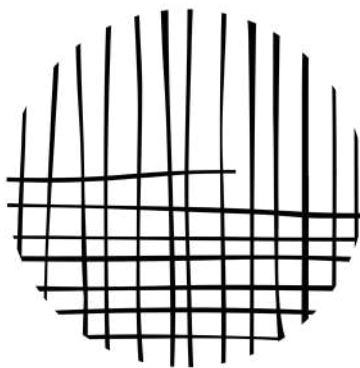


# ENERGIA

Design for evolving  
scenarios

Ahmed Adnan  
Nausica Bianchi  
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Mou Hongyou  
Meutia Rahmadina



Y U B

WEAVE CONNECTIONS



# E N E R G I A

DESIGN FOR EVOLVING  
SCENARIOS

**Politecnico di Milano**, School of Design  
Master Degree in Product Service System Design  
Innovation Studio, a. y. 2022-2023

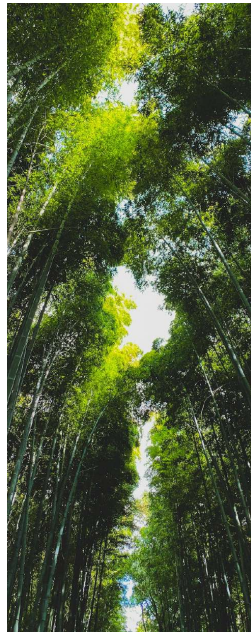
**Professors** Valentina Auricchio, Stefana Broadent,  
Marta Corubolo, Fabio Di Liberto, Ilkka Suppanen

**Tutors** Vanessa Monna, Chenfan Zhang

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# RESEARCH



**500,000**

Homes in Indonesia still do not have access to electricity <sup>1</sup>

**#1**

Indonesia is the top producer, exporter and consumer of palm oil in the world. Domestic consumption within Indonesia is mainly for food uses, especially as cooking oil which accounts to 13 million tons. <sup>2</sup>

**18,5%**

From 13 million tons of cooking oil consumed, only 18.5% of the waste cooking oil are collected. <sup>3</sup>

**59%**

Rivers in Indonesia are still severely polluted, one of the pollutants is household waste such as cooking oil <sup>4</sup>

**11,58L**

Cooking oil consumed per person per year in Indonesia (2021). <sup>5</sup>

## IMPROVING RURAL ELECTRIFICATION: COLLABORATION WITH THE GOVERNMENT

Inequal distribution of electrification is still prevalent in Indonesia. While the government states that 98% of households across Indonesia have access to electricity, there is still a significant disparity on the condition of electrification ratio across provinces.

Papua and East Nusa Tenggara provinces have the lowest electrification rates of about 61.4% and 59.8%, respectively<sup>6</sup>. In total, there are still 500,000 houses without access to electricity. Where PLN (The state-owned electricity company) electricity is not available, people depend on expensive, intermittent, and often unhealthy sources of energy such as kerosene lamps, lead-acid batteries, and communal diesel generators.

To achieve the goal of reaching 100% national electrification rate, the government have made efforts for the energy poor areas such as Papua and East Nusa Tenggara through the Smart PLN Batteries (Tabung Listrik/ Power Bank). With rechargeable solar-powered batteries, the durable energy storage and small size are sufficient to power households living far away from main electrical grids. The type of battery is Lithium Ion (Li-Ion) 1000 Wh which is enough for 8 nights/household<sup>7</sup>.

We see this as a potential to collaborate with the government's Power Bank program, by introducing the potential of biodiesel as an alternative energy resource for the rural households in Indonesia that currently do not have access to electricity.



## UTILIZING WASTE COOKING OIL

In rural areas of Indonesia, 11.58L of cooking oil is used for a single person in a year<sup>5</sup>. This means that in a family of 4-5 people around 1L of waste cooking oil (WCO) is generated every week. This presents a big potential to utilized as almost 85-90% of the WCO can be converted into biodiesel<sup>8</sup>.

As the WCO do not have any other purpose in a household after its first use, it is usually disposed, mainly by means of throwing it out or down the sink. Our system not only helps to provide electricity in off-grid household but also helps in providing a better way of disposing WCO. This also in effect helps in avoiding pollution in rivers.

## EFFICIENCY

The properties of used cooking oil can change depending on the frying conditions, such as temperature and cooking time. Thermal stress, such as during frying, can indeed affect chemical and physical characteristics of the original cooking oil.

When the oil is used repeatedly, the high heat starts to break down the molecules. Fatty acid particles detach from the rest of the molecule and start to float freely. Hence, waste cooking oil also contains a high amount of free fatty acids (FFAs). This is one of the reason why the entire volume of WCO is not converted into bio-diesel.<sup>9</sup>

High free fatty acids and water content in waste cooking oil cause the production of biodiesel difficult. In order to overcome this difficulty, two-step transesterification method is preferred for commercial-scale biodiesel production. This increases the conversion efficiency.<sup>10</sup>

## PRE-PROCESSING: THE IMPORTANCE OF FILTERING

After waste cooking oil is collected, it is filtered to remove contaminants. Contaminants varies according to the dish cooked, such as meat scraps, water, crumbs of breadding, and other leftovers. These contaminants can make the oil unusable in the conversion of the WCO to Bio-Diesel.

In addition to solids such as food scraps, the cooking oil is also contaminated with water which must be removed. Impurities are removed using a centrifugal water-oil separator. Then the oil passes through a purification filter. The less impurities there are the lower the risk of jamming or clogging during power generation.<sup>11</sup>

Even though all of the processes can be done from the treatment plant, the first layer of filtering of contaminants or food waste needs to be done from individual houses as it acts as a first line of filtering and reduces a huge amount of food waste to the being segregated in the centre.

## TRANSESTERIFICATION

Transesterification is the chemical process that turns waste oil into diesel fuel. Eventhough the name sounds complex, the process is very simple. This process combines an ester with an alcohol, and in the case of biodiesel, the "ester" is used cooking oil. A small amount of catalyst is added to the mix to start a chemical reaction, and the end results are methyl ester(chemical name for Bio-Diesel) and glycerin.<sup>12</sup>

This is a process which is simple enough to be done at home as it does not require any heavy devices or instruments. But in order to process large quantities of WCO, specialized chambers for the pre processing and Transesterification is required.

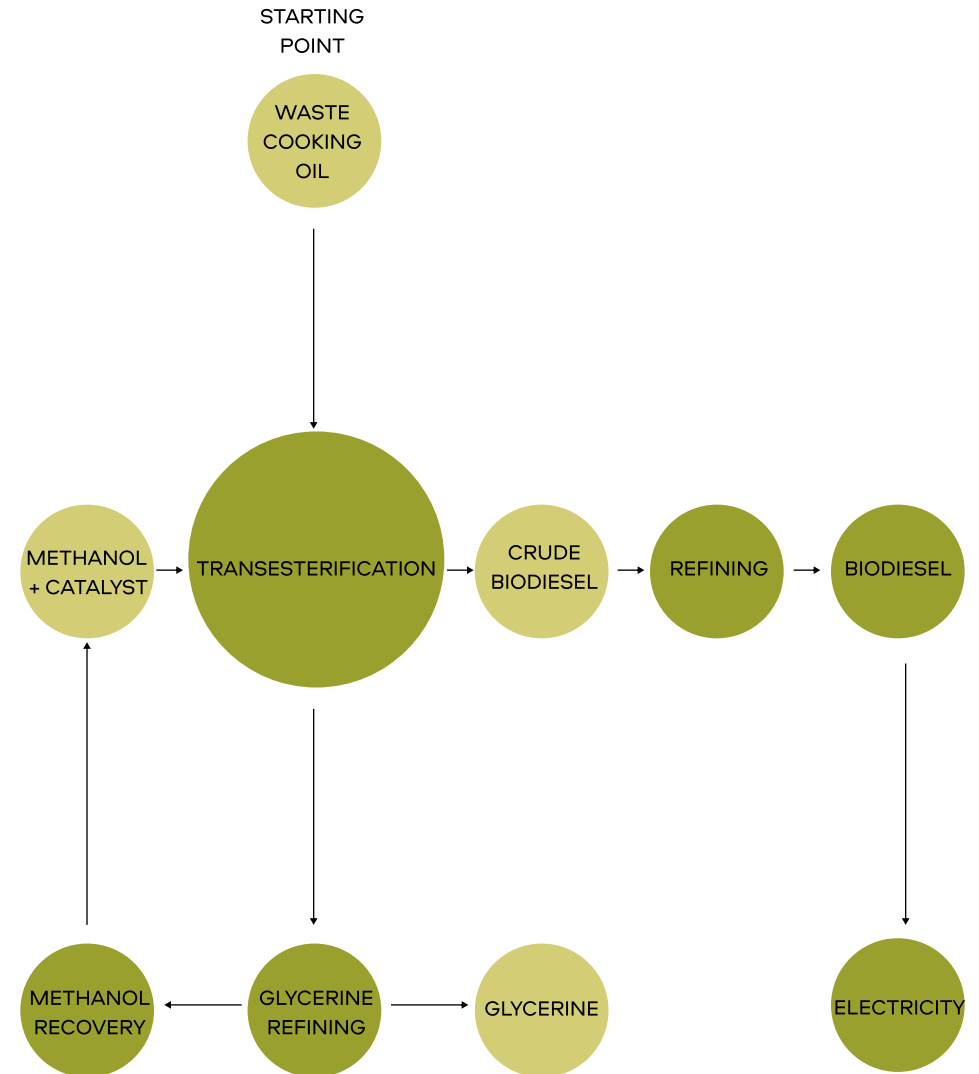


After transesterification process is complete, the biodiesel is ready to be used. The glycerin is separated out and can be used in cleaning products, cosmetics, and pharmaceuticals.<sup>13</sup> Meanwhile, the biodiesel can be used locally in vehicles, machinery, farm equipment as a replacement for Diesel.<sup>14</sup> In our case, the biodiesel generated using WCO is consumed to provide electricity in the rural regions of Indonesia.

## BIO-DIESEL TO ELECTRICITY

Biodiesel can be converted into electrical energy with the use of a standard diesel generator. It uses the bio diesel to create mechanical energy which in turn generates electricity.

A general rule of thumb is that a diesel generator will use 0.4 L of diesel per kWh produced. Therefore 1L of biodiesel will produce around 2kWh. The generated electricity can be stored in large capacity storage devices, which acts as a hub for charging individual powerbanks provided from the governments end. 1L of biodiesel can ineffect charge around 5 to 6 powerbanks (capacity of 300 KWh). The generated electricity can be stored in large capacity storage devices, which acts as a hub for charging individual powerbanks provided from the governments end.



# THE COMPLETE PROCESS: FROM WASTE COOKING OIL TO CHARGED POWERBANKS

1



Waste Cooking Oil (WCO) is collected and transferred to treating plant.

**11,58 L**

Cooking oil consumed per person per year in rural areas.

**1 L**

A family of 4 produces ~1L of WCO in a week.

2



WCO is converted into Bio-Diesel by the process of transesterification.

**90%**

85-90% of the WCO is converted into biodiesel.

**Simple**

Transesterification is a simple one reaction process, which can be even done even from home.

3



Electricity is generated from bio-diesel from Diesel generator.

**2 kWh**

1L of biodiesel will produce around 2kWh.

**6**

6 power banks, each having a capacity of 300Wh, can be charged from 1L of biodiesel.

4



Powerbanks are charged using this electricity.

**3-4 days**

One powerbank can charge a rural household for 3-4 days.

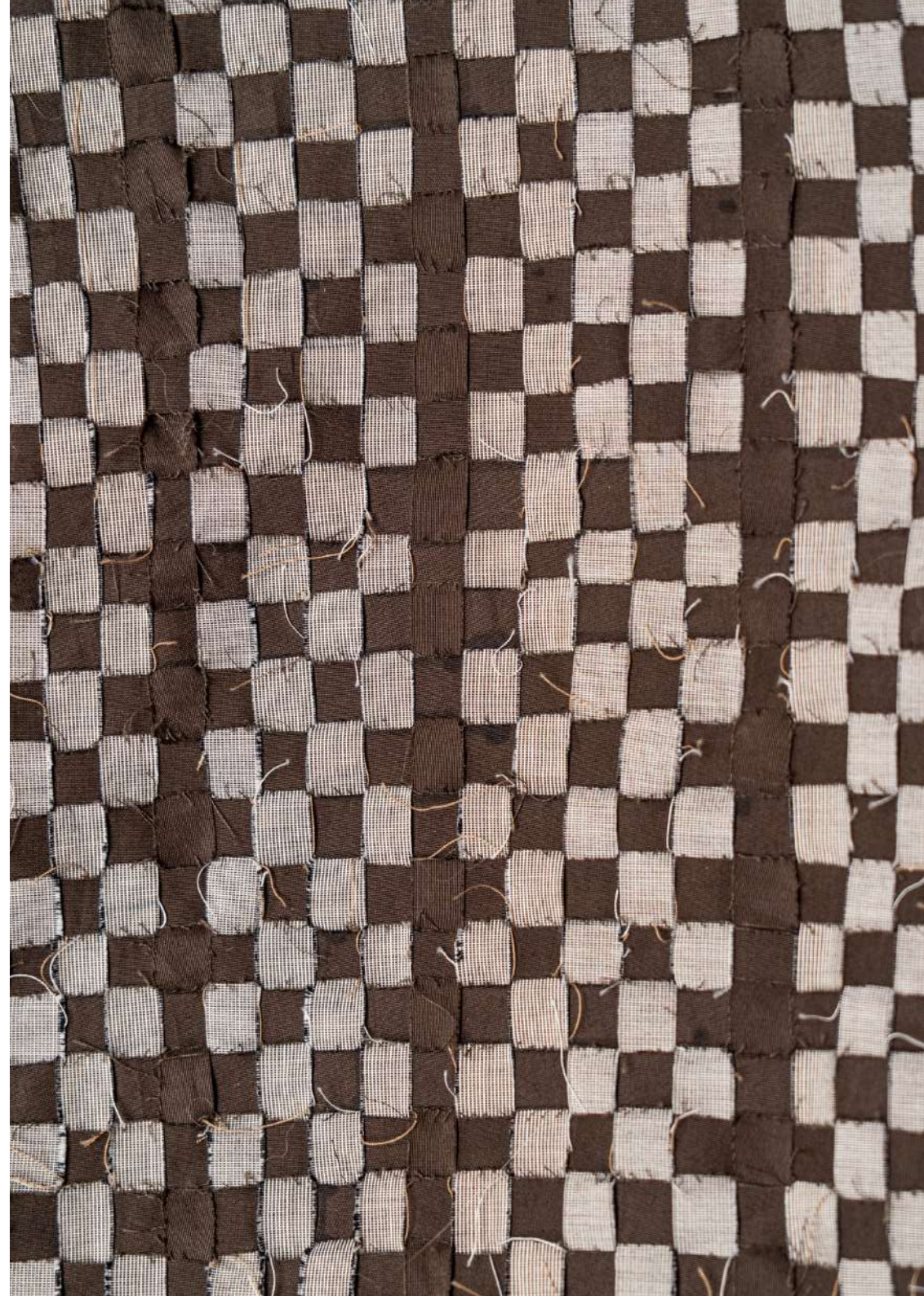
## THE ANCIENT PRACTICE OF WEAVING

On the other hand, weaving is a fundamental part of traditional and indigenous culture in the Indonesian archipelago. However in the recent years this practice has started to experience a decline, especially amongst women who were the main actors.

As in many parts of the world, globalization has impacted even rural communities, which are starting to distance themselves from indigenous practices, losing activities which are hundreds, if not thousands, of years old.

Having conducted some interviews with several non-governmental organizations who organized weaving classes for local women, we found that there are existing stigma that hinders women from continuing this legacy of traditional weaving. Some thought that weaving particular patterns will lead to blindness, which made them reluctant to participate.

For the women that took part in the classes, they experience significant improvement in their lives: Women are able to learn new skills that are useful in their lives, not only weaving skills but also entrepreneurial skills. They are also empowered financially as they can earn money for their families.





# SCENARIO

## SCENARIO

*In a far corner of the world, surrounded by the crystal clear waters of the Pacific Ocean and dotted with more than 18.000 islands, a small piece of heaven preserves hidden treasures. Tropical rainforests, exotic wildlife, idyllic beaches and breathtaking landscapes make everyone think of Indonesia as the dreamland. Indonesia as Bali, where people can live peacefully in touch with nature.*

*Sadly, as often occurs, not all that glitters is gold. Beyond this fairytale cover, lurks a multitude of different scenarios that reveal the hard truth. Traveling towards the remotest villages, we are finally forced to face the darkest side of reality.*

*About 500.000 houses do not have access to electricity, mostly in the eastern parts of Indonesia. Where we can see wood board houses in the middle of nowhere and rocky roads, even those with limited access to electricity have occasional blackouts that force families to rely on candle light for entire weeks. Studying in this condition is difficult and internet connection is not always available at home.*

*Everyday thousands of mothers struggle to feed their children and families. Despite this, frying food is an inseparable part of their lives. One household consumes 4L of cooking oil monthly on average. The waste oil is then poured anywhere: soil, rivers. Unknowingly, users are increasingly polluting their environment.*

*The steady fight against hunger leads them to cook from natural sources around them, they grow their own vegetables fruits, or buy them from traditional food stalls and markets. They gather wood and use it to cook, oblivious to its toxic longterm effects.*



*Despite all this, they are bonded by a strong sense of community.  
Friends and families come together to cook and eat food collectively.  
The disconnect to the main grid enables them to connect to one other.*

*Few families can afford bikes or motorbikes, while some walk all the way.  
In the sun or under torrential rain, children walk endless miles to get to  
school, with the hope for a brighter future; and so do women, carrying the  
weight of scarcity on their shoulders.*

*Is this life or just survival?*

*This paradoxical scenario is screaming for the urgency of the change.*

*How can we take them one step closer to the On-Grid life?*

*How can we empower them while they wait for the Government to build  
infrastructures? How can they be independent temporarily?*

*Imagine a near future where remote villages are self sufficient in terms of  
electricity; a future where a product-service system can transform used  
cooking oil to electricity and clean cooking energy. Where roads improve,  
manufactured cooking oil become more accessible, new wartegs pop up  
and more jobs are created.*

*What can we do to seize this moment?*

*A real life-changing system can be designed today.*

*It's our mission, and we can start now.*





# B R A N D I N G

## WHO ARE WE?

# Kaleidos

We are a **Third Sector Association** (TSO) aiming to create an impact in the Target Countries by helping rural households get one step closer to the main electrical grids. We partner with the local government and provide innovative products and services to be distributed to communities in need.

As a non-profit organization, Kaleidos can benefit from donations and tax-free policy, reinvesting earnings in production and maintenance. To get start with our product-service system, we require an initial investor (private, philanthropist, Government, legacy, etc.) who offers funds for the production of our containers and backpacks, and the building of collection and conversion points.

## OUR VOICE

### Persuasive & Determined

- we trust our strong background research
- we believe the efficacy of our products and services

### Direct & Clear

- the solution is right in front of your eyes
- rural communities can understand and use our products intuitively
- complex metaphors is to be avoided

## OUR VALUES

AFFORDABILITY



SUSTAINABILITY



INCLUSIVITY



EQUALITY



## PURPOSE

“To build and serve a supportive community where everyone can belong and thrive.”



## AMBITION

“We want to empower communities to achieve self sufficiency through a meaningful product-service system that provides a sustainable way to create portable electricity from waste cooking oil.”



## PRODUCT NAMING

### YUB

The word is derived from the untranslatable Indonesian word “Guyub”. Often simplified as “friendliness” and “getting along”, it actually carries a deeper meaning that roots in the ancient Javanese philosophy of living socially.

It is a way of life, in which everyone in a community willingly joins one another “in togetherness”, and valuing the goods of others or the community as highly as their own (if not higher). Living in Guyub means you are connected with everyone in the community and willing to share a brotherly bond with each other.

## SLOGAN

### Weave connections

The project is founded on the roots of community as a whole, creating a physical and metaphorical woven net of connections between local people.

The intent is not only to give electricity in the literal sense but also go beyond energy, generating quality and empowering individuals and communities, each with their own stories, needs and traditions that should be kept alive.

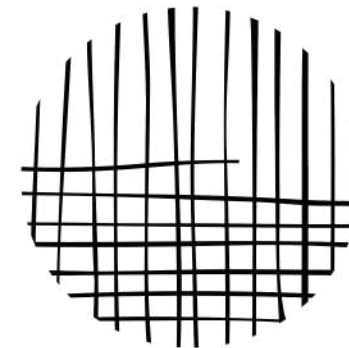
## LOGO

### Circular shape

- circular economy
- sense of gathering and community

### Lines

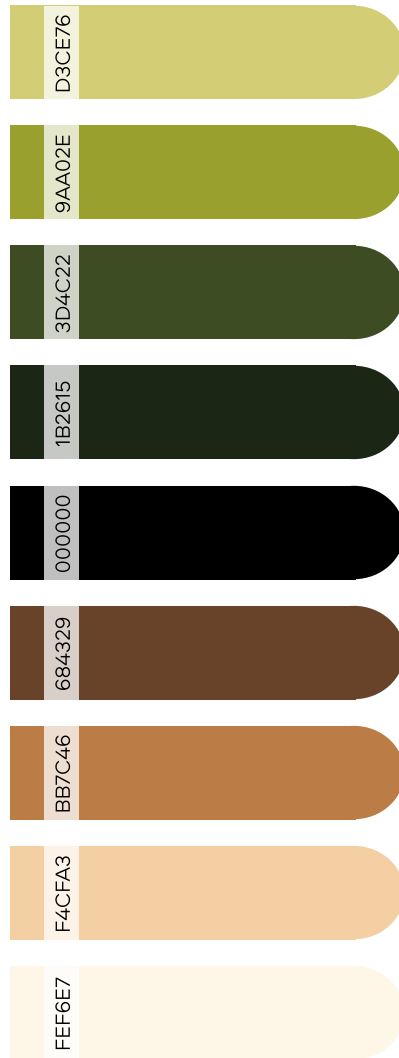
- weaving pattern
- net of connections
- symbolic of infrastructure maps

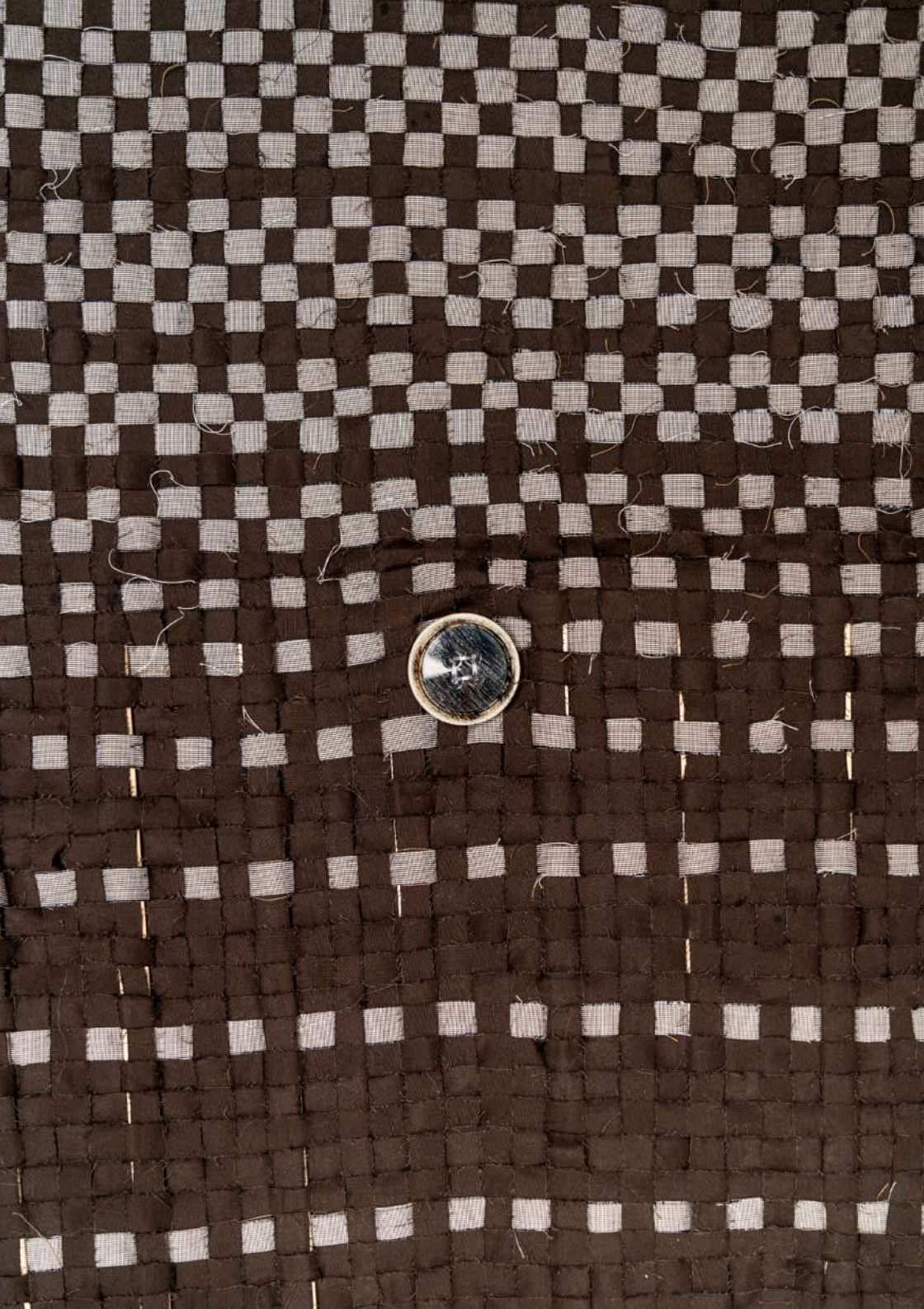


Y U B

WEAVE CONNECTIONS

# COLOR PALETTE





PRODUCTS

## WHAT IS YUB?

YUB is a simple kit consisting of the government power bank, a black oil container, and a white oil container inside a weaved backpack. The entire kit aims to equip households without access to electricity by utilizing the waste cooking oil (WCO) they produce on a weekly basis. To make the system work, rural households need to come together and participate.

When users reuse cooking oil when frying food at home, they will use the black container. When the oil have reached its maximum reuse, it becomes WCO and is stored in the white collapsible container. However when users do not have any WCO, they could use the black container to store homemade cooking oil.

When user's power bank runs out of battery after 8 days, they will bring it along with the oil containers inside the backpack to the local collection points for the exchange of a fully charged power bank. If they still have enough battery at home but the containers are full, they can exchange them with a voucher for future power bank exchange.

**A.** Woven backpack



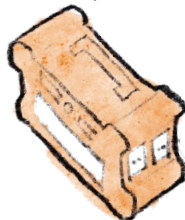
**B.** Black oil container for reusable oil



**C.** White oil container for waste oil



**D.** Portable powerbank



## THE BACKPACK

The backpack provided has a special characteristic: its weaving. The woven design is based on traditional Indonesian techniques, to keep alive native and indigenous traditions which are slowly but steadily dying out.

The manufacturing of this woven fabric is meant to be achieved in sustainable workplaces which employ native women; this helps them to care for their family and earn money that is rightfully theirs, but also intends to empower them and teach them new life skills which make them more independent.

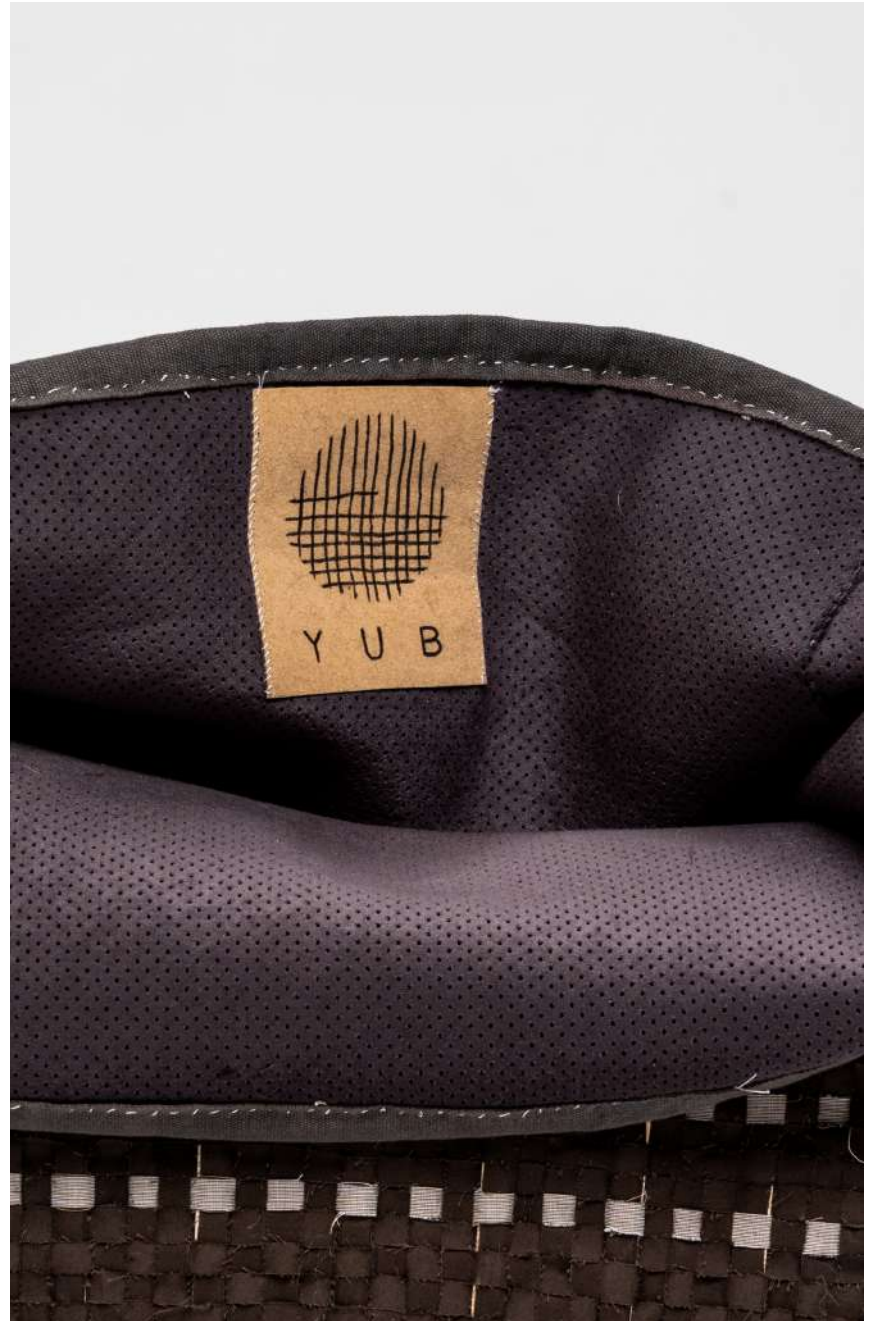
The fabric strips used come from discarded clothing and other textiles, in order to keep the product as sustainable as possible using materials which would be otherwise discarded. The use of a woven fabric made out of rags also eases the repairing process: if the backpack gets damaged there is no need to throw it away, the broken strips can be cut off and new ones weaved in.

The backpack presents a sturdy structure at the bottom, where bamboo strips are woven into the fabric. This creates a free standing object and helps the user when filling up the backpack with the power bank and oil containers

As the bamboo sticks are 40cm long, the top part of the backpack can be rolled down according to how full it is, closing it with a fast and easy method of button and string tie. This also follows the theme of sustainable resourcing of materials and pieces, and ease of repair.

The inside of the bag is lined to maintain a better structure and make the backpack long lasting.









## THE OIL CONTAINERS

The oil containers provided in the kit are two: the black one to store cooking oil which can be reused in the kitchen or homemade cooking oil, and the white one to store waste cooking oil (WCO). Either one of them can be brought into the collection point to be exchanged with fully charged power banks or vouchers. In the background, they are transported to the conversion point where the oils are converted into biodiesel and eventually electricity through the charged power banks.

The design of the bottles is based on the art of origami, to create a sturdy container but at the same time collapsible. The user pushes down on the top of the bottle to compress it when it is empty, so that space can be saved at home or inside the backpack; the compressed shape is maintained through a strip which is tightened vertically around the bottle.

The containers are equipped with metal wiremesh filters, so that the pieces of fried or burnt food do not contaminate the oil within the bottle. This filter is easily extracted from the container so that it can be rinsed under running water and reused.

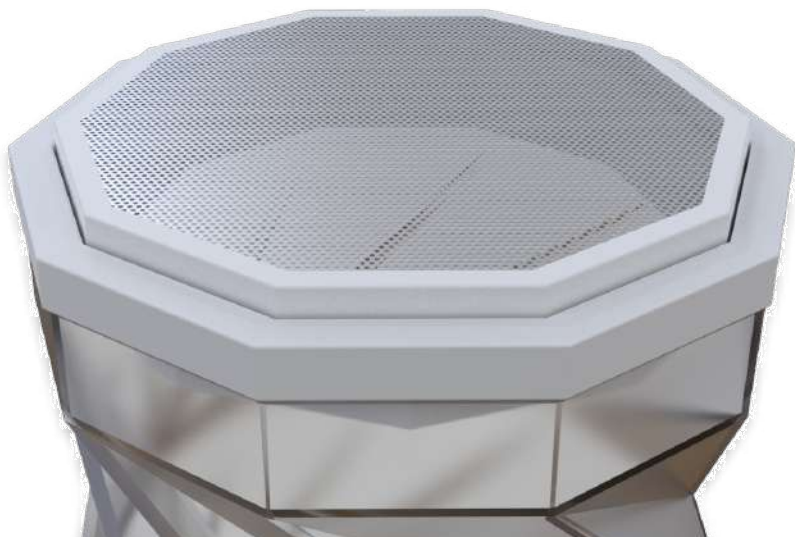
The container and the caps are made from recycled Polyethylene, which is obtained by recycling oil pouches already on the market.



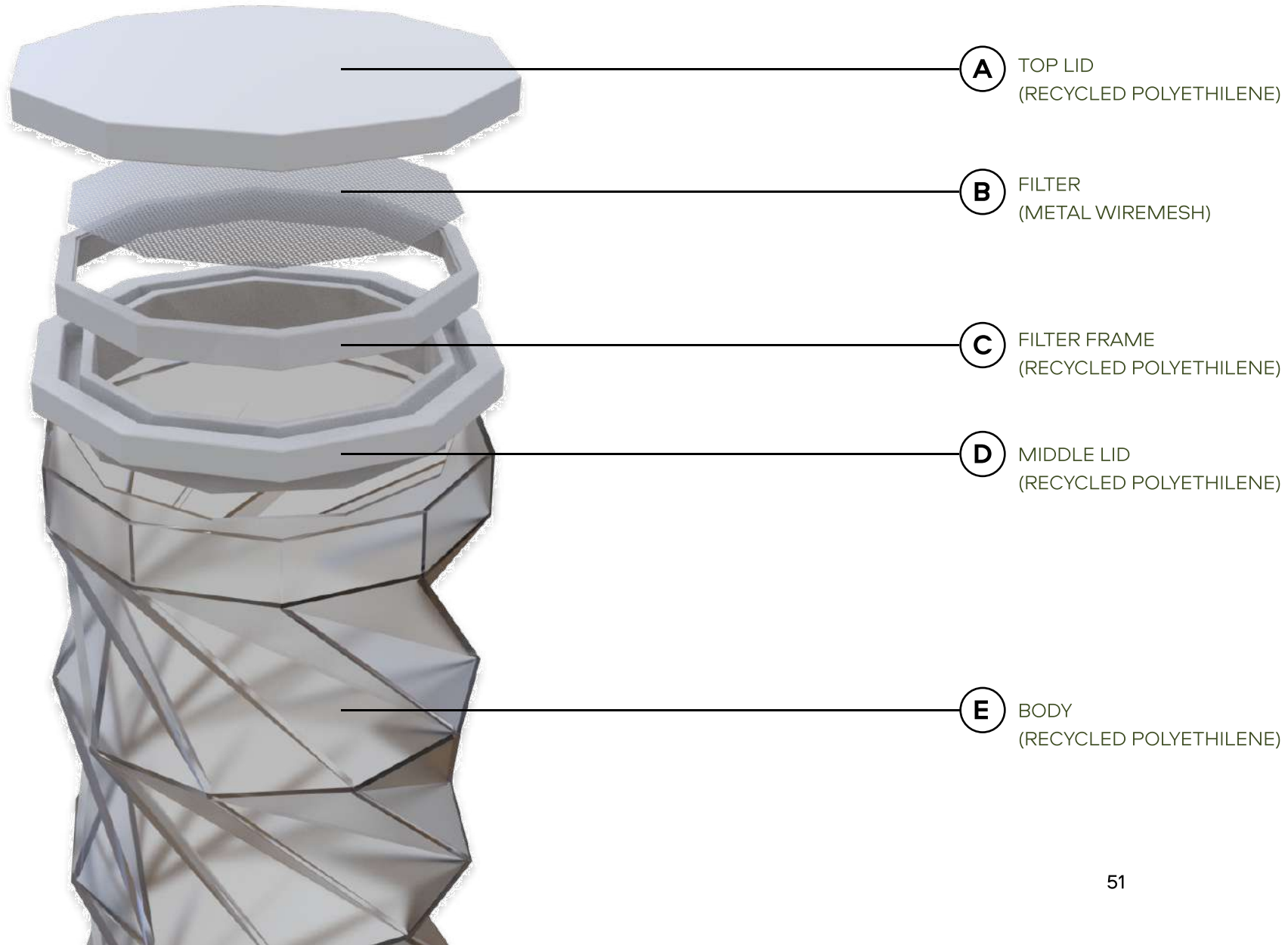
CONTAINER 1 (BLACK)  
For reusing cooking oil/  
storing homemade  
cooking oil



CONTAINER 2 (WHITE)  
For storing final waste  
cooking oil (WCO)



## THE OIL CONTAINERS





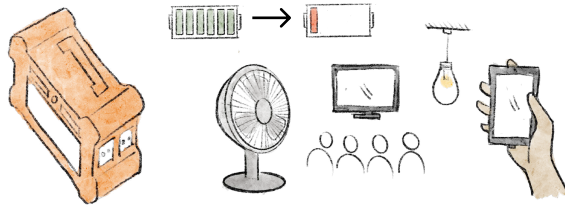


# HOW TO USE THE YUB KIT

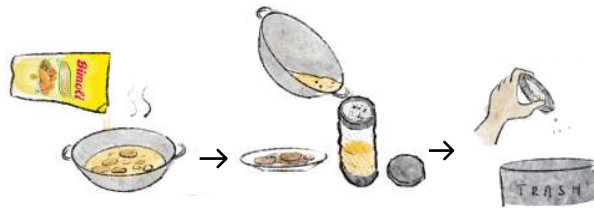
## STEP 1: USE THE ITEMS



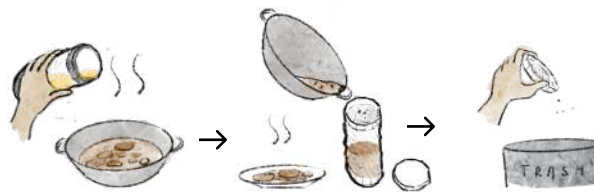
**1 POWER BANK**  
The powerbank can be used for one household (4 family members max) for 8 days.



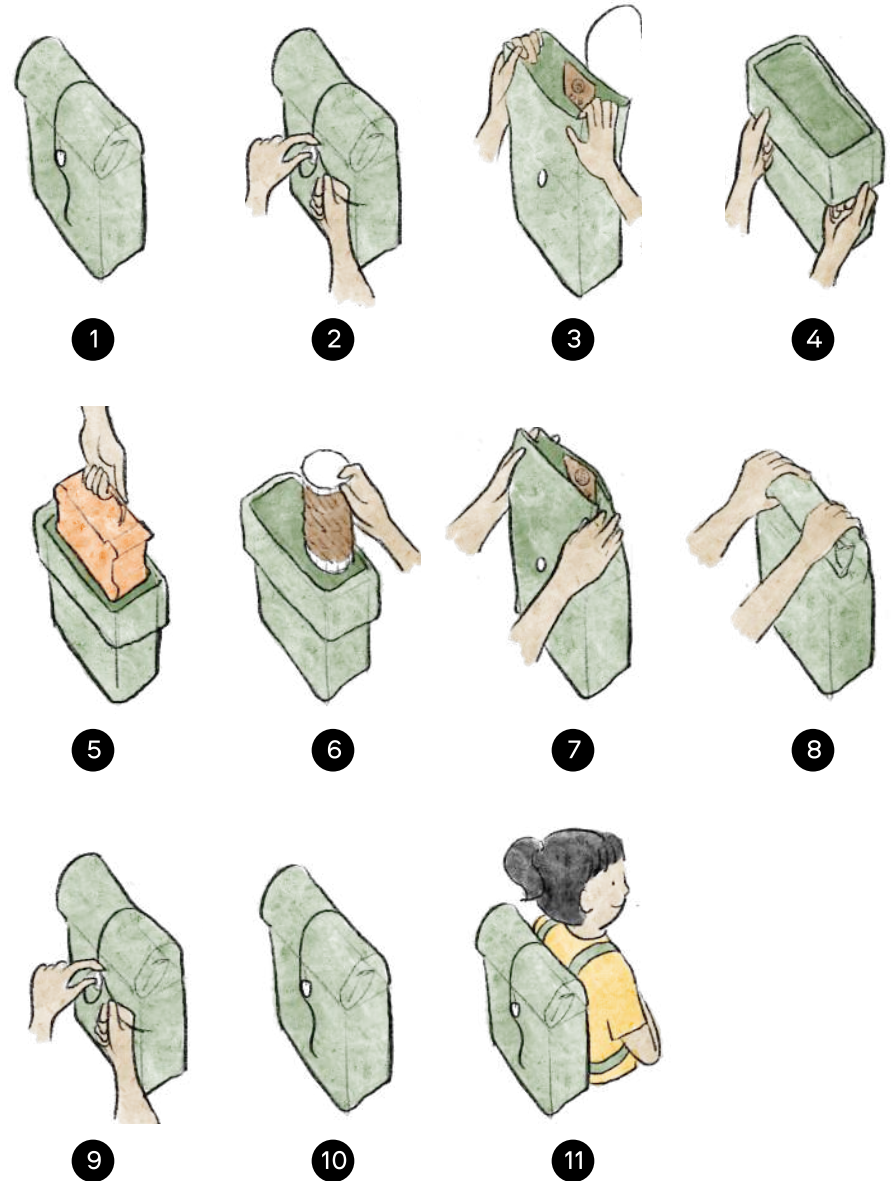
**2 OIL CONTAINER 1**  
For reusing cooking oil or for homemade cooking oil.



**3 OIL CONTAINER 2**  
For final Waste Cooking Oil (WCO).



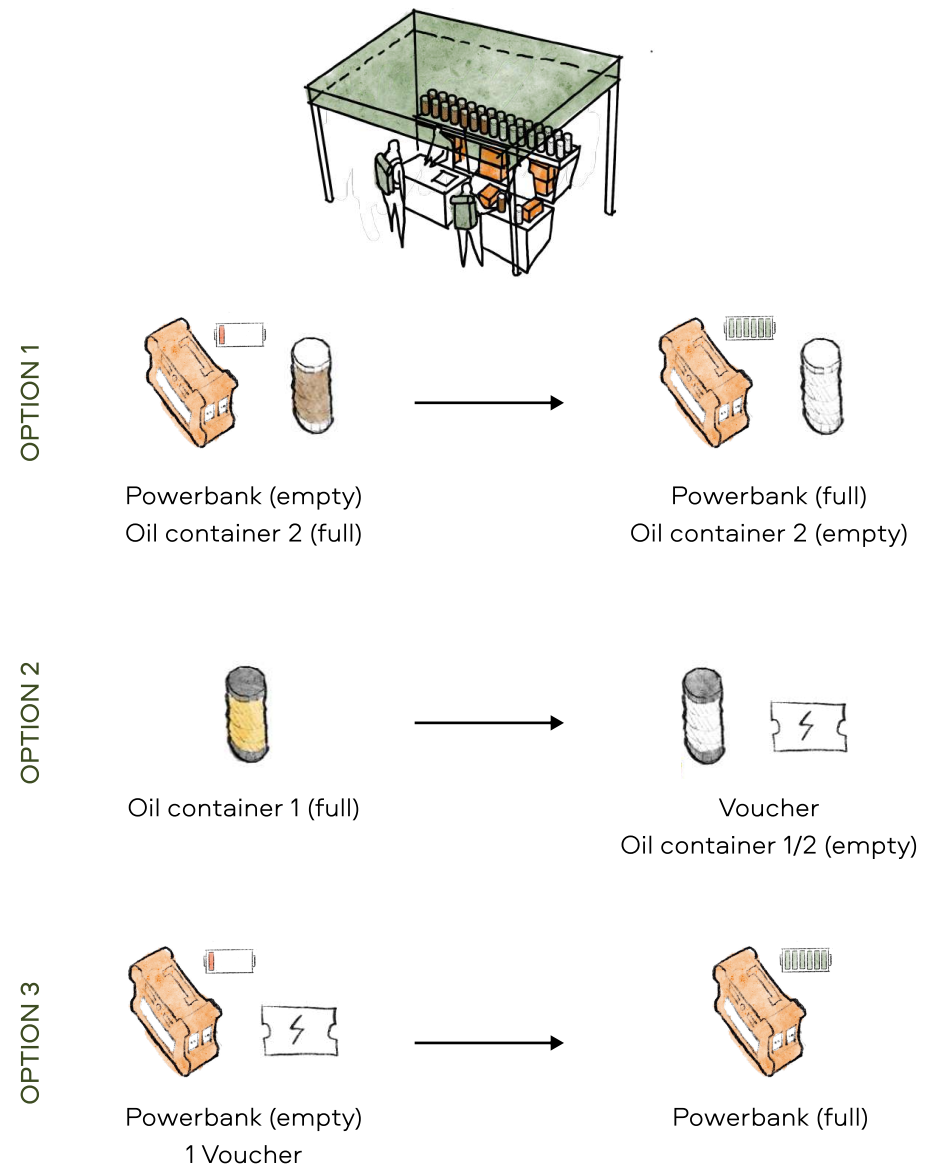
## STEP 2: PACK THE ITEMS INSIDE BACKPACK



STEP 3: FIND YOUR NEAREST COLLECTION POINT!



STEP 4: EXCHANGE IN THE COLLECTION POINT









# SERVICES

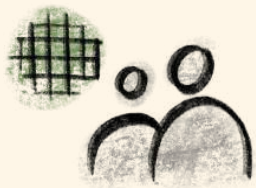
## PRIMARY SERVICES



Provides electricity to off-grid rural areas in Indonesia together with the Indonesian government.



Reuses Waste Cooking oil as raw material for Biodiesel to Electricity conversion.



Empowers women and cultivates local craftsmanship through weaving.

## SECONDARY SERVICES



Recycles the plastic from WCO container and cooking oil packages.

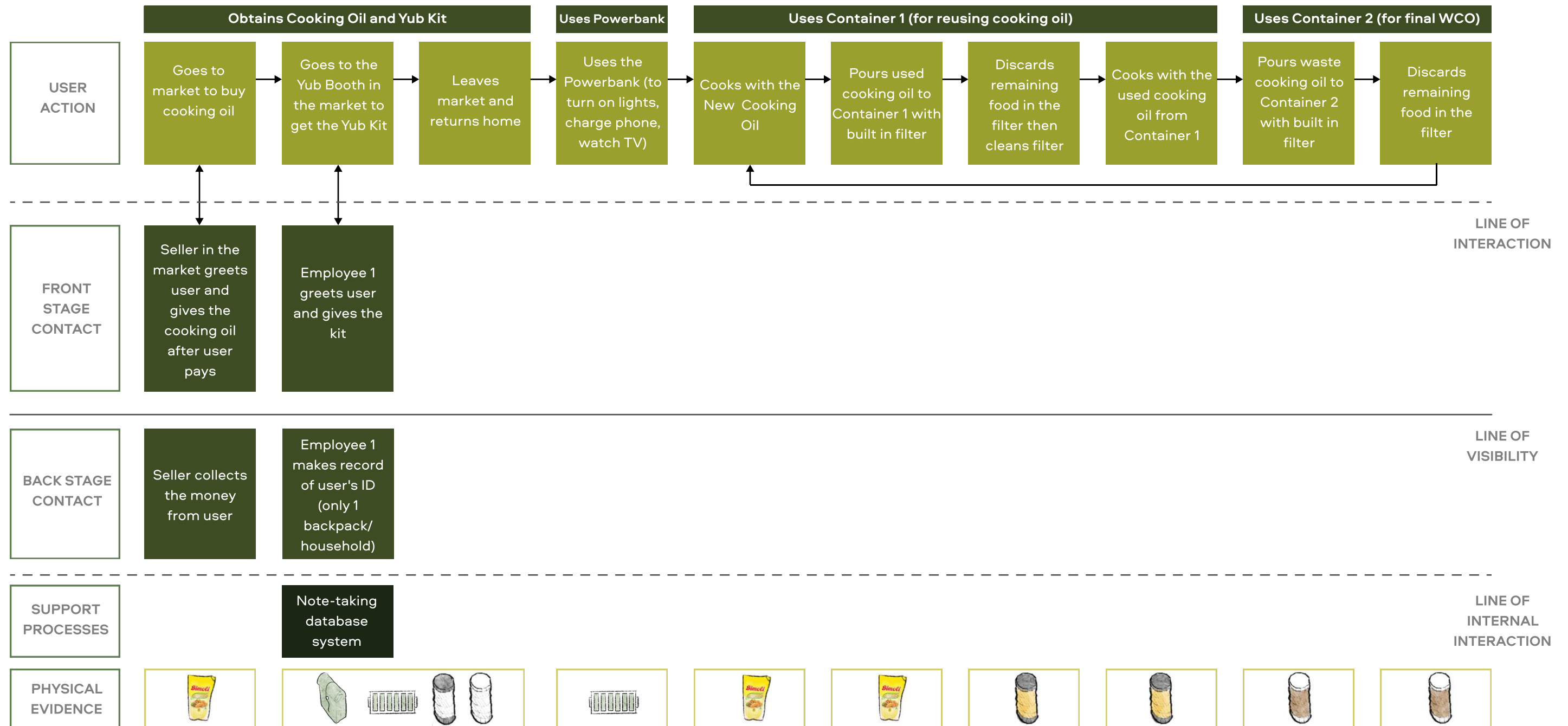


Provides backpack repair service.



Provides workshops to increase environmental awareness and the importance of reusing WCO.

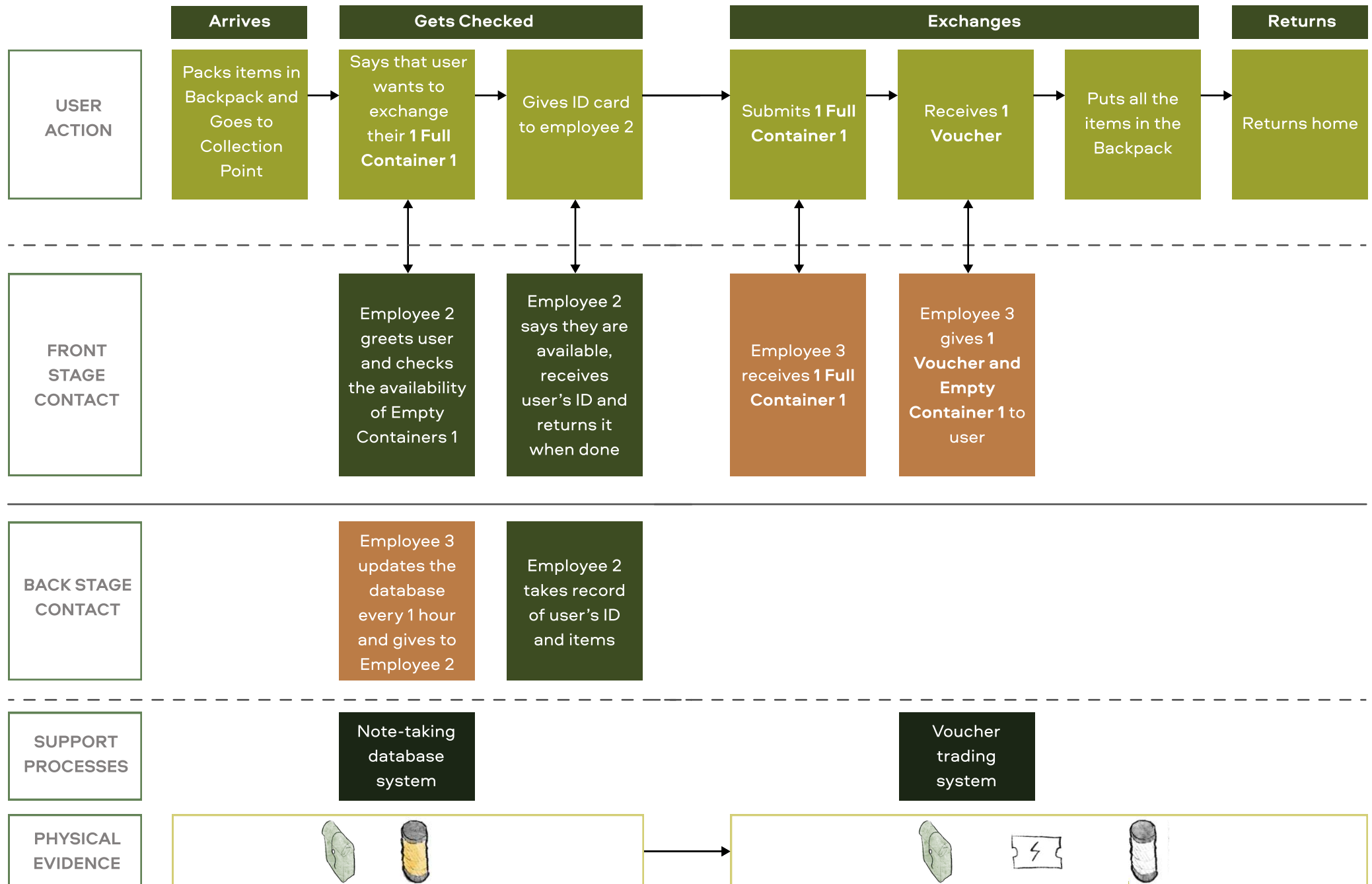
# SERVICE BLUEPRINT (MAIN)



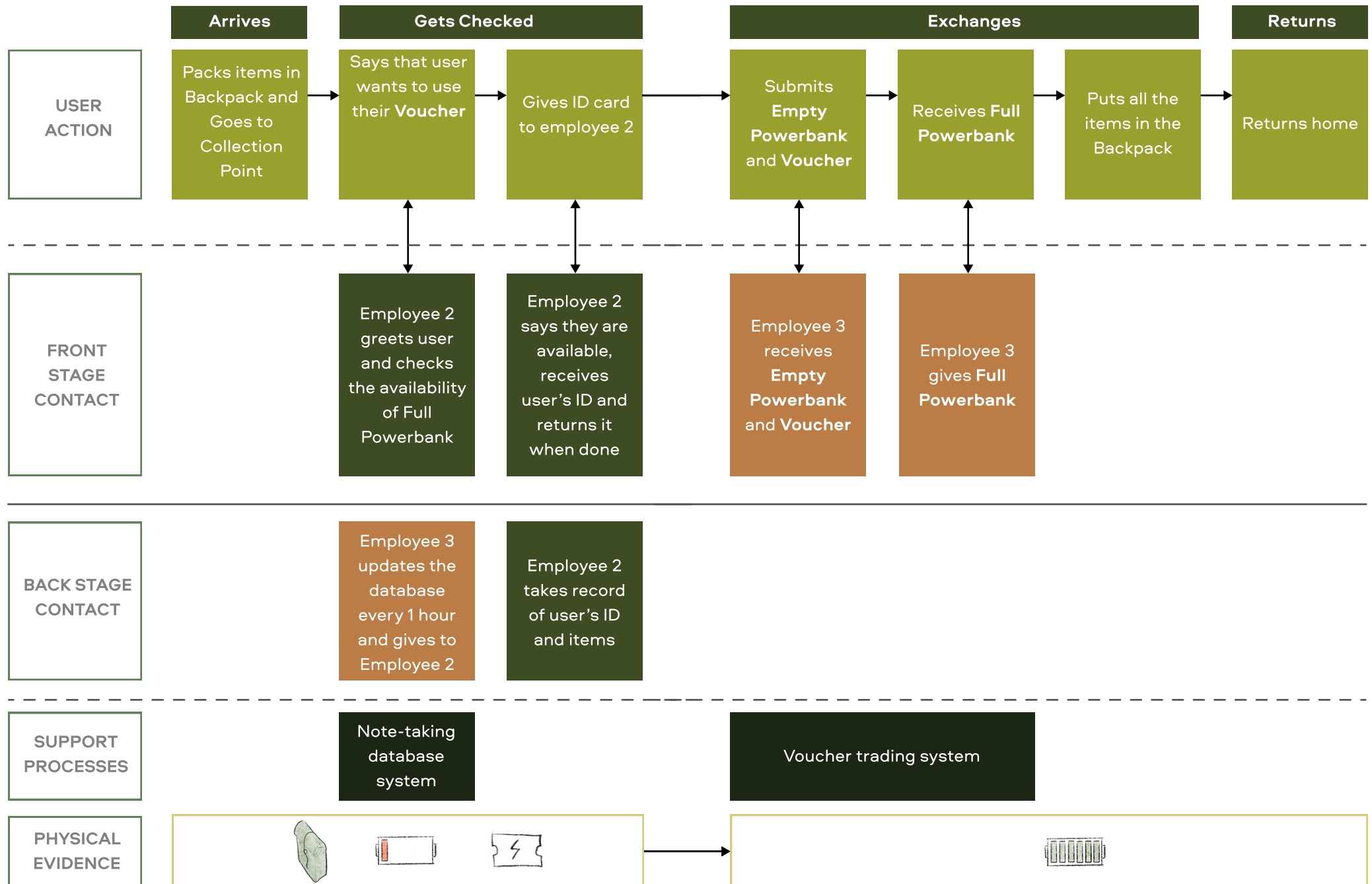
# SERVICE BLUEPRINT (OIL CONTAINER + POWERBANK)



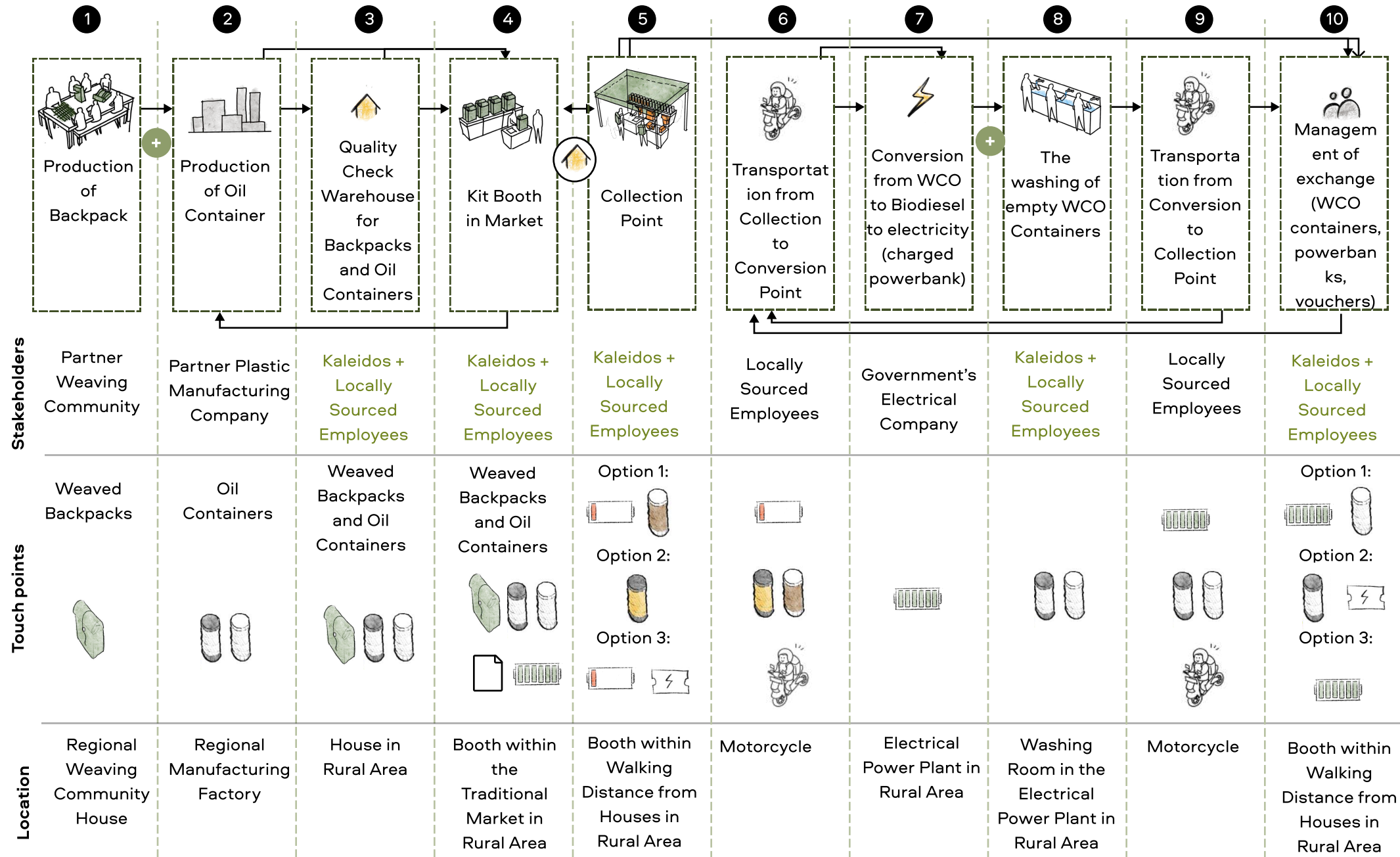
# SERVICE BLUEPRINT (ONLY HOMEMADE OIL)



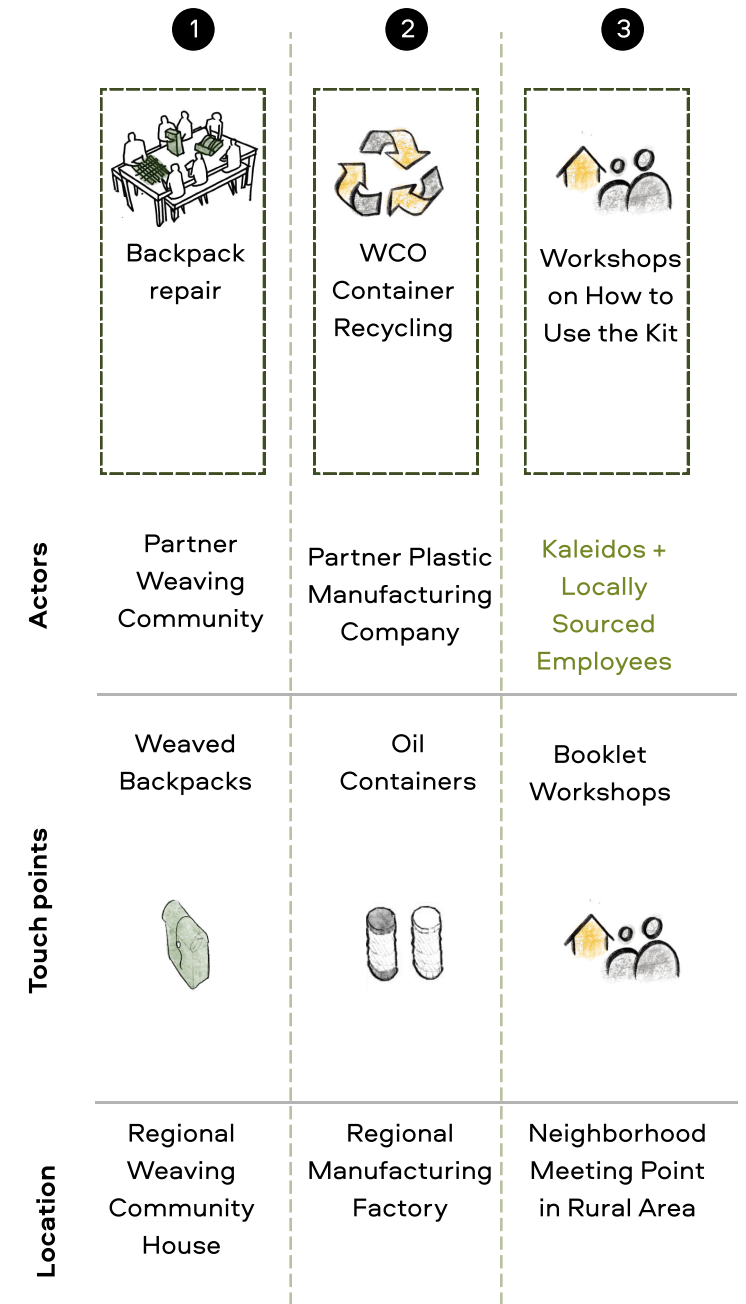
# SERVICE BLUEPRINT (POWERBANK + VOUCHER)



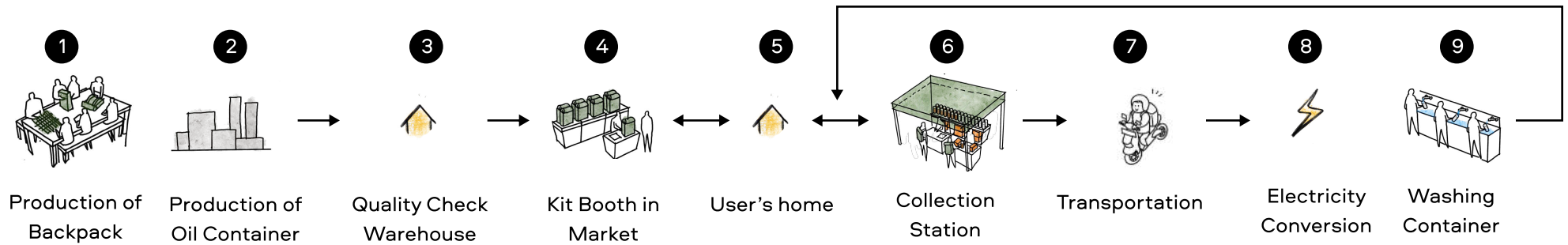
## SERVICE OFFERING MAP (PRIMARY)



## SERVICE OFFERING MAP (SECONDARY)



# SERVICE MASTER PLAN





# SYSTEM FLOW MAP

## 1. TRADITIONAL MARKET - KIT BOOTH

Yub Kit will be available in booths in the traditional market where user will also buy the cooking oil and other weekly necessities.

Each family is allotted a unique code in reference to the national ID card. The number of kits given depends on the number of members in the family. 1 Kit is only for maximum 4 people in a household.

## 2. USER'S HOME

At home, the user can directly use the items in the Yub Kit:

1. **Powerbank:** to power electricity at home for maximum a week
2. **Oil Container 1 (Black):** for the cooking oil to be reused/homemade oil
3. **Oil container 2 (White):** for the final waste cooking oil



## 0C. QUALITY CHECK WAREHOUSE

The weaved backpacks and oil containers are combined in the Yub Kit and checked for its quality.

## 0B. MANUFACTURING FACTORY

The Partner Manufacturing Factory will be the place where the new Oil Containers are produced and broken ones are recycled.

## 0A. WEAVING HOUSE

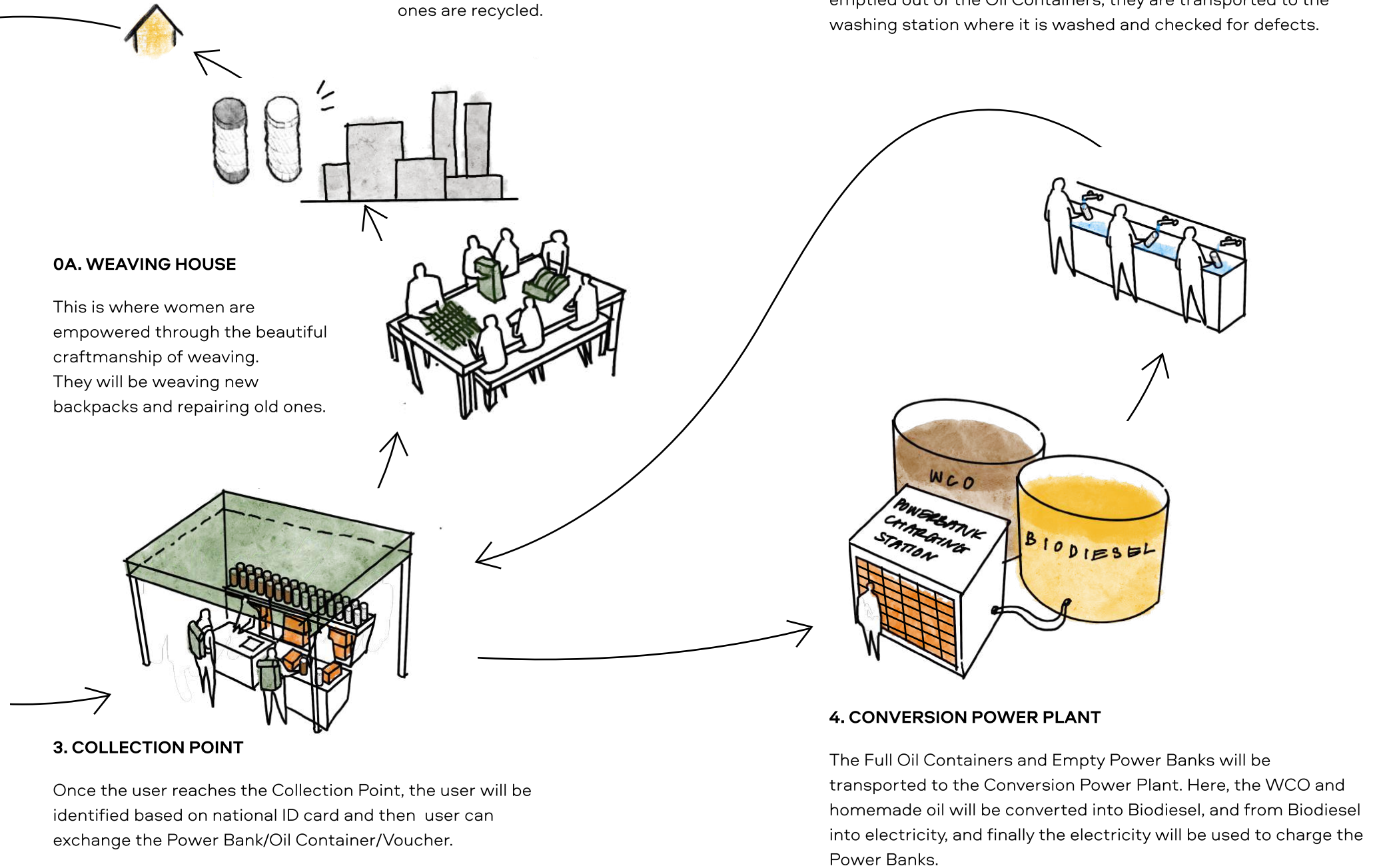
This is where women are empowered through the beautiful craftsmanship of weaving. They will be weaving new backpacks and repairing old ones.

## 3. COLLECTION POINT

Once the user reaches the Collection Point, the user will be identified based on national ID card and then user can exchange the Power Bank/Oil Container/Voucher.

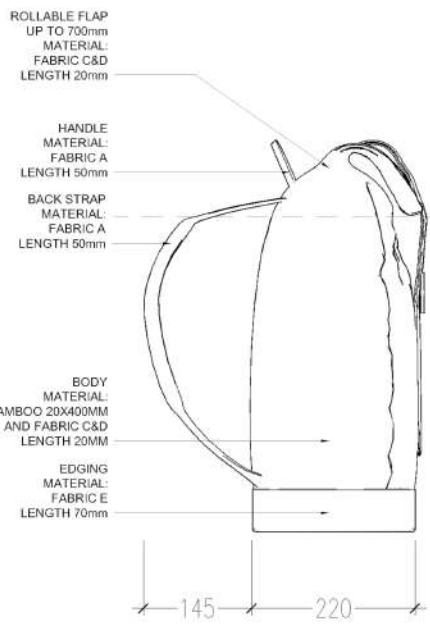
## 5. WASHING STATION

When all the Waste Cooking Oil/Homemade Cooking Oil are emptied out of the Oil Containers, they are transported to the washing station where it is washed and checked for defects.

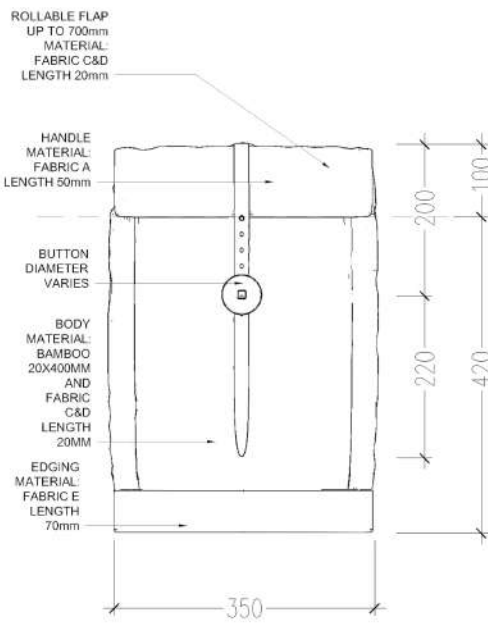




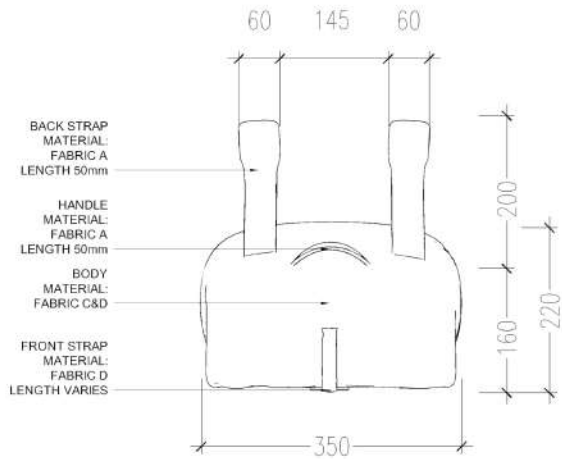
# A N N E X E S



3 SIDE VIEW  
SCALE: 1:10



4 FRONT VIEW  
SCALE: 1:10

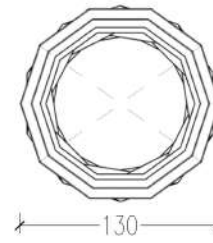


2 PLAN  
SCALE: 1:10

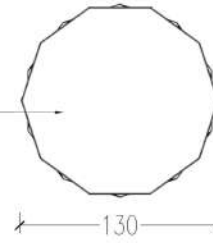


1 AXONOMETRIC VIEW  
SCALE: N/A

COMPONENT	SCALE	UNIT OF MEASURE	MATERIALS
Backpack	1:10	mm	Mixed



4 SECTION A  
SCALE: 1:10



3 TOP VIEW  
SCALE: 1:10

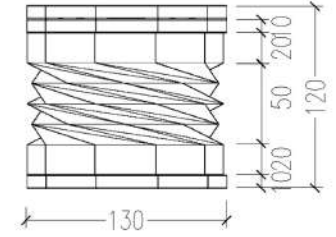
TOP LID  
MATERIAL:  
POLYLACTIC ACID  
(PLA)  
COLOR  
WHITE/BLACK

TOP LID  
FILTER FRAME

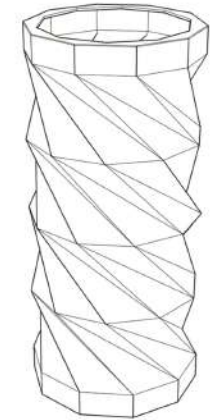
CONTAINER BODY  
MATERIAL:  
POLYPROPYLENE

BOTTOM LID

2 FRONT VIEW  
SCALE: 1:5



5 FRONT VIEW (COMPRESSED)  
SCALE: 1:10



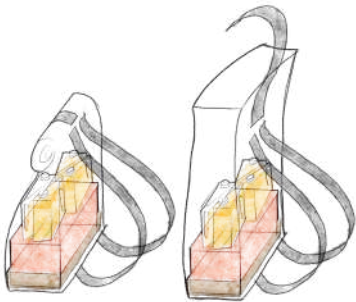
1 AXONOMETRIC VIEW  
SCALE: N/A

COMPONENT	SCALE	UNIT OF MEASURE	MATERIALS
Oil Container	1:5	mm	Mixed

## PRODUCT DEVELOPMENT: BACKPACK

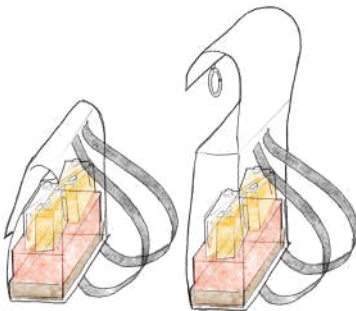
Prototype 1: rollable bag

Material: reused cotton fabric



Prototype 2: non-rollable bag

Material: reused leather



### REFLECTIONS:

- Material: the weaved materials need to be sturdy in order for people to easily place and remove items into and from the backpack. Since the materials in these 2 prototypes are not sturdy and the height of the backpack is quite high (70cm), we had a hard time to move objects inside the backpack. Solution: we use bamboo sticks to reinforce the structure of the backpack for the final product, combined with fabric to maintain its flexibility.
- Rolled vs non-rollable flaps. With these 2 prototypes we were able to test that the rollable part is the better decision because it can accommodate more items inside the backpack. However, since in both prototypes the fabric is soft, the roll-ability is not achieved because there is no sturdy structure where the rolled part will rest on. Solution: we create a 'box'-like structure for the main body of the backpack, so the rollable flap can rest on it.
- Buckle/buttons. Since this product will be in rural areas of Indonesia, it is better to use buttons for simplicity. Buckles are more expensive to produce and may break easily in the long term but buttons are inexpensive and will last a long time if sewn properly. Solution: we use the button to fix the rolled flap with a twisting method of an envelope thread.

## PRODUCT DEVELOPMENT: OIL CONTAINERS

Prototype 1: prism container with lid on the side



Prototype 2: triangular pouch with lid in the middle



Prototype 3: collapsible origami with rectangular shape

Prototype 4: collapsible origami with basic cylindrical shape

### REFLECTIONS:

- Compressibility and ability to be freestanding : prototype 1 has the lowest compressibility because of the lid and the prism shape, but it can stand quite well. Prototype 2 is a bit better in compressibility because it can be rolled from the bottom and stops until the lid, but it is not stable if freestanding, especially if the content is empty.
- Therefore we tried prototype 3&4 where the compressibility and state of freestanding is better. With their origami shape, they can be compressed into very thin and small shape. They are also stable when standing even if the inside is empty, because of its even weight distribution.
- Grip: in terms of grip when someone is pouring something inside the container, prototype 3&4 are better than prototype 1&2. Thanks to the origami shape, it provides corners where the fingers can rest and hold on to the whole body. For prototype 1&2, the grip is only on the side and it is made of cut out thin surface which makes it easy to break and slip.
- Prototype 3&4 have the better option of larger opening and filter because of its larger body compared to prototype 1&2.

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EVOLVING  
for shared system