



**MECS**  
Modern Energy  
Cooking Services

**MECS-TRIID Project Report (public version)**

**IoT LPG Cylinder Tag & Trace**



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## **Document Control Sheet**

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## Executive Summary

Liquefied Petroleum Gas (LPG) is the only readily available cooking fuel that can enable the transition to clean cooking today. Unfortunately, LPG is distributed in cylinders that effectively price the fuel out of reach for the billions of consumers that live in the “Sachet Economy”. The big takeaway from technology diffusion success stories in emerging markets is that in order to be successful, you need to match, not change, consumer spending habits.

The supply chain for LPG in emerging economies is fragmented and broken. The fragmentation leads to an inefficient distribution model that ultimately increases the price for the end consumer. Solving the global clean cooking problem requires a concerted effort to solve both the demand and supply side of the equation.

Currently, LPG suppliers manage distribution through predominantly analogue processes. Cylinders are tagged and inspected prior to being sold in the market, but data collection ends there. The entire supply chain, after the refilling operation, is essentially invisible. This is a missed opportunity for both suppliers and consumers. For suppliers, the data is not captured and therefore is not used to make decisions. For consumers, there is no means of validating their purchase - the cylinder may have been refilled illegally; it may be underfilled, or it may not be in a safe condition. Ultimately, these inefficiencies lead to higher prices for end consumers, keeping them priced out.

PayGo Energy has created a platform to connect consumers, businesses and cylinders in the LPG supply chain. The IoT LPG Cylinder Tag & Trace technology PayGo built for this project ensures each brand owner registers every cylinder. Every time a cylinder is moved through the supply chain, the date, time and location of the movement is recorded. This provides end to end visibility from the wholesaler of LPG to the retailer and home delivery to the consumer. This platform also connects to PayGo’s cylinder smart meter, which enables end-users purchase gas in small quantities matching existing spending habits on other fuels. Through the deployment of its end to end platform, PayGo Energy has demonstrated that digitizing the LPG supply chain brings about significant improvements in distribution efficiency, cylinder retention and customer retention.

Digitisation has the potential to transform LPG distribution in Kenya and beyond. This digital transformation will occur in three steps. First is utilising data generated by customers, retailers and wholesalers to make better operational decisions. This might include decisions on how many staff are needed or when to restock inventory. Second, predictive analytics will be created based on consumption and distribution data to predict when customers will run out of gas, and when retail locations require inventory. Lastly, prescriptive algorithms can be created to optimise LPG distribution, for example, the best delivery routes to be used and automatic creation of stock replenishment orders.

IoT LPG Cylinder Tag & Trace technology provides a great opportunity for the industry to become more efficient through digitisation. Improved efficiency will lead to lower distribution costs, which should ultimately lower the price for consumers, resulting in more people accessing safe, affordable gas.

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## Section 1: Introduction

The past 30 years of interventions in the clean cooking sector have failed to have any tangible impacts that solve the global clean cooking problem. The interventions in the clean cooking sector have failed to have an impact for two reasons. A failure to understand consumer demand and a failure to develop a sustainable supply chain. Both of these failures have occurred in the context of an emerging economy.

Consumers in emerging markets want to cook with clean energy but they are priced out of the market. LPG, the only readily available cooking fuel that can enable the transition to clean cooking, is distributed in cylinders that effectively price the fuel out of reach for the billions of consumers that live in the “Sachet Economy”. For consumers living and working in the sachet economy, it is the access to goods and services in small amounts that enables them to access modern conveniences. The big takeaway from technology diffusion success stories in emerging markets is that in order to be successful, you need to match, not change, consumer spending habits.

But having a new consumer technology that matches consumer spending habits does not inevitably lead to adoption. For products that exist in the physical world (as opposed to financial technologies that exist primarily in the digital realm), the supply chain associated with the production and distribution of the goods is as important as the technology itself.

The retail of most goods and services in emerging markets (40%) is within the informal sector. Supply chains do exist but they are often fragmented and essentially unregulated due to lack of enforcement of regulatory standards. The supply chain for LPG in emerging economies is fragmented and broken. The fragmentation leads to inefficiency, unscrupulous and unsafe refilling and distribution practices. The fragmentation leads to an inefficient distribution model that ultimately increases the price for the end consumer.

Solving the global clean cooking problem requires a concerted effort to solve both the demand and supply side of the equation. One company alone will not be able to solve both the demand and supply side of the equation. The sheer scale of the problem and associated financing costs are too much for one company to handle. The recent digitisation of the UK gas and electricity infrastructure has cost nearly \$11bn (BBC, 2019). PayGo Energy is building a collaborative ecosystem of partners that specialise in specific areas of the LPG supply chain to unlock new markets and solve the global clean cooking crisis.

LPG is a by-product of oil extraction. It is a mixture of propane and butane. After the gases have been captured, they are stored in large storage tanks. Shipping vessels transport the gas to strategic ports. At the port, a berthing station is required to transfer the gas to a large storage tank. The gas is then transferred from the tank to a truck and transported to a refilling station. At the refilling station, the gas is filled into a gas cylinder. The gas cylinder is then loaded onto a truck and delivered to a retail location. At the retail location, a customer either collects a cylinder or pays a premium to have the cylinder delivered to their home. The LPG is usually presented in this linear description. But far from being straightforward and linear, the LPG supply chain involves a number of different companies, people and technologies in order to safely deliver and use the gas.

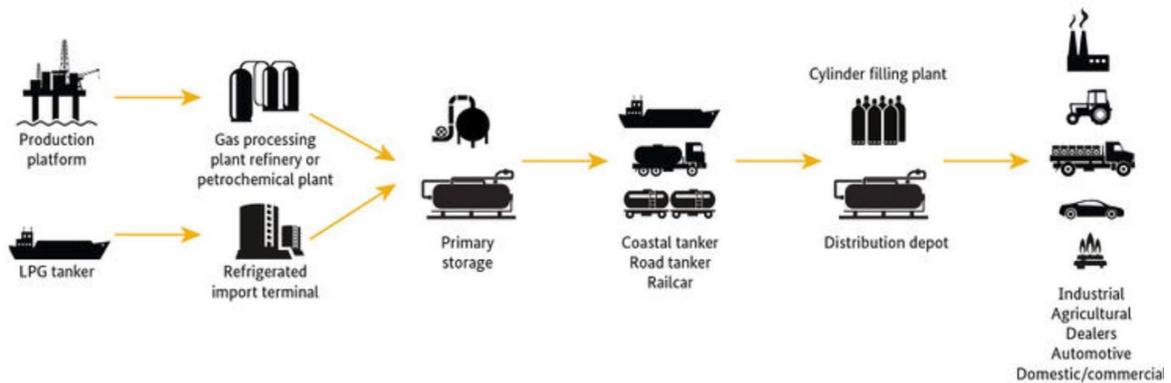


Figure 1 - LPG Supply Chain

In Kenya there are currently 1.6 million households that use LPG and 10 million households that cook with other fuels (Dalberg, 2018). The industry standard rule of thumb is to have 2.5 cylinders for each household (PIEA, 2018), which means an estimated 4 million LPG cylinders are in circulation in Kenya. If we take the number of households (1.6) multiplied by the number of exchanges per year (9 based on our experience), approximately 14.4 million cylinder exchanges occur per year in Kenya. This downstream LPG activity is largely invisible to companies, investors and regulators because it is mostly done by informal service providers. The lack of transparency results in companies not knowing where to disburse their marketing budgets because no real-time market data exists. Investment funds do not want to invest in the space because the return on investment is not secured and regulators have struggled to enforce regulations as there is no visibility into the cash-based, informal retail supply chain.

## Aims of the project

The aim of this project is to improve the efficiency of the LPG supply chain through the development and implementation of cutting edge IoT technologies to create visibility into the LPG supply chain. PayGo Energy has developed a complementary suite of products to expand access to LPG and make the supply chain more predictable, trusted and efficient. Our all-in-one cooking setup and customer service brings LPG cooking gas to your home. Our digital delivery infrastructure enables LPG suppliers to deliver to every home. To further enhance this LPG management platform, PayGo Energy will tag and trace LPG cylinders as they move along the LPG supply chain. The process of cylinder refilling will also be digitized and integrated within the PayGo Energy platform.

## Objectives

The project has 3 objectives;

- 1) Identify a cost-effective tagging option for LPG cylinders in emerging markets.
- 2) Identify a cost-effective smart weighing scales for LPG cylinders in emerging markets
- 3) Create MVP transport and demand forecasting applications for LPG cylinder management

## Section 2: Methodology

### Outline of the concept

A fragmented downstream LPG environment leads to few investments in the supply chain which ultimately leads to higher prices for the end consumer. PayGo Energy is trying to create a virtuous cycle of growth where a better customer experience attracts more customers to switch to using LPG, the customers, in turn, attract more sellers of LPG, this leads to more choice for the consumer and ultimate stronger competition in the market, the companies that will come to dominate the market are ones that have a lower cost structure to be able to provide a great customer experience at a lower price. This theory of change is based on Amazon's virtuous growth cycle. The companies that have lower cost structures and better customer experiences will win in the long term during the process of market consolidation.

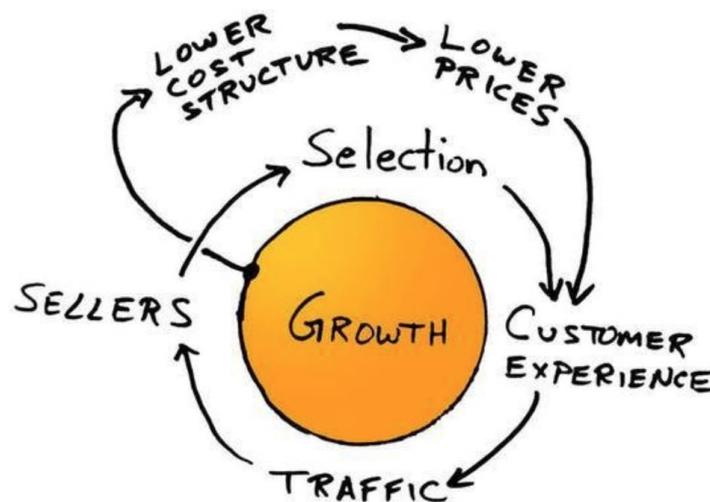


Figure 2 - Amazon's virtuous growth cycle

PayGo Energy has designed and developed consumer technologies that match existing consumer spending habits. PayGo has created the cylinder smart meter (CSM), which attaches to any commercially available LPG cylinder. PayGo Energy provides an all-in-one cooking setup (inclusive of a new stove, a gas cylinder, the CSM and fire safety equipment) and customer service to bring LPG cooking gas to customer homes. The service includes home installation. This customer experience is considerably better than available options on the market. The Kenya Bureau of Standards has developed the world's first standard for this technology and mandated that every cylinder smart meter have a third party ATEX certification (EU directive for electronics operating in explosive atmospheres). PayGo's technology is the only one in the market today which is compliant with these regulations.



*Figure 3 - PayGo Energy cooking system*

PayGo Energy is modernizing retail gas delivery in markets without grid infrastructure, making it possible to tap into the largest growing demographics and provide a quality of service not available to even existing LPG customers. In order to harness the potential LPG market, PayGo Energy has developed a digital delivery platform for LPG companies. This enables companies to expand access to LPG for customers while making distribution efficient and secure.

PayGo Energy's digital delivery platform removes the barriers for industry and retail customers alike. Our networked system brings visibility to what until now has been unknown, by tracking assets and gathering information throughout the entire retail supply chain.

What happens when you can suddenly see into every point in the delivery system and how customers use gas? PayGo Energy's system creates predictability, experiencing a 99% cylinder return rate while increasing customer retention and overall gas use, and allows for tailoring solutions based on unique demographic needs.

The solution is based on creating digital delivery platforms for LPG suppliers, retailers and customers. Figure 4 displays the physical movement of LPG cylinders from refilling station, transport to the retail location and delivery to the customer home. After the gas in the cylinder has been used, the empty cylinder is collected and delivered back to the retail hub. A batch of empty cylinders is then collected and delivered to the refilling station where they will be filled with LPG and be ready again for circulation.

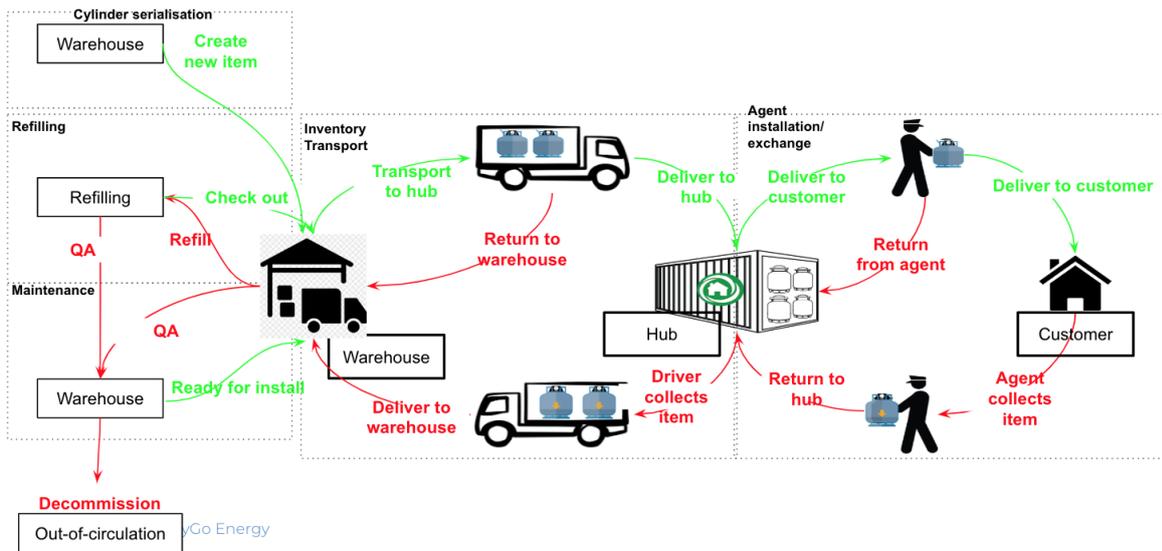


Figure 4 - PayGo Energy LPG cylinder ecosystem

## Deliverables

The deliverable for this project will be a proof of concept pilot to demonstrate the impact of tag and trace technology in the LPG supply chain. The project will be delivered over 6 months. The first month will be a review of best practices for the use of IoT in tagging and weight measurement of cylinders. Month 2 will be focussed on prototyping the most appropriate tagging technology for LPG cylinders and either sourcing or creating a smart scale that can scan a cylinder and measure its weight. Months 3-5 will involve a pilot of the chosen technologies in the field. Month 6 will be a review of the project, creation of a whitepaper that details the technology and potential ROI for partners.

## Intellectual Property Rights

PayGo Energy has patents granted and/or pending in 71 countries. PayGo's mission is to unlock clean energy for the next billion, we know this cannot be done by one company alone. PayGo leverages its intellectual property rights, to ensure consumer safety and international standards compliance. PayGo's Intellectual property rights can be licenced under fair, reasonable and non-discriminatory (FRAND) terms by any company or individual wishing to utilize the PayGo platform.

## Assumptions

PayGo has been in operation since 2016. During this period the company has developed an in-depth knowledge of the LPG industry and key problems in the Kenyan supply chain. The team understands industry pain points and the potential for technology to improve the supply chain. A recent [report](#) by ENEA showcases the problems of the LPG supply chain in Tanzania. Through experiencing the challenges related to the management of downstream LPG operations, PayGo identified that the wider industry struggles with management of cylinders, customers and fleets. The inefficiency of the supply chain ultimately increases the distribution costs which are born by the customer

PayGo's view of market development, and therefore its business model is based on building an efficient supply chain through partnerships. Any product that PayGo develops is co-developed with potential partners. This ensures that the product is fit for purpose with the partner. PayGo develops products for wholesalers, retailers and customers along the LPG value chain. The products are a combination of software applications and connected devices, supported by PayGo's support team and cloud infrastructure. One of the key components of PayGo's connected device offer is Cylinder Tag and Trace.

## Section 3: Implementation

The first month of the project was focussed on the review of best practices of using IOT for scanning movable assets. Key stakeholder were interviews with potential partners and solution providers were had. In total 6 partners were interviewed. The interviews were problem-based to deeply understand partner requirements. The information gathered from the interviews enabled PayGo to develop a value proposition that meets partner requirements.

### List of Partners interviewed

- Commercial off-take partners for the PayGo CSM meters that also license PayGo products
  - One is a manufacturer of LPG cylinders that has purchased 5,000 meters from PayGo.
  - One is a Pay-as-you-go solar company that is aiming to expand its product portfolio to include PayGo LPG.
- Existing LPG wholesalers that are interested in licensing PayGo products
  - [Alfa Gas](#) is a regional LPG marketer that PayGo has partnered with to distribute LPG in Mukuru Kwa Reuben.
  - 4 other regional and international LPG marketers that have all expressed interest in the PayGo platform.
- Small scale LPG distributors and tech companies that are interested in licensing PayGo products.
  - A small distributor based in Nairobi
  - A small distributor based in Lagos

Through discussions with partners, a list of MVP requirements was created for the product. These were:

- A retailer can:
  - Create a cylinder refill order and that information is sent to the marketer
  - Complete a cylinder refill order and the sales information is logged on the system
  - View the location of each of their customers and the fill level of each cylinder
  - View cylinder inventory levels at the hub
  - Estimate days until stock runs out at the hub
  - Create a cylinder transport order visibility into the location of their custom
  - Complete a cylinder transport order to move cylinders between different location
- A wholesaler can:
  - View an open cylinder refill order
  - Complete a cylinder refill sale and the sales information is logged on to the system
  - View the cylinder inventory levels at each retail location
  - View an open cylinder transport order

- Tag and Trace can:
  - Uniquely identify each cylinder
  - Be durable for the movement of cylinders throughout the supply chain
  - Be cost-effective for large scale implementation with cylinder fleets of over 500,00 cylinders
  - Produce a tag to a predefined quality specification
  - Produce a tag to a predefined timeline
  - Record each cylinder event at:
    - Refill
    - Transport
    - Home delivery
    - Customer usage
  - Identify days since the last scan
  - Calculate cylinder retention
  - Calculate throughput per cylinder

From these partner requirements PayGo built out a platform offering for LPG wholesalers and retailers.



Figure 5 - Overview of PayGo Energy LPG Management Platform

A summary of the PayGo for wholesalers, PayGo for Retailers and Cylinder Tag & Trace products are in figures 6,7,8 in the following pages.

## PayGo for Wholesalers

Grow your market



*"For us, downstream distribution was a black hole. We delivered cylinders to our retailers, and most of them we'd never see again. The PayGo for Wholesalers platform is a game changer."*

*Sylvester Oloo, Operations Lead*

**PayGo for Wholesalers** is an end-to-end platform that supports gas wholesalers to expand into new markets through smart metering technology, managing their retail network and controlling their cylinder fleets. The platform provides end-to-end visibility for wholesalers to make smart investments and secure a return.

### Features

- ✓ Grow your market share by accessing new markets with connected devices.
- ✓ Tag every cylinder with a unique ID, and track your fleet by scanning each cylinder at each touchpoint.
- ✓ Use data insights to match supply and demand, reducing waste in operations and enabling value-adding supply chain investment.
- ✓ Integrate with retailer and customer applications to create a fully digital supply chain.



Figure 6: PayGo for wholesalers

## PayGo for Retailers

Connect with more customers



*"PayGo has helped us to provide a better service. We track our customers, cylinders and revenue – all through one application. It makes my job so much easier."*

*Newton Inganji, Retail Manager*

**PayGo for retailers** is an end-to-end platform that supports gas retailers to provide a better customer experience, expand their customer base, and operate more efficiently. The platform supports the critical components of a gas retail business including the management of customers, cashflow, deliveries and inventory.

### Features

- ✓ Build and manage your customer base
- ✓ Manage customer service - including cylinder installations and exchanges - through our Agent App
- ✓ Never run out of stock with real time inventory management
- ✓ Manage revenue in a secure digital vault



Figure 7: PayGo for retailers

## Cylinder Tag & Trace

Control every cylinder

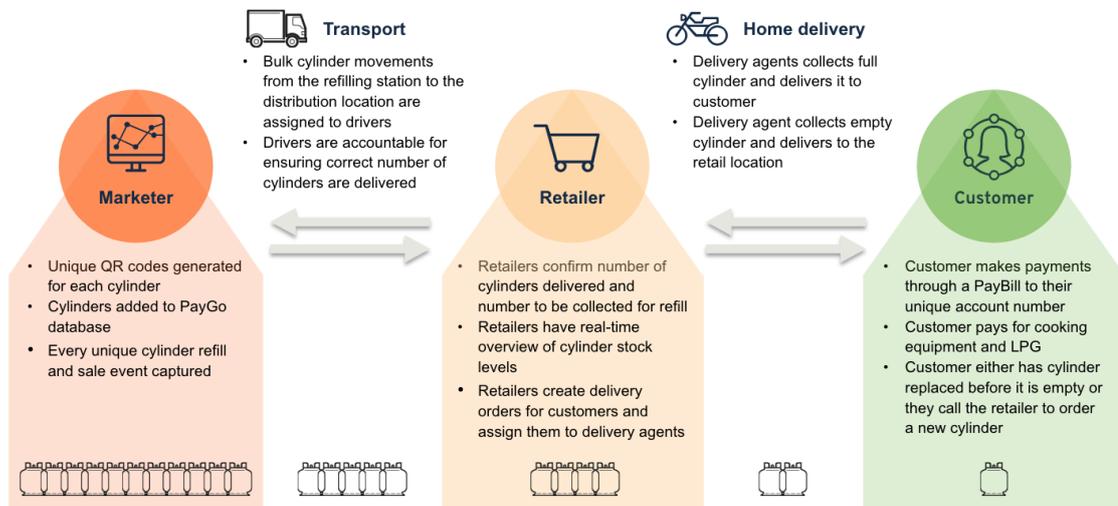


Figure 8: Cylinder Tag & Trace

### Selection of Tags

After the requirements were defined, PayGo reached out to existing tag providers and reviewed case studies of existing implementations. The next sections discuss the two different tagging options, RFID or QR, and the different options available for industrial scanning functions.

RFID - Radio Frequency Identification is a new technology within the LPG industry. It is however a known and widely used tagging technology in other industries. The benefits of RFID are that it can be read from a distance without line of sight to the tag, this makes it useful for applications where you might want to hide the tags or you are processing many assets concurrently. Scanning does require a specialist reader which is expensive.

Two RFID providers were interviewed during this discovery phase. One international provider specialises in RFID tagging for LPG cylinders and has implemented a solution in India. The company provides an end-to-end solution for cylinder tracking using RFID technologies. The solution works quite well in developed markets. In developing markets such as Kenya, the jury is still out. One of the reasons for low adoption of this technology in developing markets could be that the RFID scanners are quite expensive (\$150+). A second provider was also interviewed. Their quote for tags was too high to be considered (\$2.5 per tag).

QR Code - A quick response code is a variation on a barcode which is quick to read by scanners and can store much more information than 1D barcodes. The codes can be read by many devices including mobile phones with camera and can be produced on many different surfaces including wood, metal, plastics and paper. QR codes come in a variety of formats, the most commonly used ones for asset tagging are weatherproof labels and stainless steel tags. PayGo has been testing

weatherproof labels within its operations for the past 2 years. The labels last about 6 months before wearing out and needing to be replaced. The tags currently used in the market are durable and easy to retrofit on the handle of an existing gas cylinder.

After evaluating all options the decision was made to choose stainless steel QR tags. The option was chosen over RFID because the technology is already being used in Kenya and anyone with a smartphone can read a QR tag. Ultimately the cost of RFID readers makes it difficult to see how RFID will be widely adopted in downstream LPG distribution for emerging markets. RFID technology is great when processing large volumes of assets. But since the major problem in the LPG supply chain is related to the loss of cylinders outside the refilling station, the utility of RFID quickly diminishes the further a cylinder is from a refilling station. It is PayGo's opinion that RFID technology is not suitable for downstream LPG cylinder management.

After selecting stainless steel QR tags, PayGo contacted two local vendors that specialise in production of steel equipment. Requests were made to both vendors but only one replied. The vendor that responded created sample tags based on PayGo's unique serial codes. After agreeing on the specifications and quantity for the tags, the vendor started production. The tags requested were the same serial numbers as existing weatherproof QR stickers. The upgrade enabled us to keep using the current applications while the new tag was tested. Figure 5 displays the attachment of the new tag and the condition of the printed label tag. In Figure 9, you can also see the aging and weathering of the weatherproof labels.



Figure 9: attaching QR code on existing cylinders

## Improved QR tags

The tags were upgraded halfway through the project to new QR tags with a scratch resistance surface and white background to make scanning in low lighting easier.



*Figure 10: Improved QR tag attached to cylinder*

## Selection of Smart Scales

PayGo is currently using a digital scale to measure each refill event of a cylinder at Alfa gas under its current PayGo operations. The purpose of this measurement is to provide PayGo with a credit note so that the company is not charged extra for any gas that remains in the cylinder. This process enables PayGo customers to never run out of gas, as a delivery agent swaps the cylinder prior to it being empty. Providing PayGo customers this value add service ensures high levels of customer retention.

Figure 11 illustrates the current refilling process. The later half of the process requires PayGo staff to manually record the weight of each cylinder. The output required from the process is as follows:

- Capture cylinder serial number from QR code
- Capture the weight data from the scale
- Send the respective cylinder serial number and gross weight measurement to PayGo server as a transaction
- Cylinder and cylinder transaction tables updated based on the data provided

Even at PayGo's current operational scale, this process is cumbersome and requires a lot of data entry. The goal is to keep the same level of data quality, but to reduce the amount of time taken to refill and enter data.

## Process 2: Cylinder Refill

Eric D. Costa | September 2, 2018

SOP NUMBER: PGL-SOP-OPS-02

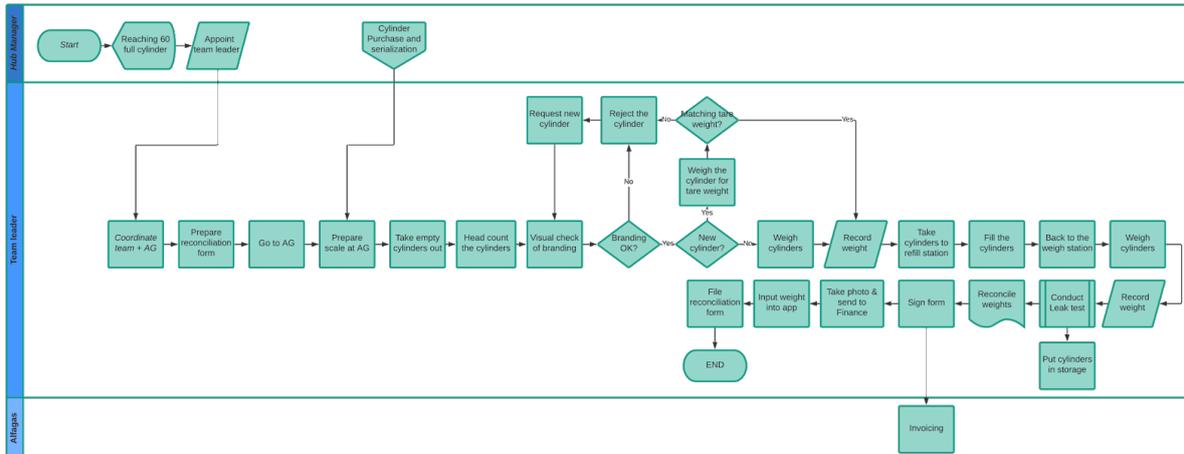


Figure 11: Cylinder Refill process

PayGo investigated two different options for the improvement of the refilling process. The first option was to connect to the USB output on the existing digital scale. This option would require a USB QR Code scanner plugged into a CPU (raspberry pi, or equivalent). The connection would be direct to scale with GPRS connection via modem or wifi. The data then needs to be sent back to PayGo server. This device would then need to be explosion proof to pass ATEX certification. PayGo would have to certify the device with an independent lab.

The second option was to source an existing industrial smart scale and try to incorporate it into the refilling process at Alfa gas. PayGo was able to source a smart scale from China. The smart scale product has been developed and certified with ATEX certification, so it can be plugged into existing refill operations.

The advantage of working with a supplier that has already developed and commercialised a smart refilling solution is that it (potentially) drastically cuts down on the product development cycle. The smart scale solution is also based on QR codes so it is in line with PayGo's current method of tracking cylinders. The next step will be to purchase the smart scales and attempt to integrate them with PayGo's system.



Figure 12: Electronic Scales

## Development of Transport and Forecasting Applications

MVP cylinder transport and demand forecasting applications were built. The QR cylinder tags and the smart LPG refilling scales were integrated into an end to end platform. Through an iterative process of building and deployment through the PayGo Energy operations, the software team was able to develop an MVP tool to improve LPG distribution management. The tool is now in operation for PayGo Energy, with a plan to scale the Applications with other LPG companies.

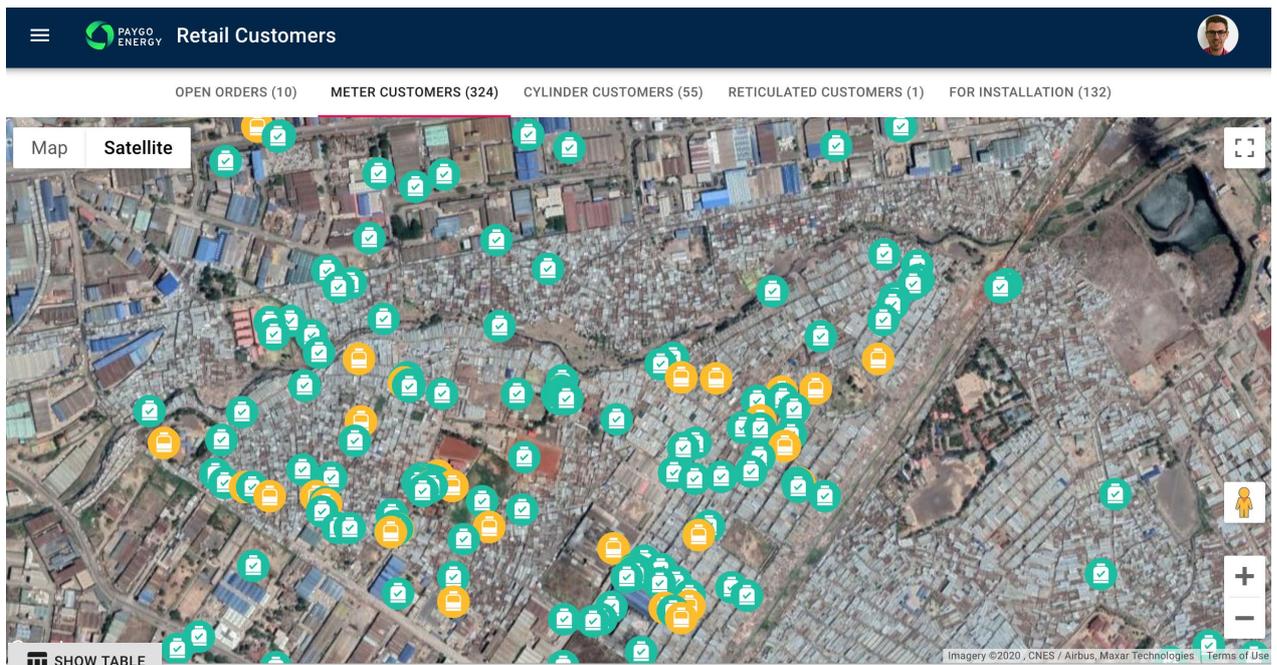


Figure 13: Cylinder Location Map screen of MVP platform.

The MVP build included the development of an Android Application to scan the QR tagged LPG cylinders, each time they were moved from one location to another. This was integrated into the PayGo Energy CRM which tracks customer orders. The LPG scales were integrated into the CRM so that automate refilling reconciliation could be processed. Previously this was a manual pen and paper process, prone to error and pilferage. Each customer and cylinder is now visible on the PayGo CRM as shown in figure 13 above. LPG cylinder inventory location and status is now visible to the retailers as shown in figure 14 below. This is the first step towards demand forecasting based on live cylinder data.

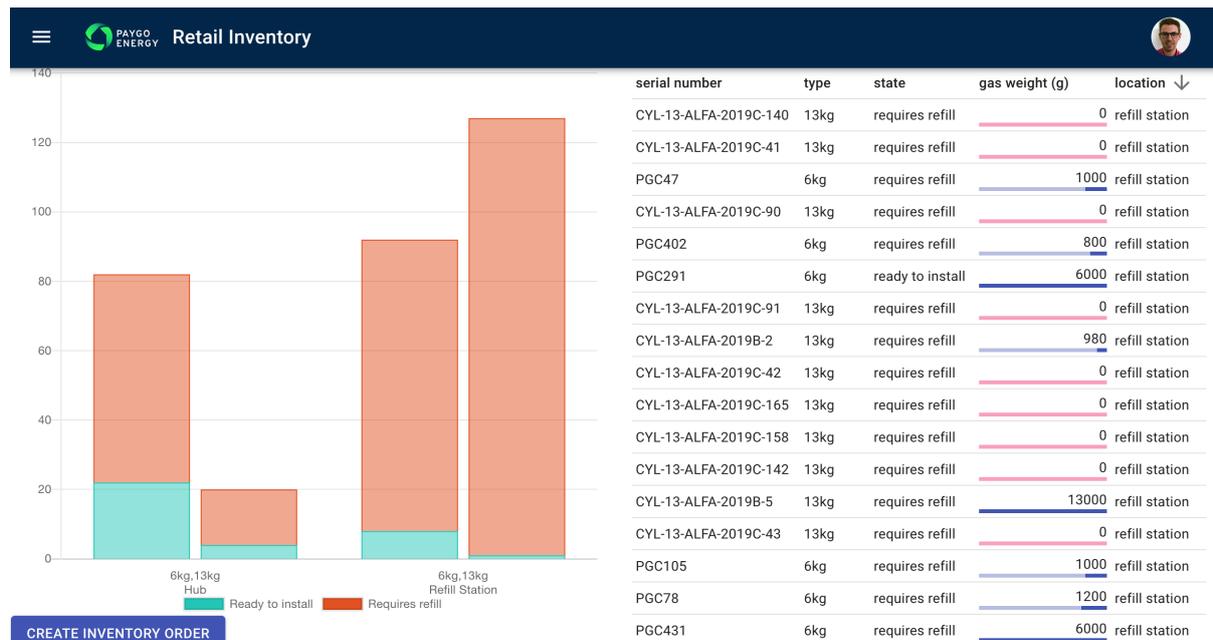


Figure 14: LPG cylinder inventory location & status.

Cylinder movements are initiated with an order created on the retail manager portal, this can be a cylinder exchange or a request to restock a sub distributor with full cylinders and collect empty cylinders. Once the order is created, it is assigned to the nearest agent, who receives the order on their android phone. The agent can then open the PayGo Energy application, where they will see a request for a new task. The cylinder exchange request, will appear along with any other pending job on the PayGo app. Figure 15 on the next page shows the work sequence for the agent. Once the cylinder exchange order is opened by the agent, the agent is now prompted to scan out the QR code for the empty cylinder in the customer home, then scan in the QR code for the full cylinder being delivered to the customer. This completed the cylinder exchange on the PayGo CRM and allows accurate tracking of the cylinder location. Previously this operation would not be tracked, leading to end of day reconciling of cylinder inventory or no reconciliation at all.

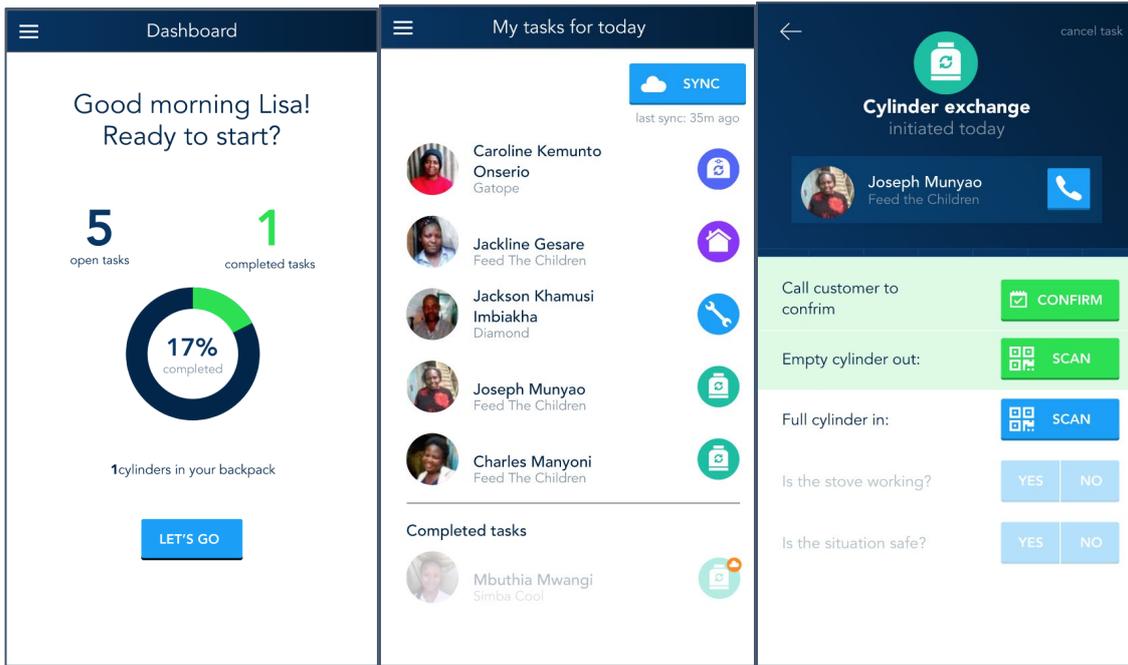


Figure 15: LPG cylinder delivery app with QR scan function

The scanning system also allows for the tracking of bulk cylinder movements. For example moving a truckload of refilled cylinders from the refilling depot to the distributor hub. The agent is able to log into the PayGo app, and scan the QR codes of the cylinders they wish to transport. The cylinder location is then updated on the PayGo database.

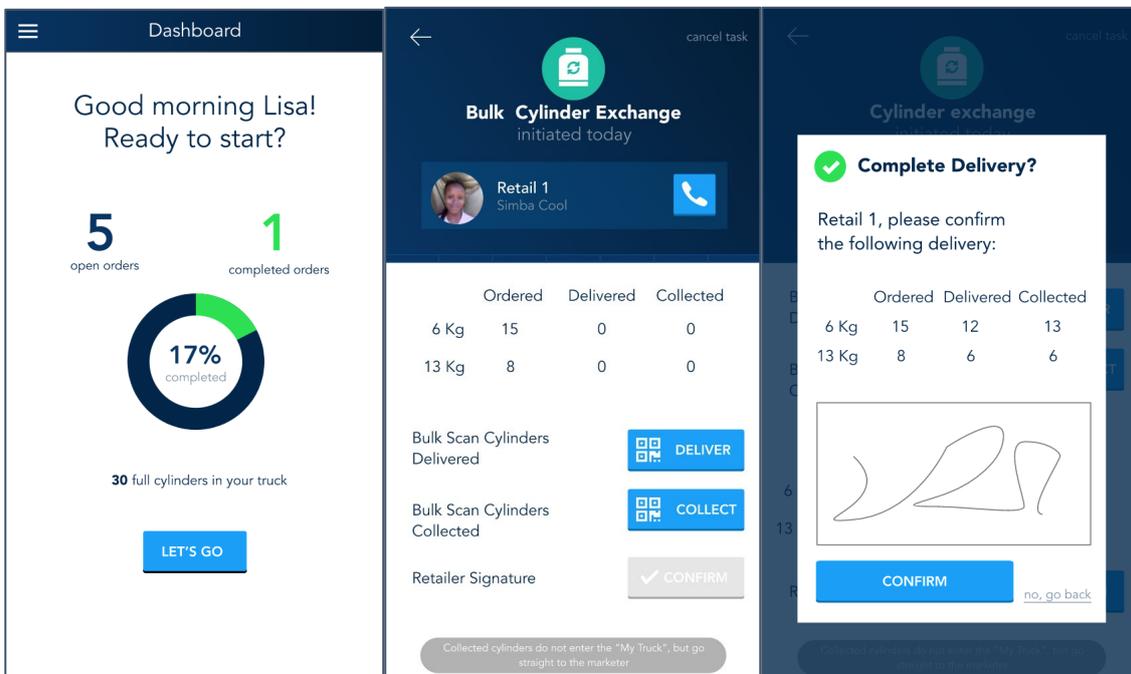


Figure 16: QR tag enabled bulk cylinder transport app

## **Challenges faced and their resolution/mitigation**

Production of commercial-grade tagging and weighing technologies in Kenya was not possible. Therefore, Paygo had to source partners from other markets outside of Kenya. This added time and complexity to the project.

In order to speed up the process, PayGo purchased tags and a smart scale from a partner in China who has produced these products for companies in China.

There was a delay during the manufacturing and importation of the items from China so they did not arrive until the start of January. This delay affected the implementation timelines.

## **Gender & Equity Inclusion**

PayGo is aware that the end consumers of PayGo's service are predominantly female. PayGo's products and services have always been designed with our consumer in mind. During the design, development and implementation process, PayGo has ensured that key stakeholders were consulted and had active input in the design of the solution - without this critical buy-in it impossible to build long lasting solutions

## The project findings

The integration of the tag and trace system with the rest of the PayGo platform has led to improved cylinder and customer retention. PayGo's key performance indicators are significantly higher than industry average. Indicating that the tag and trace platform can improve the distribution margins for the LPG supply chain.

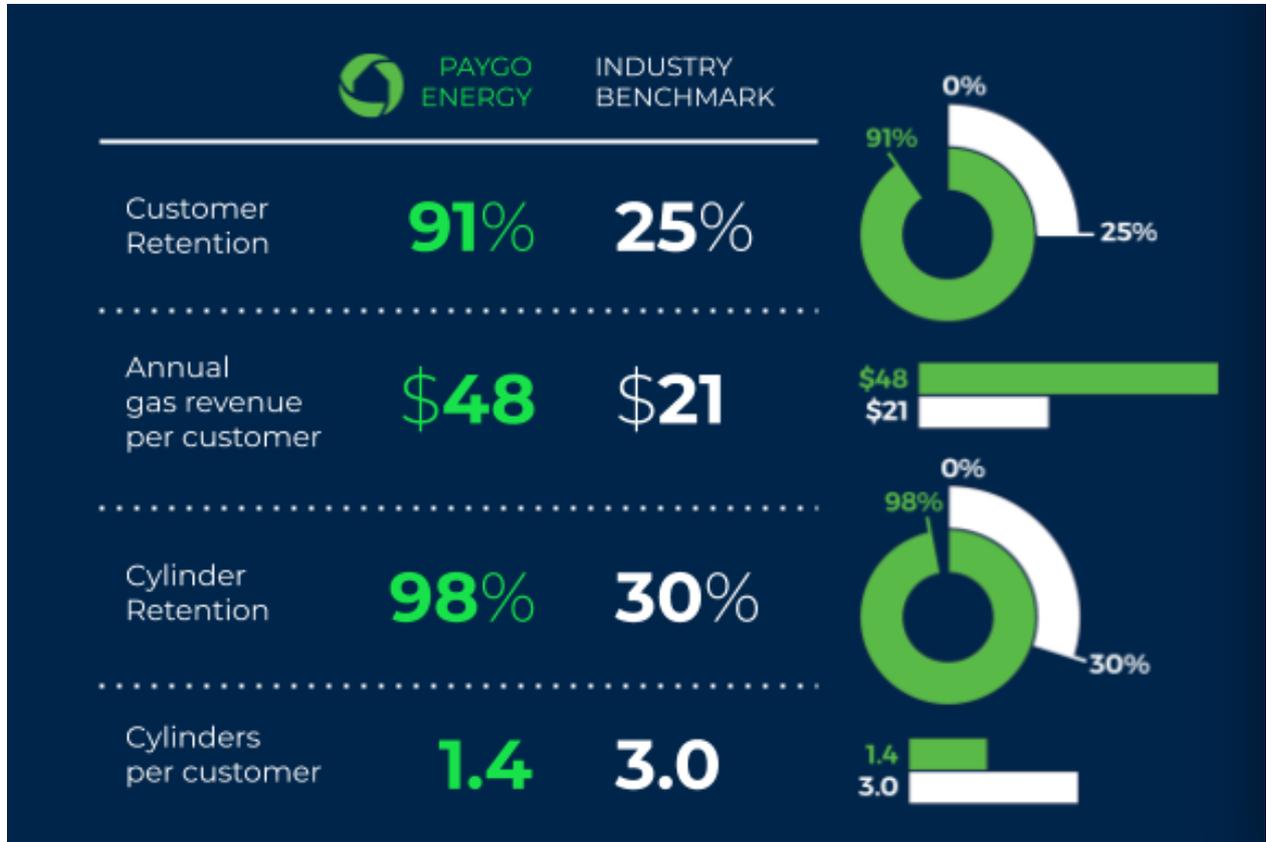


Figure 17: PayGo platform vs Industry Benchmark

## The supply chain for LPG is fragmented

The fragmentation of the supply chain leads to higher distribution costs, which are ultimately passed onto the consumer. LPG retailers and distributors lack the systems to manage and track their LPG cylinder inventory. Companies serving over 100k customers track their inventory using pen and paper and/or excel. Inevitably assets get lost, items go missing and inventory is accounted for. These companies are drowning in day to day operations and are not able to support continued growth - their growth is limited by lack of systems. In order to continue growing, these LPG companies hire more staff to carry out tasks which could be automated. This adds operational cost to the business which must be passed on to the end consumer. The automation of manual systems can lead to improved business efficiency and lower distribution costs. By lowering the distribution cost, the end price for the consumer can be reduced. Once business processes are digitized and automated, inventory tracking through QR codes, allows distributors to make decisions based on real-time data. This can improve the distribution efficiency - A recent deployment of bulk LPG tank monitoring using IoT sensors by ISA produced a 20% decrease in costs in just 3 months! ([https://www.wlpga.org/wp-content/uploads/2019/06/WLPGA-lot\\_REPORT-1.pdf](https://www.wlpga.org/wp-content/uploads/2019/06/WLPGA-lot_REPORT-1.pdf))

## **Regulations help improve LPG adoption through cylinder tracking**

In China LPG is heavily regulated, with every cylinder tracked. This was a government led initiative to support country-wide LPG adoption. It has led to a dramatic increase in access to energy. By contrast in Kenya, regulations are in place but there has been lax enforcement. Technology can provide a way to grow LPG adoption, without heavy-handed enforcement. Kenya has now introduced new regulations (Legal Notice 100) which require every LPG cylinder to be tracked by its owner and for the owners to ensure cylinders are in good condition. This regulation has been brought in to improve consumer safety, but as we have seen in other countries, we anticipate that it will also improve distribution efficiency once cylinder locations are known.

## **QR tagging technology is difficult to procure locally**

Producing QR tags locally at the quantities required to serve the current LPG market demand, is not feasible in Kenya. The metal fabricators contacted during the project do not have the equipment required to produce high quality QR tags. When shipping and clearance costs are factored in, it is cheaper to import QR tags.

## **The LPG Industry needs to be digitally transformed**

Companies in Kenya have shown interest in PayGo's tag and trace product, this is encouraging for the scale up of the solution. PayGo is in the process of finalizing contracts with these companies. Kenya currently has an estimated 4 million LPG cylinders in circulation. The cost of tagging all these cylinders would be roughly \$3 million. Given that these assets move roughly \$48 million of LPG per annum over the lifetime of the asset (8 years), it would take just a 0.7% increase in efficiency for a national tag and trace project to pay for itself.

## How can the results help us move forwards with the solution to the problem you originally identified?

The general hypothesis that digitization of the LPG supply chain leads to increased access to LPG has been proven. The [acquisition of competitors in the market](#) further demonstrates that a digital LPG supply chain is key to unlocking access to clean cooking. The results need to be shared across the wider industry to influence government strategy and policy. The Government of Kenya has been watching and listening. The Ministry of Petroleum and Mining has just put out a tender for 80,000 LPG cylinder smart meters (<https://www.petroleumandmining.go.ke/wp-content/uploads/2020/02/FINAL-Tender-for-Provision-of-Metering-Reviewed-for-upload.pdf>)

Investors and funders have a negative perception of LPG, and rightly so, because it is a fossil fuel. However, it is the cleanest fuel available today which can solve the clean cooking crisis. Switching from charcoal and/or kerosene to LPG has a positive impact on the environment. The data and impact studies need to be shared with the wider clean cooking community, to start changing donor and investor perceptions.

### Limitations of the innovation/approach/design/system

- Financial
  - Requires capex spending on tags and smart scales
  - Many LPG companies do not have large amounts of capital to invest so need to make sure the sales process and ROI on the tech is clear.
  - Working capital facilities required to facilitate investment in LPG infrastructure. Nigeria is a good example of where this is happening with help from the world bank.
- Technical
  - The configuration of this technology in a context that has not previously used technology, requires a lot of training.
  - Training materials need to be created and training programs need to be delivered effectively to LPG distributors and marketers taking up the technology. Government support here would help accelerate the roll-out.
- Government
  - The Government in Kenya is actively developing this market and supporting the initiative.
  - The Government needs support enforcing new regulations to ensure a level playing field for LPG marketers.
- Regulation
  - New regulations in Kenya specifically call for the digital tracking of cylinders using QR codes. These need to be enforced.

## **Section 4: Practical applications of the concept to the national cooking energy system (including costs)**

The new software system along with the QR tags have been integrated into the PayGo platform. The system is now operational within PayGo. 3 gas companies in Nairobi have now approached PayGo Energy to implement a tag and trace solution for their LPG operations, it is encouraging to see this demand level so early on. PayGo will look to roll-out this solution in Q3 2020 with these local companies.

PayGo is presenting at the regional LPG workshop in East Africa and will continue to push for the digital LPG management platform to be included as part of Kenya's National LPG roadmap. This is in-line with the National LPG strategy which aims to make the entire supply chain more transparent and efficient.

It is too early to include a cost benefit analysis of the impact this technology could have for the region, however the results of the roll-out with 3 LPG companies will give us a good insight. The system needs to be tested at scale (100,000 cylinders tagged) to evaluate the potential efficiencies it brings to LPG operations.

Currently, forecasting on a basic level to prevent stock-out is possible through tagging of a small number of cylinder assets. Descriptive level analytics (seeing how many cylinders are at each location) is possible with the tagging of a company's entire LPG fleet. Once an entire fleet is tagged, the next level would be predictive analytics, to create an order for next Tuesday for example. After this prescriptive analytics would inform the user that an order has been automatically created for next Tuesday. Implementation of a system on this scale, would produce maximum fleet efficiency.

## Section 5: Next steps

It is important to measure and understand the efficiency of a full scale roll-out of the PayGo platform. This would include, tag and trace, smart scales and integration with PayGo's existing cylinder smart meter. IoT deployments in other industries have yielded 20-30% improvements in logistic efficiencies, but what does it actually look like in an emerging market context? Could improved efficiency produce savings that can be passed on to the end user? The reduced cost of LPG should increase adoption but we won't know for sure until we measure at scale. To measure the effectiveness of the platform, a scale of 100k or more units is required.

## Section 6: Dissemination Plan

PayGo Energy plans to publish a blog post summarizing the lessons learnt from this project. Mark O'Keefe also published an article on the PayGo solution developed during this project - [link](#)

The project will continue to scale as new companies have signed up to use the PayGo platform.

## Conclusion

Solving the clean cooking problem requires us to rethink and reframe the problem. Historically, the problem has been focussed on the stove. Making it more efficient. This approach has failed. We need a new approach that can connect the multiple partners along the LPG supply chain.

PayGo's approach is based upon a networked infrastructure that provides full visibility to everyone involved in the supply chain (customer, retailers, wholesaler). PayGo's approach starts from the demand side and connects demand data to suppliers of LPG. To unlock the demand there needs to be investment by different partners across the supply chain.

Significant scale (10k+ units) is required to measure the efficacy of the platform. Partnerships are required to reach scale, however partnerships are risky as was seen during the project. It takes time to secure the right partnerships.

Macro adoption of LPG on a countrywide scale is always visible - bulk monthly LPG figures from the port are available. The PayGo platform however, sheds visibility into the internal market dynamics. It is possible to monitor gas flows on a daily basis. The dynamics of an LPG market at the household level, consumption patterns are all visible, giving the operators the information required to understand where the market is succeeding and where it's failing. This helps identify key gaps and improve the supply chain, ultimately leading to lower costs for end consumers and high adoption.