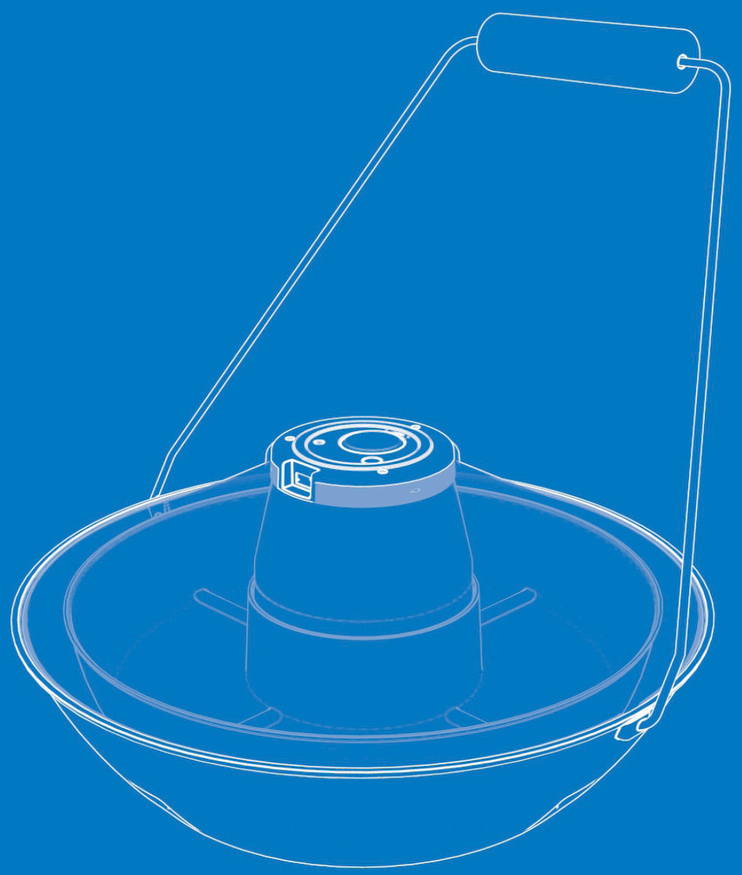
SUN AND SALT

A temporary off-grid device for families in developing countries

By Ruoxi Zeng,May 2018

LUND
UNIVERSITY



Degree Project for Master of Fine Arts in Design, Main Field of Study Industrial Design, from Lund University, School of Industrial Design, Department of Design Sciences
Examiner: Lecturer Andreas Hopf
Supervisor: Professor Claus-Christian Eckhardt
2018
ISRN: LUT-DVIDE/ EX--18/50406-SE

Introduction

-Background: off the grid
-Goal
-Method
-Brief

Chapter 1

- Figure tells
- How much are we off the grid?
- Conclusion
- Design opportunity

Chapter 2

- Technology route
- Initial sketch
- Selection

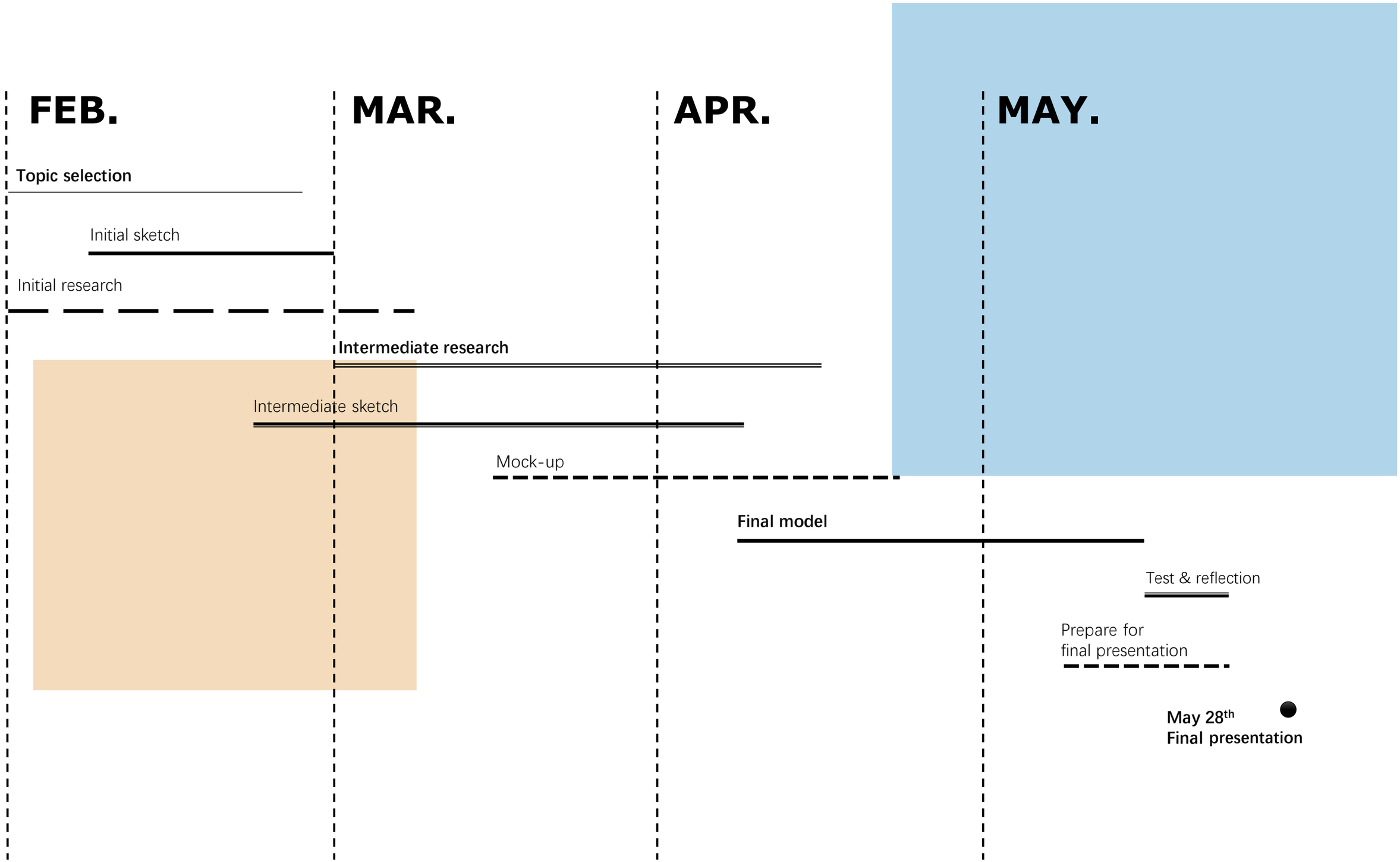
Chapter 3

-Sketch, selection
-Mock-up
-Function model
-Section view

Chapter 4

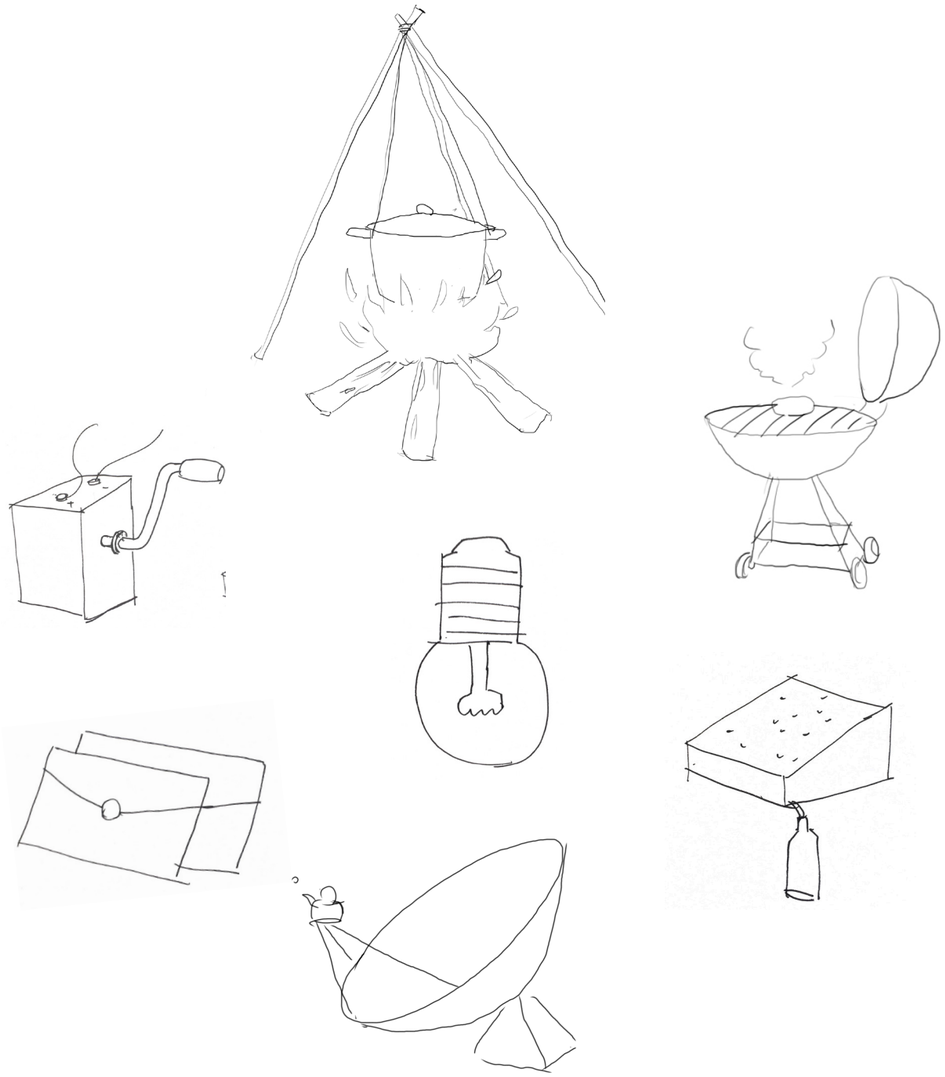
-Rendering
-Drawings
-Construction
-Final prototype
-Test & reflection

References


FEB.
MAR.
APR.
MAY.
Topic selection
Initial sketch
Initial research
Intermediate research
Intermediate sketch
Mock-up
Final model
Test & reflection
Prepare for
final presentation
May 28th
Final presentation

INTRO

- Background: off the grid
- Goal
- Research method
- Brief



Background: Off the Grid?

Off the grid means living without connection to the water grid, electricity grid, internet, etc. Before entering modern civilization, human beings live in an off-grid way.

Today, we have connected to the water and electricity grid, also connected to the internet as well during the last two decades. However, there are 1,4 billion people out there that don't have access to electricity. And for housing, water, it could be more. In some countries, people still have to live off-grid. At the same, some people want to live fresh: be more independent and more self-sufficient.

We could find many off-grid solutions in our life, for example, for cooking, we need a campfire or a barbecue grill. For electricity, we have hand-crank electricity generator, and for communication, we used to have paper mail. In different circumstances, we need to get off the grid in different ways, no matter if we're willing to or forced to.

Goal

By learning about the problems and scenarios of off-the-grid living, the goal of this project is to solve potential off-the-grid problems using low and affordable technology, making the off-the-grid solution could be acceptable by most people.

Brief

Develop a product for the off-the-grid living scenario, mainly for families in developing countries with poor infrastructure. It should be reliable and affordable by using simple technology with minimized impact to the environment.

Methods

The methods used in this project is mainly literature review about the off-the-grid concept, scenario, users, etc. To make the final product accessible to more people, the research about current off-the-grid technology is necessary. In product development process, test and mock-up looping is a must. Test and reflection will happen afterward to get ideas for possible further improvement.

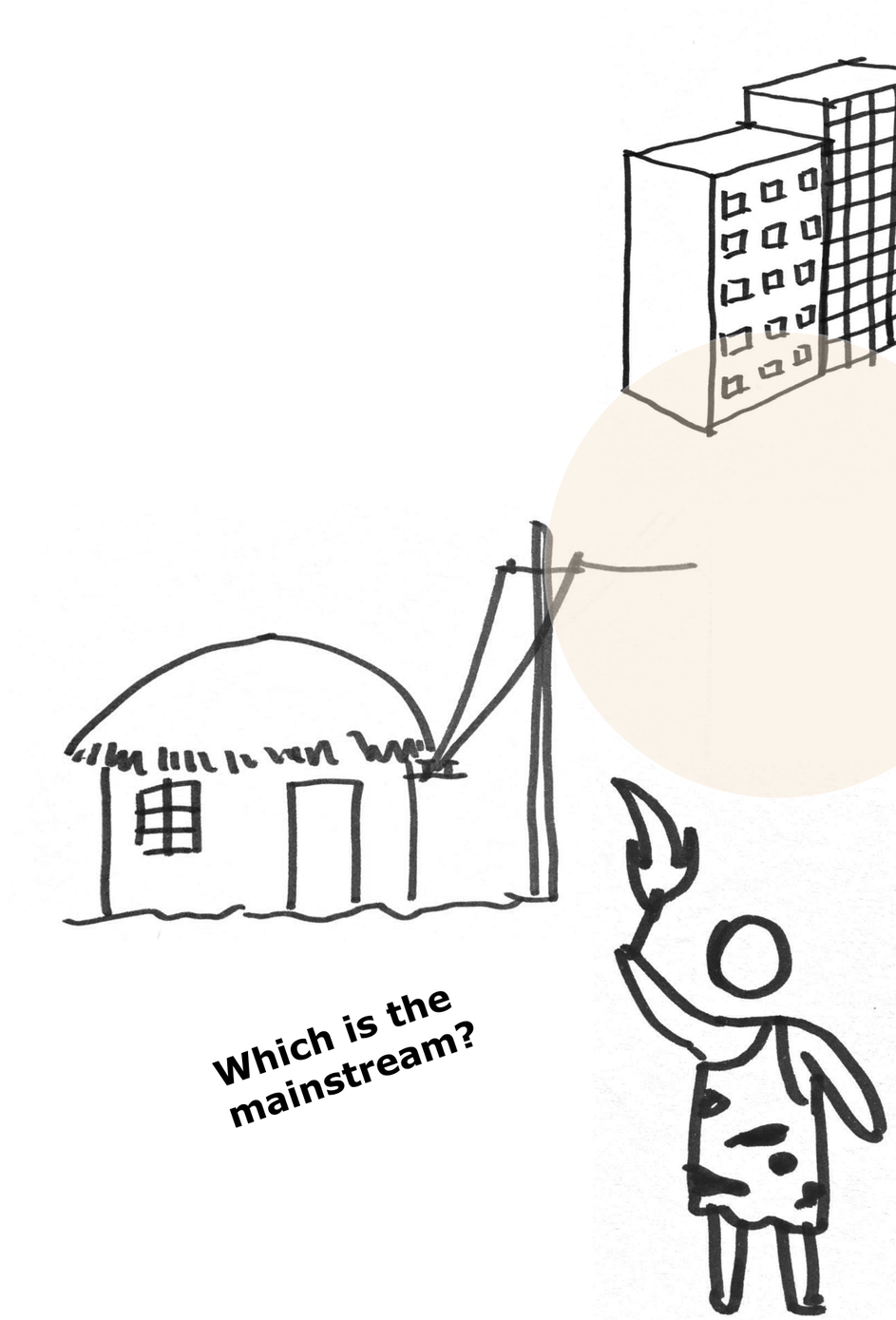
CHAPTER 1

- Off-the-grid level
- Figures tell
- How much are we off the grid?
- Conclusion
- Design opportunity

Off the grid level

For people with access to electricity and water, they still need to be off the grid sometimes. The reason could be either they have the poor infrastructures or have the need of off-the-grid life, such as camping. They are half off the grid.

We could define off-the-grid in different level: Completely on the grid, which means people get full access to water. Half off the grid, which means people have access to water and electricity grid that is not stable or tends to be more self-sufficient and live without electricity grid. And completely off the grid: live totally without water and electricity supply.



Figures tell

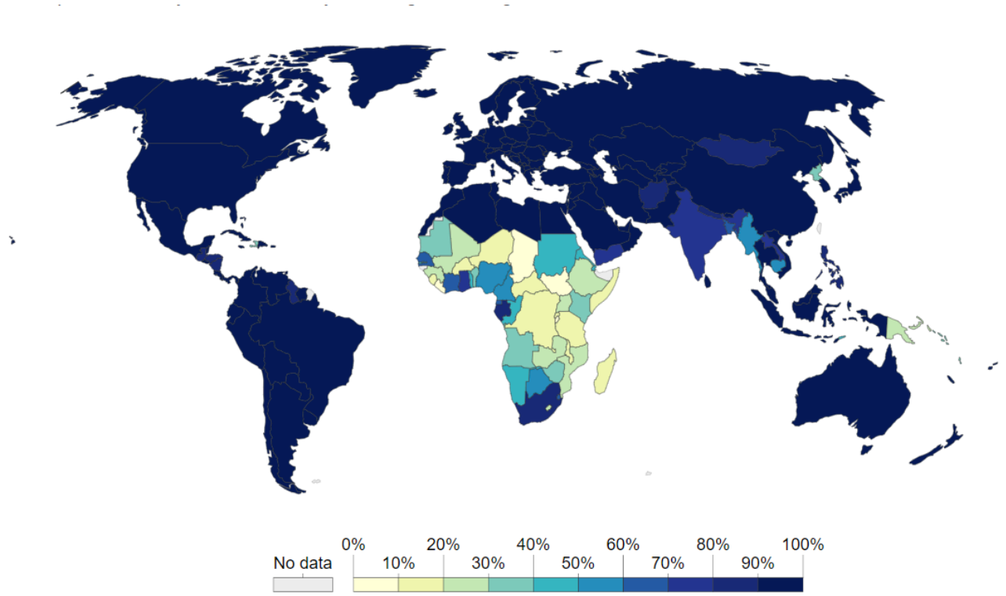
10 places short of clean water

Tanzania (15.3% of population)
Niger (14.4% of population)
Sierra Leone (14.2% of population)
Burkina Faso (13.1% of population
Central African Republic (10.8% of population)
Liberia (9.8% of population)
Malawi (9.8% of population)
Burundi (6.5% of population)
Chad (6.4% of population)
South Sudan (5.1% of population

10 places short of electricity

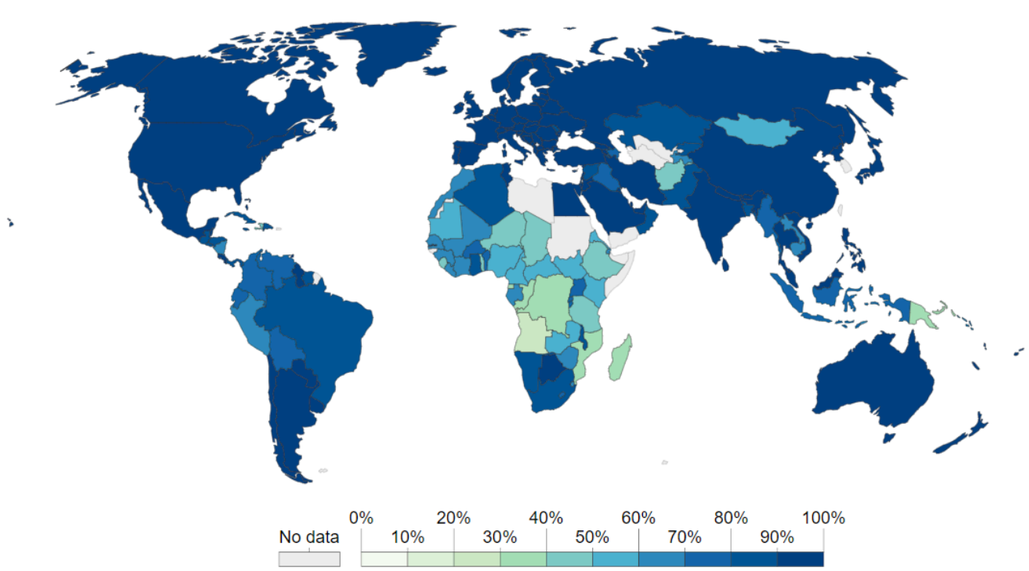
Afghanistan
Ethiopia
Chad
Cambodia
Laos
Haiti
Ghana
India
Rwanda
Bangladesh

Access to electricity

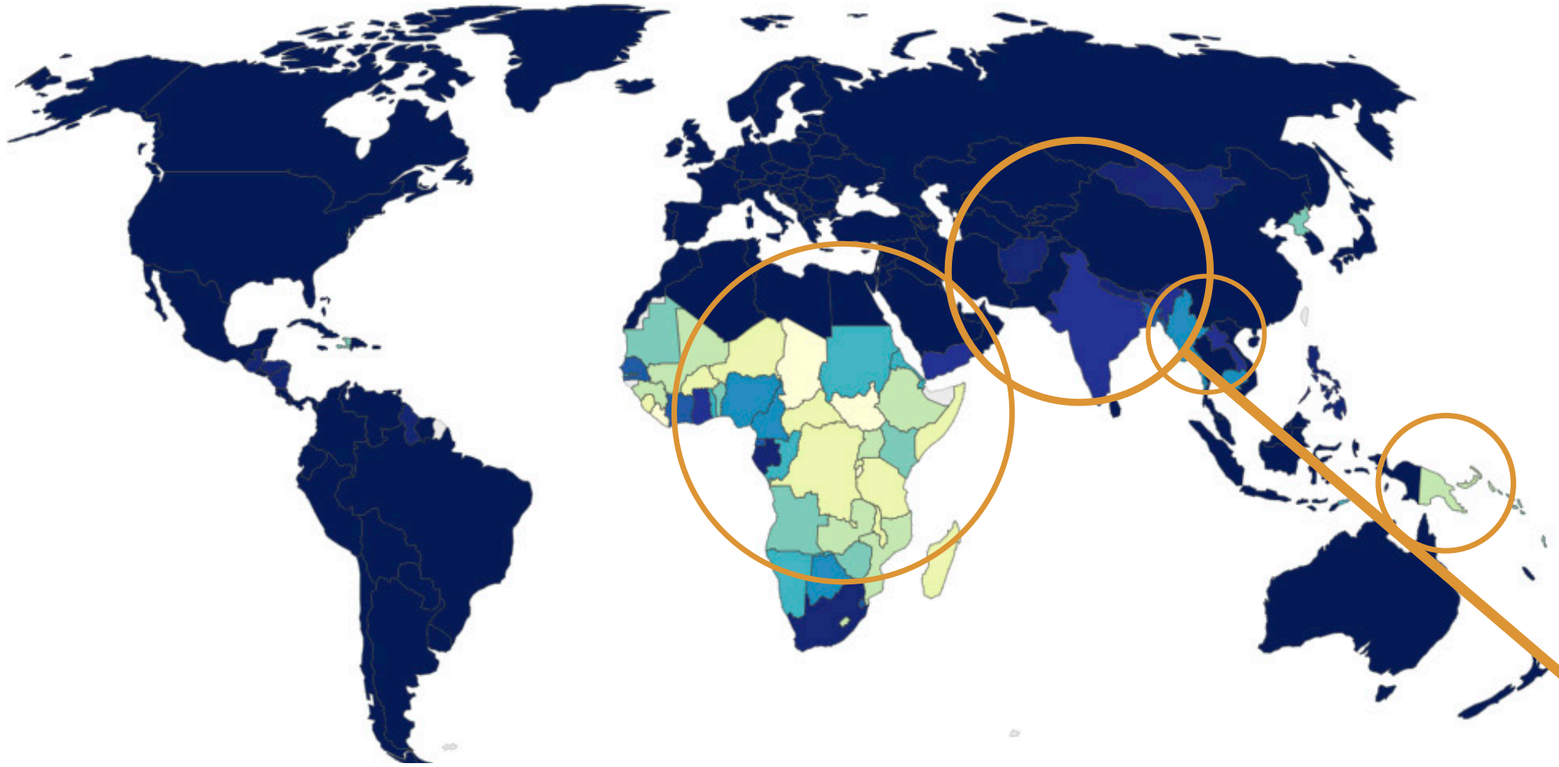


Source: The World Bank

Access to imporved water source

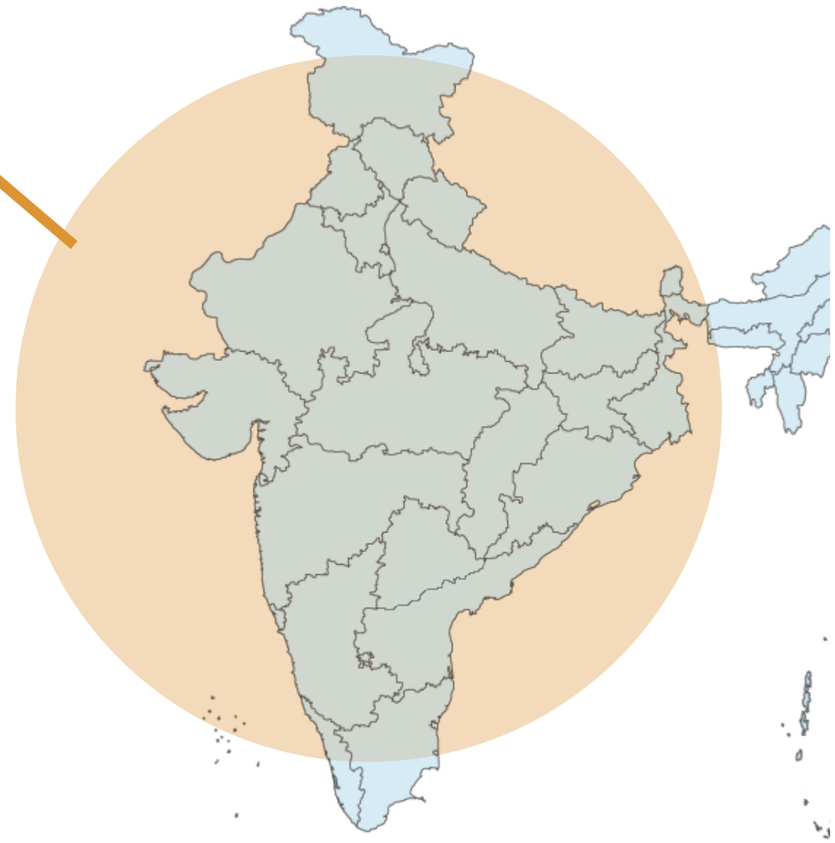


Source: World Bank – WDI



For example?

In India, there're 163 million people lack access to safe water and 210 million lack access to improved sanitation. Also, 300 million people in rural areas live without electricity supply. Besides, for people who get access to electricity, the electricity supply is not stable.

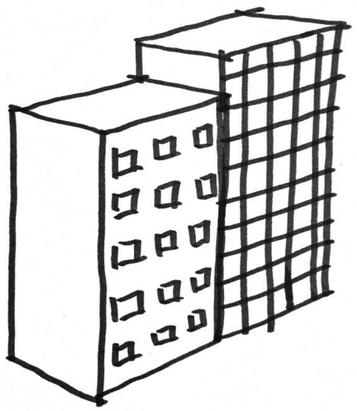


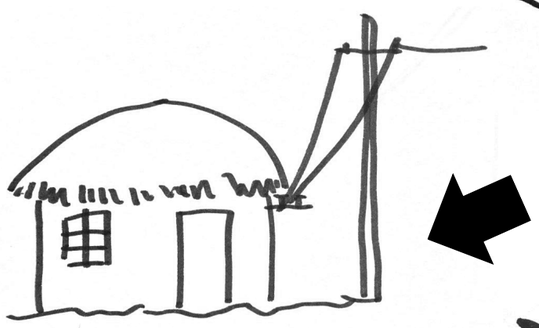
What could we find?

From the map, we could find out common areas that are short of electricity and water resource. They are mostly Africa countries, some Southeast Asia countries and South Asia countries. They are all developing countries with poor infrastructure.

How much we are off the grid?

Majority of us is on the grid



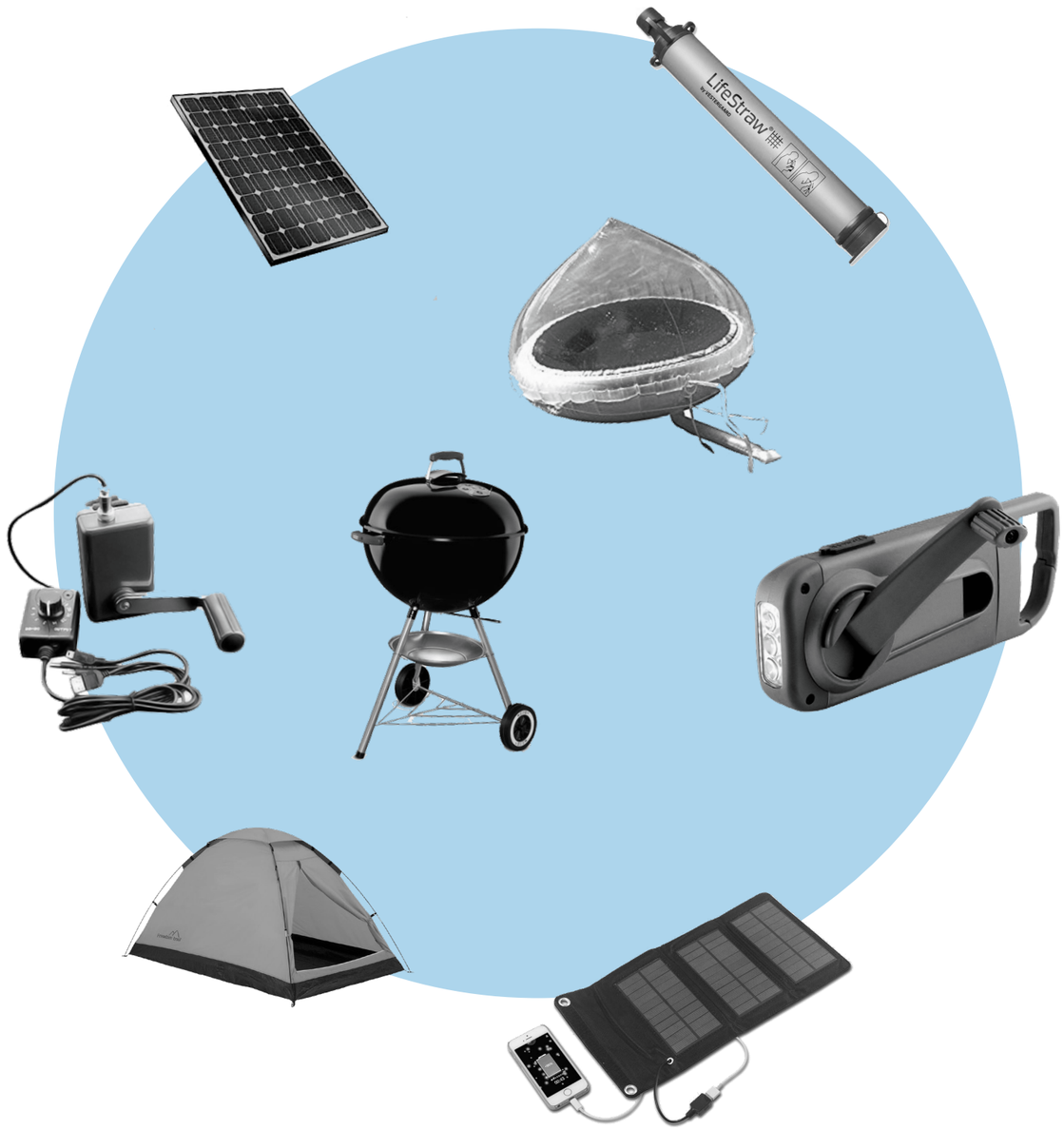


Some of us live in developing countries are off the grid, or not completely on the grid

Very few of us are totally off the grid

Conclusion

Most people on the earth connect to the grid. However, some people are still suffering from water and electricity supply problems. They usually don't come alone, especially for people living in developing countries with infrastructure. It means in some countries, people with poor clean water supply may also lack electricity. Besides, even though many people have connected to the grid, the water, and electricity supply could be quite unstable.



Existing products

There're existing products used for the different off-the-grid scenario. For example, there're products for off-the-grid scenarios in the wild, like life straw, hand-crank flashlight, or solar panel charger. Many off-the-grid products are not for an extreme off-the-grid scenario, like a tent or barbecue grill.

Design opportunity

It could be a design opportunity that we develop a product solving two off-the-grid problems at the same time, for example, energy and water. Besides, there're few products aim for families or home which is not connected to the grid or could not get stable water and electricity supply.

It's hard to solve the long-term off-the-grid problem though, but it's still possible to solve short-term water and electricity shortage, which could be the key for the product.

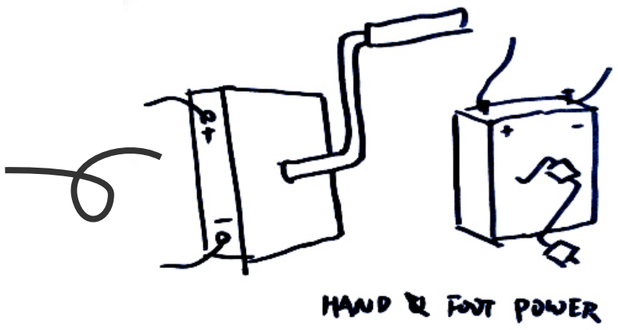
CHAPTER 2

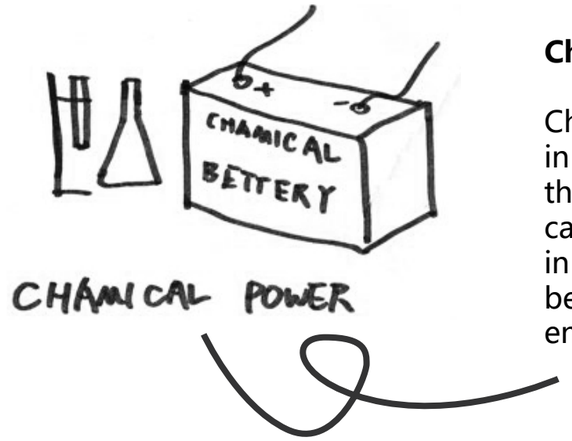
- Technology route
- Initial sketch
- Selection

Technology routes: electricity

Hand & foot power

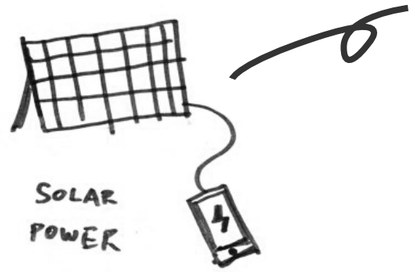
The hand-crank electricity generator is a simple device. It doesn't produce any pollution, however, to produce enough electricity, it means you always need to crank the electricity generator, which is not convenient for long-term electricity supply.





Chemical power

Chemical energy is everywhere in our daily life. We could find them in electronic device and cars. However, some chemicals in chemical batteries could be extremely harmful to the environment.

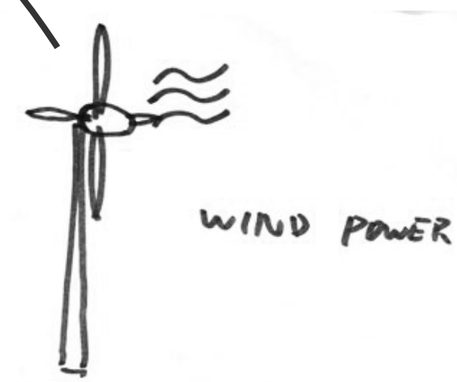


Solar power

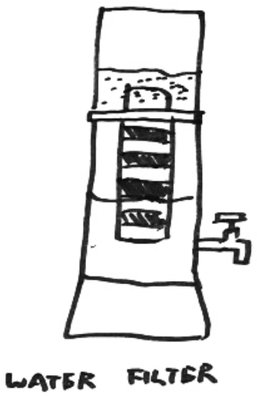
Solar power is the most common energy on the earth. However, the efficiency of the solar power is low, and it couldn't work fine in places where there're not enough sunshine.

Wind power

Wind power is 100% environment-friendly and effective. However, traditional wind power electricity generator is pretty huge. Usually produces electricity for the electricity grid.



Technology routes: water purification

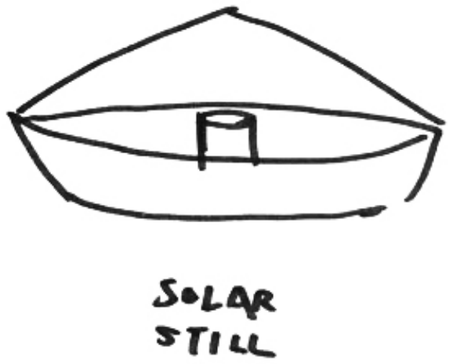


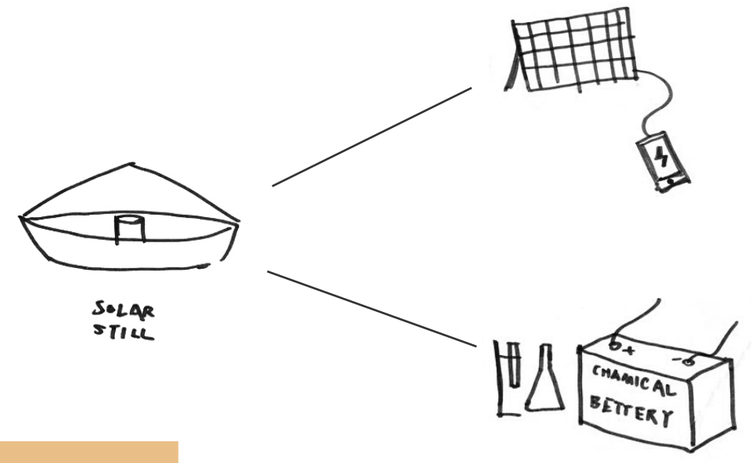
Water filter

A water filter is a common purification device. However, you need always keep an eye on the filter part and change it frequently. For some water resource, it doesn't work very well.

Solar still

Solar still is a simple device using solar heat to get distilled water. It's reusable and cheap. However, it couldn't work in the places where's cold and has few solar resources.





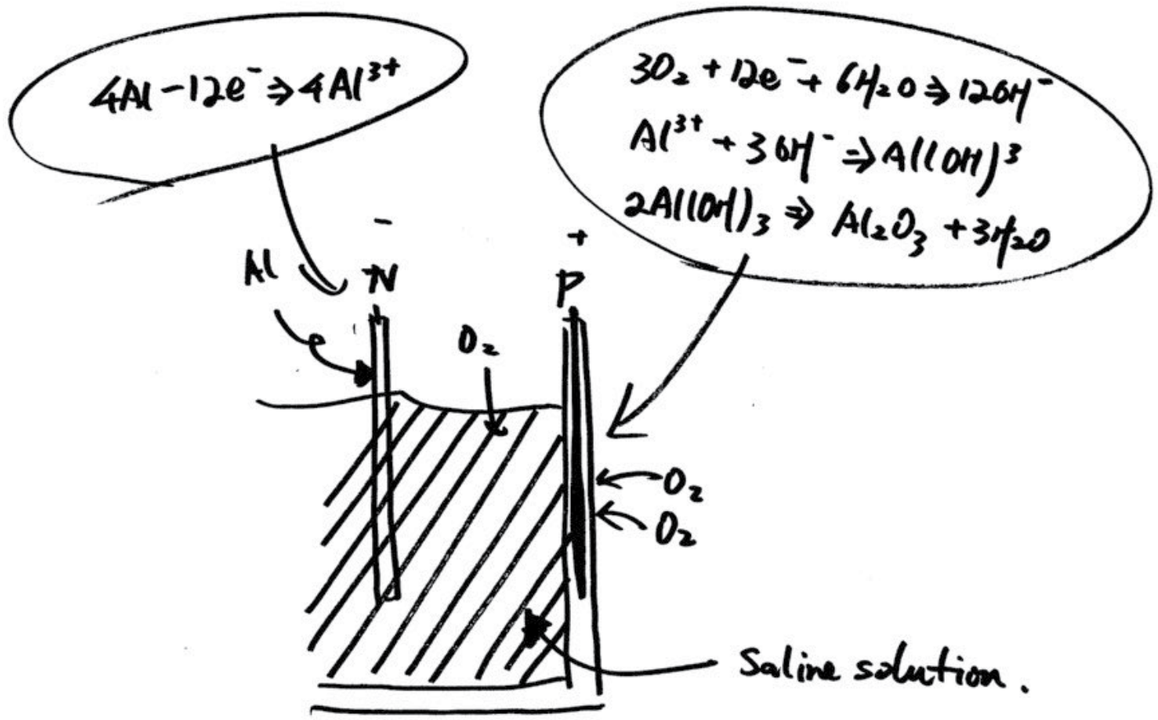
Selection

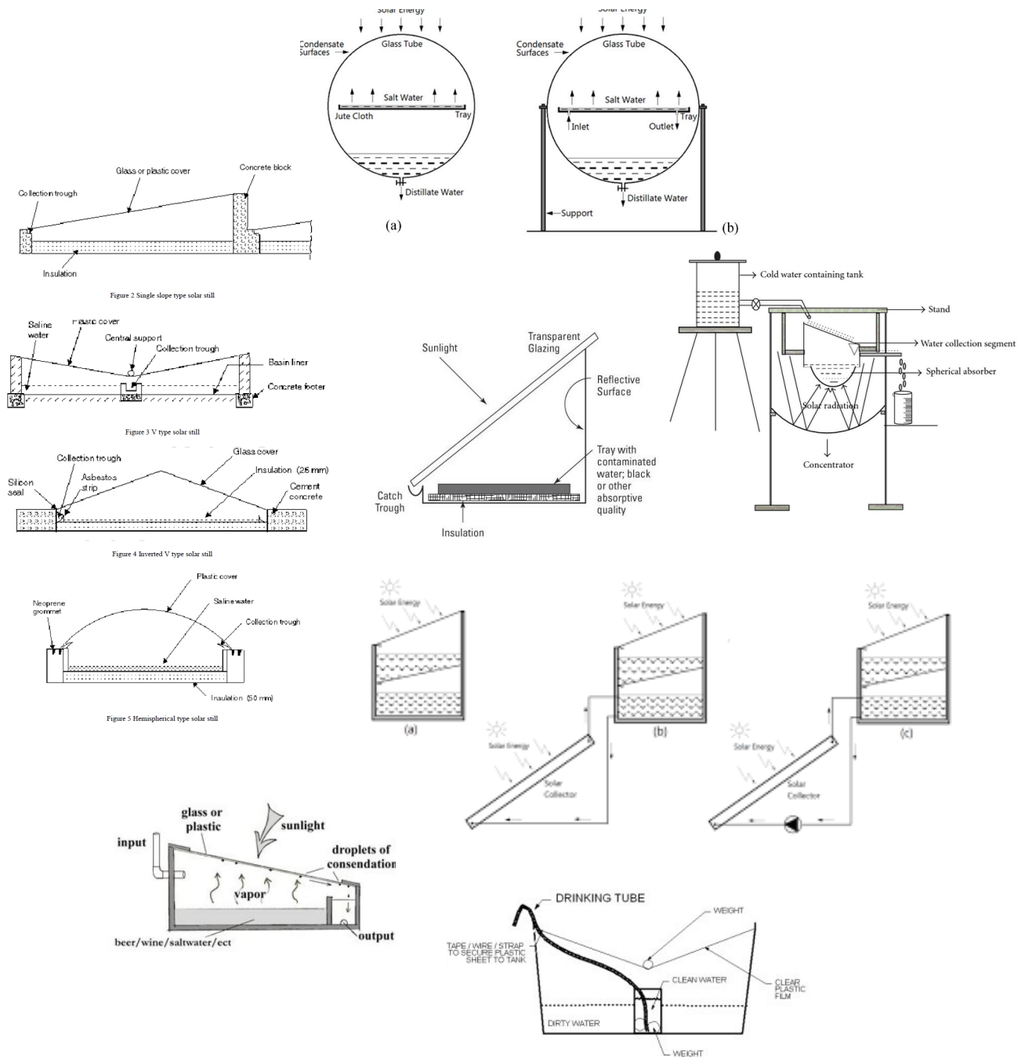
The technology route for the final product is to combine solar still with chemical battery or solar panel. This combination makes the device more portable, reliable and affordable.

Further research: salt water battery

There are loads of experiments on saltwater battery. It's easy to find relevant videos regarding the way of using saltwater to produce electricity. In addition, there're also some saltwater light products. To learn more about saltwater energy, I learned about the principle of saltwater energy and relevant existing product to get more information for the final construction.

The best material for the negative pole of the battery is Aluminum. In the saline solution, Aluminum lose electrons without getting blocked by the oxide coating, making electricity generation possible. Most importantly, the by-product of the reaction is not harmful to the environment.



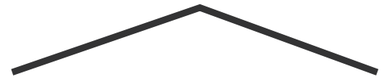


Further research: solar still

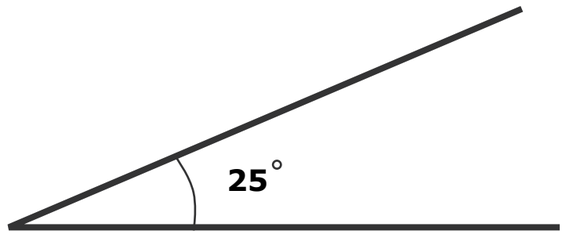
There're different types of the solar still with different sizes using in different scenarios. According to the research above, places that are lack of water and electricity are most likely warm and humid. It means that the incline of the solar still should be at around 25 degrees to get maximum efficiency.

It's also necessary to consider the shape of the solar still. Usually ramp shape is more effective than a dome shape because the distilled water is less likely to get back to dirty water.

Dome shape

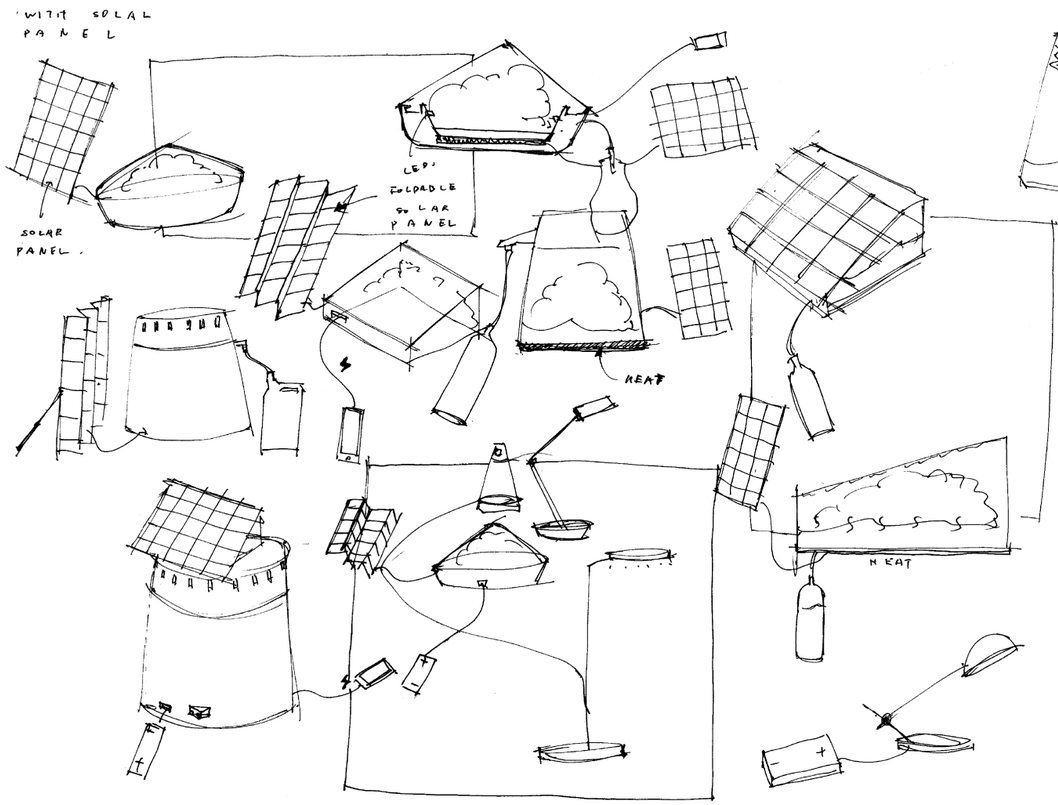


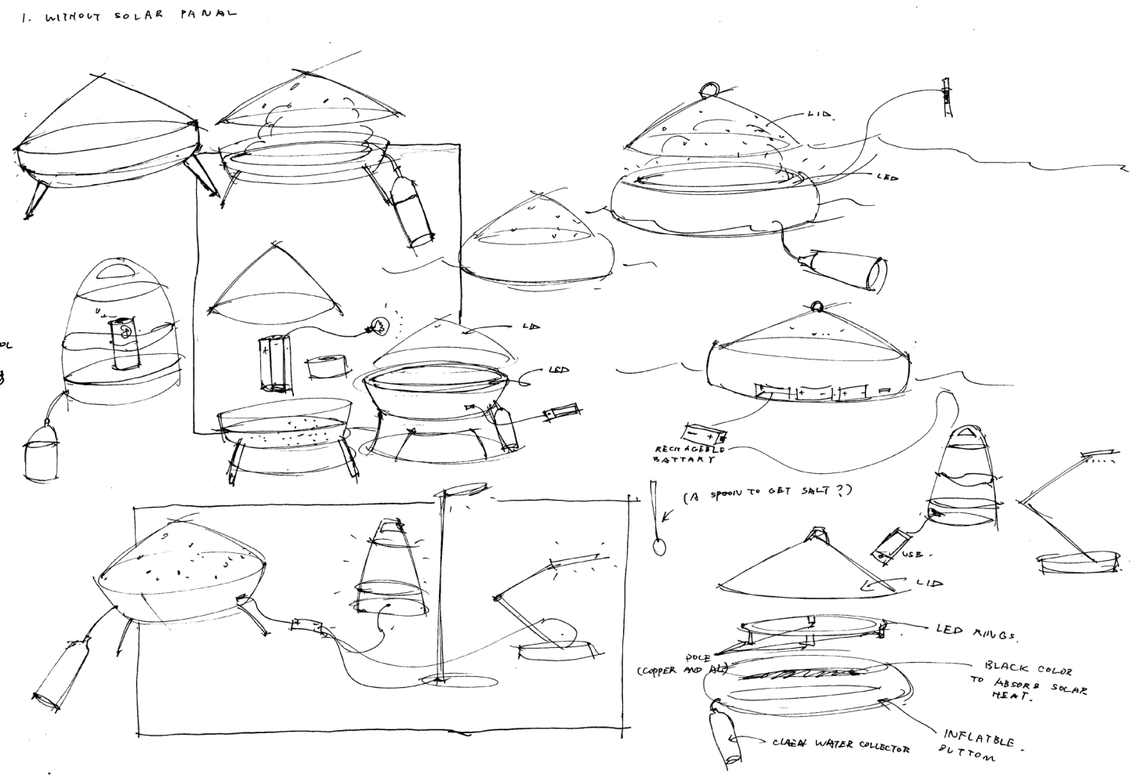
Ramp shape

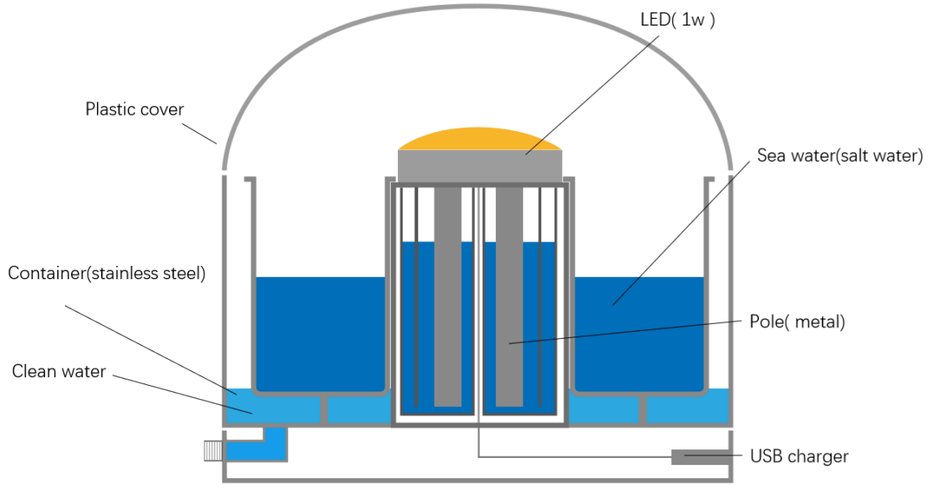


Best angle

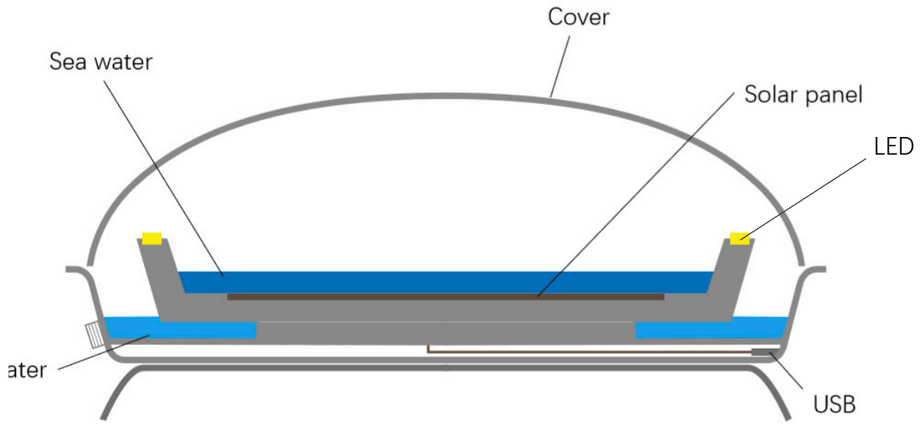
Initial sketch







A



B

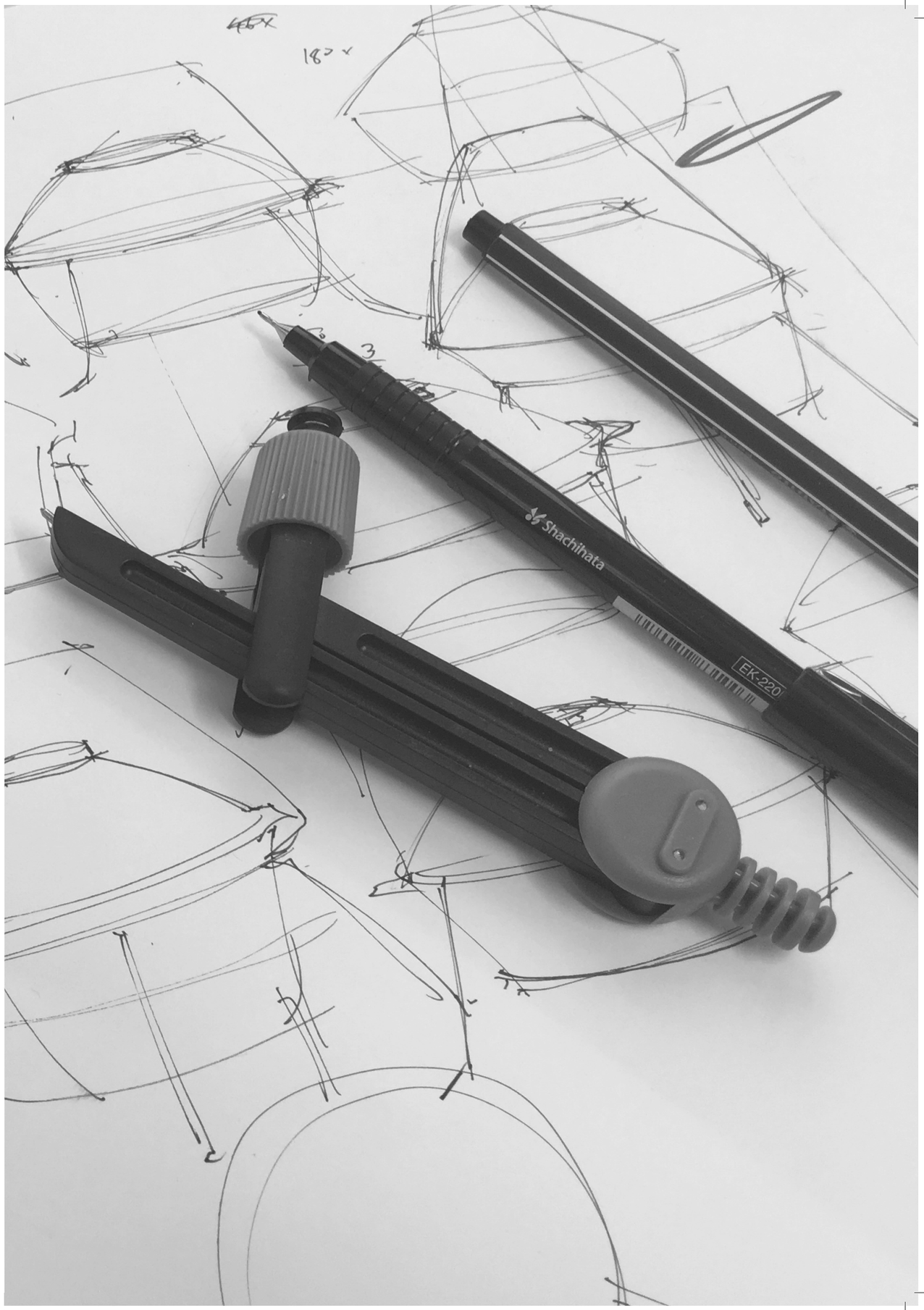
Final selection

The section view shows two technology routes for the device: solar still with salt water battery or with the solar panel. For plan A, the saltwater battery is inside while solar still is outside. In plan B, the solar panel is placed underwater to save space.

For the saltwater battery, there're existing products using saltwater as energy. For the solar still, we could find lots of relevant products and experiments. In plan B, electricity generation efficiency and waterproof could be problematic. Thus the final choice is plan A.

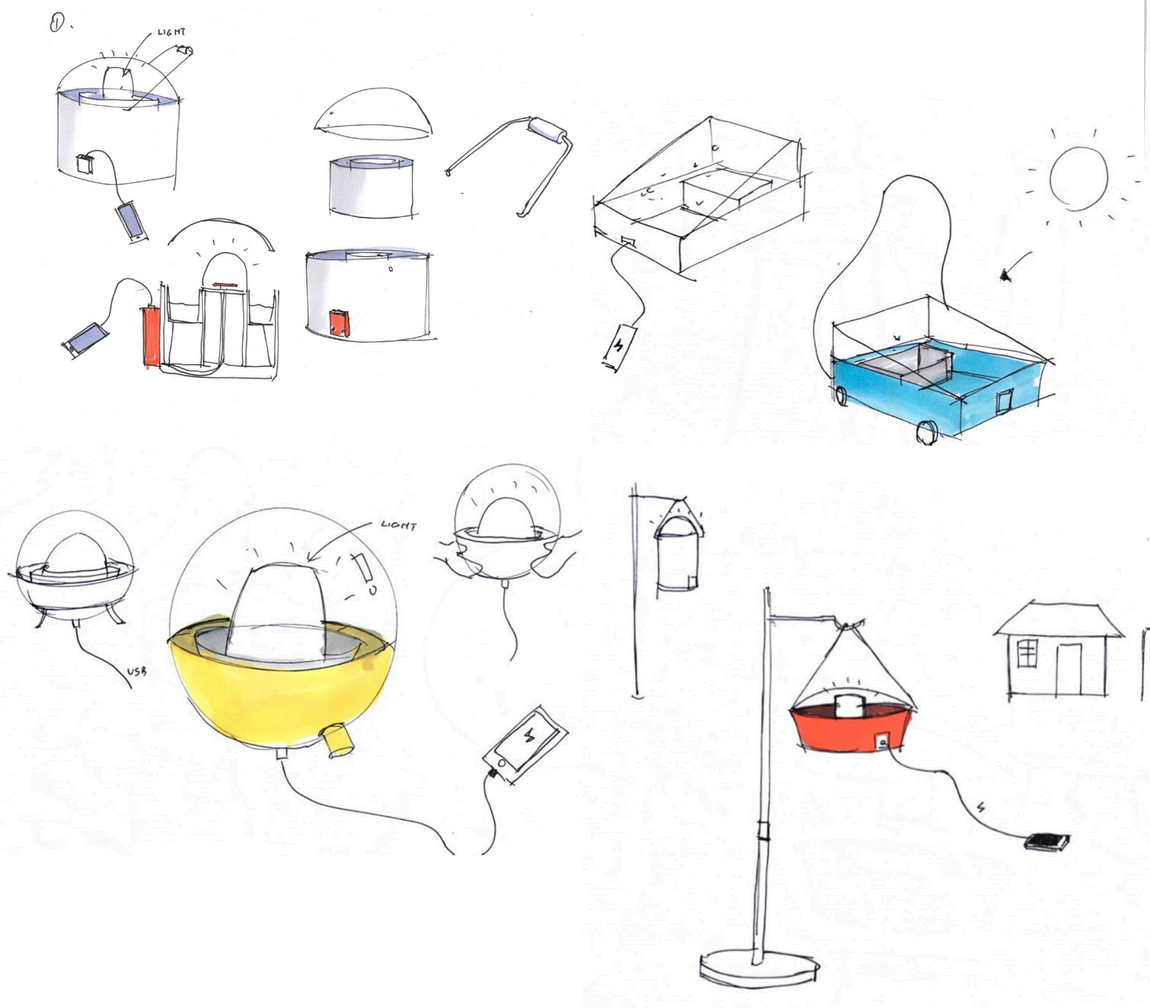
CHAPTER 3

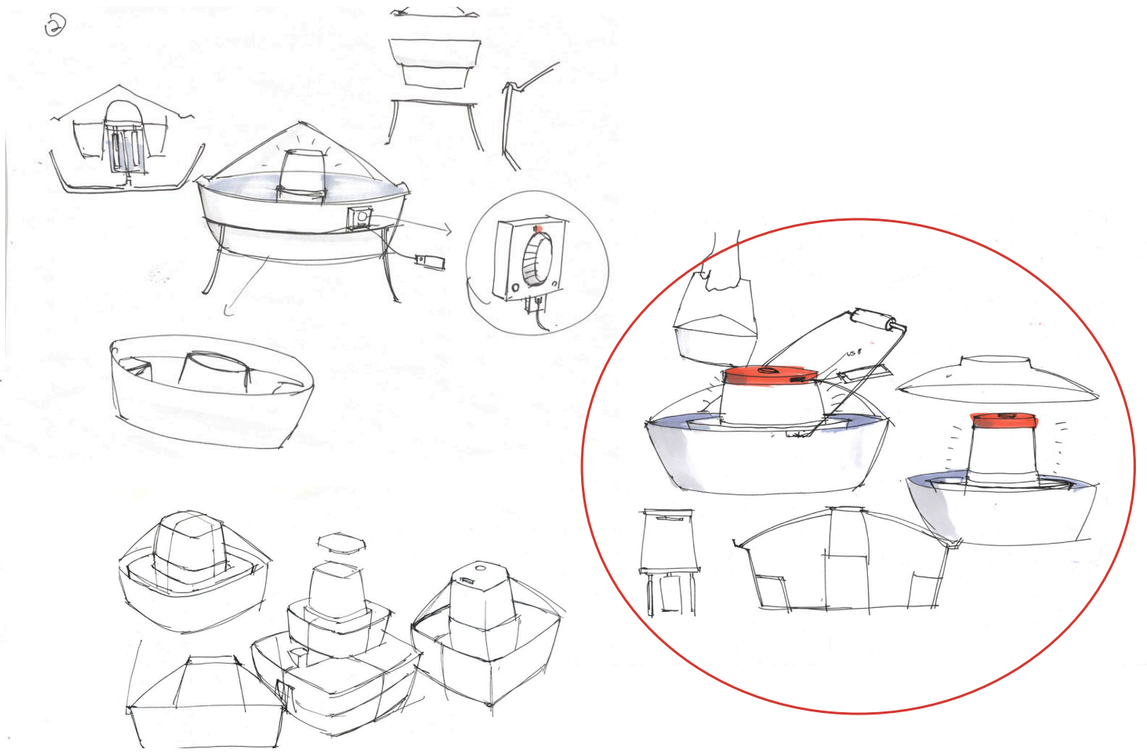
-Sketch, selection
-Mock-up
-Function model
-Section view

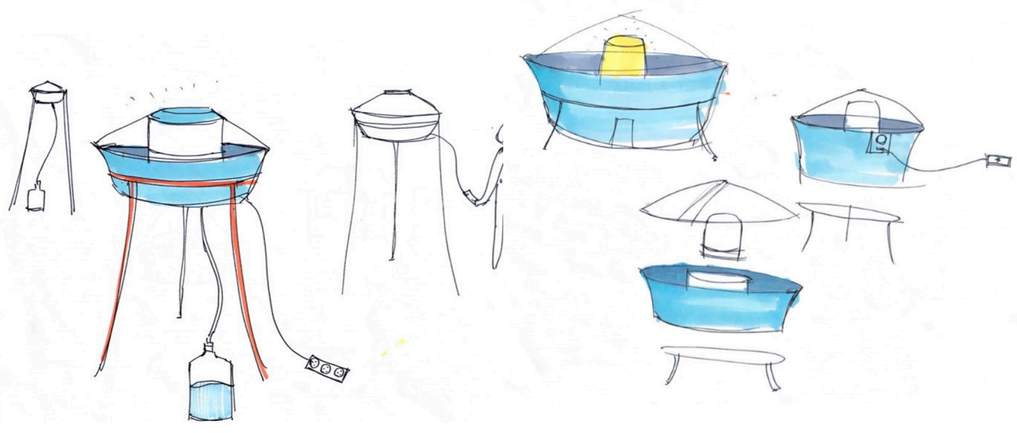


Idea selection

This off-the-grid device is for the family and portable for usability consideration. As the ramp or cone shape is the best for the solar still, the appearance is more functional based.

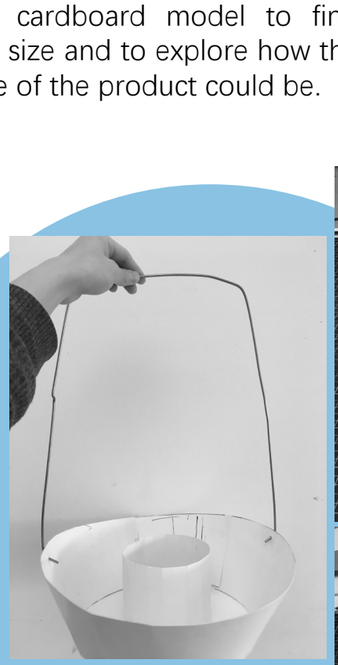


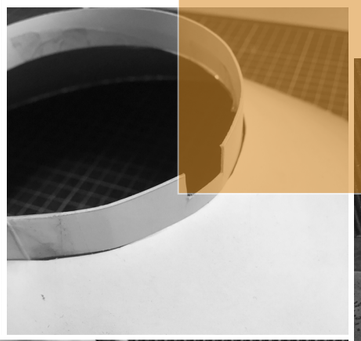


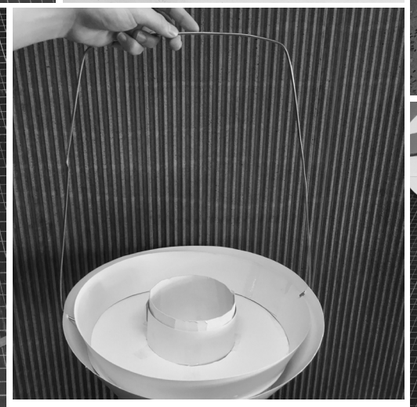


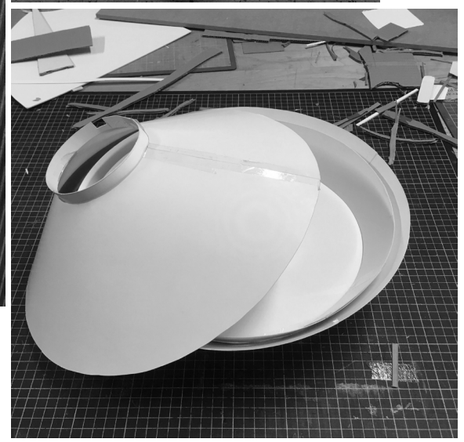
Mock-up

To make sure that the prototype could be in the right size, I made a full-size cardboard model to find the best size and to explore how the structure of the product could be.

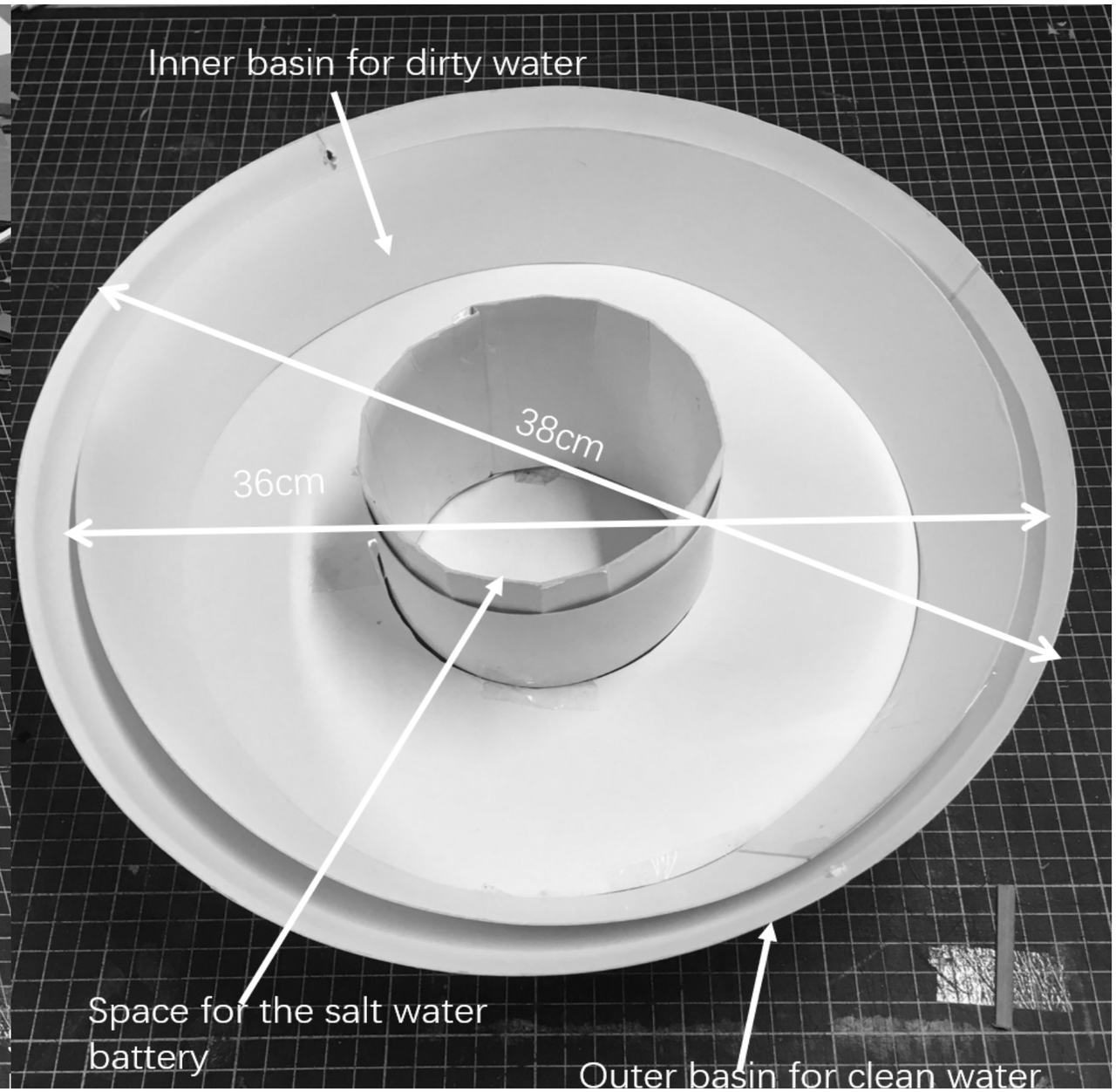









Space for the electronic parts
Water distill lid


Inner basin for dirty water
38cm
36cm
Space for the salt water battery
Outer basin for clean water

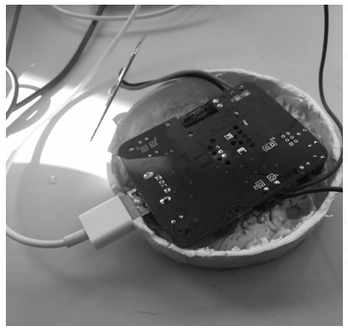
Function model

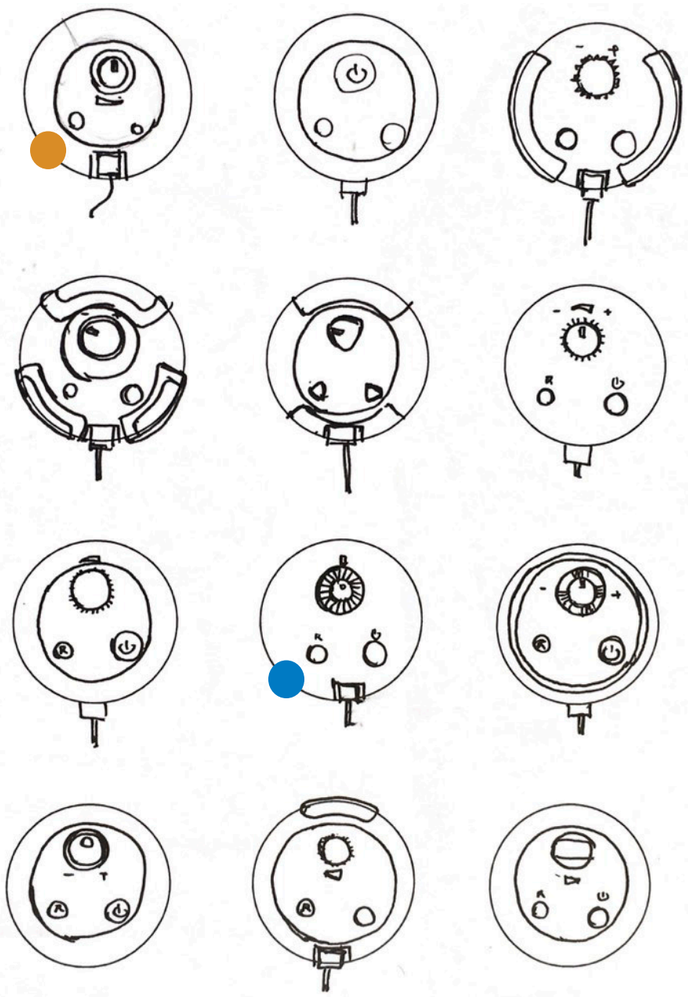
In this step, I tried to figure out if the shape of the solar still is reasonable. I made a plastic cover and to put it in the pot. It turns out working perfectly. Then I put this device under the 25 degrees sunny weather in Sweden, and it gets started to collect water in 1 hour.

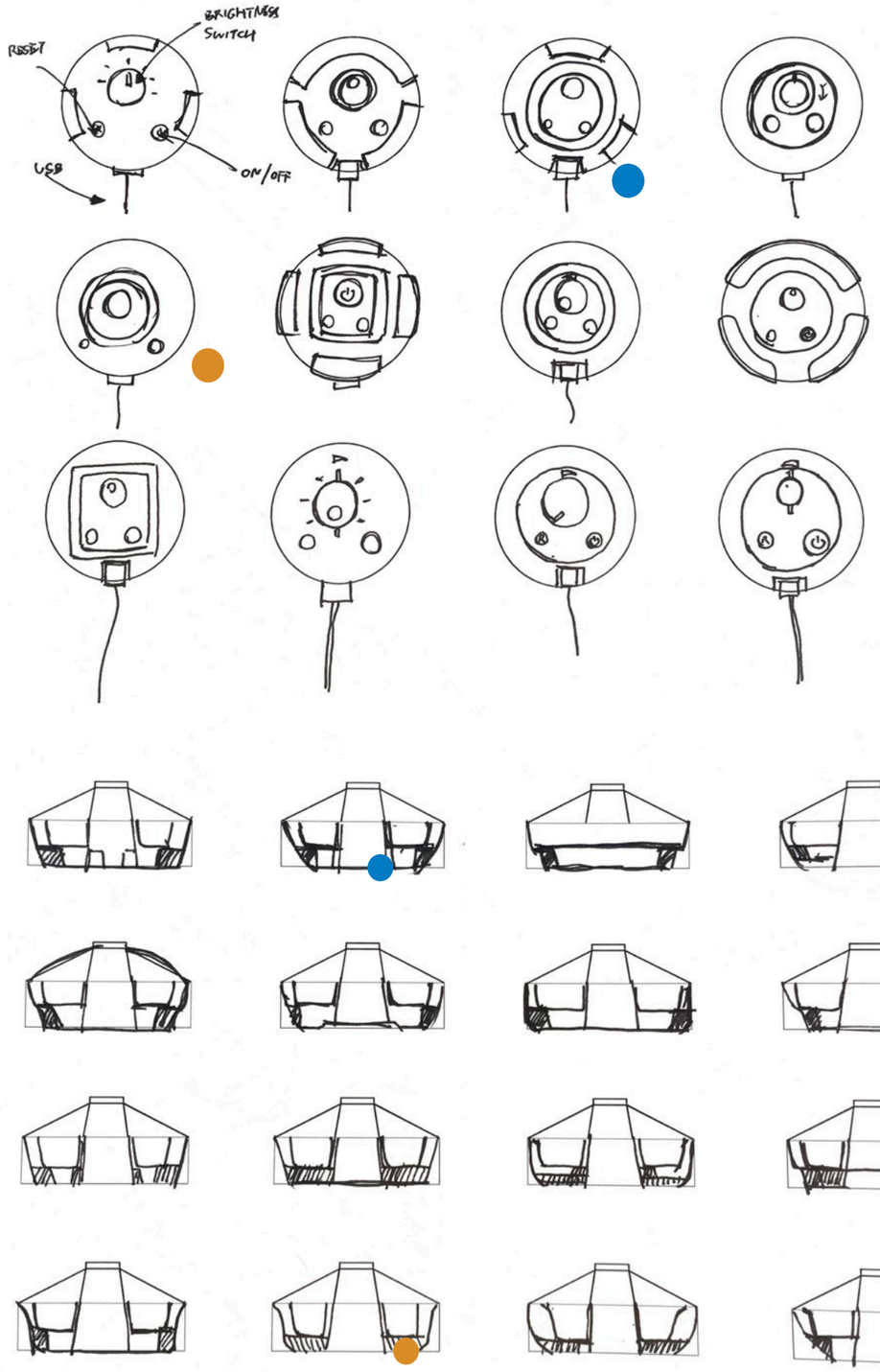
Second sketch

For this project, I got a circuit board used for the final prototype. There are three buttons on the circuit board: power, brightness and reset button. The inner part is for the light, the outer is the water distiller.

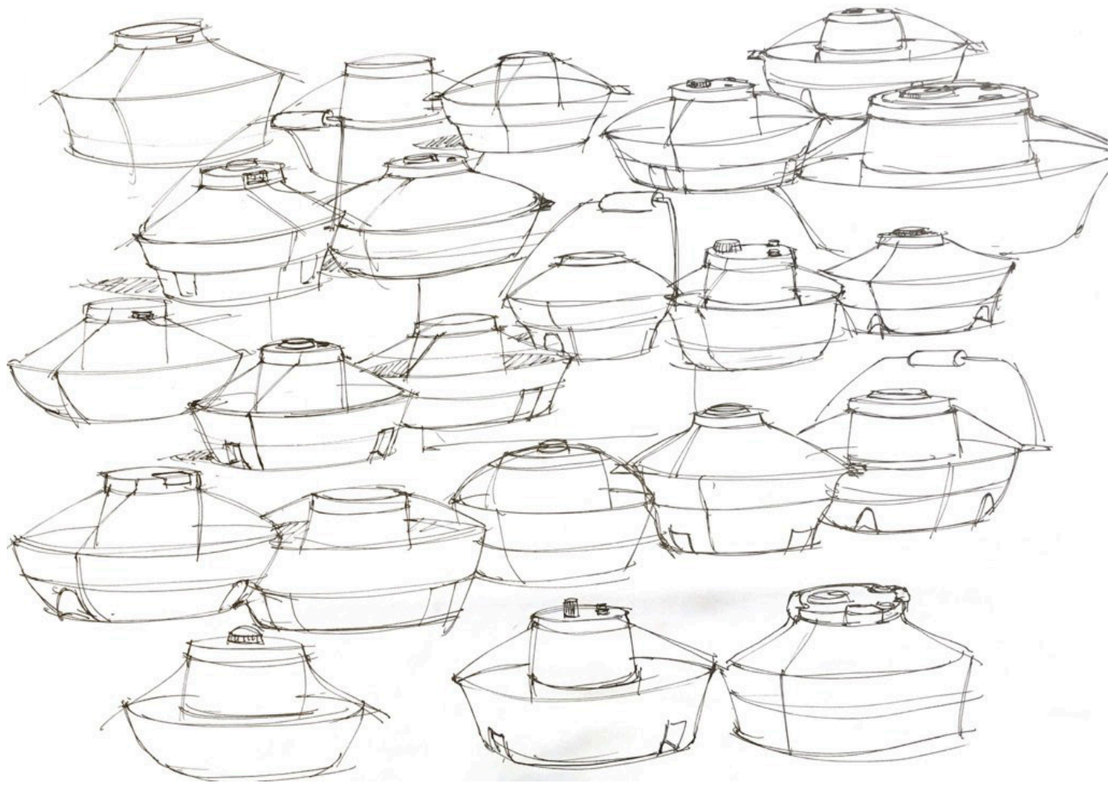
These sketches are about the cover on the top which contains the circuit board for the light and USB, and also for the body: The collector for the distiller device.

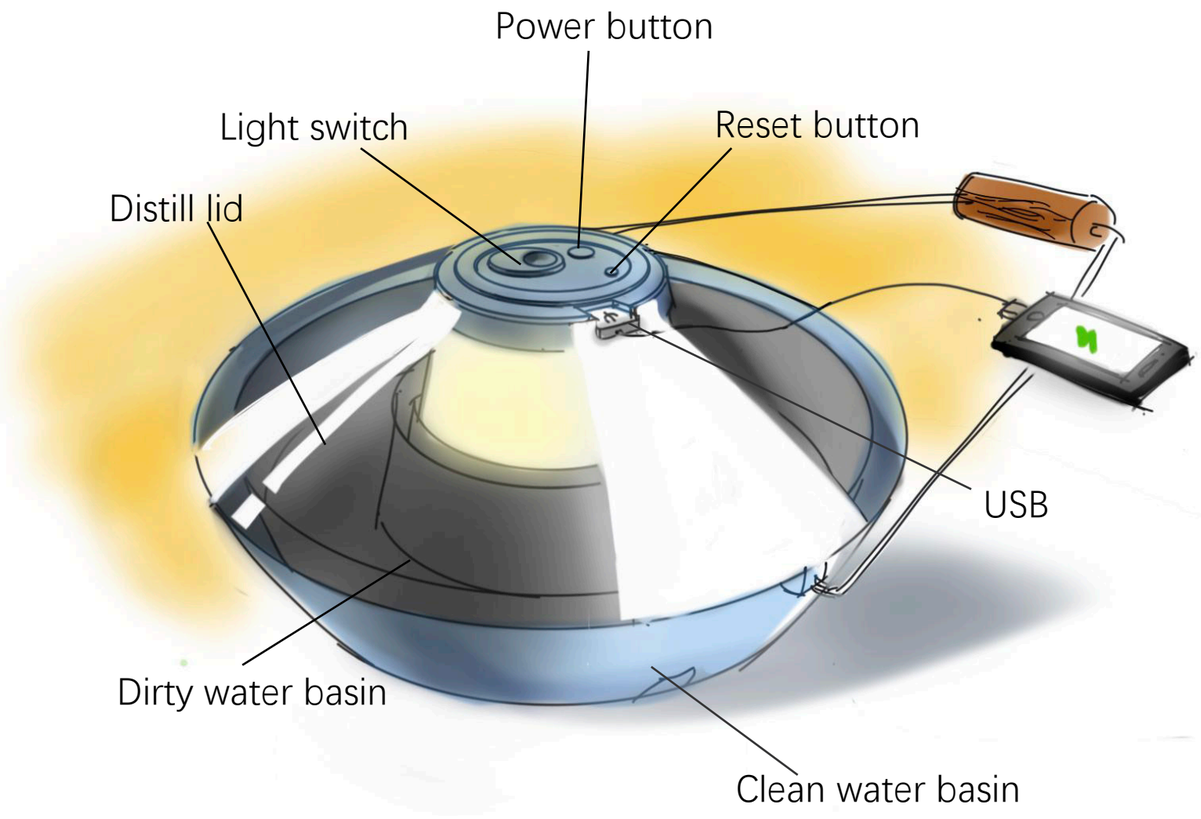




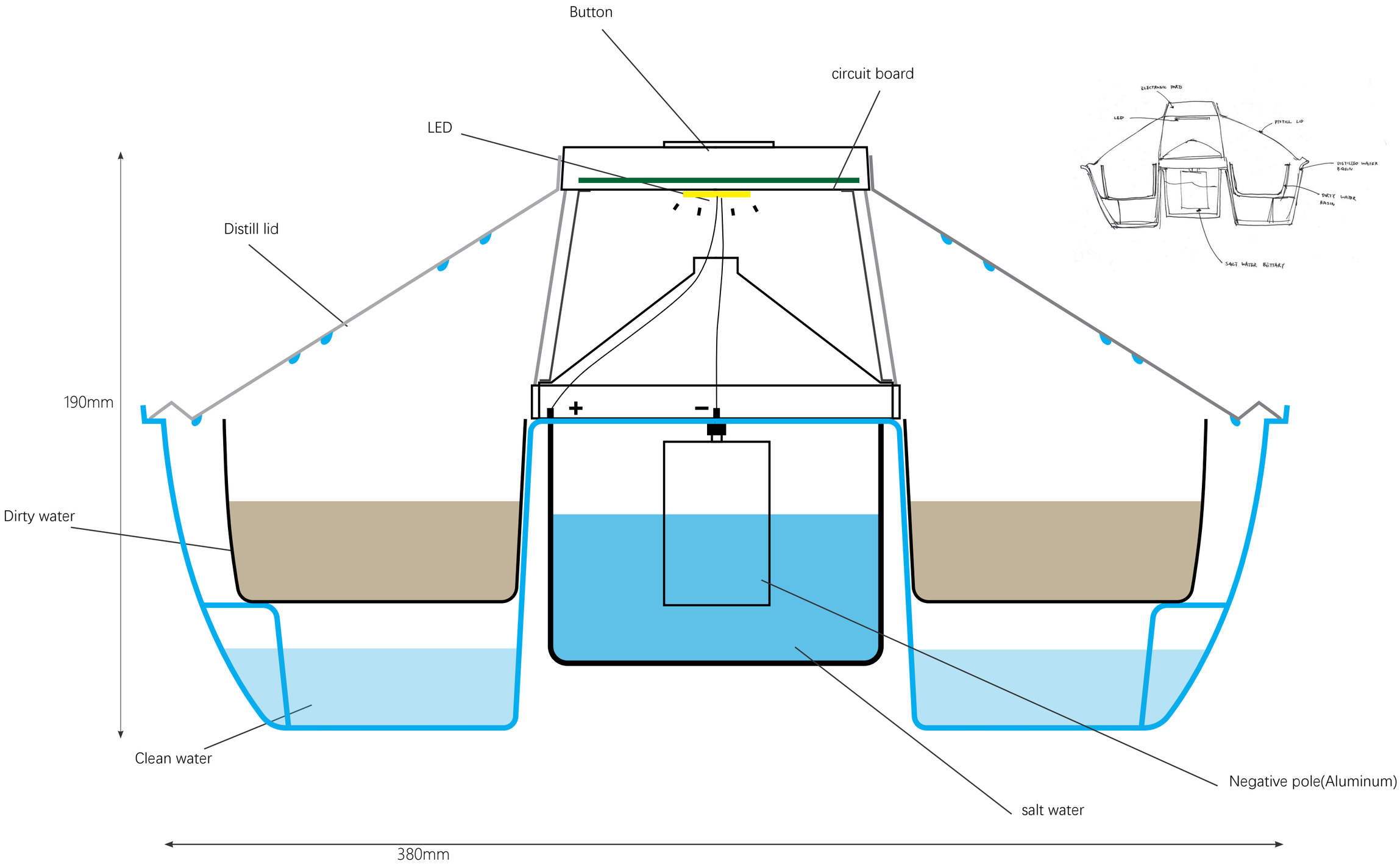


Ideation & final sketch



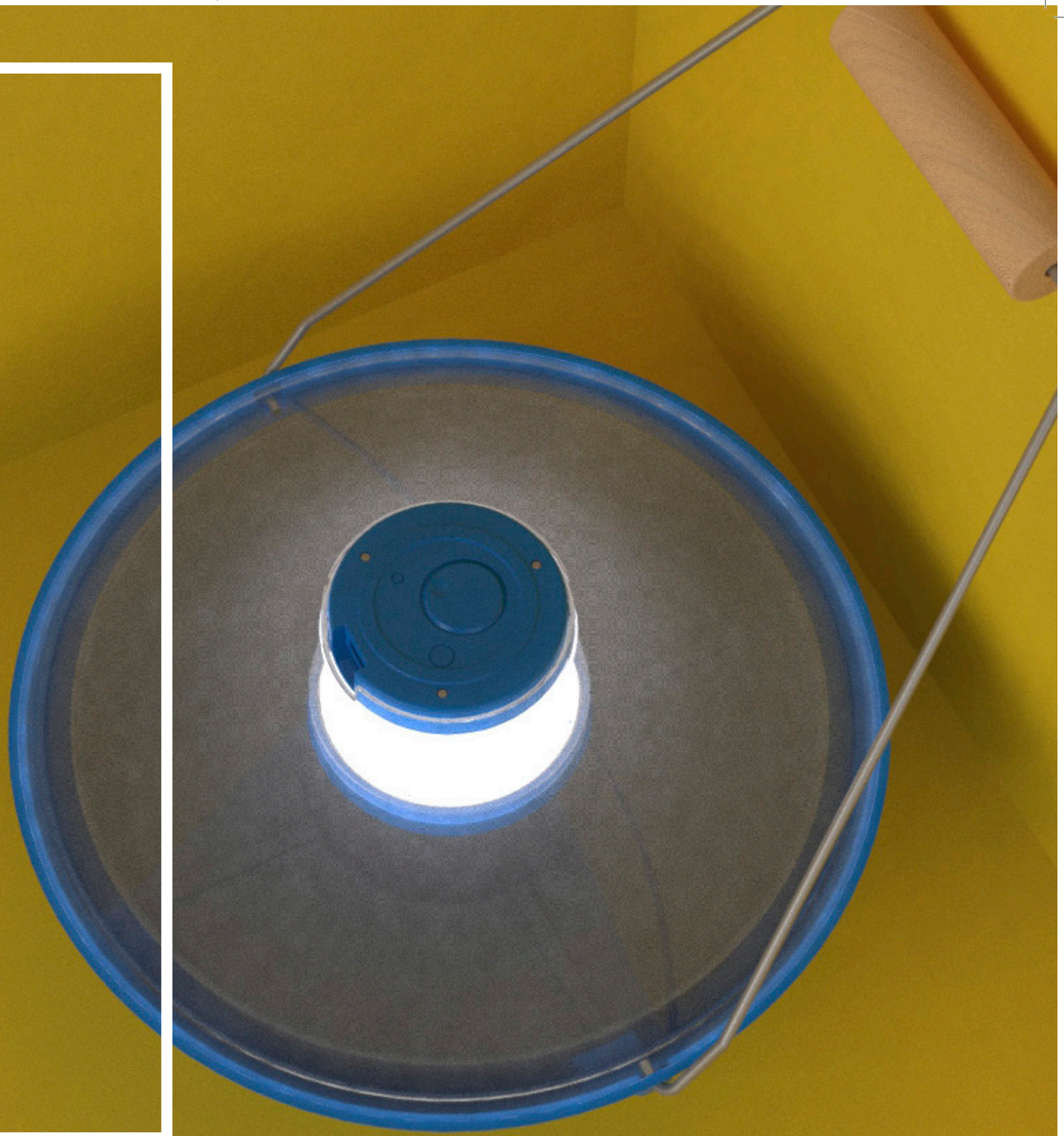


Final section view



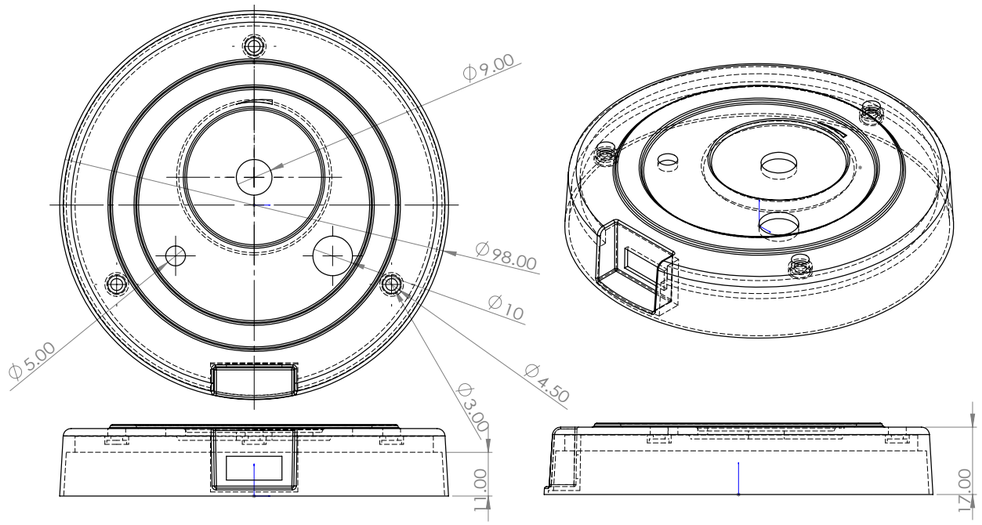
CHAPTER 4

- Rendering
- Drawings
- Construction
- Final prototype
- Test & reflection

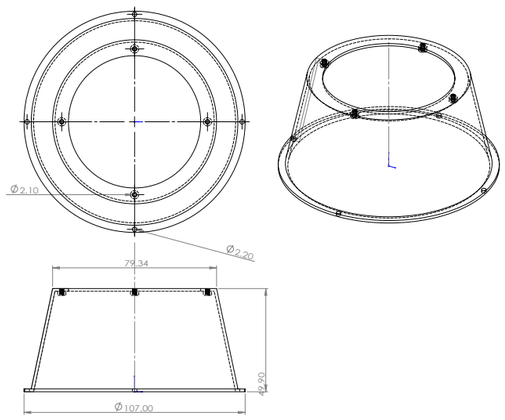


Drawings

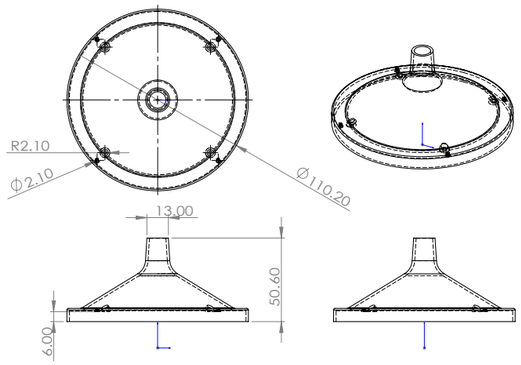
These are the drawings of light and battery parts. They're made by SLS 3D printing.



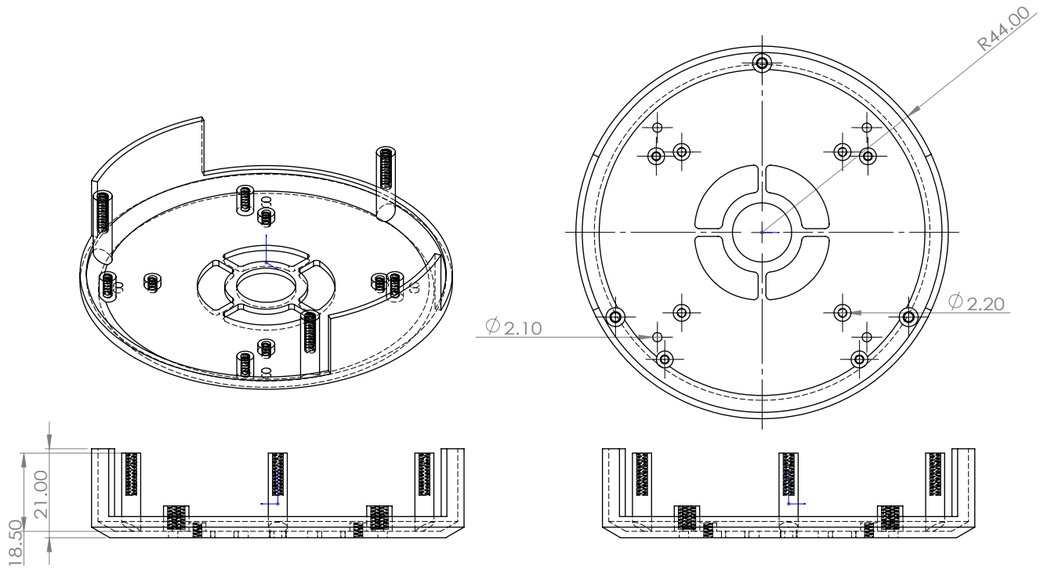
Top part



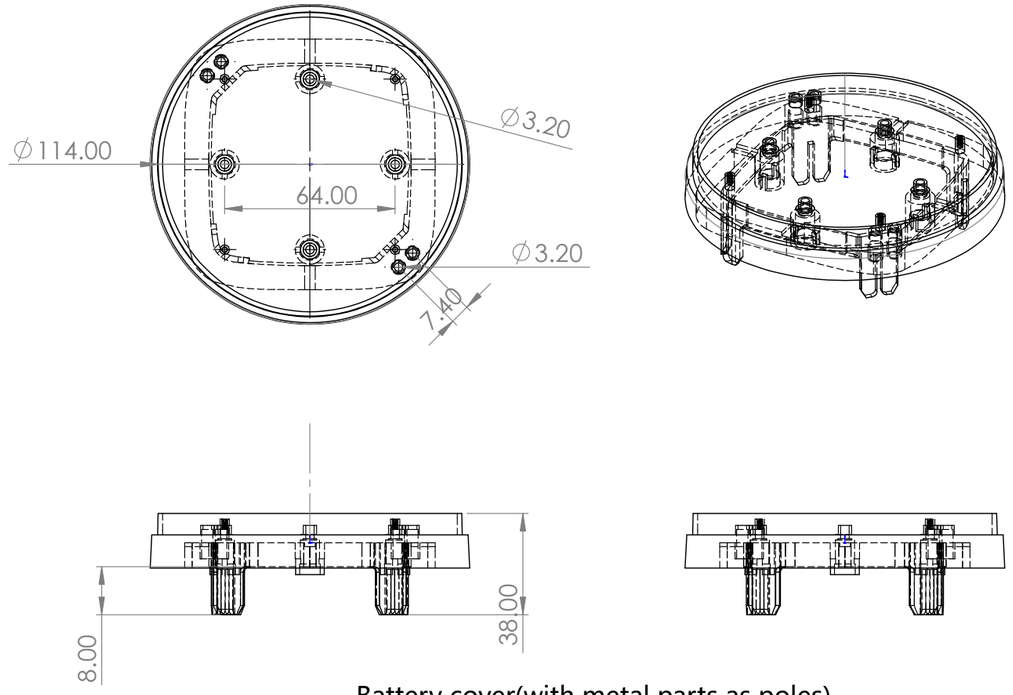
Inner light cover



Reflector



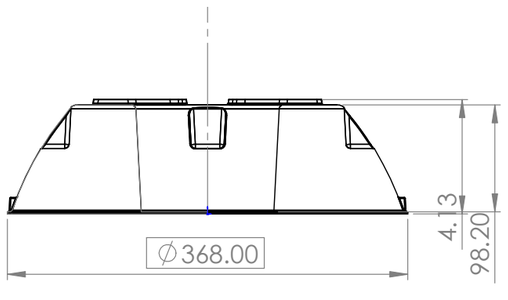
Circuit board cover

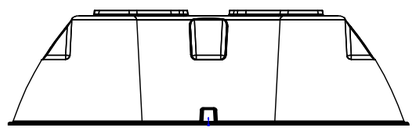


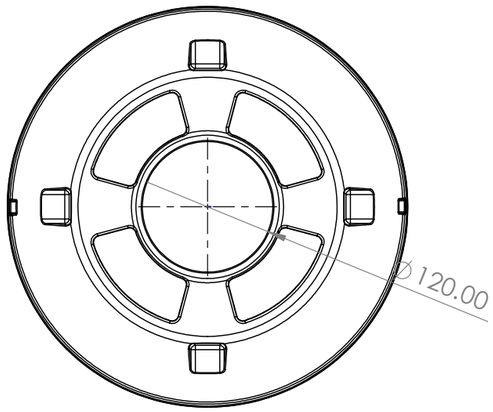
Battery cover(with metal parts as poles)

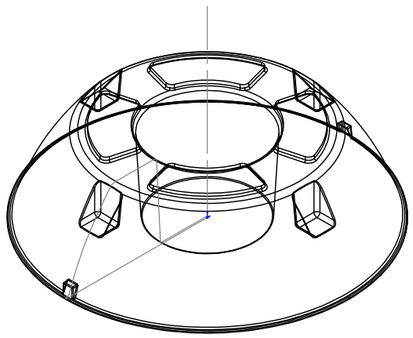
Drawings

These are the drawings of the vacuum forming molds of the plastic parts. They will be made of wood using CNC machine.

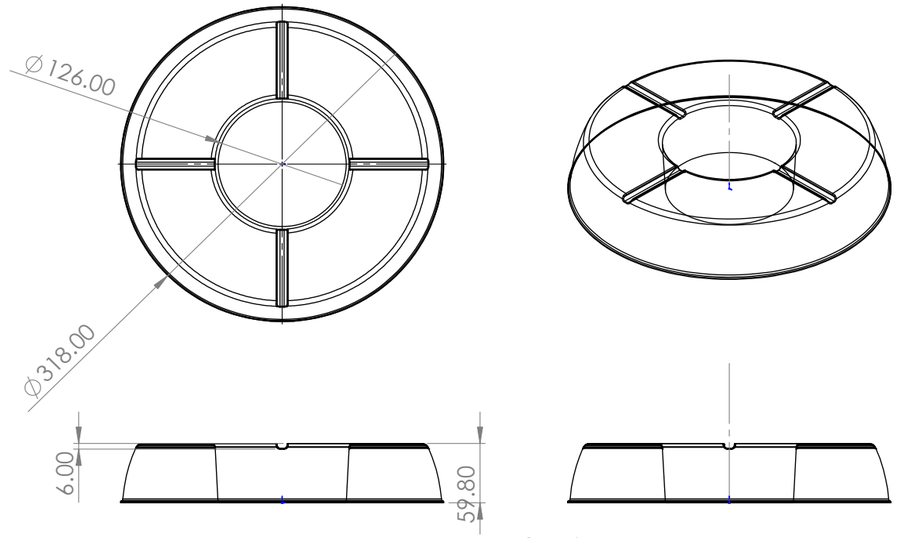




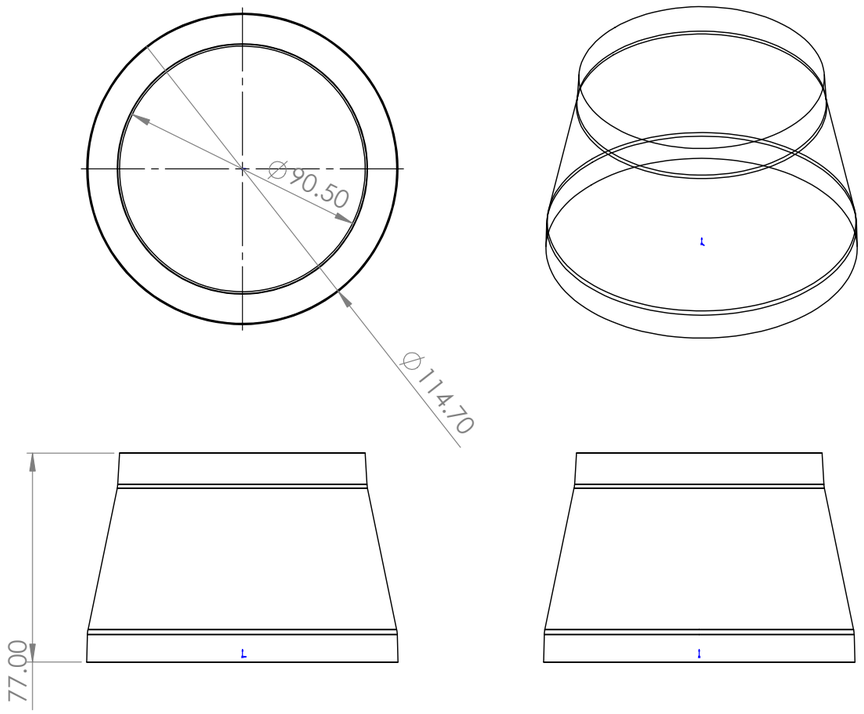




Outer basin

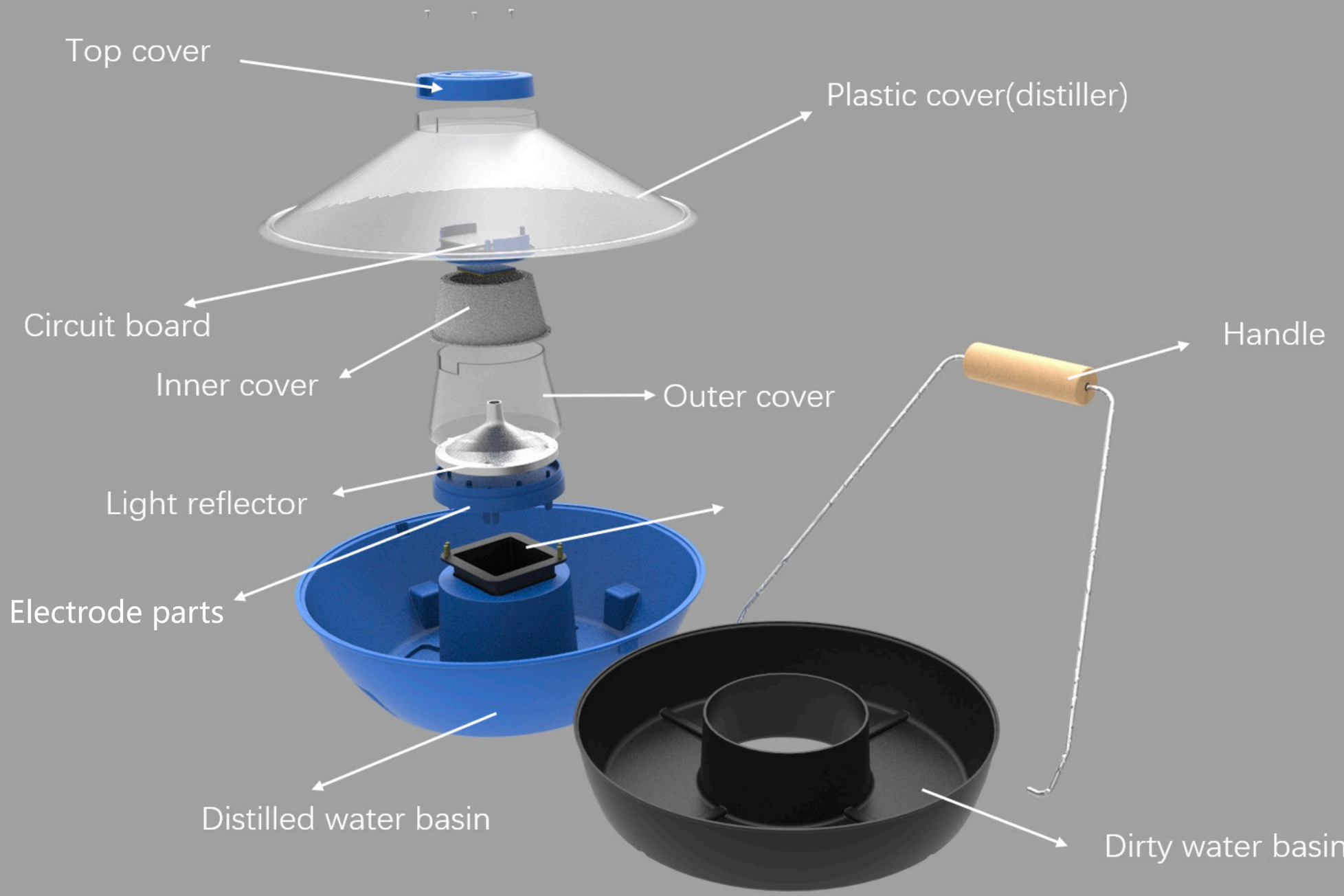


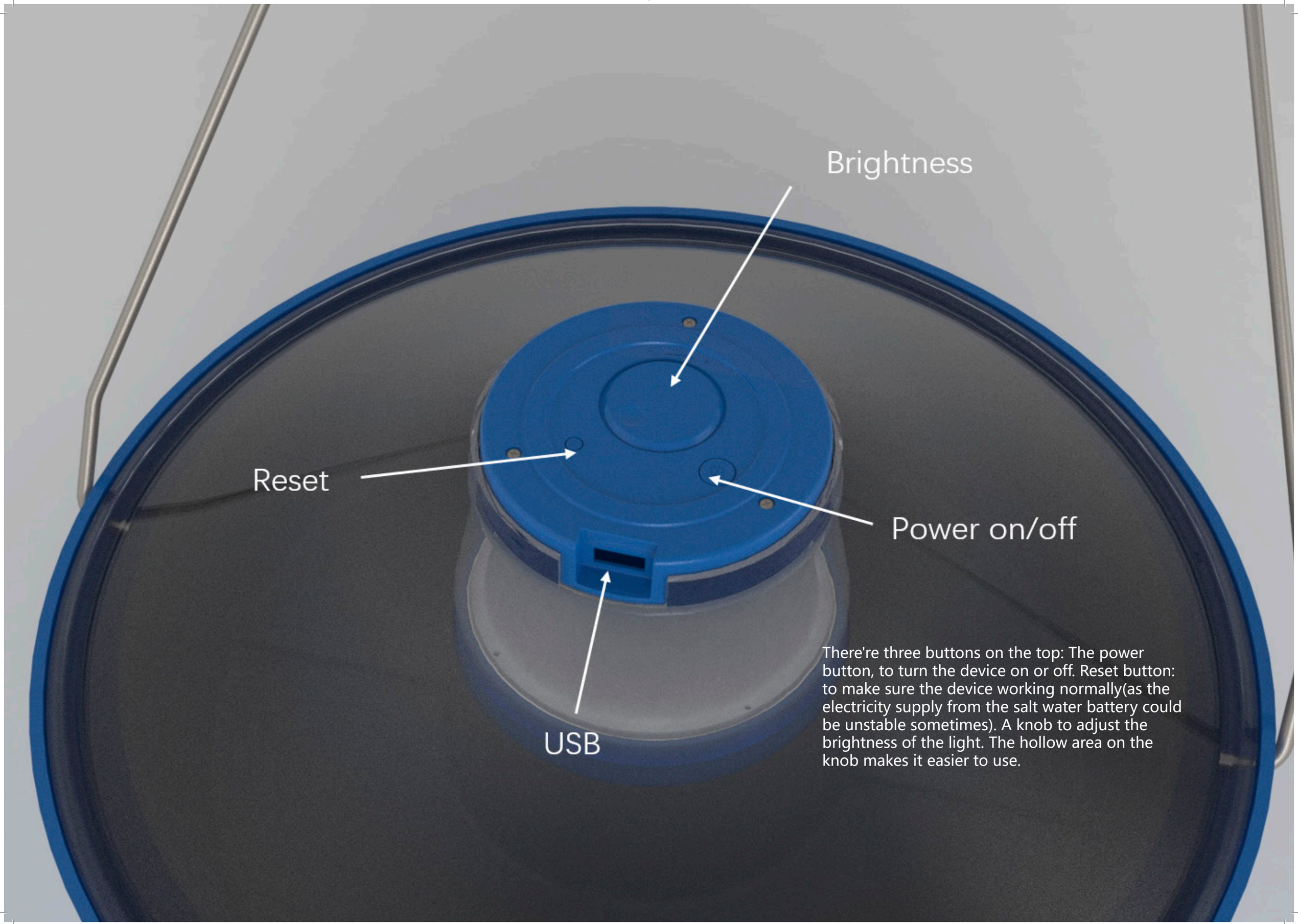
Inner basin



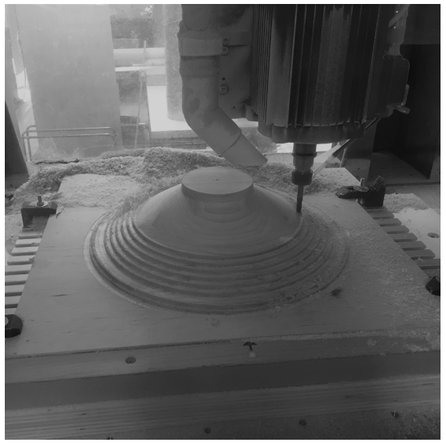
Light cover

Explode view

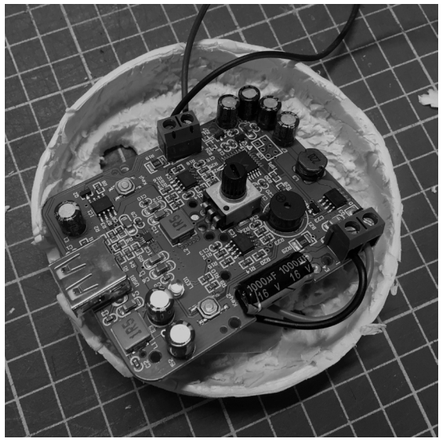
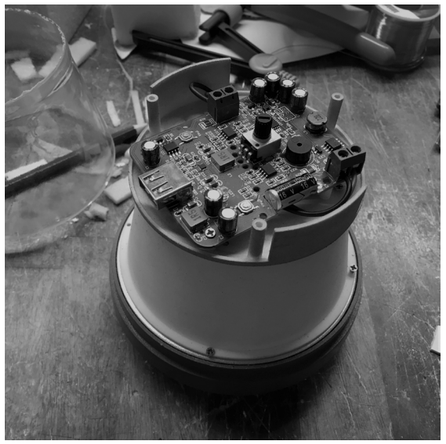




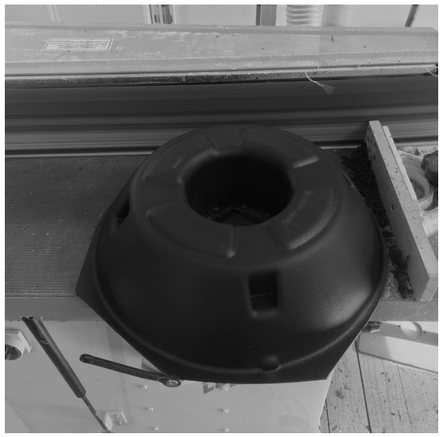
There're three buttons on the top: The power button, to turn the device on or off. Reset button: to make sure the device working normally(as the electricity supply from the salt water battery could be unstable sometimes). A knob to adjust the brightness of the light. The hollow area on the knob makes it easier to use.



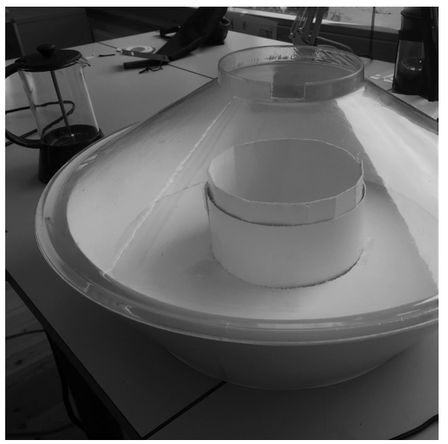
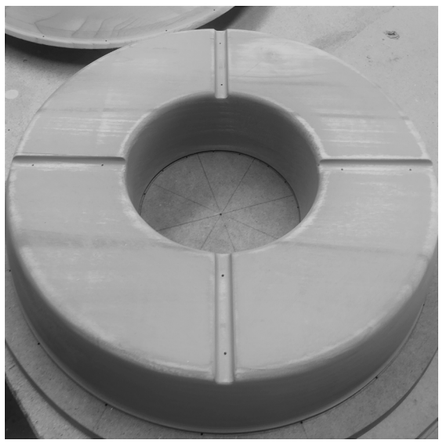


Construction process





Final prototype

Saltwater box

Inner basin

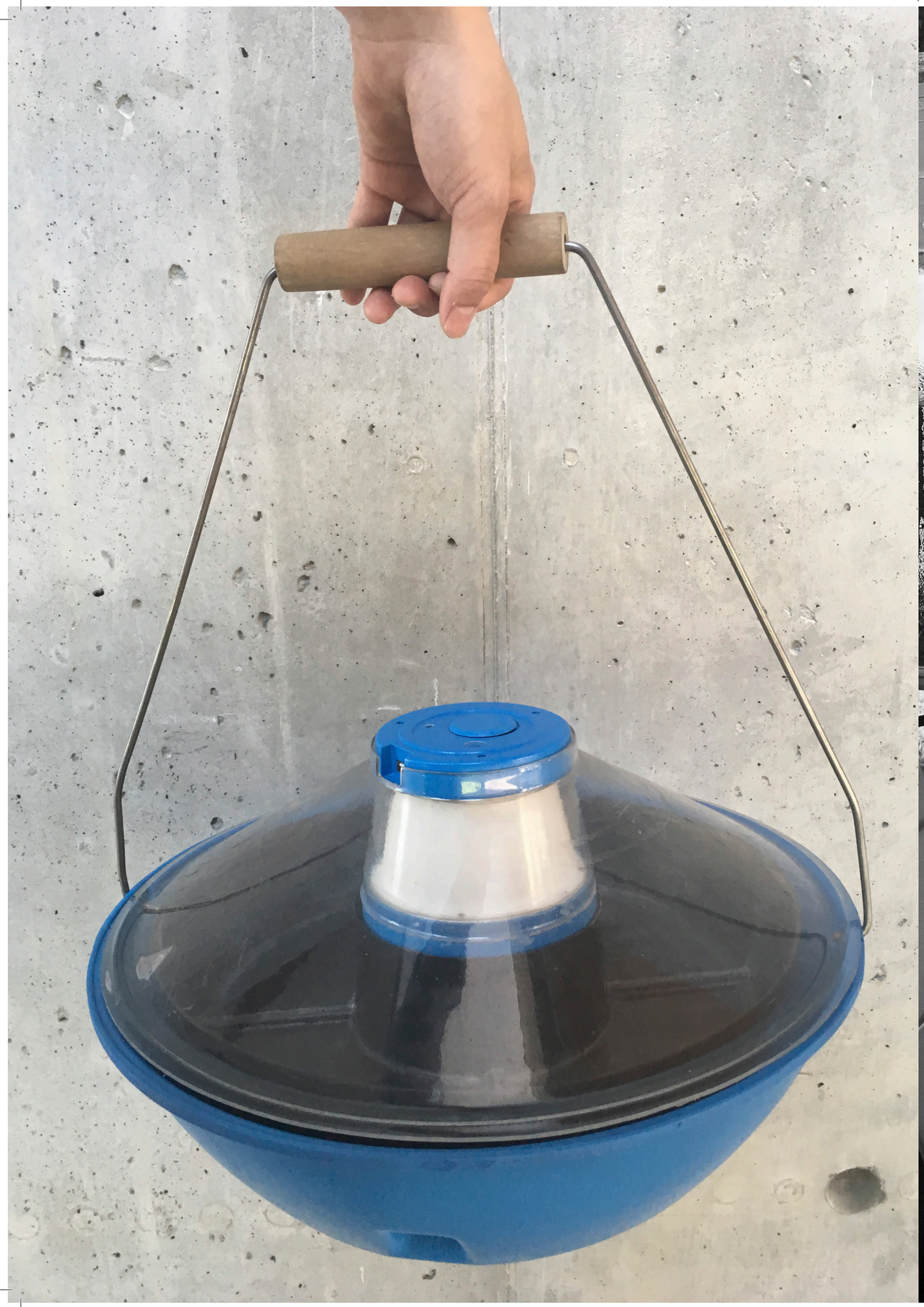
Outer basin

Light parts

Aluminum electrodes

Distillation cover

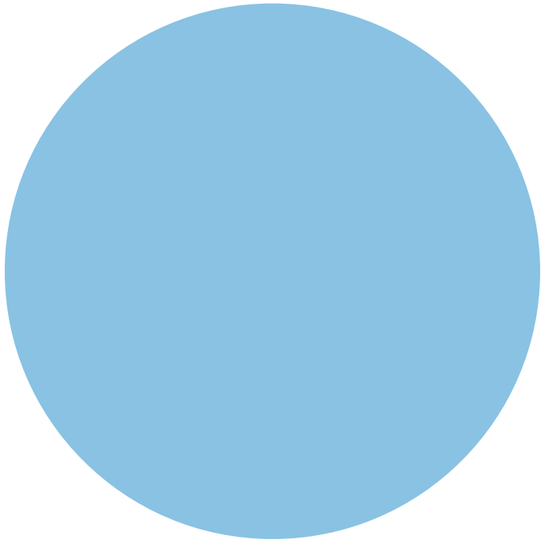
Try out & Reflection



Reflections

1. Manufacture process. The body of the prototype is ABS plastic and vacuum formed. In the mass production. to make the thickness of the outer plastic parts even and the overall quality better, injection molding should be introduced for the manufacturing process of the body parts.

2. Although saltwater and aluminum battery causes no pollution, there's still the possibility to get improvement: as the production process of aluminum consumes large quantities of electricity and is not friendly to the environment.



3. The light with brightness for two people should be at least 700 lumens. However, for this prototype, the only available light is 350 lumen due to the limitation of the battery. If possible for further development, a brighter light should be introduced.

4. Usability. By changing CMF features of the buttons and the knob on the top, it's possible to improve the user experience of the device.

5. Others. The connection part between the handle and main body is not strong enough due to the limitation of vacuum forming. Besides, the thickness and weight of the main body should be reduced to make it easier for daily use, like pouring water or carry.

Reference

Literature

V.SivakumaraE.GanapathySundaramb(2013)**Improvement techniques of solar still efficiency: A review.** Renewable and Sustainable energy reviews

The Guardian: **Access to clean water and sanitation around the world. https://www.theguardian.com/** global-development-professionals-network/2015/jul/01/global-access-clean-water-sanitation-mapped

The world bank: **Access to electricity(2018).**https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?view=map

Chittranjan Tembekar(2018)**:Tankers are fast depleting Mumbai's groundwater. Times of India.** https://timesofindia.indiatimes.com/city/mumbai/tankers-are-fast-depleting-mumbais-groundwater/articleshow/64087345.cms

Shyam S.Nandwani(1990) **Economic analysis of domestic solar still in the climate of Costa Rica**.Solar & Wind technology

Hannah Ritchie and Max Roser,**Water Access, Resources & Sanitation.**Our world in Data

Somit Sen(2017) **Demand for power in Mumbai soars as mercury climbs.**The time s of India

Videos

Energy Salt water: https://www.youtube.com/watch?v=6J5R9X8QrJA

Charge smartphone by water, amazing smartphone life hacks .https://www.youtube.com/watch?v=_cw1NcTp4L8

Solar still design processhttps://www.youtube.com/watch?v=QdH09J9hBb0


LUND
UNIVERSITY