

EFFICIENCY FOR ACCESS RESEARCH AND DEVELOPMENT FUND: INNOVATOR SERIES

STANDARDS-BASED SOFTWARE FOR SECURE COMMUNICATION BETWEEN OFF-GRID DEVICES



Photo: Futurepump

SMART APPLIANCES AND THE NEED FOR DIGITAL COMMUNICATION

More than half of people living in Sub-Saharan Africa lack access to electricity. High performing, solar-powered appliances, such as solar lanterns, solar home systems (SHS), and solar water pumps, can be viable solutions to increase energy access. However, appliances can still be unaffordable to run for people in off-grid settings. Pay-As-You-Go (PAYGo) financing, integrated into 'smart' appliances, can be an effective and inclusive tool for increasing energy access in low-income and off-grid populations, as users pay for what they need in affordable instalments, overcoming barriers around upfront costs.

Smart appliances incorporate an ever-growing set of features that rely on digital communication. Consumers can connect to devices through digital handsets, such as in app-driven media systems. Devices can also talk to each other, such as smart lighting systems, and companies can talk to devices through smart utility metering.

In the solar-powered appliances sector, this type of device-to-device communication can allow data to be shared and collected to enable smarter system features for end-users. Remote digital communication with devices can reduce the cost to service, troubleshoot or maintain devices for distributors.

To date, digital communication in the PAYGo solar sector has been implemented through centralised messaging with individual devices. As consumers acquire more devices or appliances, the individual management and payments for each device can become complex for consumers and expensive for PAYGo providers.

DID YOU KNOW?

Around 25 – 30 million people gained energy access with PAYGo models between 2015 and 2020.



ANGAZA

Based in California and Kenya, [Angaza](#) enables financing for life-changing products for consumers in emerging markets. Angaza software allows product distributors to digitise their data, automate their operations, and rapidly scale their last-mile distribution businesses.

To date, Angaza has enabled over two hundred last-mile distributors across 50+ countries to sell millions of affordable, life-changing solar products and appliances in low-income communities.

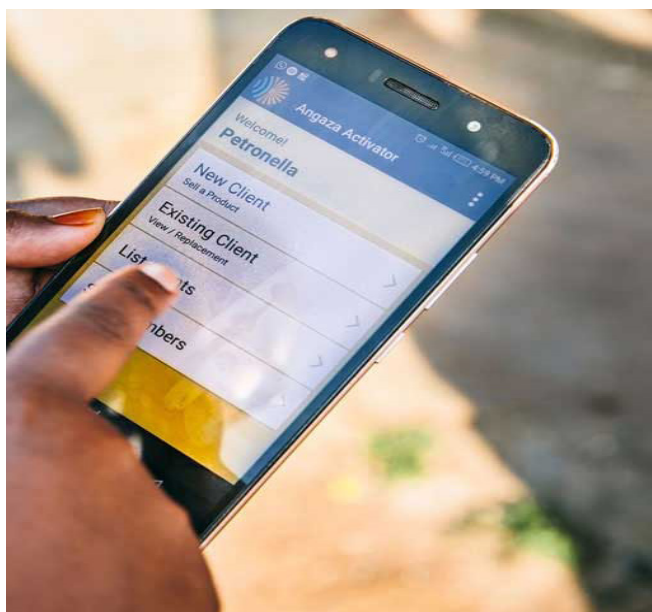
ANGAZA:

"Working with the Efficiency for Access Research and Development Fund made Nexus Channel possible. The Fund's support allowed Angaza to develop a comprehensive solution for communicating with off-grid appliances, then distribute it as high-quality open-source software which benefits the entire industry."

– Bryan Silverthorn, Chief Technology Officer, Angaza

DEVELOPING A DEVICE-TO-DEVICE COMMUNICATION LAYER

During this project, Angaza developed a device-to-device communication layer built on open-source standards. This involved identifying and adapting the appropriate standards, implementing them so that they were suitable for off-grid appliances, and building new software to enable the secure communication of data to other appliances and cloud services.



Specifically, this project produced a high-quality embedded library written in portable C, code which can run on any device. It leveraged important standards adopted by the broader IoT industry. The communication layer can be used in different types of off-grid devices such as fans, televisions, smartphones, egg incubators and other appliances. It provides a common language for communication between devices connected via the same SHS. The software can also prevent message tampering or spoofing and any consumer modification of device links (communication / control / accessory relationships between two devices). These security properties make this technology suitable for PAYGo metering, a common requirement for distribution companies working in off-grid energy access.

The software also provides benefits to the end-user. As customers acquire more appliances, the appliances compete for the amount of energy produced by their solar home system. If those devices can talk to each other, they can ensure that critical energy needs, like keeping food cold in a solar-powered refrigerator, are prioritised over less critical appliances. This makes it easier for end users to manage their own energy use.

THE SOLUTION

This situation called for standards-based communication software that could be used throughout the energy access sector for a variety of different appliances. To meet this need, the [Efficiency for Access Research and Development Fund](#) supported Angaza to develop an open-source technology for the PAYGo industry, known as the [Nexus Channel](#). The technology enables appliance developers and manufacturers to incorporate a secure communication link into their products at no cost. The link will allow appliances to communicate and translate data to and from each other, such as PAYGo or battery information, and allow a SHS with several devices to be managed more efficiently. This capability can make off- and weak-grid appliances more useful to consumers and more effectively supported by businesses, ultimately improving both affordability and performance.

Angaza developed this by adapting existing standards from the broader Internet of Things (IoT) industry, primarily using the [Open Connectivity Foundation](#) (OCF) standard, to represent relevant device data and to function on resource-constrained off-grid systems.

Many of these productive-use appliances also generate income or help improve quality of life, including improvements in health and the environment. Micro-entrepreneurs could especially benefit from consumer financing across multiple devices, device-to-device communication, and device-to-cloud data. For example, the technology produced in this project has been embedded into OVO Solar's solar-powered egg incubator model, which is also funded by the Efficiency for Access Research and Development Fund. With OVO Solar's new model, customers are able to increase the capacity of their incubators by adding an additional egg tray. Angaza's embedded technology enables the egg incubator controller to communicate with the expansion units over time. It will allow OVO to easily monitor the PAYGo of the additional units.

WHAT DID THE PROJECT ACHIEVE?

Sharing the software with organisations. After developing the software, Angaza released it on GitHub, an online platform that lets users download opensource code. Angaza released the software in two sources, nexus-embedded and nexus-channel-models. All of the source code is available under a commercially friendly, open-source license, and can be used by any organisation without charge. This means that organisations can leverage the design, reference material, and software libraries produced under this project. Beyond its value to individual organisations, the industry can work toward a shared language for device communication.



Becoming a key component of the Connect Initiative's

Interoperability Stack. GOGLA's Connect Initiative named Angaza's Nexus Channel as a key component of its interoperability stack in its Connect White Paper. This white paper sets out a vision for industry standards for interoperability by creating an 'interoperability stack' – four key elements to create a universal standard for solar-powered appliances in off- and weak-grid settings. The stack named Angaza's Nexus Channel, along with another Efficiency for Access Research and Development Fund grantee, Solaris Off-Grid's Open PAYGo link, as two out of the four key components for interoperability. Angaza worked closely with GOGLA, and this partnership helped to set out industry-wide best practice to increase interoperability in the sector.



Engaging with the Sector. Through the project period, Angaza engaged directly with other organisations involved across the industry. Two commercially available devices have already used its technology to support new product features. Numerous other energy access organisations and manufacturers have also expressed interest and are in talks with Angaza to further explore the technology.

Faster development time for new appliance products due to open-source resources, measured through project R&D activities. Before the project, the baseline for appliance development was around 13 months, but after, products took around eight months or less on average. This was because the software was readily available, rather than a need to code it from scratch. As a result of the project, Angaza demonstrated that these new development times are possible in cost- and resource-constrained settings. Lastly, Angaza demonstrated this technology in a proof-of-concept prototype, then collaborated with a hardware partner to leverage this technology in a new productive-use appliance for the energy access market.

WHAT DID WE LEARN?

Standards for interoperability take time to implement

Although Nexus Channel was identified as key to the interoperability stack, other components are still needed to fully create and optimise an interoperable environment for appliances, such as the connector standard and other electrical requirements. More solar appliance companies need to cooperate and engage to help the transition to a more interoperable market.

There has been a slower growth of multi-device installations than expected

COVID-19 negatively affected the distribution market, and consequently the installed base of larger appliances and multi-device installations and has caused these to grow slower than projected. However, Angaza expects growth to accelerate over the next several years, and this type of communication technology will be an important part of that acceleration.

Enabling more partners through software

Angaza encourages other industry organizations to leverage the software developed in this project. More products, and more partners, will be enabled through this open-source software release.

This work has demonstrated that standards and technologies from the broader IoT industry can enable innovation within energy access. These resources can reduce duplicated work, accelerate product development, and ultimately help move the world closer to the goal of eliminating energy poverty.

GET IN TOUCH:

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DID YOU KNOW?

Over 40% of all sales of off-grid solar lighting products in Sub-Saharan Africa are conducted through PAYGo.

