EFFICIENCY FOR ACCESS

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EFFICIENCY FOR ACCESS RESEARCH AND DEVELOPMENT FUND: INNOVATOR SERIES

SMART BATTERIES: THE KEY TO SCALING EFFICIENT AND AFFORDABLE OFF-GRID APPLIANCES?

Large, low energy productive-use appliances for off- and weak-grid settings have yet to penetrate the market. A battery is core to the delivery of reliable energy services for off-grid appliances and technologies, including solar home services and solar powered lighting. This is partly due to the fact that oversized batteries must be used to ensure reliability. As these batteries increase in size, they become more expensive and much harder to monitor.

If a battery stops working, a solar light or solar home system user may be without power and need to revert to using alternative power solutions, most commonly burning kerosene which emits greenhouse gases.

Burning kerosene can also have negative health effects, such as respiratory problems. The ability to predict if and when a battery may stop working allows for an uninterrupted power supply, and also helps to mitigate electrical waste.

DID YOU KNOW?

Each year, nearly 4 million people die prematurely from illnesses attributed to household air pollution from inefficient cooking practices using polluting stoves, paired with kerosene.

M-KOPA'S SMART BATTERY CHIPS

M-KOPA is a connected asset financing platform and market-leading provider of off-grid solar services in Kenya, Uganda and other countries in Sub-Saharan Africa. Led by M-KOPA Labs, the dedicated Research and Development unit of M-KOPA, this project encompassed a team across M-KOPA's UK and Kenya's (HQ) offices.

The Efficiency for Access Research and Development Fund supported M-KOPA in the development of smart battery chip technology, which can help to improve customer experience. This is because they allow for real-time reporting of battery health, which allows customers to pre-empt or prevent maintenance costs, resulting in greater service uptime for the customer.

Effective battery monitoring and management also avoids significant costs for low-income customers. Customers do not have to take transport to return faulty devices, and it avoids the premature expiry of high-value appliances. The M-KOPA pay-as-you-go (PAYGo) business model reduces the upfront ownership costs for customers. M-KOPA also takes on the majority of the financial risk by providing a three-year warranty. This means that if any of the systems become faulty, M-KOPA will pay to replace those units.

Equally, if a customer decides to stop using the system, all they have to do is stop the PAYGo payments. In this way, M-KOPA loses out on 90% of the loan given to customers, but it means that customers do not incur significant financial losses.

M-KOPA

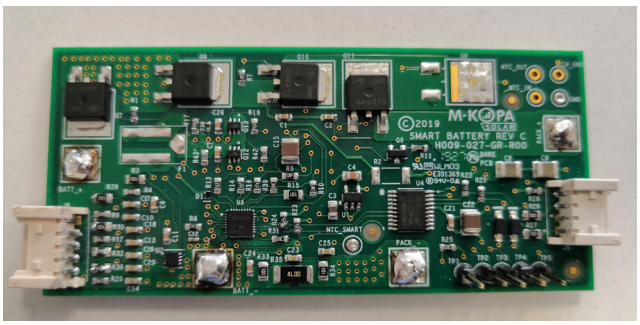
The Efficiency for Access Research and Development Fund grant was essential in helping M-KOPA monitor how our remote customers use and depend on their solar fridge. The grant helped us to develop our smart battery chips, and we have even secured additional funding Efficiency for Access' network.

—Katherine Owens, Head of M-KOPA Labs

HOW DOES IT WORK?

M-KOPA customised smart controls to link with a battery management system (BMS) that can report, in near real-time, the performance of batteries powering a 100L DC fridge. What makes this technology unique, and much more accurate than existing solutions, is a self-learning mechanism that accounts for the ageing effects that cause the change of battery life. These smart controls enable M-KOPA engineers to monitor battery health with accurate readings, so M-KOPA can provide customers with care before issues arise.

Extending battery lifetime has numerous benefits for the customer. There are financial savings, as customers do not have to use kerosene fuel or make frequent trips to a service centre. Additionally, income can be made for those using their system productively.



M-KOPA aimed to create optimally sized batteries that can help make off- and weak-grid appliances cheaper and more efficient. Previously, embedded chips in devices powering larger appliances did not capture granular readings of the battery's state and performance, such as voltage, current, accurate capacity, and state of charge. This limited the quality and guarantee of power delivery over the appliance's expected lifetime as technicians were not able to accurately predict how long a battery would last before repair or replacement was needed. Furthermore, prior to this study, M-KOPA had no understanding of how this advanced, yet 'off-the-shelf' technology would perform in an off-grid setting.

WHAT DID WE LEARN?

Customising a BMS is more complex than initially thought

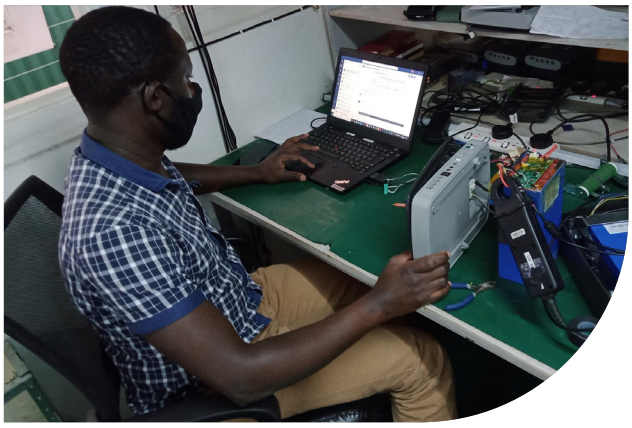
The study revealed the complexity of customising a BMS, including the requirement for the BMS to "learn" from the battery by designing the back-end code with an atypical off-grid application in mind. The pilot team faced a number of challenges to appropriately align the parameters of the embedded controls and machine-to-machine (M2M) communications. This required frequent troubleshooting with the supplier to achieve this. As a result of this troubleshooting, there was an increase in investment to enable the deployment of smart batteries.

Aggregating real-time data is important.

During the roll-out of test units in the field, M-KOPA project members could view each battery performance in near real-time. They were able to detect instances of battery downtime and, consequently, interruptions to customers' service delivery. Instead of customers returning their devices to shops, M-KOPA could proactively call customers or send a technician to repair their products. This helped ensure that customers saved time and money on unnecessary travel to repair products and experienced less system downtime. The results helped M-KOPA to pinpoint data usage trends to better inform their future product design.

There is a need for data about reliable suppliers.

During field testing, M-KOPA generated the data to show that some sourced batteries did not meet the performance and quality standard thresholds that M-KOPA requires for its off-grid systems. As a result, they changed battery suppliers and consequently, batteries. This change was closely monitored for instances of accelerated degradation. In doing so, M-KOPA has begun to leverage data to collaborate with its suppliers. This will ensure that they meet the standard level agreements and, where interest lies, design better batteries for off-grid applications. This illustrates the importance of working with collaborative partners who see the commercial interest and possible impacts to innovate for off-grid communities.



SMART BATTERY MONITORING: ESSENTIAL FOR INCREASING AFFORDABILITY AND EFFICIENCY OF OFF- AND WEAK-GRID APPLIANCES?

The funding from the Efficiency for Access Research and Development Fund allowed M-KOPA to assess the value of smart batteries and management system for larger off-grid solar systems.

The introductory design of a printed circuit board with an integrated chip formed the first prototype smart battery pack.

With 30 test units in the field, M-KOPA was able to see readings on current, voltage, temperature, depth of discharge, safety protection and cell balancing on a 10-minute basis, rather than hourly. This, in turn, can help an accurate data feedback loop for design and servicing, currently not enabled for large systems.

The increased use of smart battery data enabled M-KOPA to have a more comprehensive overview of device failure, which will be key in their future product design and development. For example, during the field trial, it was able to rule out battery failure as a cause of device failure. This meant M-KOPA had to revisit and improve its fault-finding processes to identify the real causes of device failures or faults better including customer behaviour. It can also fundamentally underpin M-KOPA's operations, making its service more efficient and influencing future management of operations.

M-KOPA is now able to graph, track, and set overtemperature and overcharge alarms that automatically detect incidents of fault. The BMS then 'learns' to disable solar charging to protect the battery, thus avoiding battery failures and, consequently, premature e-waste.

M-KOPA now has a full, detailed list of more than 80 different data types. As the company now has the right resources in place, it can compare these data types on an individual battery and as a population. This allows M-KOPA to understand key specifications and quality standards for higher-quality, longer-lasting batteries.

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EforAgrants@est.org.uk