



MECS-TRIID Project Report (public version)

The Internet of Gas

M-KOPA Labs

M-KOPA

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Executive Summary

- 1.1 Clean cooking is an area in which M-KOPA's customers require product innovation, as they still largely depend upon wood, charcoal and other inefficient and harmful fuels for their daily cooking needs. In this context, LPG can provide many potential benefits to M-KOPA's customers, if it can be provided in a way (utilising the PAYG methodology) that makes it affordable in comparison to alternatives.
- 1.2 With support from the MECS programme through this project, M-KOPA Labs sought to address the challenge of accessing reliable and affordable sources of energy for cooking that do not require the use of wood, charcoal, kerosene, or other fuels that represent fire and health hazards. Adoption of LPG could reduce deforestation and improve health in the household – particularly for women and children who spend more time at home near fume-emitting cookstoves.
- 1.3 The use of technology has not yet solved the affordability and commercial scalability of LPG distribution. The solutions that have been developed (primarily "Locking Valves") represent high-unit costs and have so far resulted in comparatively low distribution and sales numbers, even amongst urban settings where distribution for LPG is highly concentrated. This project set out to explore the hypothesis that the use of lower cost IoT-enabled sensors at key stages throughout the distribution chain and consumption process can provide an affordable, commercially viable, and easily scalable solution.
- 1.4 MECS support enabled M-KOPA Labs to: test the market structure and opportunities in Kenya and Uganda; undertake a review and testing of a range of technical alternatives to the locking value solution; explore commercial partnerships in Kenya and Uganda; and undertake a limited useability test of various monitoring technical solutions with households in Uganda.
- 1.5 The current market and fuel pricing structures are currently not supportive of further product hardware R&D in this area in the short term given the high costs and low (margin) returns. However, because clean cooking is an important problem area for customers, M-KOPA Labs will continue to seek opportunities to leverage its market presence and to act when a viable solution is proven.

Contents

2. Introduction.....	5
Aims of the project.....	6
Objectives of the project.....	6
3. Methodology.....	7
Outline of the concept.....	7
Intellectual Property Rights.....	7
Assumptions Made.....	7
4. Implementation	9
The work conducted.....	9
Market analysis.....	9
Surveying M-KOPA customers to understand LPG use.....	9
Engaging with potential LPG distribution partners.....	9
Assessing available technologies.....	10
A focus on gender.....	10
The project findings.....	10
Technology findings.....	11
Findings in the Ugandan market	13
How can the results help us move forwards with the solution to the problem you originally identified?	13
Limitations of the innovation/approach/design/system.....	13
5. Practical applications of the concept to the national cooking energy system (including costs).....	14
6. Next steps	15
Dissemination Plan	15
7. Conclusion	16
8. Appendices.....	17
Appendix 1. Customer LPG Survey – Kenya	17
Appendix 2. Ugandan LPG Market Assessment.....	17
Appendix 3. Technology Comparative Analysis.....	17
Appendix 4. Uganda LPG Test Trial Report	17

2. Introduction

- 2.1 M-KOPA is a provider of flexible and affordable pay-as-you-go (PAYG) products (such as solar home systems, TVs, and smartphones) and digital services (such as cash loans and agricultural input credit) throughout Africa. M-KOPA has more than 1 million customers, who have utilised M-KOPA's PAYG products to access life-enhancing products and services. Clean cooking is an area in which M-KOPA's customers still require product innovation, as they still largely depend upon wood, charcoal and other inefficient and harmful fuels for their daily cooking needs. In this context, LPG provides many potential benefits to M-KOPA's customers, if it can be provided in a way (utilising the PAYG methodology) that makes it affordable in comparison to alternatives.
- 2.2 However, the use of technology (aligned with process improvements) has not yet solved the affordability and commercial scalability of LPG distribution, as well as sale and adoption of clean cooking fuels in low-income households. The solutions that have been developed (primarily "Locking Valves") represent high-unit costs and have so far resulted in comparatively low distribution and sales numbers, even amongst urban settings where distribution for LPG is highly concentrated. This project set out to explore the hypothesis that the use of lower cost IoT-enabled sensors at key stages throughout the distribution chain and consumption process can provide an affordable, commercially viable, and easily scalable solution.
- 2.3 For low-income rural and urban customers, this project sought to address the challenge of accessing reliable and affordable sources of energy for cooking that do not require the use of wood, charcoal, kerosene, or other fuels that represent fire and health hazards. Adoption of LPG would reduce deforestation and improve health in the household – particularly for women and children who spend more time at home near fume-emitting cookstoves.
- 2.4 LPG distributors are exposed to inefficiencies in the physical distribution of cylinders; loss of cylinders in the market; loss of gas sales through illicit re-filling. These customers face the challenge of making lump-sum cash deposits that are hard to finance, or post-paid schemes that are rigid and do not consider other demands on the household purse. As a result, LPG distributors focus on higher-income and more densely populated urban market segments. Meanwhile low-income customers have limited access to this clean-cooking fuel – hence resorting to using other more readily available and more easily financed fuel sources, such as charcoal and wood.
- 2.5 Finding a solution to these challenges will play a significant role in reducing deforestation for cooking fuel; reduce harmful housefires and lung-related illnesses related to some inhalation; and free women from the taxing (time and energy) burden of fetching wood/charcoal for more productive uses.

- 2.6 M-KOPA Labs' hypothesis was that a solution would significantly increase the efficiency of LPG distribution and sales, also reducing the loss of cylinder inventory. For customers it would make available a clean cooking fuel to customers who lack collateral and/or credit histories, while allowing re-payments on a flexible basis.

Aims of the project

- 2.7 The aim of the project was to test the hypothesis that: innovative use of IoT technology (when applied together with process enhancements and PAYG financing) can significantly reduce the costs of PAYG LPG cooking for low income customers whilst increasing commercial viability for providers.

Objectives of the project

- 2.8 The objectives of the project were to challenge the concept that to "secure" an LPG cylinder and the gas within, it is necessary to physically lock the valve and enable PAYG by regulating the flow of gas. The objective of this project was to explore the hypothesis that both the supplier and the customer have key needs that can be met with the innovative use of IoT technology, including:
- Inventory management and tracking of cylinders using RFID sensors;
 - Weight of cylinders taken at delivery and collection points with IoT enabled scales;
 - Daily consumption measured through the use of IoT enabled flow-valves and IoT enabled scales;
 - A cloud-based platform to collate and correlate data – feeding into the prediction of customer use and efficient/timely delivery; and
 - Flexible financing enabled through M-KOPA's PAYG credit financing methodology.
- 2.9 It was M-KOPA Labs' understanding that the use of technology in this way was unproven, hence the need for this funded project. In addition, there was no "state of the art" status for the affordable and commercially viable provision of LPG. Even the most active smart "Locking Valve" solution providers have reached only a comparatively small number of customers after several years.
- 2.10 Therefore, the project was to test manual data collection at relevant stages in the distribution chain and consumption process; and then prototype and test technology to automate the collection of data. These two tests would validate the plausibility of the hypothesis - for further investment in development of both the process and the technology.
- 2.11 This was the first time this approach has been tested in a PAYG setting rather than the locking Smart Valve solution. In addition, although sophisticated IoT sensors exist and are given many uses – primary use cases relate to products for higher-income customers in developed economy markets.

3. Methodology

Outline of the concept

- 3.1 The project sought to find technical solutions that effectively address the issues that prevent sales of LPG to lower income customers.
- 3.2 The methodology for the project involved undertaking primary research in Kenya with LPG distributors and M-KOPA's own customers to understand the market structure, and the need and willingness to pay of M-KOPA's customers.
- 3.3 M-KOPA Labs researched available technology solutions, and lab-tested a significant number in order to assess the appropriate combination of technologies for application in a PAYG solution.
- 3.4 The intention was to prototype test a number of promising technologies in Kenya in collaboration with commercial partners. However, this became impossible, and Labs shifted focus to explore the feasibility of developing the same solution for Uganda.
- 3.5 M-KOPA Labs then undertook additional market research in Uganda to reframe the solution concept to meet the needs of customers in Uganda.

Intellectual Property Rights

- 3.6 No original product development R&D was undertaken that resulted in the development of any unique Intellectual Property (IP).
- 3.7 IP relating to the technologies tested during the project belong to the commercial manufacturers of those technologies.
- 3.8 Findings of the project are available for public sharing, except for certain aspects of the findings of the structure of the Kenyan LPG market, which are somewhat commercially sensitive.

Assumptions Made

- 3.9 At the outset of the project, it was assumed that actors in the LPG market would welcome technology innovations to enable PAYG sales of LPG to a new (lower-income) customer base. This assumes that the additional costs of locking-valves to the total cost of sales for LPG cylinders is prohibitive, when addressing lower-income customers.
- 3.10 In essence, these assumptions have proven to be correct. However, because of the significant barriers to entry in the Kenyan market it was not possible to test solutions with customers (the Kenyan LPG market is dominated by a small number of large actors, all of which have invested heavily in their businesses and in gaining market share).
- 3.11 In Uganda, the comparatively low-cost of charcoal challenges the ability of a PAYG solution for LPG – even when the costs of the cylinder are spread out across a number of payments.

3.12 Ultimately, M-KOPA Labs was not able to identify the right partner that had the necessary balance of: market share; ownership of its own distribution chain; and freedom to extend payment terms to end-customers. This has made it impossible to deploy a solution in the market to-date – other than an unsecured sale of LPG “vouchers” as an “upgrade sale” as detailed further in Section 3.

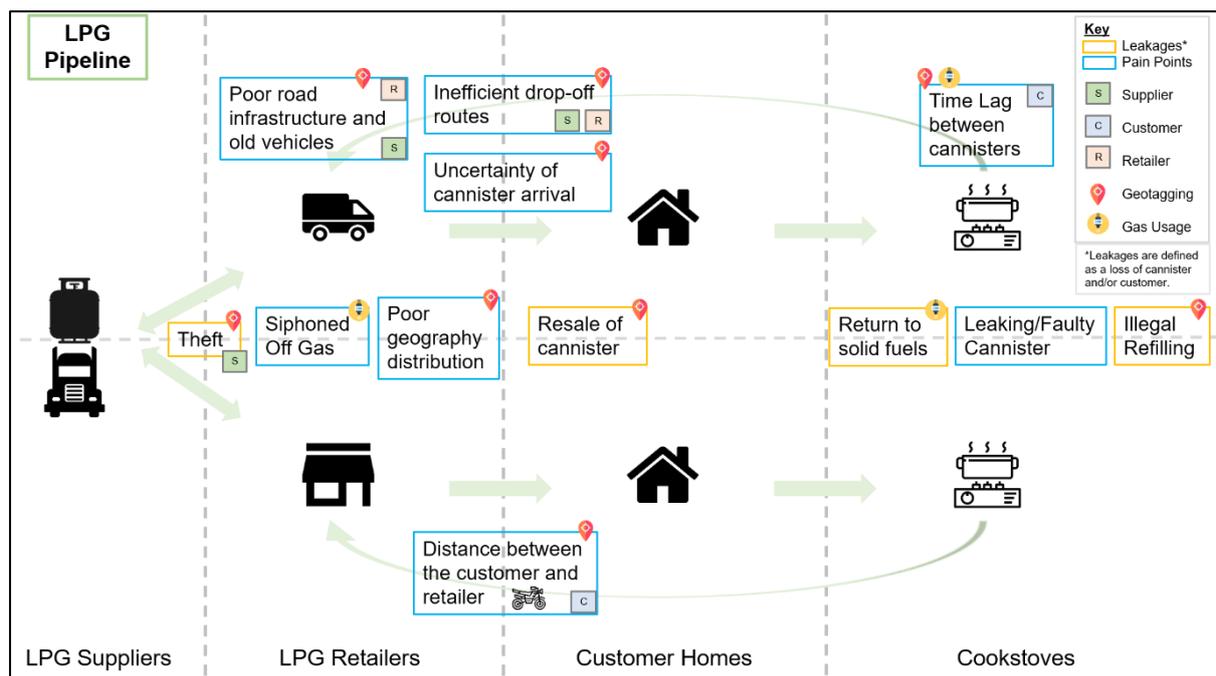
4. Implementation

The work conducted

Market analysis

- 4.1 M-KOPA Labs first sought to better understand the issues set out in Section 1 by undertaking a market analysis, to better understand the structure of the sector and the challenges facing LPG distributors and retailers. This enabled M-KOPA Labs to develop an understanding of the structure and processes of the sector, and the key challenges constraining sales to low income customers (as illustrated in Figure 1).

Figure 1: challenges in the sale and distribution of LPG to low-income customers



Surveying M-KOPA customers to understand LPG use

- 4.2 M-KOPA Labs then undertook a survey of its own customers to understand their current use of, or desire to use LPG (see Appendix 1). This demonstrated significant desire to use, and willingness to pay for LPG. The primary motivators were to have access to a clean fuel for “quick” cooking.

Engaging with potential LPG distribution partners

- 4.3 M-KOPA Labs engaged with a number of potential commercial partners and developed approaches to test the sale of LPG in Kenya. The Kenyan LPG market is a challenging market for new entrants, and (with agreement of MECS), M-KOPA Labs eventually concluded that it would not be possible in the short-term to run a market test in Kenya. As a result, M-KOPA Labs moved its focus to the Ugandan market and undertook an additional market scoping exercise to better understand the structure of the market, and the opportunity for LPG sales to its customers (see Appendix 3).

Assessing available technologies

4.4 M-KOPA Labs then undertook an extensive assessment of available technologies that could enable M-KOPA Labs to track the amount of LPG being used by customers. This information could then be reconciled upon collection of the cylinder to accurately charge the customers for their actual consumption rather than expected rate. The technologies can also enable the collection and storage of data to track a cylinder's journey to a customer. M-KOPA Labs sourced a number of products that were tested by M-KOPA Labs engineers, including:

- Ultrasound sensors
- Weighing scales
- QR code systems
- NFC and RFID devices
- iBeacons.

These sourcing exercises and tests enabled M-KOPA Labs to make a comparison of the available technologies, and the costs of deployment (see Appendix 4).

A focus on gender

4.5 In Kenyan and Ugandan households women still bear the majority of the responsibility/burden for managing household budgets, for shopping and cooking for the family. Women are often the main purchasers and users of household cooking fuels, and much of their time is spent obtaining fuel, or cooking meals.

4.6 As a result of these factors, M-KOPA Labs focused most of the market research on female customers and on understanding their needs and wants. M-KOPA Labs experience is that products that only save women time and labour in the household do not necessarily generate purchase decisions for new products (for example the M-KOPA fridge). However, products that result in household cost savings do generate purchase decisions. Therefore, M-KOPA Labs intention is to develop products that can deliver cost savings, whilst also having a positive impact upon the women in a household – and this is the intention with M-KOPA Labs exploration of LPG solutions.

The project findings

4.7 The concentrated structure of LPG markets presented challenges to M-KOPA Labs as it explored ways to bridge access for customers utilising technology and LPG suppliers/distributors.

4.8 In summary, there are limited opportunities for new-entrants such as M-KOPA to break into the LPG distribution chain. The barriers to entry (political and economic) are significant, and present significant reputational risks for M-KOPA. However, existing LPG distributors are interested in accessing new customers in partnership with PAYG companies and it remains possible that last-mile sales and distribution opportunities

remain available. This implies finding an established LPG distribution partner that is willing to explore new channels to reach customers, and which is willing to enable M-KOPA to on-sell LPG to its customers as an “acquisition” product. This will require considerable innovation by LPG partners who have largely wished to own the end-to-end distribution chain, whilst also steering away pre-financing of customers.

Technology findings

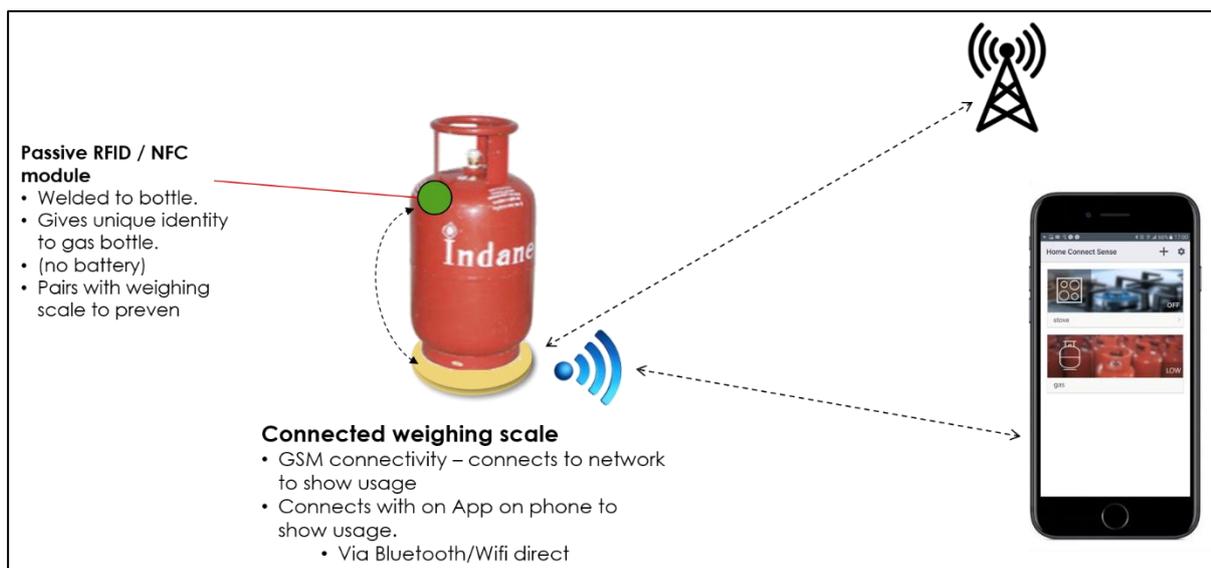
- 4.9 In so far as the use of technology is concerned, M-KOPA Labs discovered that in-fact there are significant supply-side markets of LPG tracking and measurement technologies (primarily in Scandinavian and East Asian markets) that serve many of the needs that this project sought to address. Appendix 4 provides a summary of the technologies that M-KOPA Labs investigated, including QR codes, Bluetooth beacons, radio-frequency identification (RFID) and near-field communication (NFC) tags for location tracking, and ultrasonic sensors, thermal gas level strips, and digital scales for gas usage. All of these technologies are now available “off the shelf” from vendors in Scandinavia and East Asia where there are significant LPG distribution markets. In fact, one locking valve supplier in East Africa is now acting as a reseller of RFID tracking technology in Kenya – demonstrating the potential for the update of less-costly technologies in this market.
- 4.10 Appendix 5 provides a report on a test that M-KOPA Labs ran in Kampala with five households. This demonstrated that amongst the test-segment of urban professionals, there is a willingness to adopt LPG solutions when these are convenient to use, and provide a suitable cooking experience.
- 4.11 These technologies will need adaptation for use by M-KOPA, but the availability of the technology enabled M-KOPA Labs to test these technologies with limited original R&D expenditure required.
- 4.12 The remaining challenge for M-KOPA Labs is to identify the appropriate sales model, within the wider context of the PAYG business. Pre-financing LPG sales to customers involves a considerable amount of risk, both the cylinders and LPG content must be pre-financed, and the commodity risk increases with each pre-financed sale to new customers. The margin available on each cylinder of LPG is very limited, therefore, a profitable solution must be capable of achieving great scale – thereby multiplying any inherent risks.
- 4.13 Although the “locking valve” solutions nominally deal with these risks, feedback from the market suggest that the technologies available are experiencing functional difficulties, and customers are also not utilising their LPG at the regular rate of consumption required (by the business model). Because the locking valves add ~<\$43 cost per customer, the business model is very sensitive to these issues and profitability is easily challenged.

4.14 Despite all of these challenges, LPG remains an important commodity for M-KOPA's customers and M-KOPA Labs remains focussed on uncovering a viable PAYG solution. Nominally there are three avenues of further exploration:

- LPG as an **"upgrade"** product for existing customers: where M-KOPA has existing customers that have completed payment on an existing PAYG product (such as a SHS or smartphone), it is possible to extend a new loan and re-activate the remote-locking functionality of their existing product. This will allow M-KOPA to offer financing for LPG in the form of electronic coupons that can be redeemed with partner LPG distributors. The challenge with this approach is that the margins on LPG are very small, and M-KOPA is able to offer its customers other products that provide higher margins.
- LPG as an **"acquisition"** product for new customers: in this case new customers with no previous trading history with M-KOPA could place a deposit on a cylinder, and make daily PAYG repayments. Technology is required to manage the sale to the cylinder and gas and to minimise the risks of default/non-payment:
- Utilise the non-locking technologies to track the cylinder to a customer's house, and monitor utilisation. This approach would not "secure" the cylinder, but would address most of the tracking and monitoring needs; or

4.15 Invest further in the design and development of a lower-cost locking valve. This approach implies that there are still engineering solutions that have not yet been uncovered by the existing locking valve technology providers. A significant down-side to this approach is the high levels of investment required to design, manufacture and gain a licence to operate an in-line valve.

Figure 2: possible combination of technologies to enable PAYG sales



Findings in the Ugandan market

- 4.16 As set out in Appendix 3, the need for clean cooking fuel alternatives in Uganda is very significant. However, the price structure of the fuels market means that even when sold on a PAYG basis, LPG is not price-competitive with charcoal.
- 4.17 The relative convenience of charcoal (due to the prevalence of re-sellers) and the comparatively low cost, makes it challenging for M-KOPA to compete on the basis of LPG as a direct alternative.
- 4.18 However, M-KOPA Labs has learned (both in Uganda and Kenya) that its customers do aspire to gain access to cleaner cooking solutions. Appendix 5 provides the findings of a small useability test undertaken with users in Kampala. This shows that although PAYG LPG is an attractive solution – more work is required on the cooking station itself, to ensure that users can gain the full benefits of cooking with LPG.
- 4.19 In particular, customers appear willing to pay for more “modern” solutions when this relates to the “fast cooking” element of their cooking – in which LPG does not replace charcoal (mainly used for the “slow” cooking). M-KOPA Labs believes there is a discreet but meaningful segment of the population – including urban dwelling professionals, who will be willing to acquire LPG cooking solutions.

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

- 4.20 Although this project has not defined a single product solution for M-KOPA Labs to develop further, it has identified areas of opportunity for further exploration. The results demonstrate that the use of lower-cost technologies can facilitate the adoption of LPG cooking solutions – when these technologies are convenient and easy to use.
- 4.21 In addition, there is a clear need to work with providers of cooking station solutions – in order to provide customers with cooking stations that provide an acceptable cooking experience and solution.

Limitations of the innovation/approach/design/system

- 4.22 The direction of exploration that has taken place has led M-KOPA Labs to focus on a particular segment of the population: urban professionals that do have access to electricity, but who continue to use charcoal and kerosene as part of their fuel stack. This does not imply that there will not eventually be wider applicability of the potential solutions, but that there is a viable segment for M-KOPA Labs to target and which makes further product R&D worthwhile.

5. Practical applications of the concept to the national cooking energy system (including costs)

- 5.1 Aspects of the market structures in Kenya and Uganda limit the extent to which product innovations by providers such as M-KOPA can unlock affordable access to LPG as a clean cooking fuel alternative. In Kenya, the presence of a number of large incumbent distributors means that there are significant barriers to entry for new actors and currently the only way of bringing innovation to market is in collaboration with an incumbent. The high-costs and low margins involved in pre-financing LPG also present challenges.
- 5.2 The business models of the incumbents in Kenya have to a large extent depended upon supplying the hospitality sector, but demand during Covid has declined significantly. This means that there may be opportunities to explore partnerships again in Kenya as the incumbents seek new markets for their product.
- 5.3 It may be that the Kenyan government could also offer incentives that encourage providers to innovate beyond their current business models. Currently the low margins on LPG refills does not offer a significant return on the costs of innovation, and the role of the Government could be helpful in this respect. Likewise in Uganda, because of the comparatively low costs of charcoal, Government action could help to accelerate the move to LPG solutions.
- 5.4 More broadly, encouraging the availability of clean and efficient cooking stations could also support adoption of LPG by urban customers who use a more modern cooking fuel, but who need an acceptable level of efficiency and effectiveness.
- 5.5 M-KOPA Labs found that its staff members often cook using electrical cookers. However, the intermittent supply means that they must frequently revert to charcoal, wood, or kerosene. Although efficient electric cookers provide one clean form of cooking, the dependency on a reliable electricity supply means that there is a place for LPG as a cleaner alternative that can help with overall emissions reductions and reductions in air pollution.

6. Next steps (e.g. beta or field testing and implementation; more development etc)

- 6.1 Whereas M-KOPA has borne the costs of being the innovator in its development of a number of products, in the case of LPG a different approach is required. The low margins per unit, and the significant commodity risk mean that the business case for further product R&D investment is very weak.
- 6.2 However, recognising the significant need of its customers for clean alternatives to charcoal, wood and kerosene, M-KOPA Labs will continue to explore for commercially viable solutions that can unlock access to PAYG LPG sales. At this stage of market development, M-KOPA Labs will continue to carefully monitor the progress of existing solutions, and new solutions as these arise.
- 6.3 Through the MECS funded project, M-KOPA Labs has been able to significantly advance M-KOPA's understanding of the LPG market, and to develop partnerships with a wide range of market actors. M-KOPA Labs will continue to foster these relationships and to explore opportunities for joint testing of solutions as appropriate.

Dissemination Plan

- 6.4 Labs is keen to work with MECS on how key lessons from this project can be shared with other innovators in the space. Already a leading smart valve LPG technology company and Labs is being open (within commercial reason) with its understanding of customer needs and where it sees market opportunity.
- 6.5 Labs has not publicly shared the key lessons learnt from this project, although it did complete a comprehensive report for its R&D Board Committee. Insights (where not commercially sensitive) could be shared via the MECS blog post and through Labs' budding R&D newsletter distributed within the development and innovation sphere.
- 6.6 n/a

7. Conclusion

- 7.1 M-KOPA Labs has been able to test the hypothesis that lower cost alternatives exist to the “locking valve” solutions that can enable PAYG sales of LPG to lower income customers.
- 7.2 M-KOPA Labs has found a range of viable technologies that can be adapted for use in a PAYG model, although it has not been able to market test the extent to which a non-locking system results in re-payments by customers.
- 7.3 In Kenya there is a market opportunity given the price structure of the fuels market, but entry into the LPG supply market is constrained by several significant barriers to entry. Whereas incumbent operators had shown limited interest in innovating around a PAYG model, the collapse of C&I demand during Covid may create a new opportunity to explore collaboration and innovation.
- 7.4 In Uganda, the low costs of charcoal against LPG reduce the mass-market opportunity, although M-KOPA Labs has found that LPG use by urban professionals does represent a meaningful opportunity. In addition, M-KOPA Labs has been able to partner with Total to test the market opportunity to a certain extent.
- 7.5 More work is required to develop cooking stations that meet the needs and expectations of urban professional customers – such as being able to cook on two hobs at the same time, and obtaining sufficient gas pressure whilst cooking.
- 7.6 As clean cooking is a ubiquitous need amongst its customers, M-KOPA Labs will continue to explore innovations that can enable LPG cooking solutions to provide a cost and quality competitive alternative to charcoal, wood and kerosene.

8. Appendices

Appendix 1. Customer LPG Survey – Kenya

Appendix 2. Ugandan LPG Market Assessment

Appendix 3. Technology Comparative Analysis

Appendix 4. Uganda LPG Test Trial Report