REPIC

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

State Secretariat for Economic Affairs SECO

Swiss Agency for Development and Cooperation SDC

Federal Office for the Environment FOEN

Swiss Federal Office of Energy SFOE

Final Report:

---

hiLyte cubes

Renting of Solar-recharged, Smart and Affordable Power banks

Authors:

Briac Barthes, hiLyte
David Lambelet, hiLyte

Date of the Report:13/04/2023	Contract Number: 2021.06
Institution: hiLyte Sàrl	Country: Tanzania

Prepared by:
hiLyte Sàrl
Rue de la Pierre-à-Mazel 39, CH-2000
contact@hilyte-power.com

With the Support of:
REPIC Platform
c/o NET Nowak Energy & Technology Ltd.
Waldweg 8, CH-1717 St. Ursen
Tel: +41(0)26 494 00 30, Fax: +41(0)26 494 00 34, info@repic.ch / www.repic.ch

The REPIC Platform is a mandate issued by the:
Swiss State Secretariat for Economic Affairs SECO
Swiss Agency for Development and Cooperation SDC
Federal Office for the Environment FOEN
Swiss Federal Office of Energy SFOE

REPIC

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

State Secretariat for Economic Affairs SECO

Swiss Agency for Development and Cooperation SDC

Federal Office for the Environment FOEN

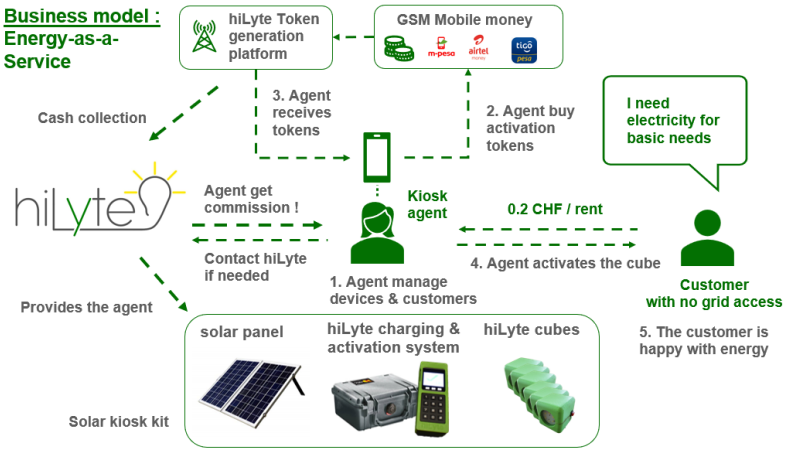
Swiss Federal Office of Energy SFOE

Contents

1. Summary

A billion people don't have access to the electric grid, and spend up to 30% of their income for light and phone charging. According to the WorldBank, in Sub-Saharan Africa, almost 90% of people own a phone but only 40% of them can charge it at home. That means half of the population owns a phone but can't charge it. These are the problems that the REPIC project address. Following our field experience in Tanzania, the company developed the hiLyte cube, which is a portable smart power bank that embeds a powerful LED and high capacity battery. It can provide lighting to a household during one or two full evenings and to charge simultaneously up to two phones. The cubes can always be recharged locally in a solar kiosk equipped with a PV charging system installed by hiLyte. After several years of activity in Tanzania the company has received precious feedback from people in the field that were used to design a product that fits their needs. Good quality solar products are expensive and the challenge linked to immediate electricity access is "how to enable the target market to have access to clean & affordable energy" and to our cubes. The business model of hiLyte that replies to these needs and economical constraints is the following:

- Find villages where most of the people have no electricity and cannot afford reliable solar systems
- Install a solar kiosk kit in a shop in the village and provide 20-25 cubes.
- The shop charges and rent the cubes to customers. Thanks to a security system based on mobile money payment, the cube is activated from the time the customer takes it and until the end of the location. That incentivises the customers to bring back the cube to the shop.



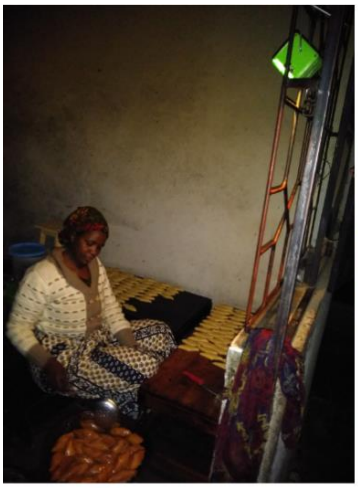
The REPIC project enabled the development of 12 solar kiosks, each of one managed by a local agent and the distribution of 250 cubes lamps distributed in the Manyara region. The product was developed by hiLyte Sàrl. The cubes were manufactured and tested by the Tanzanian team at hiLyte's office in Arusha with a local team who was trained on the 3D printers, Arduino coding, and the PCB design of the lamps. PV panels, charging systems and the cubes are then set-up in villages around Arusha. A map of the different villages and their access to electricity was drawn with more than 100 remote villages of the Manyara region evaluated for kiosk multiplication. While building the map, the hiLyte employees was looking for potential new agents and taking their contact. Once a new kiosk was ready and a village targeted as interesting for hiLyte, the employee would go to the village, install a solar kiosk at the agent's shop, and explain to the agent how the renting works. A weekly phone contact was maintained with agents that manage the kiosks and a monthly visit was organized to keep a good relationship with the agent and solve the problems that could arise.

At the beginning of the REPIC, for the first few months, the project was well on track with new solar kiosks deployed, with cube renting rates around 50% and the milestones were achieved rapidly. However, after a drought[1] that impacted rural areas of Tanzania in the end of 2021, the renting rate decreased to 15% and revealed key weaknesses of the hiLyte model. It made it very difficult for people living with agriculture to stay in the villages. Thousands of cows died, crops in the fields didn't bring the expected yield, fishermen left villages. This drought during the project made us figure out how much a model that deals with low-income people is directly dependant on their daily situation, and how difficult it is to lower this risk for a company. Despite our effort to keep as much as possible the project on the track, the cumulation of this crisis with the other challenges faced in 2022 brought us to the conclusion that the model is not resilient enough. With a model not scalable enough and the other solar solutions available on the market more and more competitive, it has been decided not to pursue further the development of hiLyte. Through this report we also hope to share our rich learnings gained throughout the project.

[1] https://www.aa.com.tr/en/africa/fighting-drought-tanzania-faces-loss-of-62-000-livestock/2482330

2. Starting Point

Before the start of the REPIC project, a first generation of the hiLyte cube and solar kiosk kit was already developed. Around 60 lamps were distributed to 3 different agents installed with hiLyte solar kiosk and the business model was validated at micro-scale by achieving a renting rate higher than 50%. Moreover it was shown with that the Cube renting from solar kiosk were stable over months which was an important milestone achieved to prove customer satisfaction. However, the size of the pilot project was too small to prove the scalability of the solar kiosk model. The REPIC project was therefore an important opportunity to realize a pilot project at larger scale to test the model and its potential as a solution to address the electricity access issue in Tanzania.

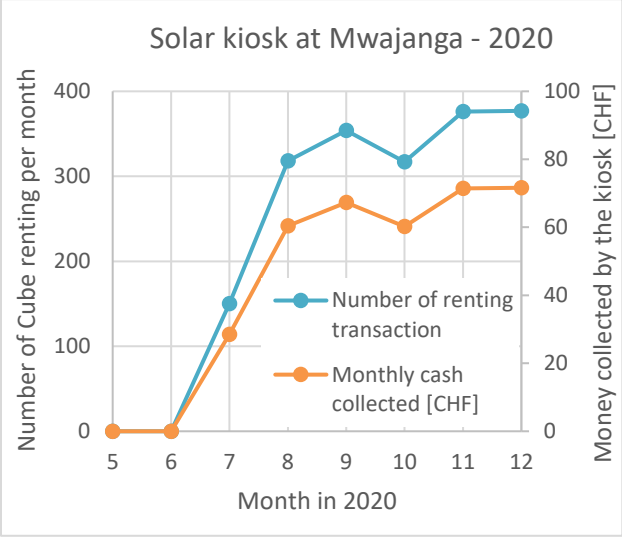


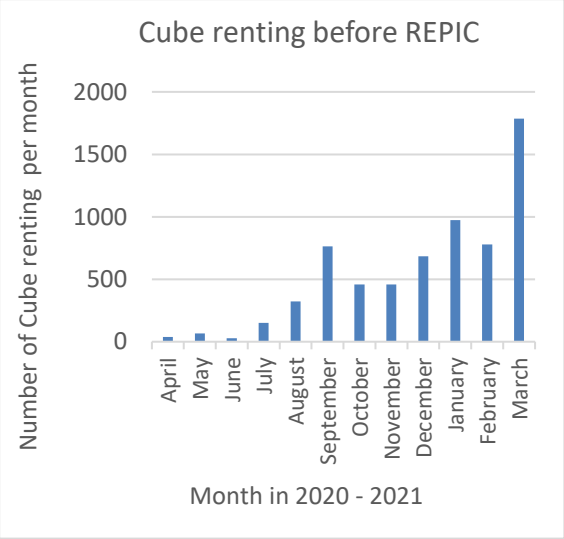
Home users

Street seller users

A customer bringing back the cube at home

The software system to rent and activate the cubes with "tokens" was partially developed to be able to run the first pilot and track the renting rate of the cubes as seen below. However there was no interface and easy way to manage the agents for the Tanzanian team.





Our employee Evarest setting up the solar panel at agent and making a last "health check" of the charging box.

Hilyte Tanzania had already one employee who had been trained on 3D printing and was learning about solar energy and PCB manufacturing. Besides, at the start of the REPIC, despite having a clear idea of the need of solution for off-grid electricity solution, the company had no real mapping of the off-grid villages targeted. It was not known where they were, and how deep it was needed to go to find the villages where the solar kiosk could be installed. Indeed while Tanzania had a very little access to electricity, president Magufuli worked very hard on the REA (Rural Electrification Authority) project to bring electricity in all villages. Therefore we had to find villages with the following criteria:

- No access to the grid electricity (and not planned in the next 2 years)
- People coming to the village regularly, to give the lamp in the morning and take it back in the evening
- Access to the phone network not too far for the agent to be able to buy tokens and activate the lamps
-

3. Objectives

The company's main objectives through this project were to enable people in villages to get light and charge a phone in a cleaner and more affordable way as well as proving the scalability of our model in order to attract impact investors which would allow us to scale-up in Tanzania and other Sub-Saharan African countries.

With further understanding that the target market where we can have an strong impact was not just " people who don't have access to the electricity grid" but also and more specifically "very-low-income people living with no access to electricity whatsoever", the development started to be more focused on the Manyara region, an area where demographics fit better with hiLyte's target market.

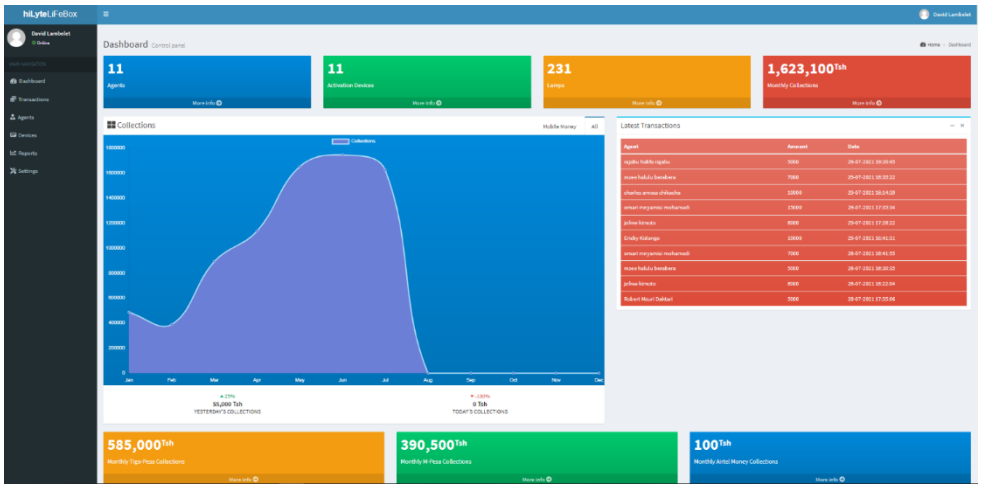
The different outputs hiLyte was looking for in this project were:

- How long does it take to train a person to assemble the devices?
- How many cubes & solar charging boxes can be assembled per day by one person?
- How efficient are the distributors after the 2-week training? What size of region can he handle?
- How many agents can a distributor follow-up with to ensure optimal services?
- What is the size of stocks needed so that everybody can keep working well?
- Get data to understand the use of the cubes and PV system energy production for lean improvement
- Assess users & agents satisfactions, build customer trust with the hiLyte branding.
- Is the business interesting enough to attract impact investors?

4. Project Review

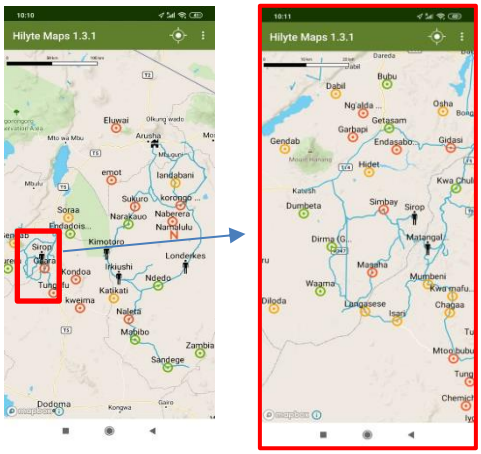
4.1 Project Implementation

- In order to be able to monitor closely the project, the cubes renting and follow the different agents owning the hiLyte solar kiosks, a software interface to monitor the cube renting was developed. It allowed us to 1) register the agents 2) accept payment from MPesa, Airtel Money, or other mobile payment systems 3) generate and send SMS to the agents with encrypted activation codes (tokens) proportionally to his payment amount 4) monitor the number of tokens purchased.



- 200 cubes were manufactured with the version 2 of the electronic boards (PCBs) designed with the Swiss team. Despite the PCBs (electronic boards) that arrived with technical issues for the first batch of 100 PCBs, due to a weakness of an electronic chip, the Tanzanian team worked to find a solution to use them. In parallel, the Swiss team worked on fixing the problem at the root for the next batch of the PCBs. After several iterations, long testing and all the problem fixed, the 200 lamps were ready to be deployed in the villages which allowed to reach the first milestone of the REPIC project targeting 1500 renting per month.

- Another important step for the project was to map the villages and check where are the roads to go there, how many people would live in each village, how do they get light and charge their phones, do they have access to the phone network. An app designer built an app that would not need the network, but would save the GPS points of were the person passed, and in each village save all the data needed to know what happens in this village. 2 people were hired to ride a motorbike in the Manyara region, saving all the off-grid villages visited. This enabled us to understand better where was the marker we were targeting, how far they were, and to have a first contact with potential agents in the selected villages.



- When the lamps were ready, hiLyte employees would know where to go, install the solar panels, give a set of lamps to the agent, and explain him how to rent them and make additional incomes from their shop. This

hiLyte team visiting a village

Rehema installing a PV panel

Briac discussing with an agent

was widely accepted and liked, people in the villages were very happy with the new service they could propose to customers. In the villages near Dodoma, we discovered a Japanese company already present and having the same lamp renting model : Wassha[2]. This was an interesting surprise as our prototypes would be tested against competitors right from the beginning. As the battery of the cube is bigger (7000mAh instead of 2500mAh) and the light brighter, many customer switched to hiLyte lamps.

- Once all the lamps were distributed in the villages, an employee had a call with the agents every day to make sure everything was working fine, to motivate them, to get feedback and to better understand the feeling of customers regarding the lamps. Even though the feedback was really good and motivating, the 3D printed cases were not solid enough and the monitoring was showing that the average renting rate was not high enough for the company to be financially viable (70% renting rate was targeted, but the actual renting rate was more around 50%). When the 3D printed case fails, usually after few months of use in the field due to the harsh environment, the cubes at the kiosk were replaced and then repaired at hiLyte office with a new printed case. The robustness of plastic case was the main failure observed in the field, cable disconnection and electronic chip failures were also observed a few times.

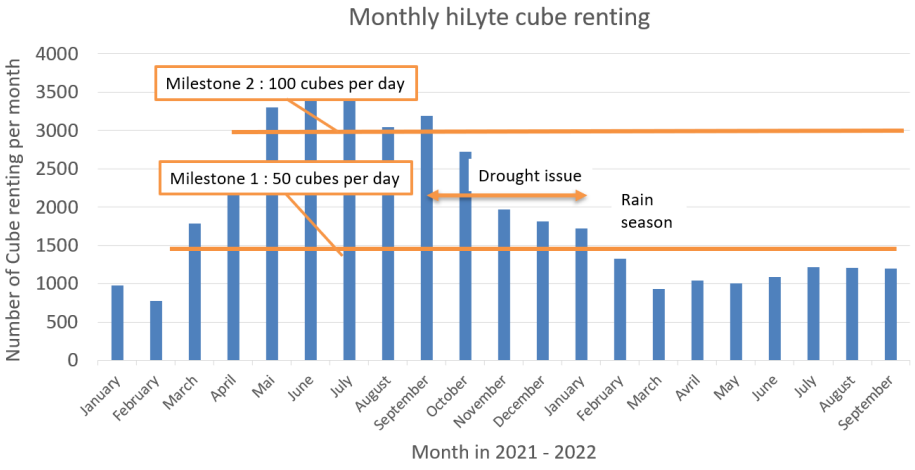
- In parallel of the work in the field to deploy and maintain the solar kiosks, in a period where hiLyte employees had more time available, they went to study at the Arusha Technical Collage and took part to the solar training program. It was a great opportunity for them to develop further their skills about solar energy and to share their experience with our solar kiosk installation. They came back with a certificate that they will be able to use if they look for another job in solar energy later, and had the opportunity to grow their network in the solar industry in Tanzania.

[2] https://wassha.com/en/

- In parallel of the deployment of the first 200 cubes with the PCB version 2, a new version, the PCB version 3 was developed to have a design ready for mass-manufacturing with all the functionalities (microcontroller, power management, battery protection circuit, etc) included on a single board. The design was also developed to improve the reliability of the PCB and to ensure that the technical issues encountered with the series 2 would not appears again. The two iterations of the PCB version 3 took approximately 1 year (PCB design, manufacture of 20 pieces, sending them to Switzerland and Tanzania for tests), and we finally decided to order another 200 pieces for a bigger test of the PCB. The manufacturing usually takes 3 months including shipping and passing customs in Tanzania, but with Covid-19 and the issue related to the electronic components supply that the industry faced, it took much more time, around 6 months per iteration. Indeed the Indian PCB designer with who hiLyte was working from the very beginning of the project and who was manufacturing the small series, was waiting for a very long time before receiving the component to build the PCBs. Once he finally could manufacture the PCBs, he was testing them and sending them to Tanzania.

- In November 2021, the drought[3] started hitting Tanzania. For our agents, it was a catastrophe. In the villages where there were a lot of fishermen, everybody left and the village passed from 800 to 20 people living there. In the villages where people would work a lot with the cattle, most of the animals died and there was a smell of death everywhere we would pass on our way to these villages. The people left the villages and came to town looking for other jobs. In the villages where people were cultivating, without water they couldn't work and people were leaving the villages to find another way of living. At the same time, in the villages where Wassha, our Japanese competitor, was present, they brought a new lamp that had a bigger battery and a brighter light, so that they could compete with us. This enabled them to take back a lot of their customers, and in those villages we were left with 20% of the market share. We pay better our agents than Wassha, so the agents are more motivated, but the customers like novelty so they choose the latest one who came in their village. Besides the 3D printed cases were not solid enough and that is something customers didn't like from our lamps.

- All of this made the renting rate decrease to approximately 15% where it stabilized. This is not enough to be scalable and attract any impact investing fund in the project. It was decided to close hiLyte Tanzania and to transmit the assets to the 2 main employees who could keep running the company as "micro-entrepreneurs" following their interest to keep running the kiosks, and without having to carry the administrative heaviness of the company, such as annual audits and tax declarations. Therefore while they were still working on renting as many lamps daily, those two employees were trained on the overall running of the company. An model document helps them having an overview of the whole company with Excel, to run the companies with reduced cost (e.g. not having to pay for our server). The objective is to keep improving the renting rate with the actual kiosk deployed and distribute the next 200 lamps when they are ready.



[3]https://www.aa.com.tr/en/africa/fighting-drought-tanzania-faces-loss-of-62-000-livestock/2482330

4.2 Achievements of Objectives and Results

The project was separated on different phases. The first phase consisted in developing the product up to something we could mass-manufacture easily. This was achieved on the PCB side, and the plastic case design was improved. But the plastic case was not validated and we did not start mass manufacturing.

On the first phase, the mapping of villages was completed, people trained about solar energy, lamp manufacturing, PCB repairs, 3D printing and product assembly. 250 lamps were brought in the field in different villages. A payment and monitoring system was developed, enabling us to better monitor the renting rate and understand how the lamps were used. This monitoring system helped us to detect rapidly failures, for example when there was a problem with battery pack in the solar system of the kiosk. It also enabled us to see the time at which customers were bringing back their lamps and making. For example, in a solar kiosk, people were bringing back the lamp late and leaving not enough time to have them recharged before sunset (the battery acting of the solar system acting only as a small energy buffer for clouds). In that case, thanks to the monitoring system, we could ask the agent to make sure customers bring their lamp earlier so that they have more time to be fully charged in the evening.

Because of material supply delays, the timeframe of the project faced important delays. This has also led to increased fixed costs that didn't help the project growing as expected but that were mandatory to continue the project. The revenue of the lamps already in the field was not high enough to be able to provide the necessary incomes to run the company as it was (e.g. high fixed cost of server, audits, etc). The delays, the low renting rate and the difficulties in the field showed us that the project as it is will not be financially interesting for venture capitalists, which we would need absolutely if we wanted to keep the company growing. That is the reason why it has been decided to stop the project where it is and close the company. However the two local employees want to continue to run the solar kiosk and will make a living out of the actual activities (achieved by cutting the fixed costs of the company office, lawyer, government, fixed salaries) the project will continue with them running it. That is already a nice result we can be proud of, 12 villages and 250 households having access to light and phone charging in rural area.

4.3 Multiplication / Replication Preparation

As the project's aim was to grow up to mass-manufacturing, tools have been developed to be able to map easily villages, and distribute to local agents in the villages in a fast way. However after deciding to close the company due to the lack of scalability but to keep open the existing solar kiosk and to keep renting the existing lamps, a new tool was developed to make sure the employees could keep running the project with lower operational cost (e.g without having to pay for a costly server).

The two employees who will continue the company were prepared to take over the activities, they know all about the project as they have been there since the beginning, were trained on the devices and knows how to assemble or repair the lamps. They also have the map with all the villages of the region hilyte is working on, with the contact of a potential agent in each interesting village, and they can further optimize the distribution of the lamps kiosk by kiosk to make sure the renting rate is good enough for them to be profitable.

4.4 Impact / Sustainability

During the project, solar kiosks were installed in 12 different villages. In each of this villages, 10 to 30 lamps are charged and rented.

Ecological	**Unit**	**At the REPIC Project's Completion**
Installed renewable energy capacity	[kW]	5
Renewable energy produced	[kWh]/year	8000
Amount of fossil fuel energy saved	[kWh]/year	1195
Greenhouse gas reduction	[t CO_2-eq]/year	15
Newly collected and separated waste	[t]	0
Newly recycled waste	[t]	0
Economic		
Energy costs (LCOE)	[ct/kWh]	20
Triggered third-party funding/investments	[CHF]	0
Local private income generated	[CHF]	9'000
Social		
Number of beneficiaries	[Number]	250
Number of new jobs	[Number]	15
Number of trained personnel	[Number]	4

5. Outlook / Further Actions

5.1 Multiplication / Replication

As we saw that the project cannot be multiplied further, we decided to stop looking for further funding for project replication. The project in place will keep running and focus on villages where the need for off-grid lighting and phone-charging is the highest.

5.2 Impact / Sustainability

Without scalability, the impact achieved is not as big as desired at the beginning. However the project is still bringing impacts on several aspects. The first impact of the project concern the 250 customers who stopped using kerosene lamps and rent the hiLyte cube regularly. They got a better, stronger and safer light as well as being able to charge their phone to stay connected with people. We could see Massaï farmers walking with their cows and having their phone charging with the cube. Women who could cook more easily in the evening. Children who study with the light or women using hiLyte lamps to sell vegetables in the evening. The second impact concern the people involved on site with the development of hiLyte and the REPIC project. 2 people employed full time with the activities and fully trained on installing & maintaining solar system as well as assembling or repairing lamp or solar lamp. Besides, 12 agents were trained on the basics of solar energy and are currently renting the lamps, and get a part-time equivalent salary. The third impact is the key learnings on starting an off-grid energy company that deals directly with very low income people in Africa. A legacy that we are happy to transmit further. A business case study concerning "low-tech impact start-up" was written by a lecturer from the University of Neuchâtel and used for university courses (c.f. references). Cofounders are also eager to help new entrepreneurs developing their ideas and sharing our experience. Two of the three hiLyte cofounders are now working in solar energy in Switzerland, applying its rich learnings daily, three previous interns are currently working in the field of renewable energy in Switzerland and our last intern is now working on access to electricity in Madagascar.

6 Lessons Learned / Conclusions

The entrepreneurship journey of hiLyte and this REPIC project was difficult but very interesting, despite having to end with a very difficult decision for the team. Many lessons are to learn from this experience for new projects to be able to thrive through the jungle of energy access entrepreneurship in Africa.

The first big mistake that we did is that we tried to reinvent too much the wheel. Indeed the whole project was about a lamp with a bigger battery, an embedded software to control it, and a solar charging system to enable the recharge of many lamps with one big solar panel. All of this already exists but not in the specifications we considered ideal for rural Tanzania. It would have been much easier for hiLyte to deploy customized products rather than creating a new product from scratch. Iterating takes a lot of time and prototypes are not as good quality as products that can go to market. Building the software is always easier than building the hardware.

As we were assembling everything in Arusha, we needed to get all the components to the plant, which was also very complicated. Delivery companies had a lot of difficulties following up with the packages, and several time it got lost between the supplier and Arusha. Customs also gave us a very hard time, raising the value of the goods trying to make us paying more than the needed taxes, or keeping the packages for months. Covid didn't help as delays before shipping were already very high and we wasted a lot of time waiting for supplies to manufacture new lamps to distribute. We should have developed a slower timeline to be able to respect it and taking into account all possible delays. As much as possible, we strongly recommend to find a partner that manufactures the whole product for you, it makes the process easier and less risky.

Power cuts also impacted the company. When hiLyte was started, electricity in Arusha was really good and power cuts were coming approximately once every two weeks for half a day. President Magufuli pushed for an electrification of the whole country without pushing for a big enough increase in electricity generation. Therefore in 2022 there was a power cut almost every day, which would make it difficult to work. The company had a generator and the whole lab was working with a solar system but the power cuts still impacted us, for the maintenance of the existing cubes and manufacturing of the new lamps as it needed 8h of uninterrupted electricity to print the prototypes.

The balance between the need, the power of purchase, and the quality is really difficult to find. Nowadays the off-grid energy market in Tanzania is saturated, mainly with pay-as-you-go systems and cheap low-quality solar lamps. People know differences between the systems and the brands, they do look for quality products. Renting lamps is not something that customers dream of, they hope that one day they won't have to pay for their light, and hiLyte couldn't position itself as the dream product for our customers.

Another point that was also underestimated is the challenge of "last mile distribution". hiLyte's customers live far from any good road and infrastructure. Getting to them is really difficult and transportation was from far the main source of costs and working time. Any problem with these customers is very difficult to handle, and even new products could arrive not working because of the bumps of the road. It is something to know beforehand and manage with good transportation means.

Finally, our customers are low-income people who live on a day-to-day basis and that don't plan on the future. If the people who are supposed to bring a regular revenue can decide from one day to another that they don't have enough money to spend it on electricity, the company's plan can fall rapidly. This challenge was known from the beginning, but it was thought that the business dynamic at the community level would compensate individual difficulties. However in our project experience, when the drought happened, the difficulties were just multiplied to everyone in the community, ending up in a situation where few people had little extra-money to pay for lighting, revealing the main weakness of our model. For a company to be financially sustainable, customers need to be reliable, and for low-income people, the only way to do that is to sell once the product.

7 References

Tabares, S. & Reuter, E. 2022. hiLyte: Growing a Business That Provides Clean Electricity Access (A). Case Center. https://casecent.re/p/187531

Tabares, S. & Reuter, E. 2022. Teaching note. Case Center. https://casecent.re/p/187532

Tabares, S. & Reuter, E. 2022. hiLyte: Funding a Venture Providing Electricity Access (B). Case Center. https://casecent.re/p/187533

Tabares, S. & Reuter, E. 2022. Teaching note. Case Center. https://casecent.re/p/187534

Reuter, E. & Rabilloud, A. 2023. HiLyte and the commercialization of sustainable technology. Accepted for publication in Sustainability Strategy: A Systems Approach, édité par Kanashiro, P., Neesham, C., Siqueira, A. SAGE.