TECHNO-ECONOMIC FEASIBILITY STUDY

INITIAL PILOT OF THE "POWER-BLOX" TECHNOLOGY FOR THE LELEPA ISLAND COMMUNITY IN VANUATU

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Contact Sheet

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A Executive Summary

The wonderful Lelepa island, part of the Roi Mata's Domain and a UNESCO World Heritage Site, is interesting not only in its culturally important role, but also in its development potential. As part of the Prove of Concept project (POC), the project team was able to carry out an initial infrastructure test with its innovative swarm technology and equip five buildings on the island with solar power based on a Flex-Grid[1] meter based mini-grid.

The project has shown that thanks to the modular and simple technology, a solar power project can be carried out in the shortest time and with minimal preparation. In the specific case of the POC, the practical work consisted of a one-day site visit and a two-day installation phase. After the installation, conventional alternating current was immediately available to the residents and has since been used actively by the local population.

The technology was very well received by the local population. The simplicity (comparable to a diesel generator) and flexibility were highlighted. The pay-as-you-go approach was also welcomed and the tax of 450 VT per month for a basic service was considered reasonable.

We would recommend continuing the project by electrifying the entire island as proposed in this study. However, after the very positive result of the POC, we would also recommend examining the application possibilities for further projects, since the application possibilities go much further than could be tested in the area of the prove of concept and could substantially stimulate the economic potential of other villages.

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[1] Flex-Grid is a special concept based on Power-Blox and the Smart-Meter technology developed by www.flex-grid.com, which allows billing on a pay-as-you-go basis.

B Background

UNDP support the Ministry of Climate Change in Vanuatu (cced Director General & Director, Energy) in the field of island electrification.
As part of this support, the Ministry of Climate Change now wanted to test the swarm electrification approach for the first time as part of the electrification of the small island of Lelepa Island. The island has around 80 to 100 households (in a cluster) along with a school and church.

B.1. Scope of work

The scope of the project is to carry out a first feasibility study on the use of the innovative swarm technology for the electrification of rural villages on the islands of Vanuatu's.

The feasibility study of the project consisted of a preparatory joint visit to the island, together with the Vanuatu government and the local implementation partner PCS Limited. In the first visit the following questions had to be clarified:

- Which first buildings are to be electrified?
- What is the expected energy demand of the buildings/customers?
- Which building can be used around the infrastructure (Power-Blox, fuse boxes, solar panels, monitoring equipment)
- Drone-mapping of the terrain
- Photo documentation of the buildings and local situation

In addition, a number of further questions had to be clarified and a small pilot plant was installed. This should demonstrate the practical suitability of the technology for island electrification, as well as the acceptance of the technology with the local population and the ability to perform certain basic maintenance and troubleshooting tasks.

C Lelepa solar micro-grid

C.1. Site visits

C.1.1. First mission to Lelepa

The joint visit to the island took place on 28 October 2019. The visit was carried out as planned and all questions were answered. The local population, especially the Village Chief, actively supported the project and showed great interest.

During the first and second visits to the island, several face-to-face interviews were conducted with key local representatives and other users. The detailed catalogue of questions and the answers are listed in the appendix. The most important results of the questions are listed in the coming chapters.

C.1.2. Current energy situation on Lelepa

C.1.2.1. Solar home systems for smaller appliances

Some private houses have solar home systems. However, some owners of these systems were not satisfied with this solution. The reasons given were that mobile phones could not be charged at all or only very slowly. In addition, the operation of larger devices such as televisions, sound systems, refrigerators, sewing machines and brood lamps for chickens was not possible. The systems would also have to be replaced after a few years, as they would then no longer function reliably.

C.1.2.2. Fossil based generators

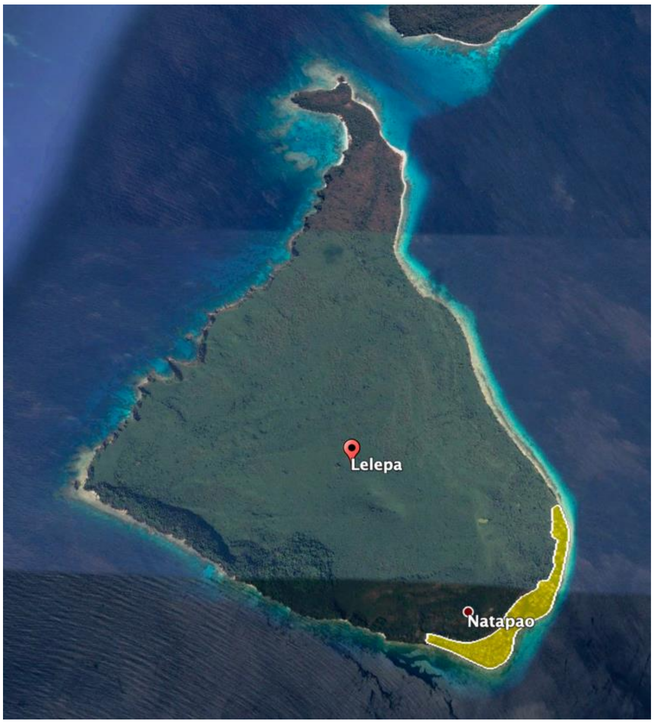
Small generators were also used. This was mainly done by institutions with devices that could not be operated with the solar home systems. These include, for example, the church with a sound system and the school, which operates photocopiers and a computer. The Medical Center also has a higher energy consumption due to its laboratory equipment and a refrigerator for medicines.

Some households, such as the Village Chief's, also have a generator to operate a television and an electric sewing machine. However, the cost of operating the generator is too high at 500 Vatu per day, according to the Village Chief.

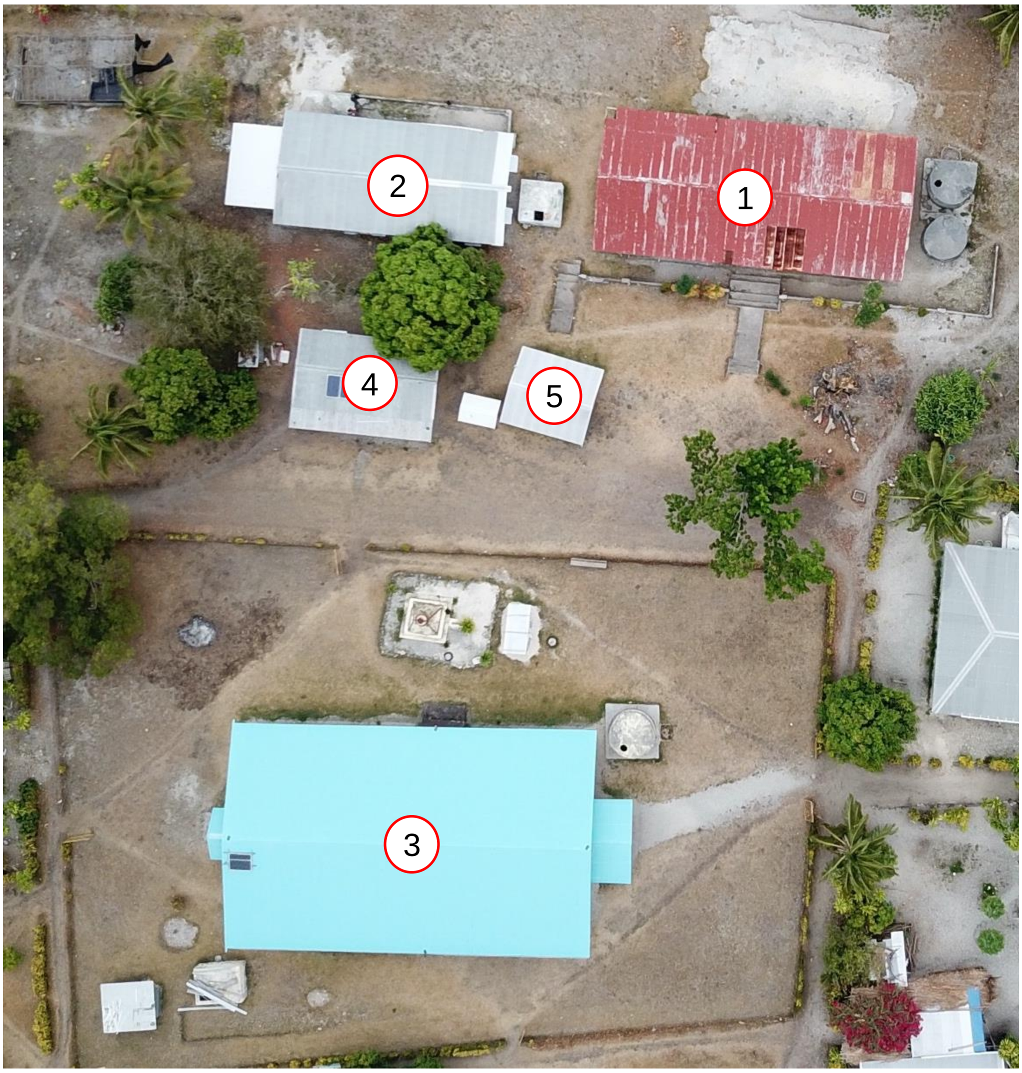
C.1.2.3. Cooking

The inhabitants of Lelepa currently use firewood or liquid gas for cooking. The cost of LPG is 4900 Vatu for the period of 3-4 months.

C.1.3. Project location



The project village Natapao is located in the south of the island Lelepa, a neighbouring island of the larger island Efate. A central cluster of the village Natapao with five buildings was selected as the project location:



1. Community Center
2. Mamas House
3. Presbyterian Church
4. Shop
5. Information Center

The Information Centre building was actually reserved for another project, but thanks to the intervention of the municipality, it was able to be converted into a site for the first Power Blox at short notice. However in a later stage, the Power-Blox will have to be moved to a special Power-Hub, as the building will be used for another project.

C.1.3.1. POC preparation

In a first step, the cabling was planned, and the prepared five Flex-Grid Smart Meters were configured:

P-0555-0154

ID	Usage	Account	Balance	Eff.
00	1.395 kWh	Lelepa Community Center	9,987.60 VT	
01	0.151 kWh	Lelepa Mamas House	9,998.32 VT	
02	1.555 kWh	Lelepa Presbyterian Church	9,981.55 VT	
03	1.021 kWh	Lelepa Shop	9,988.16 VT	
04	0.282 kWh	Lelepa Information Center	9,997.13 VT	

The first visit allowed the exact planning of the required material to be carried out and the project to start the next day together with PCS.

Material transport to Lelepa by boat.

C.2. Second mission to Lelepa

C.2.1. Installation work with PCS and the local community

At October 29th 2019 the team from PCS Limited together with Power-Blox and the local community started to do the installation work.

It was decided in advance that the cabling would be routed underground. This is for reasons of better protection against storms and to protect the townscape, which should be preserved as originally as possible, especially for the tourism sector. For this reason, the local population dug trenches into which the pipes can later be laid.

At the same time, the PCS team installed the solar modules and took care of the electrical interior installations of the first buildings.

The buildings were equipped with basic infrastructure such as lighting, sockets and switches. Care was taken to install as much local material as possible, but at a good quality level. This with the background that the installation team can carry out the electrical work according to their usual standards and practices as far as possible and that later changes and extensions can also be easily carried out by other teams.

In a further step, PCS laid the underground supply cables. These were laid in a star topology, as all smart meters were installed in a central meter hub in Building No. 5. This corresponds to the standard topology of the Flex-Grid Meter concept, but can also be adapted to other meter systems (e.g. spark meters). The choice of topology depends on various factors such as

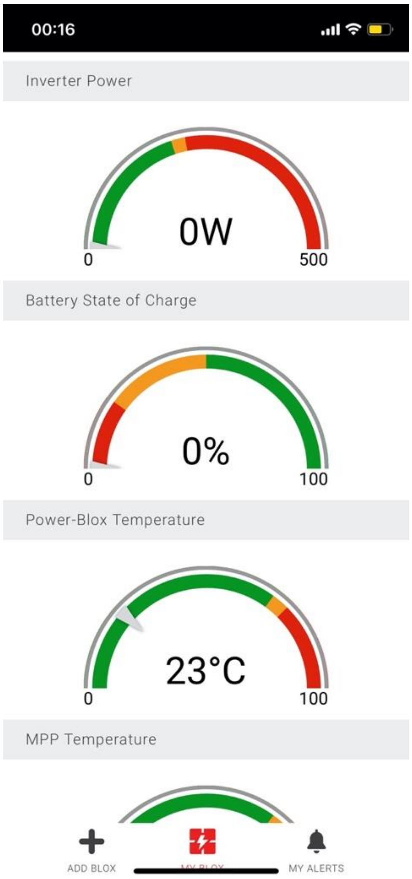
- Meter topology and communication
- Cable Cost Optimization
- Largest consumer in the network
- Subsequent integration into the public electricity grid

While PCS took care of the indoor installation and wiring of the houses, Power-Blox worked on the commissioning and testing of the communication and metering infrastructure. This was pre-configured in advance so that the installation work lay mainly in the cabling and communication tests.

The monitoring system consists of three components:

1. Life-monitoring of the overall consumption of the village (for test purposes in order to observe short-term power peaks)
2. Performance monitoring of all parameters of each individual Power-Blox, such as charge level, inverter power, solar module power, temperatures, error status and many more
3. Smart meter data to measure the consumption of each individual household

During the tests it was determined that system no. 2, which measures the performance data, does not yet deliver all the data. This means that not all the performance data for the individual Power Blox can be displayed yet. This error will be investigated by the development team after Power-Blox returns to Switzerland and can most likely be solved remotely.



At the same time the Power-Blox were installed. This installation work consisted essentially of interconnecting the Power-Blox, connecting them to the central distribution switchboard and plugging in the solar modules.

After the cabling work for the first two buildings was finished, these lines were already powered and tested.

The following day, the remaining three buildings were electrified the same way and also tested.

These tests also marked the successful completion of PCS's work.

For the Power-Blox team, the next day's work continued with final communication tests and training of the local community. A core team was formed by two community leaders (including the Village Chief) and one technical leader. This team was then trained in the following areas:

- General structure of the system with function of the individual components
- General approach of a swarm system, in contrast to conventional systems
- All connections and operating options
- Combination and separation of the individual Power-Bloxes
- Solar connection
- Connecting external power sources (mains, generator)
- UPS operation without solar module
- Possibilities of extension, if the system reaches its performance limits
- Possible malfunctions, such as empty battery, overload, overheating, defective components
- Procedure in the event of misconduct
- Testing a Power-Blox for correct function
- Removal of a Power-Blox from the Mini-Grid for test and repair purposes
- Re-installation of a Power-Blox, e.g. after a repair

The team was able to carry out the tasks set very quickly and independently disassemble and reassemble the swarm system. The coming weeks and months in the operative phase will show how the training proves itself and how the team can act on the technology.

During the training it was also pointed out that the Power-Blox technology is very robust and can therefore also be used in a “trial and error” approach. For example, the inverter can practically not be destroyed, not even in overload situations or in very rough environments. The technical team was even encouraged to try out certain things and create their own experiences with the equipment. This is to reduce fears of contact with the technology and to develop new ideas. Power-Blox should become a tool like any other. Same as a generator, mobile phone, fishing net, sewing machine, motorboat. Every woman and every man knows how to handle it and know where the possibilities and limits of technology lie. If we manage to establish the solar system in the field of "ordinary everyday objects", the number of applications will increase exponentially.

C.3. Demand assessment

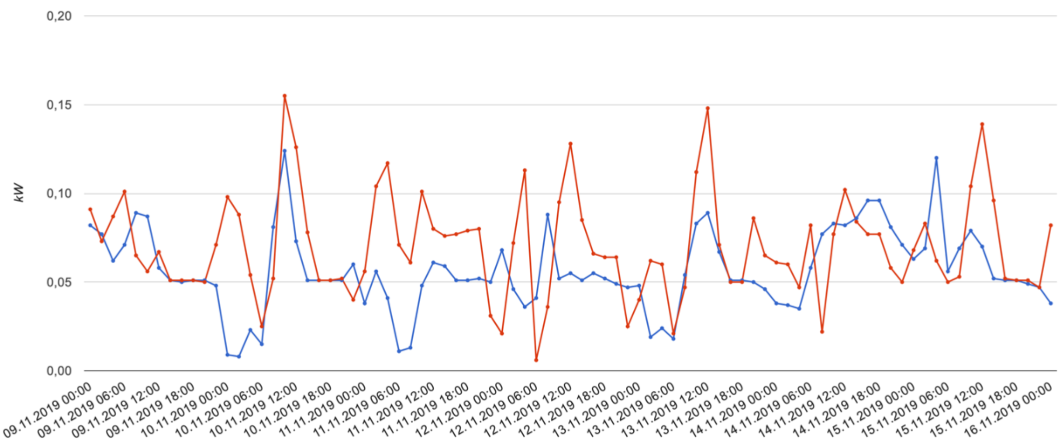
A rough demand assessment was carried out during the two visits.
It is important to note that the swarm approach does not require a detailed analysis, contrary to conventional Mini-Grid projects. The design of a swarm network is based on a phased expansion in which roughly made assumptions from a first assessment are compared with the real measured values and the system is adapted to the real situation if necessary. Since the expansion is modular, this can happen at any time.

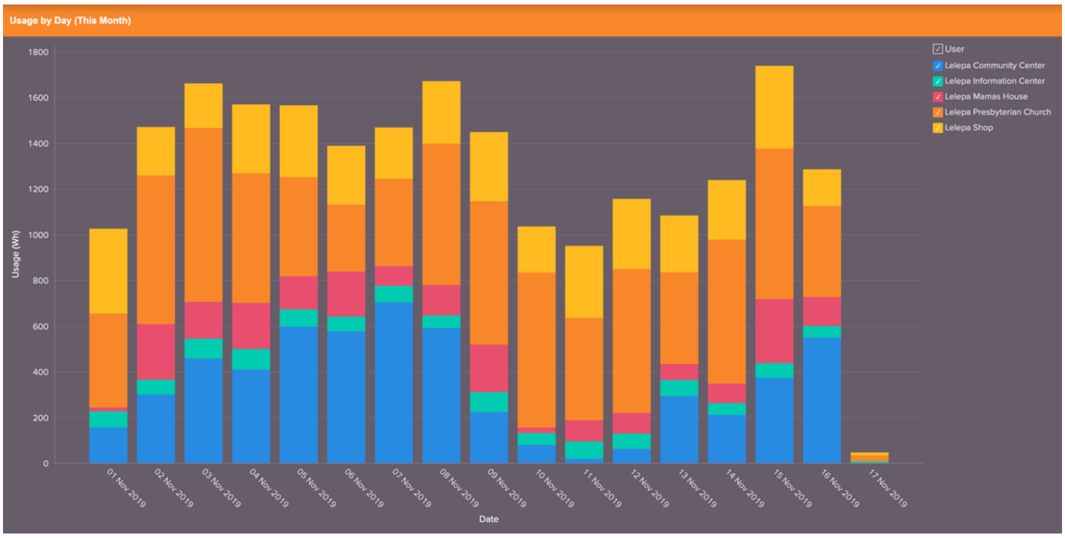
Using the POC as an example, the demand assessment can be explained as follows:

1. For the five public buildings, the largest consumers are roughly determined.
   These are in
   a. Music system of the church: 300W
   b. Expected charging activities for mobile phones and battery lamps in the community building: 100W
   c. Light in all buildings (approx. 5 LED lamps per building with 7 Watt each): 175 Watt
2. the rough estimate resulted in a maximum power of 575 watts, whereby it is not expected that all loads will be used at the same time
3. Based on this estimate, a first number of power bloxes is selected to cover the peak power of the consumers. The approach can also be reversed, i.e. first a number of power bloxes is determined for the experiment and a suitable number of consumers for the first phase is sought. In our case this was

the procedure where, for cost reasons (logistics), only three Power Blox should be flown in to Vanuatu and the five buildings appeared to be suitable for the first electrification phase

4. Over the first days and weeks, the peak consumption and the required energy are measured:





5. Further the Power-Blox devices itself are monitored, to see if all electrical data (e.g. the state of charge of the batteries) are in normal ranges
6. Key stakeholders, like in our case the village chief, are called from time to time via Whatsapp to ask, whether everything is working smoothly and you are satisfied with the new system Result of the feasibility study

The result of this practical demand analysis will be checked after a first pilot phase and the assumptions will be adjusted if necessary before the extension to the whole village. This allows false assumptions to be identified as early as possible and thus saves costs, as the energy system is neither oversized nor undersized. This significantly reduces the risk of a bad investment and the failure of an energy-based business model.

Our POC showed that the system for the five buildings was rather generously estimated and the available peak power was only used to 50%, so there is enough reserve for further consumers.

C.3.1. Result of our demand assessment

When checking the solar energy generated, the POC could only work with an approximate value that the monitoring module (gateway) unfortunately did not yet work satisfactorily. Here the approach would be that the batteries normally work with a charge level between 50% and 100%, in rare cases they are discharged to 30%. According to the consumption curves, however, it was found that a maximum of approx. 1800 watt hours were consumed. At the same time, it is expected that each Power Blox with its module will generate approx.

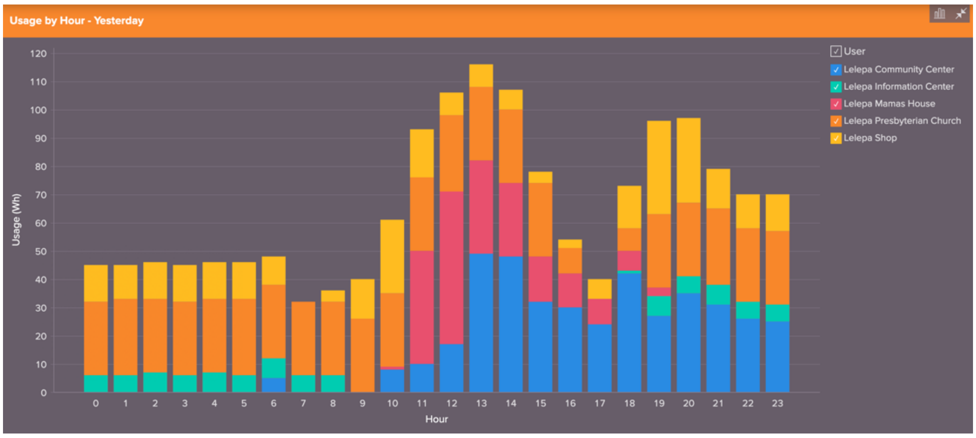
700 watt hours of usable energy per day, so in total 2100 watt hours. Thus the maximum consumption can be covered well and the batteries can be fully charged again and again to cover the night current.

C.4. Conclusion of the POC project after commissioning and the first operative days

The first productive days have shown that the swarm system fits the Lelepa application very well both technically and culturally. The local population has even enthusiastically accepted the new possibilities offered by the swarm technology. New ideas were independently developed on how to offer services and generate income based on the new energy possibilities. In particular, the ideas to exploit Lelepa's untapped economic potential were very well received and the general tenor was to do so as quickly as possible and to take advantage of the current momentum.

At the same time, it became clear that customers are willing to pay for the new energy service. We were asked spontaneously where the money for the monthly energy should be paid. Here it is certainly important to develop a proper tariff model as quickly as possible, to set up a local organization for operation and to switch to operations in order to test the practical suitability of the business model.

On the technical side, the few days of operation have shown that the swarm infrastructure functions reliably and without interruption (100% uptime). The monitoring of the individual consumers also works flawlessly:



Based on these experiences we think that the extension to the whole community is possible without any problems. In this context, the potential small businesses should also be examined and possible anchor customers for the Mini-Grid identified.

During this phase or even before, the remaining problem with the monitoring tool can be fixed, so all technical performance data are visible on the monitoring app as shown further above.

D Next steps and recommendations

Since the pilot project could be completed positively and the swarm technology represents a large potential for the solution of the rural communities and islands which are difficult to access, we recommend the following further steps.

1. Extending the pilot project to the whole island of Lelepa (100 households)
2. Develop a comprehensive tariff plan and business model to ensure reliable operations over the next 10 years or more
3. Establishment of a local business organization to run the energy service programs and delivers maintenance and trainings (capacity building)
4. Examine whether the technology would also be useful in other Vanuatu rural electrification projects in order to achieve economies of scale

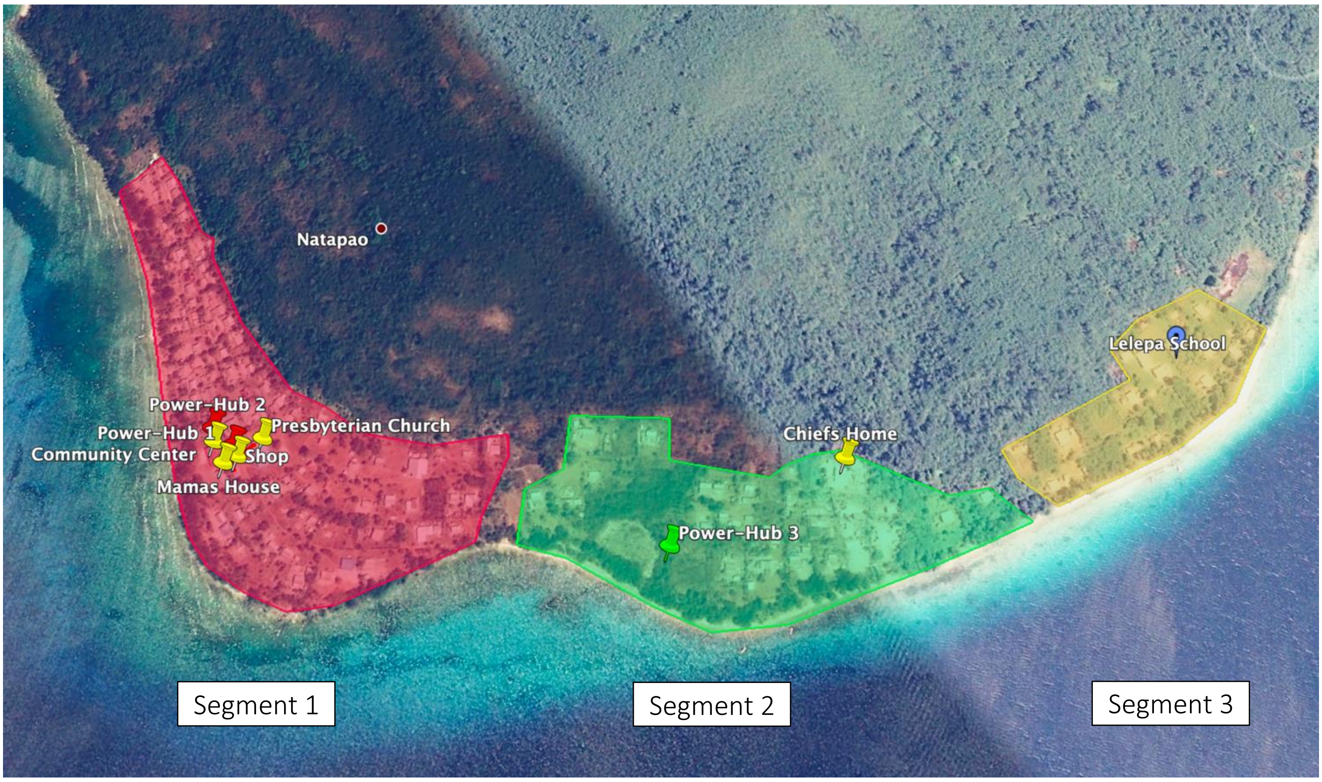
D.1. Electrification of all of South Lelepa

The electrification of the whole village Natapao was already prepared during the POC project. The project should essentially include the following areas:

a. Construction of three central power hubs to house the power blox and solar modules
b. Extension of a power hub to accommodate three large freezer cabinets for cooling fish
c. Extension of the Mini-Grid distribution network to include all households
d. Expansion of the meter infrastructure to connect all households (one meter per household)
e. Equipping all households with basic infrastructure such as light in each room (maximum 5 per household) plus sockets
f. Elaboration of a basic lighting concept for minimal outdoor lighting, e.g. by equipping households with outdoor lighting with twilight switch
g. Start to run the pay-as-you-go buisnessmodell and bill for power consumption
h. Identify further opportunities for productive use, e.g.
    - Fruit drying
    - Souvenir manufacturing
    - Tourism services
    - Chicken breeding

    and if possible find a way how to stimulate these services within the extension of the project

D.1.1. Proposed mini-grid extension to electrify the whole village



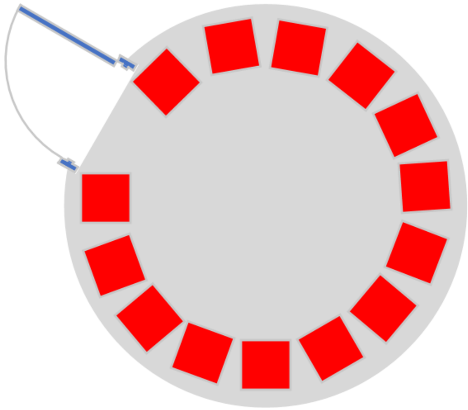
We propose to split the village in three individual segments. The segments will be interconnected with a transfer cable, but can also be separated by a divider switch and then run individually. This allows to try out different scenarios for other projects, to measure energy flows and to find out, if it is worth to interconnect individual segments in a typical village situation.

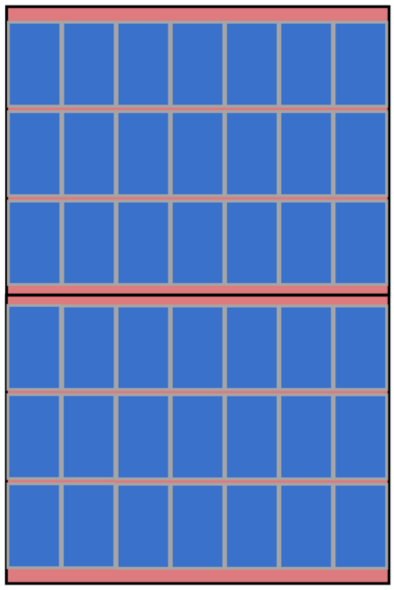
Segment 1 (red)
Main segment with approximately 45 households, as well as the already connected buildings and the medical clinic.

Power-Hub 1: Existing in the information center, but could be needed to be removed due to other usage of the building in a later stage.

Power-Hub 2: Conversion of two water tanks that are no longer used. By additional roofing, these can be protected from sun and rain and used as power hubs.

Each watertank will be able to house a maximum of 56 Power-Blox units,
or even more:





We can build Power-Blox stacks of 4 units high in the tank.

The solar modules can be mounted on the roof of the community center. However, as this roof will be renovated in June 2020, we should start with the roof extension over the water tanks. This roof part can carry 42 solar modules. This will be enough to electrify the whole mini-grid segment one. Later further modules could be installed on the roof of the community center to extend the swarm-grid, once the community center is renovated.

Segment 2 (green)
Segment with approximately 25 households, as well as the fishcooling house as anchor customer.

Here we selected a place together with the village chief, where the Power-Hub could be build. The Power-Hub could be a combined inverter house, with a second room used to put in 3-6 big freezers to freeze whole fish. The position was selected to ensure a short distance to carry the fish, a central location to electrify all surrounding houses and a space where only small trees exist, so solar modules on the roof of the Power-Hub are not shaded.

The productive use room will be equipped at the beginning with three large freezers, to freeze entire fish:

For example, Westinghouse WCM7000WD – 700L, length 1.88m, energy rating ***

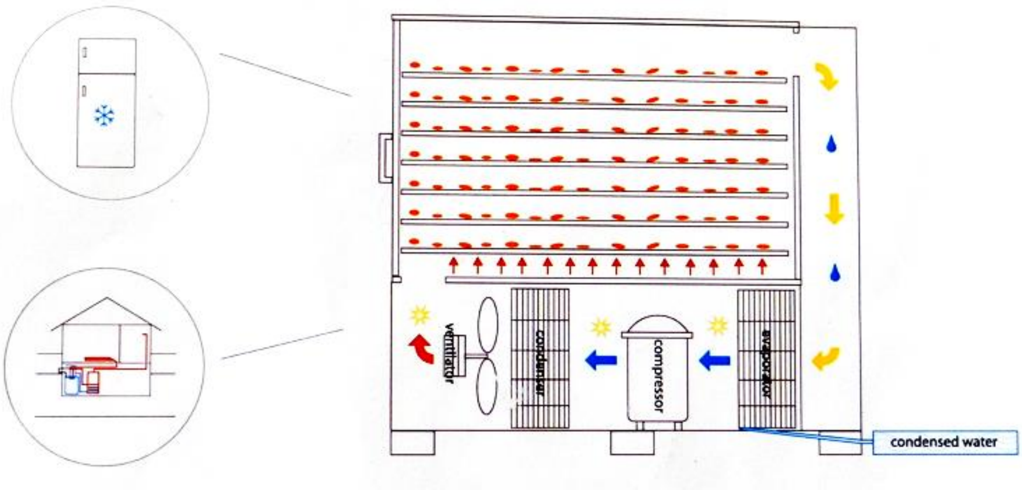
These freezers can be rented by fisherman on a daily or weekly bases. Fisherman can also share a fridge and cover the cost for the rent together.

Segment 3 (yellow)

Village extension segment with around 11 households. Could also be connected via an extended Segment 2. In this segment the school is situated. The location for the Power-Hub has not yet been selected.

D.1.1.1. Further small business support

As explained in the introductory document, Lelepa has great potential for generating additional income. The exploitation of fruit, for example, should be mentioned. With modern heat pump dryers, 150 kg of mango per day can be dried in an energy-saving way and thus preserved. Dried mangos are very popular in Europe and could also be sold directly to tourists as souvenirs:



Another important part of the local economy is the production of baskets and bags, as well as other souvenirs for tourists, which are then sold at the handicraft market in Port Vila. Here, too, it must be examined to what extent energy could have a positive impact on local production and, if necessary, make it more efficient.

E Adaptation of swarm technology for further electrification projects

Lelepa's electrification represents a very important step in determining the opportunities and limitations of the Power-Blox swarm technology. Nevertheless, it should not be forgotten that this only represent the application segment of village electrification and only in a single case. However, the possibilities of the technology go much further.

Since Power-Blox devices can be operated from single stations (200W) up to several dozen devices in a cluster, many application situations can be covered. This does not require extensive studies and planning phases every time. The approach is much more practical here and can start directly with the trial implementation. In other countries, e.g. Angola and Tanzania, our implementation partner maintains a "rolling stock" and thus implements various projects. Two 20-foot Power-Blox containers (200 units) were purchased at the beginning and are now used continuously to roll out the different projects. Since a substantial part of rural electrification projects can be implemented with one single product, the approach changes from an engineer-driven approach to a rollout and logistics-driven approach. It is important to ensure that the installed systems can cover the actual consumption of the rural population without interruption and that expansion steps are initiated in good time should consumption increase or a system be undersized. It is therefore helpful to always have enough Power Blox and solar modules in stock to be able to react at short notice.

This approach would also need to be considered for Vanuatu, especially if the objectives of certain rural electrification projects are very ambitious. As the result of the POC has shown, the rapid implementation is one of the major advantages of the new swarm technology and this advantage could also be used for other projects. This approach also exploits economies of scale and saves significantly on logistics costs. The Swiss government even offers an insurance instrument via the Export Risk Guarantee (SERV) which enables pre-financing of up to 24 months. This could also be examined in a further step.

F Appendix

F.1. Questions to the community

In addition to the installation and training work, questions were asked to the community representatives and sometimes also to other randomly present persons, which were to be clarified in the context of the feasibility study. The answers to these questions can be found here:

Energy needs of the local islanders

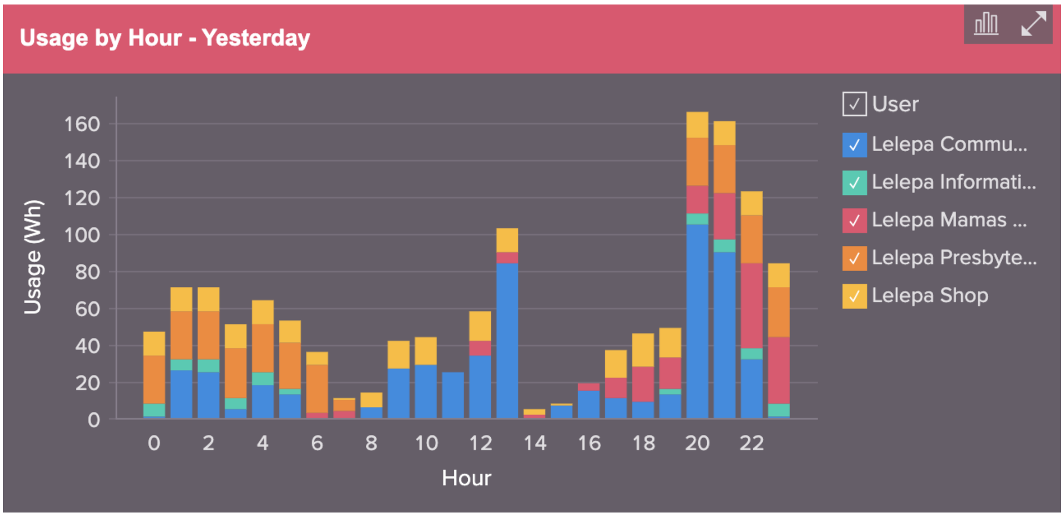
1. What exactly do the inhabitants like to operate?
   a) All households need light and all will probably later buy and use a TV. Around 10 households were expected to buy fridges. 5 households may need tools to produce artefacts and 10 sewing machines will be used.
2. What kind of businesses are active on the island and what power needs do they have?
   a) There are only small scale businesses so far and their power needs are currently low, but this will increase over time. We identified the following businesses:
      - Fishing
      - Tour operation
      - Production of souvenirs and household items
      - Growing of fruits
      - Ferry service
      - Grocery store
3. What are the basic performance and energy requirements for each
   a) Households
      - See above. Currently very low. However there is a big chance, that energy needs will rise in the first month, as people will buy additional appliances. This especially, if the productive use stimulations are successful and additional income can be generated

   b) small enterprises
      - The biggest consumption to be expected is in the area of **cooling fish**, as a lot of fish are caught and have to be cooled.
      - Therefore freezers will be needed (5-10 big freezers)
      - Fishing is also the island's largest source of income.
      - All Lelepa people are fisherman and fisherwoman
      - The **shop** needs energy for light, cooling drinks and the use of a computer
      - The **Lelepa island tours** currently have no extra need for energy. In the future, however, it can be expected that additional energy will be needed in the areas of gastronomy for tourists as well as the lighting of the cave.
      - The **production** of souvenirs and household requires energy for the operation of small machines such as sewing machines and for woodworking.

      As productive use and small businesses will be one of the most important parts of the further electrification, we provided a special chapter in the next steps and recommendations at the end of this report.

   c) Organizations (school, church, etc.)
      - The two **churches** need energy for lighting and the operation of sound and keyboard systems. In the first days of operation, this represented the largest energy consumption of the island.
      - The existing **primary school** needs electricity for lighting and a computer infrastructure with printer and copier.
      - In addition to light, the **medical center** needs energy for the cooling of vaccines and medicines and small laboratory equipment. In addition, a computer will be operated in the future.

4. Are there larger electricity consumers such as machines, air conditioners, etc.?
    a) Not yet needed
5. Are there requirements for three-phase consumers?
    a) No
6. What is the expected daily course of energy consumption? Is energy consumed at night, for example?
    a) This is not yet clearly assessable. In any case, there are various night consumers, such as televisions, freezers and lights. A first experience value resulted from the first operating days:



Initial situation and current infrastructure

7. What is already available today in terms of power generation and cabling (mini grid)?
    a) There is no central mini-grid available currently. Power is generated via generators and small solar systems.
8. Which partial energy solutions already exist today and how have they proven themselves or caused problems so far?
    a) Quite some houses currently have own solar home systems. These systems are seen as inefficient, as they cannot fulfil some needs like mobile phone charging and supplying bigger consumers like fridges, sound-systems, bigger TV's etc. If such consumers have to be driven, inverters or generators have to be run
    b) Some houses like the school and the church have generators for larger power consumptions
9. How have previous energy solutions been charged to the respective consumers?
    a) Yes, via pay as you go model or paid cash (580'000 VT for a system). Pay as you go charge: 500 VT per month.
10. How is the mobile reception on the island and which mobile operator covers the region (2G, 3G, 4G)?
    a) There are two mobile providers covering the island: Digicel and TVL. Digicel has more possibilities respecting remote top-up via the Internet and trough credit cards, while TVL has no possibilities to top-up from abroad. Communication tests with Digicel worked well.

Possible installation of the pilot system

11. Could the school or the church be chosen as an "anchor customer" and the first households be electrified from there with a micro-grid?
    a) Yes, but the anchor customer identified were the five buildings mentioned at the beginning of this report
12. Where is there space for solar modules in the vicinity of anchor customers? E.g. on roof or ground.
    a) Several roof were identified to carry solar modules. For the POC the information center (Building no 5) was used. Especially the bigger roofs like the the community center would be interesting for further installations, as there a lot of solar modules could be mounted.
13. What kind of roofs are used? E.g. corrugated iron sheets?
    a) Corrugated iron sheets
14. Could the big blue building on island be used to mount some solar modules?

a) The community proposed to rather use the roof of the community center, as the roof is of the blue building (church) is not strong enough
b) A building needed for an individual Power-Hub would approximately cost (material 300 – 500k VT). The community would help building it and only the material had to be bought

Installation, partnering and operations

15. Which company could support us with the installation during the implementation? A company that already has experience with solar energy and/or the ability to take over electrical installations as well as structural measures would be well suited
    a) The local company PCS Limited in Port Vila was selected and installed the POC in a very professional and efficient way. The company also supported us during the entire planning, import, clearance and preparation phase and fulfilled all tasks to our complete satisfaction.
16. Who could take over the operation and maintenance of the later energy solution(s)?
    a) Power-Blox is offering to build up a local company, offering operations. With the generated income, further island electrification projects could be financed and maintenance, scale-up and replacement services and material could be financed.

       In our opinion it is important to have a very long-term perspective, over at least 10-20 years and based on a high level of quality.
17. How would individual households be connected to the mini-grid (underground cabling, overhead lines)?
    a) During the POC was decided to do this underground.
18. Where can the basic material for the electrical cabling be procured locally?
    a) All material for the local cabling, except the smart-meters and Power-Blox, was procured locally.

Business model and financing

19. What are the current costs to islanders of lighting, cooking and other energy-based services?
    a) For light the community uses solar home systems (SHS), for cooking wood fire or LPG (4900 VT for 3-4 month)
20. What is the energy purchasing power of the islanders to implement a sustainable business model?
    a) For a basic service for light and running a small TV, 450 VT would be ok, even 500 VT would be decent, as this are also the costs for the much less powerful solar home systems.
21. What additional services and goods could be produced if a reliable energy system were in place?
    a) Especially the services and products already mentioned in the area of small businesses would be interesting for the islanders.
22. Which basic business model is suitable for the sustainable operation of the energy solution?
    a) The pay-as-you-go model fits well for the local population. However, the interest in purchasing Power-Blox devices was also expressed. However, we suspect that the current price of the high-quality system is (still) too high. This will probably only become affordable for the local population as battery prices fall.
23. What could the initial financing of a sustainable energy system look like for all residents, small businesses and other consumers (e.g. school, church)?
    a) The pay-as-you-go approach is a workable approach for all energy consumers. Even the public buildings, which are personally paid for by the chief, can be operated with it. The other institutions like the churches, the school, the Mamas House and the shop pay their own electricity.
24. How could the operation of the system, any maintenance work and the subsequent battery replacement be financed?
    a) Via the overlying business model, which generates revenues to cover these costs through the pay-as-you-go financial model.