Travel report Kenya 2016: A visit of the Solar Nano-Grid project

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Background

The Solar Nano-Grid (SONG) project was created as a collaboration between the Universities of Oxford and Loughborough and the not-for-profit organization Intasave, and aims at providing people in rural Kenya with access to electricity. The concept is based on a central charging station – the hub – and small, portable battery units, which can easily be carried to people’s homes where they are used to charge mobile phones and power lights as well as other small electronic devices. Apart from offering basic access to electricity, the project also provides services at a communal level in the hub, such as a mill for milling maize, the local staple crop, and chicken egg incubators. These services are meant to boost the community’s economic output and help finance the project. A second source of income for the project are small fees for charging the portable solar batteries. Two nano-grids were installed in the villages of Echariria and Lemolo B, in the Nakuru region of Kenya with a total of 150 portable batteries.

Figure 1: The solar hubs in Echariria (left) and Lemolo B (right) with technician Duncan (left), Carolyn and Damien (center) and Loise (right).

My involvement in the project was in the design and manufacturing of the portable solar batteries – the ionQube. The ionQube was designed in the Energy and Power Group, at Oxford’s Department of Engineering Science by Damien Frost, Adrien Bizeray, Robert Richardson and myself. The batteries use state-of-the-art lithium ion cells in order to ensure light weight and long lifetime, and they are modular, which means that multiple battery units can be connected together in order to meet growing energy demands in households or businesses. Based on this battery design we have created the spin-out company Brill Power, together with our supervisor David Howey and Carolyn Hicks, a graduate of the MBA program at the Said Business School.

This report gives an account of our first trip to Kenya, for which we defined three main objectives:

1. Technical support: teaching the local technicians how to maintain, repair and upgrade the batteries.
2. Collection of user feedback: talk to the users of the portable batteries to find out about usage patterns, as well as strengths and weaknesses of the design.
3. Market research: find out about Kenya’s energy market to feed in to the next generation of solar batteries.
The trip

The journey included three days of field work – two days in Echariria and one day in Lemolo B – followed by two days of meetings and site visits of companies related to Kenya’s energy sector, in Nairobi. I was accompanied by Damien Frost and Carolyn Hicks. Our local contact was Jon Leary, researcher at the University of Loughborough. We arrived in Echarira on Monday, 5\textsuperscript{th} of September, where we spent the first two days of our field work. We were kindly offered to stay at the home of Naftali (Figure 2), the watchman of the hub. Damien was in charge of the technical support, while Carolyn and I went to visit battery users in their homes to collect user feedback. We also took part in a meeting of Echariria’s Village Energy Committee (VEC), which represents the communities’ SONG users and will take on the management of the facilities once the project has reached financial feasibility. At the meeting we updated the committee members on recent project developments, the purpose of our visit, and held a Q&A session where we answered questions related to the portable solar batteries.

On Wednesday, 7\textsuperscript{th} of September, we moved on to the second community, Lemolo B, where we stayed for one day, performing the same tasks as in Echariria.

On Thursday, 8\textsuperscript{th} of September, we went to Nairobi, to attend meetings with representatives of Burn Manufacturing, a local manufacturer of low energy cooking stoves, and M-Kopa, a provider of solar home systems. We also visited the iHub, an incubator space for Kenyan start-up companies.

Technical support

Damien taught the technicians good practices in electrical engineering work, such as soldering and trouble-shooting on printed circuit boards (Figure 3). We brought equipment for the workshops in the hubs from the UK, such as a soldering iron, multi-meters and electrical components for replacements and fixes, funded by the University of Loughborough. One of the main technical issues was due to excessively high voltages of the charging hub, which broke some of the ionQube batteries. Damien taught the technicians how to diagnose this problem and how to exchange the components, in order to repair the batteries. A second frequent issue was over-discharge of the batteries, which happened if the users did not turn
the batteries off once they reached a very low state of charge. To mitigate against this problem, Damien taught the technicians how to install buzzers, which would sound if the batteries are at a very low state of charge, reminding the users to turn their batteries off. Finally, the technicians were taught how to update the batteries with the latest software updates, which they receive via email.

![Figure 3: Left: Damien teaching technicians Peter (front), Laban, William and Duncan (back) troubleshooting on the solar batteries in Echariria. Jon Leary of Loughborough University (right) installed the hub systems. Right: The personal lockers in the hub, where users charge their ionQube batteries.](image)

**Collection of user feedback**

Carolyn and I interviewed a total of 17 battery users in both villages, in order to learn more about the way our batteries are used, to find out about the strengths and weaknesses in the design and to collect data for our next generation battery. We were warmly welcomed in every household we visited. Our friend Evan made these interviews possible by acting as a translator. Below is a list of some of our key findings.

**Common findings between both communities:**

- The battery capacity is too small; people would prefer to recharge their batteries on a weekly basis, rather than every second or third day (as is currently the case).
- Both communities are subject to an electricity grid expansion project, run by the Kenyan government. However, the people expect the electricity service provided by the grid to be intermittent and of poor quality and would therefore like to maintain a battery for backup power.
- Few people use the central hub services (milling and chicken egg incubators), which results in an underutilization of the electricity generated by the hub. Alternative strategies of integration into the communities should be considered for future hub-based systems, such as integration with hospitals, schools or water pumps.
- The technicians in both communities are skilled, resourceful and experienced in repairing electronic devices. This knowledge is key for the creation of the next generation of batteries, which could be designed in a much more user maintainable fashion in order to facilitate maintenance and repairs.
Findings specific to Echariria, the wealthier of the two communities:
- Many users want the possibility to recharge their batteries in their homes, using small solar panels.
- People want the possibility to power a TV set with their battery.
- There is a need for education in electrical installations; some people connected solar panels with lead acid batteries without charge controllers and of mismatched voltages, raising health and safety concerns (Figure 4).

Findings specific to Lemolo B:
- Some people expressed an interest to use electricity for small businesses, such as a salon, printing pictures for sale and tools for construction work, if they had access to batteries with higher energy storage capacities.

Figure 4: Homemade setups involving lead acid batteries, solar panels and electronic devices, which constitute potential safety hazards.

Figure 5: Carolyn and Christoph at home visits of battery users (left) and conducting interviews at the hub in Lemolo B (right)
Market research

Our third objective was to gain a better understanding of Kenya’s energy industry. We accomplished this partly through our interviews in the two communities and partly through our meetings with Kenyan businesses in the energy sector, such as Burn Manufacturing and M-Kopa. Some of our key learnings can be summarized as follows:

- Despite Kenya’s aggressive grid expansion projects, the demand for backup electricity systems is likely to remain due to the expected unreliability of the grid.
- There is a market for kWh-scale battery energy storage systems but the margins on products are small.
- Payment plans to purchase solar home systems with small daily or weekly installments are a popular mode of finance, as demonstrated by M-Kopa, who also provide cooking stoves and water tanks.
- Close relationships with customers and their communities are key to successful electrification projects.

Conclusions

The trip was a great success and we met all of our objectives. In my opinion, it is crucial for researchers, engineers and product designers to personally engage with the people who use their products or services. This was demonstrated by our trip, through which we gained information we could not have accessed otherwise. On a personal level, it was extremely encouraging to witness the positive impact the project has had on people’s lives. However, we also learnt first-hand about the hardship that people are facing who do not have access to basic necessities such as water, electricity and medical care. The trip was inspirational and eye-opening and has left a lasting impression on me, which will play a significant role in my future projects.

I would like to take this opportunity to thank my kind sponsor, Mr Gilardini and the Gilardini Foundation for their award of the Pier Giorgio Frassati Scholarship, which made this trip possible.