



CLEAN
COOKING
ALLIANCE

SCALING LPG FOR COOKING IN DEVELOPING MARKETS

INSIGHTS FROM TANZANIA



In collaboration with
KOPAGAS

ABOUT THIS DOCUMENT

This report contains information acquired through a technical assistance engagement the Clean Cooking Alliance and ENEA Consulting delivered to KopaGas in Tanzania. The Global LPG Partnership provided additional support and consulting. The report highlights key market, financing, and regulatory challenges related to the scale-up of liquefied petroleum gas (LPG) as a cooking fuel, particularly for those low-income families living at the “base of the pyramid” (BoP). To provide context, the report also discusses the critical components of LPG supply chain infrastructure and recognized best practices to illustrate the need for investment. It highlights how technology-enabled pay-as-you-go (PAYG) solutions adapted from the off-grid solar sector are emerging to enable innovative business models that increase the affordability and availability of LPG in emerging markets, such as this case study in Tanzania. Finally, this report is for companies throughout the supply chain, current and prospective investors, and policymakers who aim to stimulate the growth of private sector-delivered clean cooking solutions. This report is the first in a series of publications that the Alliance will develop with key partners to provide useful insights and recommendations related to various technologies and business models.

Aerial photography of houses in Victoria, Dar Es Salaam, Tanzania

Cover Photo: Woman cooking meal with LPG from cylinder equipped with KopaGas smart meter



ACKNOWLEDGEMENTS

The Clean Cooking Alliance (the “Alliance”) works with a global network of partners to build an inclusive industry that makes clean cooking accessible to the 3 billion people who live each day without it. Established in 2010, the Alliance is driving consumer demand, mobilizing investment to build a pipeline of scalable businesses, and fostering an enabling environment that allows the sector to thrive. Clean cooking transforms lives by improving health, protecting the climate and the environment, empowering women, and helping families save time and money.

ENEA Consulting (“ENEA”) is an independent strategy consultancy specializing in energy transition and sustainability with offices in Paris, Melbourne, and Hong Kong. ENEA works with a wide range of actors in the energy value chain, from global energy majors and international institutions, to investors and entrepreneurs. In the energy access space, the firm has provided consulting services to more than 60 companies, social enterprises, NGOs, and public institutions to help them increase access to energy in low-income countries.

KopaGas is a technology company developing software and advanced metering technology for the LPG industry. In Tanzania, KopaGas is an LPG marketer in partnership with Oryx Energies.

The Global LPG Partnership (GLPGP) is a United Nations-backed non-profit, public-private partnership formed in 2012 under the UN Sustainable Energy for All initiative, to aggregate and deploy needed global knowledge, best practices, public and private capital, and human resources to help low-income countries transition large populations rapidly and sustainably to liquefied petroleum gas for cooking.

The Alliance, ENEA, and GLPGP acknowledge KopaGas’ contributions to this report and commend the business’ commitment to pioneering a business model with the potential to improve the lives of underserved consumers in emerging markets around the world. The Alliance remains committed to supporting KopaGas and numerous other pioneering companies in this space through various initiatives that offer technical assistance, investment capital, and other public goods.

The Alliance, specifically its private sector and investment team led by Peter George with Seema Patel, commissioned this report. We would like to thank our partners for their content, resources, and expert insights, specifically Sebastian Rodriguez (KopaGas); Richard Scotney, Fabiola Graveaud, Thomas Gazeau and Romy Abou Farhat (ENEA); and Elisa Puzzolo (GLPGP).

OVERVIEW

Nearly 3 billion people, or 40 percent of the world's population, depend on food cooked using traditional fuels such as wood, charcoal, coal, and kerosene — with the highest percentage in Sub-Saharan Africa where 80% of the total population uses such fuels [1] [2] [3].

This has negative effects on health, the climate, and the environment. It also has economic implications, with consumers spending USD 20 billion on polluting and inefficient cooking fuels in Sub-Saharan Africa in 2010, a figure projected to rise to USD 47 billion by 2020 [4]. At the household level, families can spend up to 20% of their total income on cooking fuel [4].

A commercially viable and context-appropriate transition to cleaner, more modern cooking solutions could alleviate many of these negative impacts and offer numerous socioeconomic advantages. One such alternative is liquified petroleum gas (LPG). As a cooking fuel for households in low-income countries, its availability and affordability, and therefore use, vary significantly by country. Its success is highly dependent on government policies and subsidies, as well as strong private sector engagement and innovation. While biomass stoves continue to be relevant for many consumers in many markets, considerable demand exists for more aspirational alternatives, including LPG, electric cookers, biogas digesters, and biofuels such as ethanol and compressed biomass pellets—particularly where poverty is declining, financial inclusion is growing, and consumers are urbanizing. LPG is one viable solution in the transition to fully renewable and emissions-free energy solutions; it is likely to continue to gain traction while other technologies are developed and proven at scale. The scale-up of LPG can be accelerated through subsidies to reduce upfront and ongoing consumer costs; through business model innovation and mobile technology to enable viable distribution

economics; and through businesses providing a context-appropriate user experience.

To develop a pipeline of scalable businesses and mobilize public and private sector investment in such businesses, the Alliance launched the Spark+ Investment Readiness program in 2017 to provide

What is LPG?

Liquefied petroleum gas, or LPG, is a hydrocarbon fuel comprised of propane and/or butane and used for heating, cooking, and transport (auto gas) in developing markets. It is compressed into liquid for storage in cylinders and can be easily imported and distributed without complex piped natural gas distribution systems.

technical assistance (and grant funds where appropriate) to financially viable companies that deliver high-impact solutions to meet consumers' needs. KopaGas, one of three businesses selected in the program's 2017 Request for Proposals, has been in operation since 2015, and aims to increase access to LPG for cooking through the reliable supply of gas to dealers via its distribution partnership with one of Tanzania's largest LPG wholesalers, Oryx Energies.

KopaGas also set out to address the high cost of switching from charcoal to LPG through a technology-enabled, pay-as-you-go solution. As part of its Spark+ support, the Alliance engaged ENEA Consulting to support KopaGas to refine its commercial strategy and develop a financial analysis to evaluate various business models.

This report aims to provide insights into the various opportunities and challenges associated with LPG as a cooking fuel, drawing on examples from KopaGas' experience in Tanzania, as well as examples from other international LPG markets. It highlights aspects of the market opportunity for investment into LPG supply chains, the need for proper enforcement of LPG regulations, and the benefits of technology in overcoming historical barriers.¹ The report's content is aimed at companies, investors, and policymakers. All play an important role in enabling market growth for household cooking energy solutions.

Key Takeaways

- » For an LPG supply chain to operate effectively and for supply chain actors and investors to deliver required capital investment, a policy environment conducive to investment must be in place. This includes long-term, consistent fiscal policies and properly enforced regulatory frameworks based on international standards and codes of practice.
- » LPG equipment costs remain a major hurdle for low-income households. The view that LPG is more expensive than solid fuels may be real or perceived, depending on specific market dynamics, the upfront cost of LPG "starter packs," and the relatively large "all at once" cost associated with refilling a cylinder. All these factors pose obstacles that prevent poorer households from switching fuels.

- » Several consumer finance options are available at different pilot or scale-up stages in various countries to help overcome these cost barriers.
- » Technology-enabled pay-as-you-go (PAYG) solutions are one such innovation which appears highly scalable and sustainable from the industry's perspective and could dramatically enable households to adopt LPG by allowing smaller purchases of fuel on an incremental, per-use basis.
- » Compared to PAYG for solar, PAYG LPG presents additional challenges, primarily related to the higher cost of metering systems and more complex distribution logistics associated with regular home deliveries. However, long-term PAYG customer relationships also present an opportunity for robust, long-term demand and may in turn catalyze supply chain investment. PAYG is one promising solution to accelerate the growth of LPG consumption, but it is not a silver bullet.
- » A series of interventions, including proper national regulation and enforcement, as well as financing across the supply chain, must be in place to sustain market growth.
- » Equity investors and lenders with impact goals, across social and environmental dimensions, should be aware of the strong base of evidence regarding the significant health and environmental benefits of LPG as a transitional cooking fuel, despite its being a fossil fuel.

¹The report covers major challenges to LPG sector scale-up. It does not cover logistics or safety issues in detail. Logistics and safety, while fundamental to a successful LPG market, are not currently perceived by the industry to be major barriers to scale. In addition, this study takes Tanzania as an example and does not assess differences between emerging markets. Such comparative analysis would be useful for investors and governments and merits additional study.



Oryx LPG cylinder depot in Tanzania

OPERATING AN EFFECTIVE LPG COOKING MARKET

For LPG cooking fuel markets to be scaled up, best practices and international standards must inform the design and enforcement of regulations. They create the conditions for a safe and bankable LPG sector, and stimulate the necessary infrastructure investment to establish and maintain a safe and reliable fuel supply chain. [1].

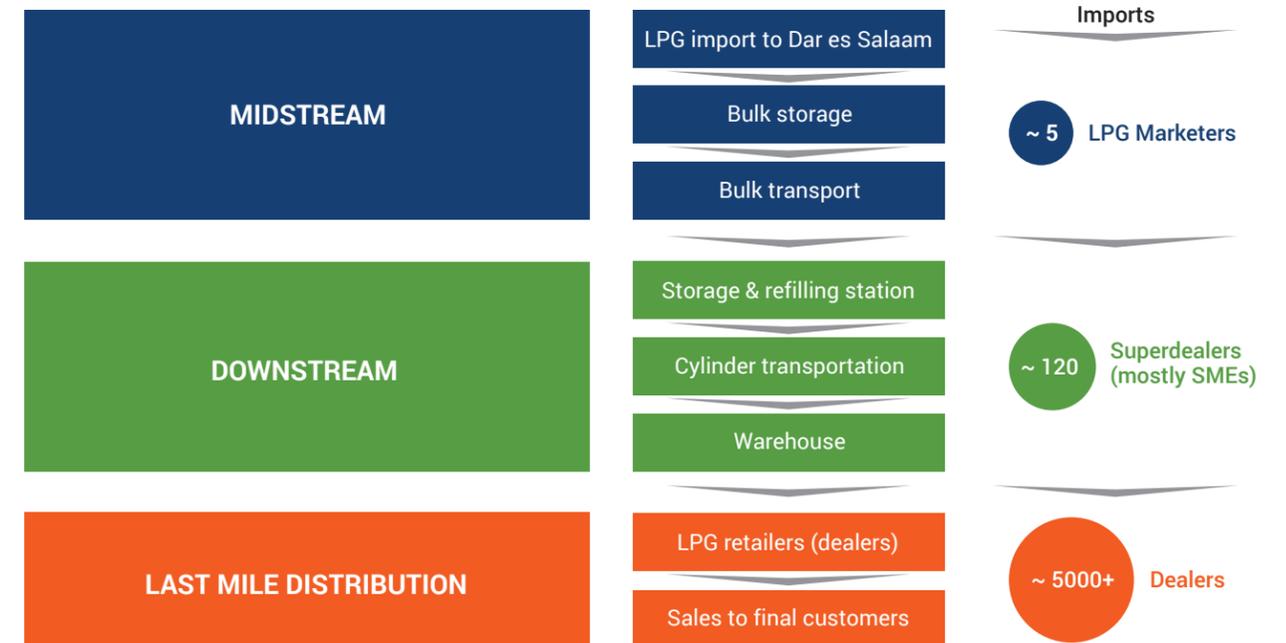
Essential LPG Infrastructure

LPG fuel originates from one of two sources: (1) separation from primary field production of oil or natural gas; and (2) as a by-product of oil refining. LPG is transported from its point of production to bulk storage terminals in pressurized or refrigerated storage tanks and then moved through midstream and downstream infrastructure by pipeline, ship, road, or rail to industrial users and LPG cylinder-filling stations/bottling plants. At this point, through last-mile distribution infrastructure, LPG is available to serve the household and commercial markets [5]. Figure 1 illustrates the LPG supply chain, using Tanzania as an example.

Management Best Practice

Cylinder ownership policies influence how an LPG marketer maintains cylinders, and dictate which party is held accountable when accidents occur. There are two primary models for cylinder distribution worldwide—the “branded cylinder recirculation model” (BCRM) and the “customer-controlled cylinder model” (CCCM). The BCRM has proven more successful, especially in early-stage markets. It ensures that refilling is done properly and that cylinders are kept safe, maintained over time, and properly disposed of once beyond repair (the typical cylinder lifespan is 10 to 20 years [6]). Under this model, customers exchange empty, branded LPG cylinders for a new cylinder of the same brand, and the empty one is returned to the marketer [6].

Figure I: Tanzania LPG Supply Chain



Additionally, the BCRM requires customers to a refundable cash deposit for the cylinder, usually less than the actual cost of the cylinder. LPG distributors, who are authorized agents of marketers, and end-users who take possession of cylinders, pay a refundable cash deposit to their cylinder provider. All participants have financial incentives to track cylinders, lowering the incidence of cylinder diversion to illegal or unsafe distribution and refilling activities.

When an end-user no longer needs a given cylinder, it can be returned to an authorized retail point for a deposit refund or exchanged for another cylinder type or size. By contrast, in the CCCM, customers may well discard old or unneeded cylinders, as they do not receive a deposit refund. But discarded cylinders can be dangerous if they still contain LPG and may be reused in unregulated and illegal refilling operations [6].

The BCRM is the market model used in the majority of countries around the world. Countries such as Tanzania, Cameroon, Brazil, Indonesia, China, and India use the BCRM. The few countries operating the CCCM, such as Guatemala, Nigeria and Haiti,

BCRM vs. CCCM

In the branded cylinder recirculation model (BCRM), government-licensed LPG marketers invest in and own the cylinders. They are responsible for cylinder safety—including inspection, maintenance, and replacement—and refilling throughout its lifetime. In the customer-controlled cylinder model (CCCM), end-users own the cylinders and bring them to filling stations to be refilled as needed. With CCCM, cylinders in circulation tend to become unsafe due to a lack of incentives for the re-filler to inspect and repair the cylinders, as well as a lack of clear rules and incentives for customers to have cylinders properly inspected and repaired [6].



Charcoal market in Dar es Salaam

have all demonstrated a lack of sustainable LPG sector growth. The government of Ghana is currently transitioning as rapidly as possible from CCCM to BCRM to reduce deaths caused by LPG accidents and to attract investment to scale up its LPG industry [7]. In Colombia, legitimate market participants lost control over cylinders and widespread illegal filling occurred under the historical CCCM regime. In response, Colombia has since become the model of successful and rapid BCRM adoption [8].

BCRM Implementation

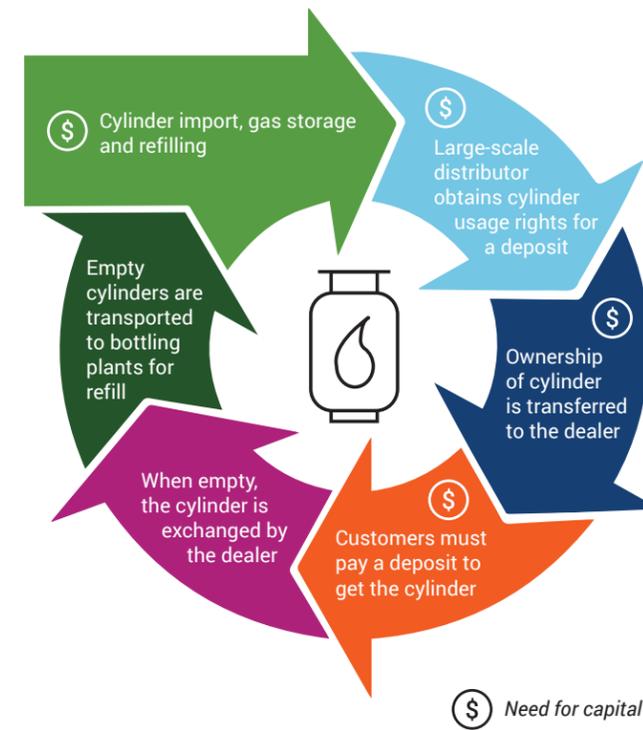
Significant investment capital is required at every stage of the LPG cylinder distribution cycle, as highlighted in Figure 2. The cycle of an LPG cylinder can be sustainably repeated only if adequate working capital is available to all of the supply chain nodes along the cylinder's journey. Indeed, in addition to final consumers, at least three supply chain players—LPG marketers, super-dealers,² and dealers—require sufficient capital to finance their inventory of LPG cylinders.

The BCRM is implementable in a strong or weak form; its strong form delivers the best environment for cylinder and supply chain investment and safety. Several best practices regarding the design of a BCRM contribute to its successful implementation:

- » In nascent markets, governments should set relatively high thresholds for licensing marketers, including requirements for adequate financial capitalization. A smaller group of larger market players helps the market to develop in a more predictable and stable manner and reduces refilling irregularities [6].
- » Governments should favor centralized filling plants, as decentralized filling infrastructure increases safety risks and makes regulatory enforcement more difficult and expensive [9].
- » Marketers should have strong property rights associated with their cylinders, including how they contract with their distribution networks.
- » Where LPG prices are regulated, margins must be adequate for supply chain actors to perform their essential functions, including safety checks, while also delivering risk-adjusted financial returns required by their investors and lenders.
- » National quality standards should be well developed and enforced. LPG marketers who violate such standards should face financial penalties and ultimately the loss of their licenses.

²A “super-dealer,” the term used in Tanzania, is typically an LPG marketer’s exclusive distributor. Super-dealers do not usually have bulk storage but rather acquire several hundred to several thousand LPG cylinders at a time by paying a deposit, with a fleet of trucks to transport them and a warehouse to store them. However, super-dealers rarely sell directly to the end-users. “Dealers” or “retailers/distributors” carry out these last-mile sales to households and commercial entities (e.g., restaurants). These market players are illustrated in Figure 1 using Tanzania as an example.

Figure 2: Typical Cylinder Journey under the Branded Cylinder Recirculation Model



The Role of Policy and Regulations in Creating a Viable LPG Market

LPG requires clear regulations to ensure public safety and give the private sector sufficient confidence in its ability to generate its required returns on investment. Given that LPG cylinders can be dangerous if not well maintained or managed, government must enforce LPG ownership and distribution regulations that enable and encourage the private sector to make ongoing investments throughout the supply chain, including cylinders, cylinder safety, and the retail network. The distribution model should also give LPG marketers responsibility for their own distribution network and their cylinders to discourage unsafe practices.

Effective LPG policies should be designed through a multi-stakeholder approach, allowing governments

to effectively define and communicate policies to consumers and a range of other stakeholders. At the national level, it is critical that planning is comprehensive, addresses all relevant issues, and gains political support. Both national LPG industry associations and/or cross-ministerial government bodies may help to facilitate efficient and effective advocacy and oversight

Governments should establish quantitative and qualitative key performance indicators to monitor, evaluate, and communicate progress in LPG market development. The Global LPG Partnership has designed and compiled a full set of indicators — the *Indicators of Sustainable LPG Expansion (ISLE)* — for a number of countries in Sub-Saharan Africa (e.g., Ghana, [10]). The ISLE indicators define data that should be routinely and consistently collected at the national level to track progress toward scaling the adoption and sustained use of LPG as a safe and clean household cooking fuel, and the resulting health, environmental, economic, and social impacts.

Country Snapshot: Cameroon

To develop its national LPG Master Plan announced in 2016, Cameroon conducted a government-led, inter-ministerial, multi-stakeholder process facilitated by experts from The Global LPG Partnership. This led to the definition of near-term and long-term objectives and the development of a robust plan to increase the share of households cooking with LPG from 12 percent in 2014 to 58 percent by 2030 [1] [11].

The LPG Market in Tanzania

The LPG supply chain in Tanzania begins with importation and ends with last-mile distribution to households and businesses as described in Figure 1. The major components and associated challenges with various segments of the LPG cycle in Tanzania include the following:

Midstream

Limited storage capacity must grow to meet expanding demand. As of 2016, the capacity of storage facilities in Tanzania was limited to 8,050 MT [12]. This poses a high risk of inadequate buffer supply if an event such as a storm at sea hampers LPG volumes from arriving at port. In Tanzania, two major LPG marketers are working to address this issue: Oryx commissioned and completed the construction of a 3,000 MT storage facility in 2016, and Miha Gas (now renamed to Taifa Gas) commissioned a 6,000 MT facility in early 2019 [13].

These storage facilities require substantial capital expenditures (“CapEx”), can take one to two years to construct, and require long-term, infrastructure-focused capital. Blended capital approaches which leverage public sector funding with private capital, concessional finance and grants, risk mitigation products, etc. can be advantageous given the current risk/return profile of such investments, but have not been readily accessible.

Downstream

LPG marketers must purchase imported or locally manufactured cylinders, which also requires substantial CapEx. There are currently between 1.5 million and 2.5 million cylinders in Tanzania [13], which have been imported and deployed into the market. Once a cylinder enters the market, it returns to the marketer’s refilling facility every two to three months, requiring each business to maintain high inventory levels to sustain revenues. Approximately twice as many cylinders as customers are required to account for typical refilling turnaround times.

The number of cylinders each super-dealer manages is limited by its access to working capital, which in turn impacts the number of customers it can serve. Super-dealers play an important role in the LPG distribution chain, acquiring cylinders from LPG marketers and transporting them to last-mile dealers. Super-dealers vary widely in size, with the largest managing tens of thousands of cylinders at one time, while others only own a few hundred. They all have significant working capital needs which, when unfulfilled, act as a bottleneck.

Last-mile

Last-mile dealers often have limited inventory due to limited working capital. The average dealer retains an inventory of between 5 and 35 cylinders. Inventory levels are rarely higher than the dealer’s existing customer base, as available working capital limits its acquisition of new cylinders, which in turn limits new customer acquisition. In effect, market growth is limited from the grassroots level all the way up the supply chain, including midstream infrastructure players.



A superdealer truck delivers LPG to dealers

COMMON MARKET BARRIERS TO SCALING UP LPG

To unlock consumer demand, cylinders must be available and deployed.

If cylinders are not deployed into markets, and imports and storage capacity for LPG remain limited, substantial consumer demand for LPG will outpace supply. Inadequate distribution of cylinders prevents many households that would otherwise invest in LPG equipment from doing so. Countries that have invested in cylinders and LPG infrastructure have managed to attain greater LPG adoption, higher LPG consumption per capita per year, and greater LPG access in a wider geographic area which includes rural communities [14].

Availability and deployment of consumer finance is an important prerequisite for increasing consumer demand.

The upfront cost of purchasing an LPG “starter pack” is one major barrier to adoption. In Tanzania, costs range from 50,000 TSH (USD 22) for a 6 kg cylinder and on-top burner to 200,000 TSH (USD 88) for a full kit, including 15 kg cylinder, double-burner stove, hose, regulator and valve [15], [16]. Households often do not have sufficient savings to purchase such a starter pack.

Because a full LPG cylinder may last for several weeks with regular household use, significant costs are incurred every time a consumer refills the cylinder, causing many BoP customers to default to fuels such as charcoal which can be purchased in daily increments. In Tanzania, each 15 kg cylinder refill typically costs TSH 50,000 (USD 23) and may last 30

to 40 days based on family size and average use. By contrast, customers typically buy TSH 1,500 (USD 0.75) 3 kg tins of charcoal that last one to two days [15] [25].³

It should be noted that cost is not the only determinant for consumers when purchasing LPG; other preferences are also at play. LPG allows for faster cooking than charcoal, particularly when accounting for set-up, fire-stoking, and clean-up times. It is significantly cleaner and healthier. And it takes less time to procure.

Lack of access to financing and concessional funding inhibits market expansion.

LPG price regulation in many countries can play a key role in constricting financial margins, leading to inadequate compensation for developers and discouraging investment. The price of LPG can be highly political as it constitutes a major expenditure for households, and where LPG subsidies exist, they can quickly become a significant fiscal burden as the market grows. In various countries, attempts to increase regulated prices have led to protests. The limitation of financial returns combined with country risks and operational challenges limit the ability of companies to raise capital on terms needed to maintain financial viability and allocate major capital investments.

Unfortunately, concessional financing⁴ for LPG is limited, in part due to multilateral and bilateral donors’, philanthropic foundations’, and others’ aversion to fossil fuels. This is despite LPG’s positive health and environmental impacts as a transition fuel.

³USD 0.75 per 1-2 days equals USD 15–30 over 40 days—potentially higher than the cost of LPG over the same period.

⁴Investment capital that accepts below-market returns (interest rates, IRRs) or terms (tenors, conditions).



KopaGas LPG smart meter in use urban Tanzanian household

Concessional funding is also likely limited due to the perception that LPG is the domain of large-scale, commercial infrastructure investment (in contrast to biomass cookstoves which are typically viewed as the domain of the development community). These perceptions are worth challenging. Donors looking to stimulate the development and scale-up of high-impact solutions and sustainable models should realize that nascent LPG markets offer a viable energy transition solution.

One of the few examples of a development sector support program is GuarantCo, an initiative within the Private Infrastructure Development Group (PIDG), which provides credit guarantees for infrastructure projects. The governments of Australia, UK, Sweden, Switzerland, and Netherlands support the program. GuarantCo recently provided a USD 7.5 million guarantee to enable Quantum Terminals to access commercial bank debt to develop a USD 20 million LPG storage facility in Ghana. This bulk storage facility allocates 3.6 percent of its storage capacity to the household LPG market. The remainder goes to a large power station, so even this LPG storage facility has a limited impact on LPG for cooking [17].

The limited support for LPG stands in sharp contrast with other distributed infrastructure solutions for the base-of-the-pyramid such as solar home systems which have benefited from various financial innovations and a plethora of financing alternatives, including Sunfunder, which has lent more than USD 50 million and OPIC's USD 253 million loan portfolio of overseas solar projects in 2017 [18].

In addition, specific PAYG solar companies have been highly successful at raising debt, including M-Kopa which raised USD 80 million from CDC Group, FMO Investment Management, Norfund, ResponsAbility, and others in 2017 [19]. In total, PAYG solar home system companies have raised almost USD 1 billion of debt and equity in the last six years [20].

OVERCOMING MARKET BARRIERS

A variety of solutions are needed to promote uptake of LPG among the base-of-the-pyramid.

To overcome initial cost barriers, countries have adopted various strategies over the years, with varying degrees and combinations of fiscal incentives, subsidies, and market adjustments. In more recent years, innovative consumer financing solutions such as microfinance, and mobile money PAYG have emerged to help overcome high upfront costs.

Emergent Pay-as-you-go LPG models benefit both consumers and businesses

Pay-as-you-go LPG offers several business and consumer advantages including:

- » **Reduced refilling costs for consumers.** By reducing the size of a refill transaction, the PAYG model eliminates the need for the consumer to invest USD 8–20 in a single transaction for a full refill, and instead spend a small amount, similar to a charcoal purchase. The refill relationship generates a continuous revenue stream for the LPG supplier, even longer than the repayment period of a PAYG solar system, in which products are typically sold on a lease-to-own basis.
- » **More frequent customer engagement.** With the model designed to deliver LPG when the PAYG meter indicates the need for a refill, a recurring opportunity is created for PAYG LPG companies to check in with customers, provide customer support, and create strong brand loyalty. The meters generate granular consumption data, providing businesses with useful information that may improve operational efficiency.

» **Improved data on cylinder fleet.** Installation of a trackable PAYG smart meter allows marketers and super-dealers/distributors to generate better data on their cylinder assets and to understand where cylinders are located and when they will likely be refilled. This data enables companies to reduce the number of cylinders needed to serve a given number of customers, reducing cylinder CapEx and enabling them to serve a larger number of customers in high-density populated areas over time, a consideration not as relevant to PAYG solar.

» **Increased brand loyalty.** In the LPG market, companies will make storage, filling, cylinder, and safety investments only when there is a level of certainty around customer retention over several years and companies can be confident they will generate adequate cashflows and returns on investment. Because the PAYG “smart valve” locks the customer in to a particular brand, it can mitigate the risk of customers’ defecting to illegal refilling options.

Compared to off-grid solar and traditional LPG modalities, PAYG LPG faces unique challenges.

PAYG solutions for LPG are more challenging than those for solar systems. And they also present additional challenges compared to traditional LPG distribution:

» **Meters for LPG PAYG cost more than for solar PAYG.** LPG PAYG requires the addition of a new smart valve (the combination of a gas meter and valve) to a cylinder to measure pressure/the amount of LPG in the cylinder, and to activate or deactivate it. The smart valve may cost more than the cylinder itself. By contrast, a solar home system needs a relatively basic alteration to the circuit board inside the control system. KopaGas and similar LPG PAYG companies in other countries are working to develop the smart valve technology and reduce its price.

» **Upfront costs for LPG starter packs are lower than for solar.** In off-grid solar, the initial cost of the solar system is far higher as a percentage of the lifetime cost as compared to LPG. A customer can purchase a 6 kg LPG cylinder and burner for USD 22 in Tanzania, whereas a basic multi-light solar home system typically costs over USD 80. The customer will, therefore, be more likely to finance a solar system, and a provider is more likely to be able to profitably finance the higher cost asset— making that aspect of the PAYG value proposition relatively higher for solar.

» **LPG PAYG models present greater risks in generating sufficient financial returns compared to traditional LPG marketing and distribution companies.** LPG prices are regulated in many countries, which means that PAYG LPG companies may not be able to sell at a high enough price to cover increased upfront costs and generate adequate profit margins even if they offer consumer finance. By contrast, in many cases, prices offered by off-grid solar companies are not regulated, leaving the industry to generate sometimes significant profit margins to compensate for high distribution and financing costs. In countries where LPG prices are unregulated, the industry may be able to charge the end-user more to ensure adequate financial returns given the current high CapEx of smart valves. But as a result, lower-priced, traditional

LPG offerings may undercut the unregulated PAYG price. Traditional LPG marketing companies are also experimenting with smaller cylinder sizes (e.g. 6 kg to 3 kg) to address the target market for PAYG solutions.

» **With PAYG, customer retention over time is more challenging compared to traditional LPG.** LPG PAYG customers may decide to transition to the traditional way of purchasing LPG cylinder refills as the aggregate payments to PAYG over a year may be more than the aggregate costs over a year of buying standard LPG refills in the market, for the same amount of cooking. PAYG solar players may face similar challenges to the extent lower-cost grid electricity becomes available; however smart targeting of consumers for whom reliable lower cost grid electricity is unlikely to be available anytime soon can mitigate such risks. LPG PAYG companies that operate a parallel traditional LPG business are best placed to accommodate customer transitions to traditional LPG purchases while retaining customer loyalty.

» **Distribution and customer services are more complex and costly in LPG PAYG than in PAYG solar.** With any LPG model, PAYG or otherwise, customers require regular gas cylinders refills typically on a fortnightly or monthly basis. In contrast, solar products “refill” from the sun, and if maintained correctly can last several years with minimal after-sales service. LPG has additional quality control requirements around safety, handling, distribution, refilling, storage, and maintenance, as it is a combustible fuel.



Mobile money being used to purchase specific quantity of LPG

How Pay-as-you-go LPG Works

In a pay-as-you-go (PAYG) business model for LPG, consumers generally pay a deposit of USD 30 to 60 and are provided a cylinder with a “smart meter” together with a stove, hose, and regulator. Customers then pay for the LPG they consume in small amounts rather than the full price of a refill upfront. The business receives a margin on the fuel consumed, enabling it to depreciate the upfront cost of the starter pack and meter and allowing it to operate more like a utility than a business-to-consumer retailer focused on cash sales.

PAYG models typically rely on mobile money to reduce transaction costs and automate payment collection. In Tanzania, there were 21 million registered accounts in 2017, representing 50 percent of the population, and many markets across the continent and beyond continue to experience robust growth in mobile money penetration [22].

Similar financing models have proven to greatly increase the uptake of off-grid, distributed infra-

structure solutions such as household solar systems, and investment in these businesses continues to grow. More than 2 million PAYG solar systems have been sold in Sub-Saharan Africa [20]. This has reduced barriers to entry for households previously unable to afford a standalone system. It has also generated a scalable business model that is now maturing from innovative, impact investment-backed start-ups to commercial, utility-scale commercial activity, with ENGIE and Électricité de France (based in France), Energias de Portugal (Portugal), General Electric (USA), and other global energy companies investing in PAYG solar across the continent.

Companies such as KopaGas, Envirofit, BBOX, PayGo Energy, and Proxigaz are currently developing PAYG LPG models. While each model is at a different stage of development, each business is making rapid strides in developing products and refining their business models, testing the value proposition with their customers, demonstrating viable unit economics, and proving feasibility at scale.



KopaGas sales and customer service agent engaging LPG customer

Beyond Pay-as-you-go: LPG Microfinance

While PAYG LPG is an emerging trend to address consumer affordability, well-designed and implemented LPG microfinance programs can also increase access and affordability.

The Low Smoke Stoves Project by Practical Action, Carbon Clear, and a local women's association was launched in North Darfur, Sudan, in 2008. Poor households gained access to LPG through a microfinance credit revolving fund, with repayments over 8 to 12 months. As of December 2017, 11,528 households had purchased LPG stoves and equipment on credit and continued to use the fuel for cooking [21]. This is the first Gold Standard certified project to use LPG as a cooking fuel due to its positive benefits to the environment, as well as Sudan's first carbon credit project.

Through Bottled Gas For Better Life, a microfinance pilot developed by The Global LPG Partnership

(GLPGP), more than 700 low-income families in Cameroon and Kenya have switched to LPG since 2017 [22]. Loans cover the cost of a 13 kg gas cylinder and a double-burner stove and accessories, with a total cost of USD 80–100. Loans are re-paid in six monthly payments and include a refundable security deposit. The fixed loan repayment schedules allow low-income customers to plan their household budget. GLPGP partnered with Cameroonian and Kenyan microfinance institutions, which conduct credit screening and originate and service the loans. Results have been encouraging, with repayment rates around 95 percent and LPG usage by the new LPG users higher than the national average. Health benefits have also been recorded, both through participant self-reporting and through household air pollution measurements by independent evaluators [23].

RECOMMENDATIONS FOR SCALING LPG MARKETS

Effectively managed and targeted subsidies can ease financial burdens on customers.

Much debate surrounds the role of LPG subsidies and if, and how, they should be adopted and implemented to benefit families in need without becoming a financial burden on government or/by creating excessive market distortion. Especially in low-income countries, subsidies may be necessary for LPG to be affordable for lower-income and rural households. The use of LPG for cooking involves costs that are out of reach for many people, both in terms of upfront costs for the start-up equipment, as well as on an ongoing basis for regular refills [24].

The high cost of rural distribution may imply higher prices for rural users, yet such consumers may also have the lowest capacity to pay and can often access free biomass fuel. Targeted subsidies are a means to close the gap, much in the same way that utilities cross-subsidize household and industrial consumers to make power generation and transmission investments profitable.

Many countries that have achieved high LPG penetration have done so initially through a regulated price. Some of the largest lower-income countries where LPG is a dominant cooking fuel have also subsidized the price of LPG. Subsidies can rapidly burden governments in LPG-importing countries if global LPG prices spike (which happened between 2011 and 2014) or if the LPG market grows very rapidly. Subsidies that inadvertently benefit wealthier households are also inherently inefficient. As the LPG market grows, government LPG subsidies should target the poorest households. International

experience shows that energy subsidies often do not reach the poorest, with as little as 4 percent of LPG subsidies reaching the lowest income quintile [25], [26]. This can happen because LPG penetration is lower among poorer households, and because wealthier households consume more energy. In India, for instance, LPG subsidies represented a financial burden to the government of about USD 8 billion in 2013, approximately 0.4 percent of GDP [26], and the system was criticized for providing benefits to wealthier households.

In order to prevent subsidies from becoming a long-term, unmanageable financial burden, governments should gradually transition toward market pricing while establishing targeted subsidies for low-income households. India launched an ambitious program of Direct Subsidy Transfer in 2014 to more efficiently target poorer households, with the government paying subsidies directly into targeted recipients' bank accounts [15]. In 2011, El Salvador removed a price ceiling on LPG for all consumers before introducing an income transfer scheme for households that consume less than 200 kWh of electricity per month [26]. In Thailand, the government also reformed its subsidy regime due to inadequate initial targeting of the poorest households [26].

Targeted subsidies require adequate means to identify beneficiaries. Records related to income and other socioeconomic indicators must be available, in addition to personal identity documentation. For its direct subsidy transfer program, India has been

Country Snapshot: Indonesia

In 2007, Indonesia launched the “Conversion Program from Kerosene to LPG,” also known as the Zero Kero Program [26]. The government provided all households with a 3 kg cylinder, valve, hose, and stove “starter pack” free of charge, followed by subsidized 3 kg cylinders. The Zero Kero Program has had a significant impact on household energy use in Indonesia, resulting in a 5x increase in LPG consumption—from 4.7 kg per capita in 2007 to 24.4 kg per capita in 2015—and a 92% decrease in kerosene use [25]. In India, the government has provided universal subsidies for several years on cylinder refills for household use [26]. India now has one of the largest LPG markets in the world and has phased out subsidies for higher income groups through the “Give it Up!” campaign, which promoted the ethical principle that better-off families who use LPG should transfer their LPG subsidy benefits to less-well-off families [16].

Communication should also be clear and consistent with the various LPG players working across the supply chain, and should allow for a fluid, facilitated feedback loop. Governments should prioritize communicating any changes to existing policies and regulations and how they will affect market participants, including timelines and risks, and solicit feedback from the private sector.

Tax advantages and reforms can increase affordability

Reducing import duties and VAT for LPG and related appliances can reduce prices relative to competing fuels. Similarly, anti-kerosene or anti-charcoal tax policies can encourage transitions to cleaner fuels.

Senegal, for example, launched an LPG program in 1974 that initially focused on import duty exemptions on LPG equipment and later introduced fuel subsidies. The program was very successful, with high adoption rates documented in Dakar and other urban areas across all income quintiles [28]. Subsidies have since been phased out, though LPG is still exempt from VAT/import duties.

Other African countries have implemented, or are evaluating, LPG tax policy reforms. In Kenya, LPG was exempted from VAT in mid-2016 and high-efficiency stoves, including those that utilize LPG, are subject to a lower VAT than less efficient models [29]. In Cameroon, the LPG Master Plan approved by the government in 2016 recommends a tax reduction on cylinder importation, accessories, and gas burners [11].

Committed and sustained government engagement is critical to market expansion and investment

A number of key market characteristics are needed for a commercially sustainable and safe LPG market to flourish, but only the government has the authority and capability to enact and enforce them.

aggressively pursuing a national universal ID system based on biometrics [14].

A proper communication strategy is also necessary to ensure consumers fully understand policies. This is especially true for subsidies that target low-income households and require customer identification. If subsidies are properly explained, customers will know if they are eligible and will not feel the process is overly complicated.



LPG cylinder store in Tanzania

Putting these necessary elements in place requires multi-stakeholder and multisectoral engagement to design an effective plan that addresses the entire LPG industry.

Governments should support effective public awareness campaigns on LPG benefits and safety

The messaging of such campaigns should be tailored to the local context. Household cooking behavior is often influenced by aspirations for modernity, affordability, accessibility, and, to a lesser extent, health benefits [26]. Government-supported campaigns to

generate awareness of the benefits of LPG and to enhance long-term adoption must carefully analyze the market to develop messages that will resonate.

Government campaigns should also describe the safety of LPG, which remains a major fear among many consumer segments, and promote convenient and safe practices. Misunderstandings and misconceptions about safety continue to discourage households in many markets from switching to LPG [26][27]. Governments can play a role in educating people on how to use LPG and reassuring them of its safety, while enacting and enforcing regulations that enhance and ensure such safety.



KopaGas LPG smart meter demonstration

CONCLUSION

No one solution alone meets Sustainable Development Goal (SDG) 7 and ensures universal access to affordable, reliable, and modern energy services, including for cooking, by 2030. However, enabling access to LPG can significantly contribute to reaching SDG 7.

Scaling the use of LPG for cooking will require complementary measures from multiple actors:

- » Governments need to enact regulations and enforcement mechanisms that support a healthy, well-managed, bankable LPG sector and incentivize LPG distribution in lesser-served areas.
- » Actors along the supply chain need to prove and scale their business models and introduce financing and technological innovations that can enable more people to access and use LPG.
- » Investors and lenders need to provide finance on reasonable terms across the LPG supply chain, from infrastructure development and cylinder purchasing to consumer finance.
- » The public sector, including national governments and development partners, needs to consider financial support, when and where appropriate, through concessional finance and/or well-targeted subsidies that enable lower-income households' access where a market-based approach is not viable.

The PAYG LPG business model is one example of a technology being adapted from a related sector that could help millions of consumers overcome a lack of upfront purchasing power. The solution also may enable marketers and distributors to provide an additional level of customer service which increases brand loyalty, improves the customer experience, and encourages customer retention. All of these elements could combine to dramatically increase capital investment throughout the LPG supply chain. PAYG has been a major driver in scaling the solar home sector, and this success may be similarly possible with LPG. Governments, development partners, and investors should seek to understand how the PAYG LPG market is evolving and determine how they can support the effective development and refinement of such innovative technologies and business models.

However, PAYG solutions alone will not be sufficient to scale up the sector. A wide range of interventions will be required, from improved regulatory support, to expanded access to infrastructure, cylinder and working capital finance, to consumer finance and to technology innovation. This report has highlighted the need for financing across the LPG supply chain, especially to increase the availability of cylinders.

An investment fund which invests debt (and to a lesser degree equity) at all levels of the supply chain may be one avenue to accelerate the scale-up of LPG as a viable cooking fuel. No major funds have been established to specifically support the LPG sector, nor are there sufficient funds for clean cooking solutions that have LPG within their mandate. This is despite a strong base of evidence regarding the significant health and environmental benefits associated with a near-term transition to LPG for cooking. To accelerate growth, development partners should consider establishing investment facilities that focus on, or include in their mandate, the LPG supply chain. This is one area that the Clean Cooking Alliance continues to actively develop with its partners in markets around the world.



KopaGas sales and customer service agent with Oryx LPG cylinders

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The Clean Cooking Alliance works with a global network of partners to build an inclusive industry that makes clean cooking accessible to the three billion people who live each day without it. Established in 2010, the Alliance is driving consumer demand, mobilizing investment to build a pipeline of scalable businesses, and fostering an enabling environment that allows the sector to thrive. Clean cooking transforms lives by improving health, protecting the climate and the environment, empowering women, and helping families save time and money.

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