuel security

Cameroon's LPG-Fired Power Project

In 2001, AES Corporation acquired and privatized 56% of SONEL, Cameroon's electric utility. Cameroon relies on hydro-electricity for 70% of its power generation, but the country has an eight-month dry season from November to June when river flows are greatly reduced. The project was designed to fill the electricity gap during the dry period. However, it is now fully utilized during the year and catalyzed investments in transmission and distribution.

To finance and commission the 85MW Limbe plant, adjacent to the SONARA refinery which supplies its fuel (the only domestic source of LPG), AES secured a \$554 million financing package from sources including EAIF, FMO and Finnfund, as well as \$168 million or 30% raised through domestic commercial equity. The Limbe project was the first project funded by DFIs followed by a larger capital expenditure program of \$293.3 million investment which was partly financed by FMO, Finnfund, Finnish Export Credit, PROPARCO, DEG, AfDB, IFC and EIB.

In 2003, EAIF committed \$30 million to the Limbe project and played the critical role in arranging the balance of the debt financing. For the larger financing program undertaken by AES in 2006, EAIF rolled over its existing facility, and increased its exposure by another \$5 million. This provided vital bridging and smoothed the way for other institutions to support AES-SONEL's new capital expenditure program. The refinancing was converted into Euro-based package. The development impact was:

Indicator	Development Impact
Private Sector Investment	\$554 million
Fiscal Benefits	Total taxes paid in 2005-12 were €166 million; increased economic activity had positive impact on indirect employment; and a more reliable electric source contributed to sustainable economic development
Job Creation	During construction, there were 508 workers which generated significant transfer of skills, knowhow and expertise to the local workforce
Additional Benefits	Limbe project increased available generating capacity by 10%; project supplies 820,000 people with improved power supply; significant improvement in electricity supply and reliability; and successful PPP model

Kenya's LPG-fired Power Project

Kenya Power and Lighting Company, the state electric utility, issued a tender for the first independent power producer in 2005, which was won by Danish BWSC and Aldwych international, a private equity fund

manager focused on the power sector. Rabai heavy oil-fired power project is one of the most efficient and among the cleanest thermal fuel plants in East Africa, which was constructed and commissioned in May 2010. The Rabai project, located near Mombasa, involved the development, financing, construction, operation and maintenance of a 90MW heavy oil-fired power plant which was converted to run on LPG.

The total investment in the Rabai Project was €111.31 million. Of this, €26.67 million (24%) was funded through a combination of commercial equity (14%) and equity from DFIs (10%). The remainder of the financing was arranged through 15-year senior and subordinated loans from DFIs including EAIF, FMO, PROPRACO and DEG. EAIF was the lead arranger, and €22.57 million was their financing amount in the project. The development impact was:

Indicator	Development Impact
Private Sector Investment	€111.31 million
Fiscal Benefits	Project increased government revenue through Corporate Tax, Withholding Taxes, Import and Stamp Duties; government subsidies for expensive emergency power generation were slashed; and power supply improved
Job Creation	During construction and operations, there were 300 people and 70 people, respectively
Additional Benefits	Project provides 400,000 households with reliable power supply, met stringent international design standards, and is convertible into LPG

29. Financing Case Studies: IFC

Sampling of IFC's LPG-Related investments

Below are the excerpts from the IFC's public disclosures on select LPG investments. The importance is that these demonstrate that the IFC as a source of TAS and non-concessional debt (mainly) are active in the LPG value chain modalities from importation, storage, bottling, filling, cylinder finance, marketing/distribution, transportation, operation finance, and technical assistance. These are all areas relevant for improvement of the Ghanaian market's LPG growth. In addition, these are instructive in that they demonstrate that the IFC is a logical target for funding and potential technical assistance.

Project Description

Approved: Jun 28, 2019

Engro Vopak Terminal Ltd.

"EVTL" or "the Company" owns and operates the largest terminal and storage facility for bulk liquid chemicals and Liquefied Petroleum Gas (LPG) in Pakistan. It is involved in the handling and storage of Para-Xylene, Acetic Acid, Ethylene Di Chloride (EDC), Vinyl Chloride Monomer, Ethylene, Mono Ethylene Glycol, Phosphoric Acid and LPG.

The proposed investment will support the Company to: i) expand LPG storage capacity by 6,000 tons; ii) expand EDC handling facility; iii) undertake 3-year terminal rehabilitation program and; iv) install solar panels (The "Project").

The total project cost is estimated at US\$40 million and IFC will provide an "A" Loan of up to US\$40 million to fund the project. The financing will provide the Company with access to critical long-term funding in an environment where such funding is scarce. IFC will also advise the Company on designing and implementing investments aimed at improving efficiency of the terminal and reducing its energy consumption and emissions.

Stated Expected Development Impact

The Project is expected to have the following development impacts: a) Environmental sustainability - the Project is expected to support energy transition in Pakistan towards cleaner fuels by increasing access to reliable supply of LPG, which has low indoor health hazards and greenhouse gas emissions relative to alternative conventional fuels like firewood, kerosene or charcoal. The Proposed Project will allow the Company to implement 3-year terminal rehabilitation capex program covering some high priority scheduled maintenance and terminal rehabilitation that is essential for its continued safe and efficient operations. b) Stakeholders Effects: The Project will have economy-wide effects by substantially alleviating current deficit of LPG in Pakistan and improving access to cleaner fuels for rural households, as well as automotive sector consumers. Extension of LPG capacity will also provide additional business opportunities for thousands of Small and Medium Enterprises operating in the downstream LPG distribution business, such as LPG cylinder distributors, fueling stations and others. c) Market creation: The Project will result in systemic changes to

the existing LPG market in Pakistan through implementation of infrastructure to import, store and market larger quantities of LPG which is expected to substantially increase the local availability of LPG.

Project Description

Date ESRS Disclosed

Apr 25, 2018

Mombasa Gas Terminal

(MGT or “the company”) is developing a greenfield liquefied petroleum gas (LPG) terminal, in the Port of Mombasa, Kenya that will import and market LPG within the country. The terminal will have direct mooring access for large-sized LPG carriers, a pipeline for the transfer of gas to an onshore storage facility which has a capacity of 22,000 metric tons (MT) that will be mounded. The aim of the project is to address issues of LPG supply and infrastructure in the Port of Mombasa to support the LPG master plan for Kenya. MGT currently operates a fleet of 20 dedicated LPG tank containers for import of LPG into Mombasa on-board container vessels.

Total Project Cost is US\$ 112 million, and IFC is considering supporting the Project by providing MGT with US\$48 million in a combination of loans for its own account and for other participating lenders. In addition to mobilizing long-term financing, IFC is providing guidance on the deal structure and in ensuring appropriate management capacity to operate the LPG terminal.

The project involves a loan of \$30 million to MGT to construct the gas terminal which will comprise; i) a private berth for unloading mid-size LPG carriers and an associated pipeline; ii) onshore mounded storage of 22,000 MT and associated infrastructure including multiple loading gantries for the transfer of G to transport vehicles; and iii) dedicated LPG transport vehicles equipment. The technology involved will enable vapour displacement from the storage tanks of the LPG carriers to feed back to the mounded storage tanks (and vice-versa) as a closed system to prevent major pressure changes between the LPG in storage at the mounded storage and the ships. The berth shall be equipped with an import system designed to receive pressurized imports at 1,000 m³/hr from Mid-Size Gas Carriers (MGC), Large Gas Carriers (LGC) or Very Large Gas Carriers (VLGC). The facility will have no blending facilities in that the LPG will be delivered with the appropriate specification from the point of origin.

The company will transport LPG using three routes: (i) LPG ISO tanks transported by truck to the Rift Valley Railways (RVR) yard in Kilindini and loaded onto flat wagons for transport to Nairobi and beyond; (ii) LPG ISO tanks transported by truck to the Standard Gauge Railway (SGR) yard in Port Reitz and loaded onto flat wagon for transport to Nairobi and elsewhere; and (iii) LPG loaded into LPG bullet trucks for transportation within Mombasa by accredited third party transporters contracted by the company or customers.

Stated Expected Development Impact

(i) Positive impact on LPG end-users who will have more access as a result of larger LPG volumes, more affordable price, and increased access to a cleaner, more efficient and safer fuel. (ii) Positive impact on distributors, as LPG will be more readily available, as a result of MGT's competitiveness arising from its scale, enabling distributors meet the growing demand and size of the market. (iii) Supports environmental

sustainability through diversification into more efficient and safer energy resources than currently available, and with potential linkages to domestic retail and distribution sector.

Project Description

Approved: Jun 25, 2018

Invested: Aug 13, 2018

Omera Petroleum Ltd.

“Omera” or “the company” is the second largest liquefied petroleum gas (LPG) player in Bangladesh, with a throughput capacity of 120,000 metric tonnes per annum (MTPA). The company has its main import storage terminal in Mongla, and three satellite storage / bottling stations in Ghorashal (Central region), Bogra (Northern region) and Chittagong (Southern region), respectively. Omera has a fleet of one river barge, road tankers, and contract distributors’ cylinder trucks to transport LPG from central terminal to satellite stations, and to customers. All storage terminals and filling stations are located along the rivers / main roads and inside industrial areas.

Total project cost over the next 2 years is estimated to be around US\$60 million including capital expenditures for cylinders, barges, storage tanks, trucks and filling machinery. IFC proposes an investment of up to US\$20 million to partially finance this capital expenditure.

Stated Expected Development Impact

1. Stakeholders Effects: a) Customers effects: Currently, about 90% of natural gas in Bangladesh is used to generate electricity, with demand from both domestic household and industrial segments expected to grow substantially. However, there is a daily shortage of natural gas of approximately 1,000 million cubic feet (mmcft/day) which might cause major disruptions to the economic activities if remain unaddressed. Due to the shortage of natural gas, LPG is even more needed now especially by the domestic households as natural gas is increasingly diverted for industrial and power sector use. The Project will help minimize the shortage gap and address the lack of storage facilities that have become the bottleneck in the distribution chain by increasing the storage capacity at various stages in the value chain. The other bottleneck is in the downstream logistic services, where certain locations are hard to reach or that the transport lead time is long, both due to the constraints in the transportation infrastructure. The Project will help smoothen the distribution of LPG to the end users by constructing capacity barges, cylinder carrying barges, and upgrading the LPG road tankers fleet. This will direct and indirectly increase the reliability of supply by shortening the delivery time and lowering the transportation costs, and to ensure end customers will have access to LPG when they need them. b) Distributors effects: OPL has established a strong distribution channel with more than 200 distributors across the country. OPL is now present in more than 22,000 retail points in the country, and has presence in all the administrative sub-districts of Bangladesh. The project will increase economic activity of these distributors and retailers, most of them MSMEs, due to the higher volume of LPGs and number of cylinders being distributed to the end users. By 2020, additional 2.1 million cylinders will have been distributed to the market and by 2018, additional 3,000 retailers will have been added to the distribution network.

2. Contribution to Market Creation: a) Resilience: The project will help create a more resilient energy system through promotion of supply diversification, by helping a private sector player such as OPL deliver LPG to the market. The Project also supports the Government of Bangladesh's policy to dedicate the natural gas production to power generation and industrial consumption, which are currently facing erratic and short supplies. Allocating more natural gas to power generation and fulfil the demand of the household segment with LPG will not only create a more resilient energy system but also lead to better manufacturing productivity and thus generate greater economic value from scarce natural gas resources. b) Sustainability: This project will support the promotion of LPG which has low greenhouse gas emission characteristics when compared to for example, conventional cooking fuels such as firewood, kerosene and charcoal. Usage of these conventional cooking fuels have reduced drastically in rural Bangladesh, but represent still around 75% of the consumption of cooking fuels, so there is a big potential for LPG to reduce greenhouse gas emissions. Inefficient cooking emits greenhouse gases such as carbon dioxide and methane, and aerosols such as black carbon. Better access to LPG in rural areas of Bangladesh through new distribution networks will provide a cleaner and efficient fuel than biomass, reducing overall emissions and thereby improving overall health of the local population. Unlike firewood and charcoal, LPG is easy and instantaneous to light, easy to control so that the required rate of heating can be obtained. LPG does not produce any smoke or soot therefore in overall is more environmentally friendly and sustainable compared to conventional cooking fuels.

Project Description

Approved : Apr 4, 2016

Invested: Nov 14, 2016

Private Enterprise Company Nadezhda

("Nadezhda") is based in eastern Ukraine and is a wholesale and retail distributor of liquefied petroleum gas (LPG), gasoline, and diesel fuel. The purpose of the project is to support the expansion of Nadezhda through a) increasing the number of retail stations, which would sell traditional fuels as well as LPG, and b) managing working capital risks by partially replacing short-term loans with long-term debt.

The total project cost is estimated at US\$22 million. The proposed IFC investment is a US\$10 million A loan and a US\$10 million C loan. The remainder of the financing will come from internal cash generation of Nadezhda. The IFC is providing: risk capital and long-term funds; guidance on environmental and social aspects of the project; and financial advice on improving the Company's debt repayment profile.

Stated Expected Development Impact

According to the IFC's disclosures, the development impacts expected include: Development of Ukraine's infrastructure based on modern and safe standards; Supporting the expansion of the distribution infrastructure for liquified petroleum gas, which is a "cleaner" fuel; and Employment creation / preservation: The investment is expected to create 238 new, permanent jobs.

Project Description

Approved: Jun 18, 2015

Invested: Dec 29, 2015

Bulmarket DM

The company is headquartered in Ruse, a city located next to the Danube river in Bulgaria. In addition to its operations in Ruse, it owns LPG terminals in Byala, Plovdiv, Sofia and Kyustendil in Bulgaria as well as Galati and Giurgiu in Romania. Bulmarket DM is the Sponsor of the project. It is a regional trader and distributor of LPG, diesel and other fuels with a number of different divisions, including railway transportation, CNG retail stations, port and auto transport. LPG is the most important segment for Bulmarket, representing over half of its EBITDA. Assets relating to LPG import and distribution include two LPG transport ships, a port and railway trans-shipment terminal in Romania, six LPG storage terminals in Bulgaria and Romania, 150 rail tank cars and trucks.

The project will finance (i) the Company's core LPG business line through the development and expansion of three terminals in Ruse, Sofia and Plovdiv; (ii) the development of a new LNG business both for wholesale trade and business to business distribution; and (iii) the refinancing of short term debt. The total Project cost is estimated at EUR31 million. The IFC investment will be an A loan of up to EUR15 million. Provision of long-term financing: Longer tenors are not readily available in the current market environment and Bulmarket needs long-term financing for this project.

Stated Expected Development Impact

Among other stated impacts, the IFC states that the financing will help Bulmarket to become the first importer and distributor of liquefied natural gas (LNG) in Bulgaria. The Company will supply off-grid, industrial end-users with a cheaper, "cleaner" burning alternative to diesel or compressed natural gas (CNG). This Project will develop the LNG infrastructure in Bulgaria, which encourages greater use of the fuel, has a positive environmental impact, and supports the Bulgarian industrial base with more competitive energy costs. In addition, the enhancement of the company's distribution capacity for liquefied petroleum gas (LPG), a "cleaner" burning fuel primarily used in vehicles as a substitute for gasoline or diesel will also encourage greater use of the fuel resulting in a positive environmental impact.

30. LPG-Related Laws and Regulations

The National Petroleum Authority (NPA) regulates the LPG market in Ghana pursuant to the following statutes, regulations and standards:

Petroleum Pricing Formula Regulations (LI 2186)

Govern the pricing of petroleum products including LPG and is enforced by the National Petroleum Authority (NPA)

Road Traffic (Use of LPG) Regulation, 1994 (LI 1592)

Regulates the use of LPG in vehicles and requires for examination (i) issued certificate and registration in respect of suitability of LPG fitting in vehicles; (ii) a sticker, renewable every six months

Local Government Act, 1993 (Act 462), Section 49

Requires permits for the siting of LPG facilities in a district, which are granted by the relevant District Planning Authority

Environmental Assessment Regulations, 1999 (LI 1652)

Stipulate that undertakings involving refined petroleum products, construction relating to products, and storage facilities be registered with the Environmental Protection Agency (EPA) and an Environmental Impact Assessment (EIA) be provided in respect of such undertakings

Export and Import (Prohibition of Importation of Used LPG Cylinders) Instrument, 2001 (LI 1693)

Prohibits the importation of used LPG cylinders into Ghana

Fire Precaution (Premises) Regulations, 2003 (LI 1724)

Require that a Fire Certificate be obtained for the establishment and use of LPG facilities; provide for setting guidelines for classification and registration of fire protection service contractors; authorize the Ghana Fire Service to enforce the code of practice regarding means of escape, firefighting and fire warning systems, as determined by the Fire Service Council

Code of Standards on LPG

Provides guidance regarding the safe construction and operation of LPG filling facilities

ISO 22991 Gas cylinders — Transportable refillable welded steel cylinders for liquefied petroleum gas (LPG) — Design and construction

This international standard specifies minimum requirements concerning material, design, construction and workmanship, procedure and test at manufacture of transportable refillable welded steel LPG cylinders of water capacity up to and including 150L, exposed to ambient temperatures

Ghana Standard ISO 13341:2010 — Transportable gas cylinders — Fitting of valves

Specifies the procedures to be followed when connecting cylinder valves to cylinders

31. Note Regarding Long-Term LPG Pricing and Availability

LPG pricing trends over spans of 12 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 for the other consuming sectors (residential, industrial, etc.), if global LPG supply tightens after 2030.

This document assumes that LPG source pricing applicable to Ghana will remain relatively stable 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 Ghanaian cooking energy and technology alternatives might affect adoption and consumption beyond 2030.

32. 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.

33. 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.