EFFICIENCY FOR ACCESS RESEARCH AND DEVELOPMENT FUND: INNOVATOR SERIES

USING IOT TO REVOLUTIONISE OFF-GRID APPLIANCES

The off-grid solar market continues to grow rapidly. There has been an increased uptake of solar home systems, large enough to power multiple appliances, and an increased awareness of the off-grid solar market's potential.

However, to sustain this growth, current distributors of solar products need to overcome a variety of challenges. Firstly, newly developed productive use appliances and solar home systems currently have limited Internet of Things (IoT) solutions available. Units that can handle bigger loads typically have a lot of redundant hardware included and are expensive, at around USD300 per unit. The "affordable" units available are designed for low-power settings and cannot be used on relatively higher power systems, such as lights and phone charging. Another challenge is that the causes of the failures in the solar systems are not easy to identify. As a result, repairs can take up to three months as solar companies struggle to find the source of the issue. There are also other high costs solar distribution companies may have to bear, such as installing the solar home systems. This usually means that the high start-up costs must be covered by the end user, making solar home systems less affordable.

DID YOU KNOW?

As of 2022, only 42% of people in Uganda have access to electricity.

Solar home systems that are large enough to power multiple appliances - around 1-10kW - are often expensive. Many end-users therefore prefer a credit-based payment model, where they pay for the system in affordable instalments, and only pay for the power that they use. Solar companies in Eastern Africa have moved to tap into this growing market, but their penetration in this segment is hindered by manual performance monitoring and rudimentary payment management tools. It is also critical that these solar-for-productive-use systems perform reliably. To do this, it is necessary to have digital systems that facilitate automatic payment management, real-time performance monitoring, and predictive maintenance features, leading to quick and effective system maintenance and the improvement of system reliability.

INNOVEX'S TRANSFORMATIVE IOT SOLUTION:

Innovex Uganda was founded by David Tusubira and Douglas Baguma, when they graduated from Makerere University. Innovex has six years' experience in the development of IoT-based digital solutions for transforming the distribution of off-grid solar systems and equipment in Sub-Saharan Africa. Its pioneering solution, 'REMOT', monitors solar-powered energy systems and solar-powered equipment. It comprises control hardware with an array of sensors, a web-based portal, and a mobile app for remote management technology. The REMOT management system delivers digital solutions for off-grid, photovoltaic (PV) installations of different types, use cases, and sizes, in solar home systems and solar-for-productive use settings.

To date, 'REMOT' has been used by over 30 companies and researchers in Uganda and Kenya, with pilots running in Democratic Republic of Congo (DRC), Tanzania, Ethiopia, Ivory Coast and Nigeria, as well as by research students at Oxford University in the UK and HEC in Paris.

INNOVEX :

"The funding support from the Efficiency for Access Research and Development Fund accelerated the commercialisation of REMOT. With the support of the Fund, Innovex improved the quality of the hardware with upgraded features for local data storage, temperature, and water flow rate sensing. Today, REMOT is the centrepiece in PAYGo business models in solar, productive-use applications. It is used by more than 30 solar companies across seven countries in Africa. "

– David Tusubira, Chief Technology Officer, Innovex

## IMPROVING INNOVEX'S HARDWARE TO REDUCE POWER CONSUMPTION

Innovex made several improvements to REMOT management system during the project with the Efficiency for Access Research and Development Fund, supported by UK aid.

It created an improved version of its hardware product line, known as Davix. It made several updates to enhance both the usability and power consumption of the technology. To do this, Innovex firstly engaged with customers through interviews to collect feedback on the user-friendliness of REMOT. Innovex redesigned the web portal to a more user-centric design, based on advice from customers, which makes the technology easier to navigate. It further improved the reliability of REMOT by migrating the platform to a top-tier cloud services provider.

Innovex also developed its physical products during the project. It migrated the entire product line from through-hole, where leads on components are inserted through holes drilled in printed circuit boards, to surface mount technology, where electrical components are mounted directly onto the surface of a printed circuit board.

This allowed for increased manufacturing automation, which reduces cost and improves quality. It also migrated from off-the-shelf enclosures to a custom-made enclosure for most of the product line.

This gave the product a more professional, modern, and compact look, and upon feedback from technicians, has made the products easier to work with. Technicians also reported an increase in uptake from customers, because of these updates. The updated version also has a reduced production time, which makes it more affordable. Innovex significantly reduced the power consumption of all its hardware by 50%, thus lowering its burden on solar systems.
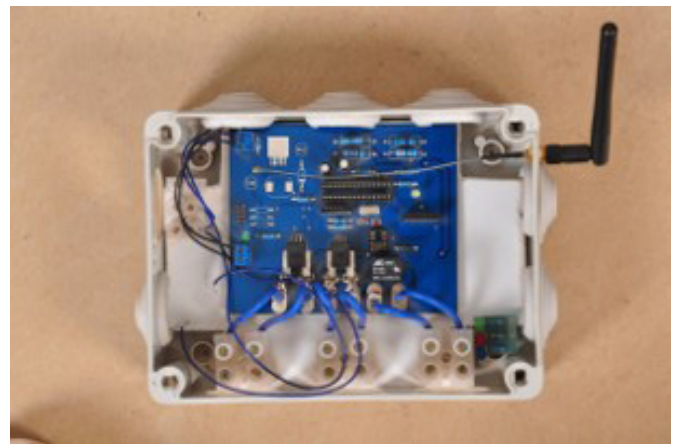
NEW PRODUCT FEATURES TO CONTRIBUTE TO RELIABILITY AND AFFORDABILITY

As well as making improvements on existing features, Innovex also incorporated new ones into REMOT. It successfully integrated local storage into the entire hardware product line. This was to ensure backup storage in the system and therefore data reliability, in case of power failures and loss of connectivity, and addressed the needs highlighted by customers during the initial interviews conducted by Innovex.

It also integrated temperature and water sensors into the product line. The water flow sensor added to the pump hardware is now heavily depended on by a number of solar water pump distributors and is a centrepiece for service based, pay-per-use business model for solar water pumps being rolled out by Ugandan-based company, Aptech Africa.

Perhaps one of the most significant additions was the integration of mobile money and USD into the REMOT system. This automated the payment process, making it more convenient for end-users to pay, and to integrate into existing PAYGo software, adding to the affordability and accessibility of the product. Innovex developed a REMOT Android app for technicians to use while installing Innovex's product or performing remote diagnostics. The app can analyse the battery's state of charge and state of health, as well as system diagnostics that help extend the life of a solar home system.

EXPLORING NEW POSSIBILITIES

During the project, Innovex was able to safely test alternative IoT and microprocessor technologies. It trialled the use of more robust processors that allow for features such as: over the air software upgrades, and more robust remote control and data management, thus creating more value for customers.

The Efficiency for Access Research and Development Fund also provided additional support, with funding from IKEA Foundation, to enable Innovex to successfully made its platform open-source, opening it up to different levels of third-party integration. This included solar equipment manufacturers and third-party software platforms.

WHAT DID THE PROJECT ACHIEVE?

Comprehensive analysis of user behaviour.

The project enabled Innovex to carry out customer interviews and extensively monitor user behaviour, in order to inform Innovex's user-centric approach to product development.

The remote monitoring significantly reduced the number of dedicated customer visits technicians had to make. Innovex's acquired data on system usage and health made it much easier to pre-empt problems and the need for technicians. It found that Innovex's partners made a saving of up to USD 30 per portfolio customer per year.

A number of poor end-user behaviour instances were reported. On three separate instances, solar distributors saw that inverters had been damaged by the end users – one had been overloaded with a welding machine causing damage to its internal circuitry. This meant that solar distributors didn't unnecessarily pay to replace parts damaged by end-user misuse.

During the initial pilot phase, data from REMOT showed that 30% of solar systems that had been installed under a project implemented by an NGO were being over utilised by rural schools in Kenya thus threatening their durability. This data led to a user energy management re-training and data from REMOT reported a change in end-user behaviour, thus reserving the lifetime of the solar installations.

Engaging with Uganda's youth population

80% of the Ugandan population is below 35 years old, with more than 30,000 new graduates annually. Without an active local product development ecosystem, many of these young people are not given the opportunity to innovate solutions to local problems. The project has created an opportunity for engineering students, as Innovex employed local developers and technicians by directly creating seven new jobs on the product development team.

Increased local assembly

The project helped Innovex to identify opportunities for local manufacturing of its electronic hardware. Originally, Innovex used a third party in China for the manufacturing of the electronics. The 60-day delivery lead-time led to several delays and 30% of the goods received were defective and had to be repaired by a local team before being deployed to clients. Innovex received funding to set up a local electronics facility in Uganda, which is fully functional, offers increased employment in local communities and means that parts can be manufactured much faster.

WHAT DID WE LEARN?

The need for collaboration to create standards for production

Innovex found that local product manufacturing in Uganda was nascent as local product certification seemed to be very limited. Local standardising bodies do not have existing standards for certification of electronic products. The only option available was extremely long and complicated. As a result, Innovex collaborated with the Uganda National Bureau of Standards (UNBS) to start the development of a new standard, and it intends to be certified by 2023. Being unable to locally certify products is a critical barrier to local electronic product development. Alternative testing and certification, such as in Europe, is expensive and beyond the capital investment of local entrepreneurs. Therefore, there is an incentive for regulatory bodies, and companies such as Innovex, to collaborate in order to develop and strengthen these standards.

The opportunity in locally-led research and development

Imported products and solutions dominate the solar industry, with little contribution in product research and development by local innovators. As a result, local innovators largely do not participate in the high value-creating activities. During the project, Innovex received lots of support from local solar companies, as many saw it for the potential it could create in the supply chain landscape. There is still a need for wider industry collaboration, to bolster research and development in local solutions.
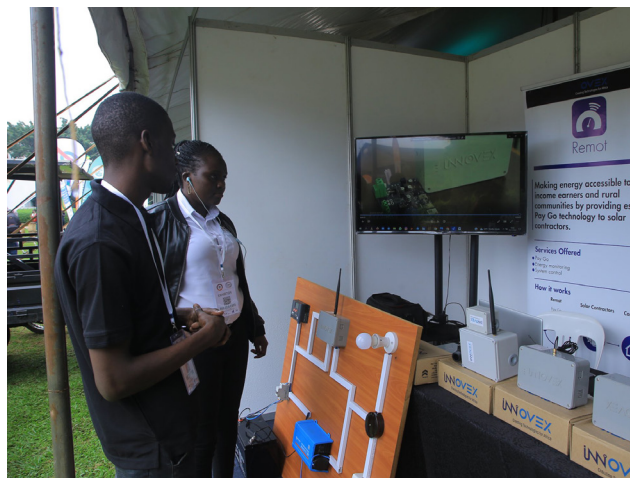
Scaling across Africa

Over the life of the project, Innovex commercialised REMOT. At the beginning of 2021, Innovex raised a pre-seed round and hired a full-time sales team for the first time. This further strengthened sales and business development operations in Uganda. At the close of 2021, Efficiency for Access coalition member, Water and Energy for Food programme, selected Innovex for financial support, enabling the scale-up of REMOT into the agricultural space in Kenya, Tanzania and Nigeria.

Innovex is building closer relationships with manufacturers to make their equipment IoT-enabled. With the additional support from the Efficiency for Access Research and Development Fund, Innovex is well placed to provide a one-stop API to enable them access added services such as mobile money, USSD, SMS and telecommunications integrations for internet connectivity.

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