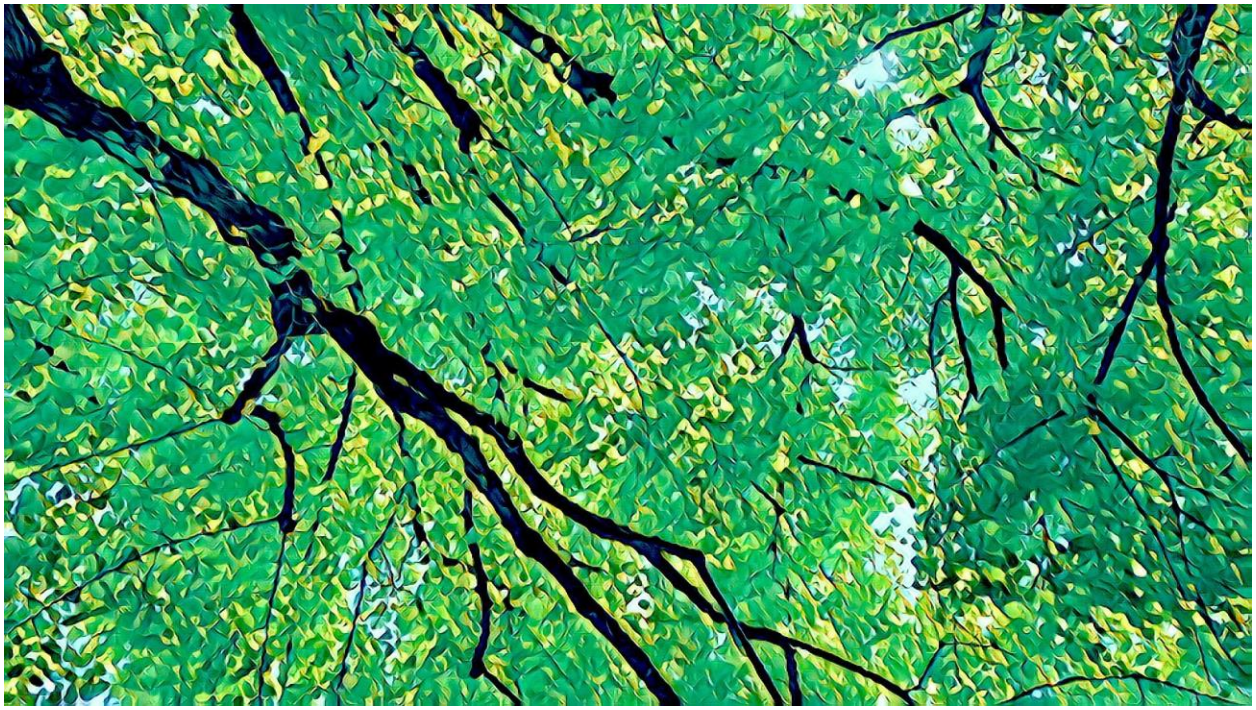

Habitat for Humanity Challenge: Affordable Water Harvesting for Low-Income Households in Urban Areas

Solar **A**ir **B**ubbles +
IBC Container +
Ultraviolet light +
Carbon Filter +

SABUC Project

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Overview

SABUC Project is an affordable rainwater harvesting system for low-income households in urban areas. SABUC Project responds to the Habitat for Humanity Challenge for affordable water harvesting for low-income households in urban areas set by Habitat for Humanity International.

SABUC Project fulfills all the requirements establish for this challenge to deliver an affordable water supply because it has:

- Affordable materials prices around 210 USD
- Flushing component to removes the initial 10 minute rainfall
- Enclosed system that prevents the growth of algae and mosquito infestation
- Aeration by bubbles to provide drinkable water after boiling
- Adaptable shape to be used in urban family homes
- A water tank of 1,000 liters
- Low tech that is simple to install under 420 USD budget
- Simple array that can be connected with existing facilities
- Low cost materials that can be replaced under 50 USD annual budget
- Modular water storage with the ability to increase capacity or move the system
- Capacity to collect enough water for all household needs (e.g. cleaning,gardening)

SABUC Project is formed by the following parts to meet the challenge requirements:

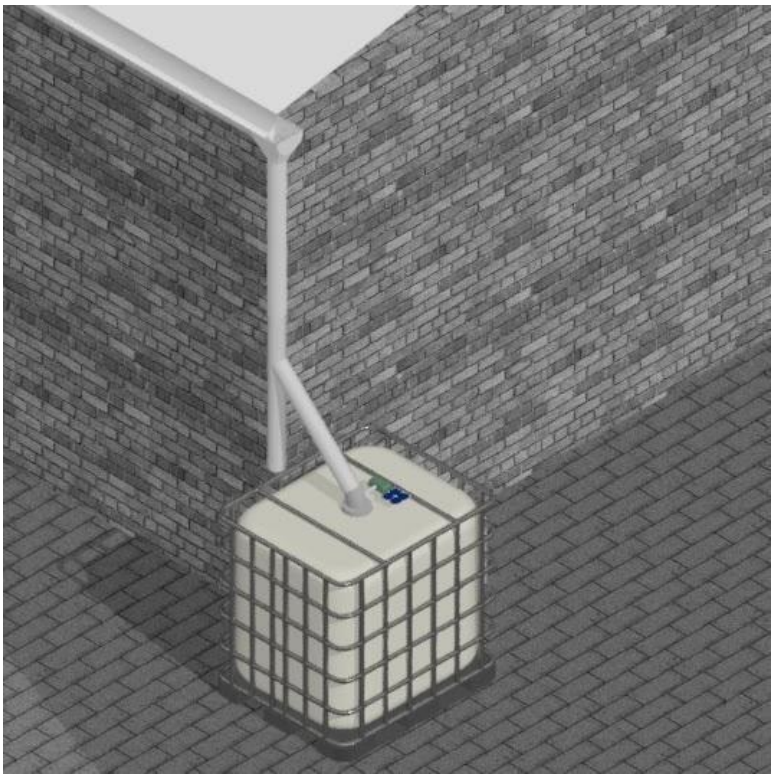
- Rainwater recollection with a gutter and debris retention in a mesh
- Initial rainfall capturing with dripping evacuation
- Activated charcoal filter
- 1000 liter water container
- Water aeration with bubbles powered by a photovoltaic cell
- UVC LED light for disinfection

This document will show a detailed description of SABUC with the technical requirements, design, annotated drawings, and cost estimates.

Table of Contents

Description

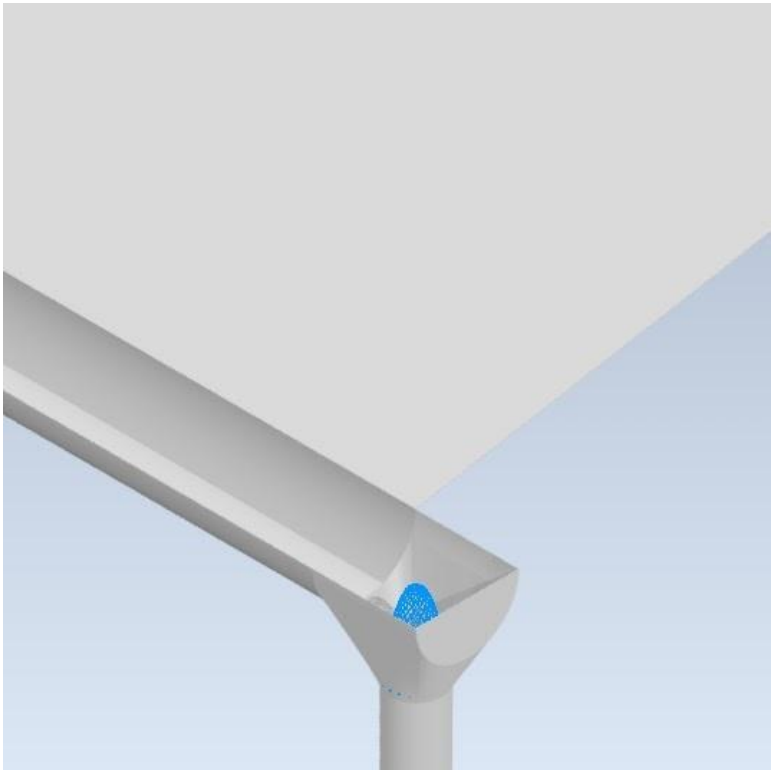
SABUC Project is an affordable rainwater harvesting system for low-income households in urban areas. SABUC will procure clean water storage with a self cleaning water equipment that uses bubble aeration to keep water clean and fresh, this system will be powered by photovoltaic cells. As well in this system, the rain water will be filtered by activated carbon to trap and neutralize contaminants picked by the rainwater falling through polluted atmospheres and unclean surfaces. A UVC LED inside a water container will further purify the water. The water tank is an IBC container and the interior is isolated from the outside to prevent the intrusion and proliferation of mosquitoes or other pathogens. More IBC containers and aeration systems can be added to increase the water storage volume of the system. A more detailed image of SABUC will appear in the blueprints chapter of this document.



Rainwater recollection

The rainwater recollection system uses the rooftop in the low-income households to collect rainwater. A gutter will be added to the edge of a rooftop to collect the water. The rooftop will be covered by a plastic impervious cloth to ensure the cleanliness of the runoff water recollection, the plastic cloth will be fixed at its place by brics, as well the brics could be used to create a slope in the plastic cloth to direct the the runoff water towards the gutter if needed. The plastic cloth

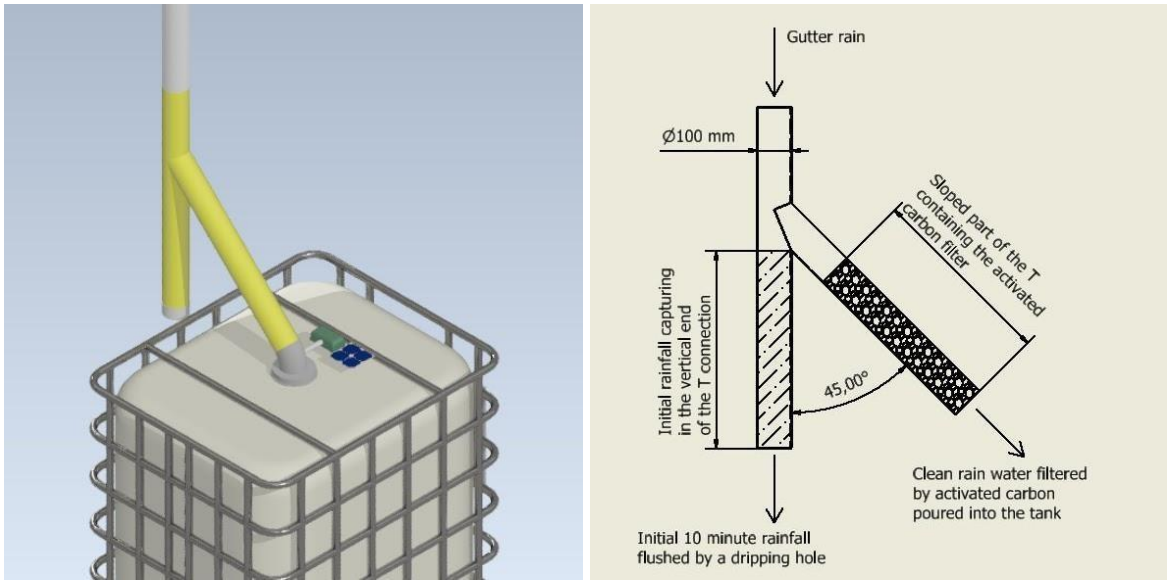
could be changed, removed or cleaned to fit the low-income households needs and to ensure a clean water recollection. The surface area of the plastic cloth will depend on the rain intensity and frequency, this will be developed further in the initial rainfall capturing epigraph. The gutter rain is gathered by a drain that has a mesh to filter debris carried by the rain fall, the gutter drain pours into a 100 mm PVC vertical pipe to conduct the rainwater into the initial rain capturing, the carbon filter and the water tank. The gutter and the drain are made with PVC with a 200 mm diameter, the mesh is made with aluminium, the diameter on the pipes will depend on the availability of local materials.



Initial rainfall capturing

Part of this challenge is to design an initial 10 minute rainfall trap to remove the pollution of inicial runoff flow, to accomplish this an initial rain capturing contraption is integrated into SABUC. The initial rain capturing uses a 100 mm PVC pipe bifurcation (or T) to trap the first 10 minutes of rainfall. The vertical end of the T connection will collect the initial rain during 10 minutes, once filled, the cleaner rain water will be poured into the sloped part of the T that will contain the carbon filter connected to the tank. The T is highlighted in yellow in the next left image. The angle of the sloped end of the T is 45°. The water collected by the vertical end of the

T will be drained by a little hole in the closing cap situated at the end of the vertical end of the T. This cap will be removable to facilitate the initial rainfall cleaning capturing system.



Vertical end of the T length

Is important to mention that the length of the vertical end of the T pipe depends on the rain intensity and the recollection surface size. The vertical end of the T must be cut to the right length, to make the installation of SABUC easier the nex table was made. The table shows the vertical end of the T length in function of the liters of volume captured in a 10 minutes rain and the area of recollection surface size, so to know the length, the person installing must know the approximate volume in liters of rainfall in the region where SABUC will be located and the area of the surface that will be draining rain into SABUC. So the length of the vertical end of the T is shown in the next table.

	Length of the vertical end of the T in mm				
	Square Meters of rainwater runoff recollection				
10 min rain (liters)	**1**	**2**	**3**	**4**	**6**
0.3			120	160	230
0.5		130	200	260	390
1	130	260	390	510	770
2	260	510	770	1020	1530
3	390	770	1150	1530	

4	510	1020	1530		
5	640	1280			
6	770				
7	900				
8	1020				
9	1150				
10	1280				

As well this table can be used to estimate the area of the rainwater runoff recollection in function of the intensity of the rain. If the rain is less intense, the area for rainfall capturing must be bigger.

Activated carbon filter

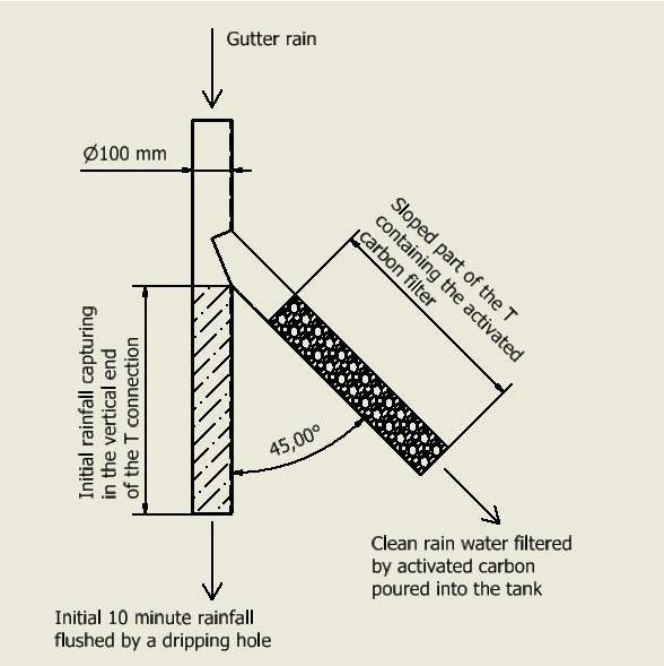
Activated carbon as a filter

Activated carbon with a high surface area, adsorbs many compounds including many toxic compounds. Water passing through activated carbon is commonly used in municipal regions with organic contamination, taste or odors. Many household water filters and fish tanks use activated carbon filters to further purify the water.

Also the article mentions that the activated carbon filter must be cleaned or replaced regularly to avoid the proliferation of bacteria. This is a consideration that must be taken into account by the SABUC users. A good method to clean activated carbon from bacterial growth at home is by heating the filter in an oven in temperatures between 100 and 150 °C during 10 to 20 minutes, as well the activated carbon can be boiled in water for 10 min to be cleaned and disinfected. Then the filter can be reused in the Low-Income Households in Urban Areas many times reducing the cost of materials replacement.

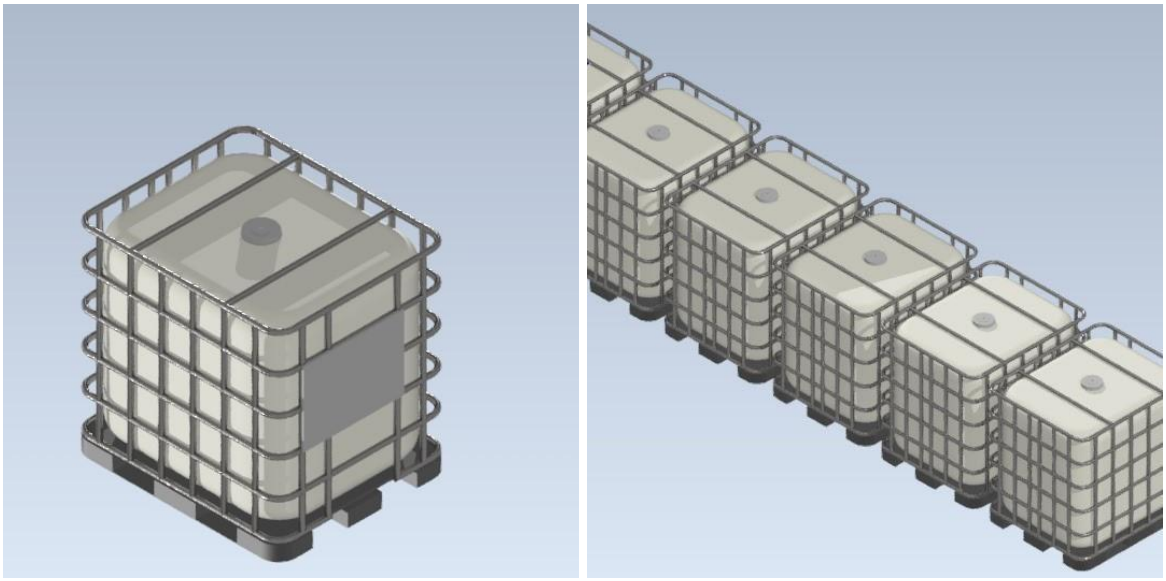
Activated carbon filter in SABUC

The activated carbon will be integrated in the sloped part of the T, this part of the canalisation will be desmontable allowing the maintenance and the cleaning of the filter. The rain water will flow through the filter by the water pressure action accumulated in the vertical pipe from the gutter drain, there is no need for great amounts of water pressure to filter the water, this filter will be integrated by loose granules. As well the carbon filter functions as a barrier against mosquitoes intrusion inside the IBC container.



Water tank

An IBC container was chosen as a water tank for SABUC because it can be easily transported, it has an innocuous material, it is durable and a second hand IBC is affordable. Only a few considerations have to be taken for the use of an IBC (Intermediate bulk container, also known as IBC tote, IBC tank, IBC, or pallet tank). For SABUC, the previous liquids carried by the IBC must have been non toxic, this means that any IBC container filled with industrial liquids, oils, detergents, paints or other non natural materials can not be used for this project. Gladly many other IBC containers are used to carry foods, syrups or wines, these IBC totes could be used safely in SABUC as rainwater storages after a thorough wash. The supplier must certify or asure the IBC container only has been used to contain foods.



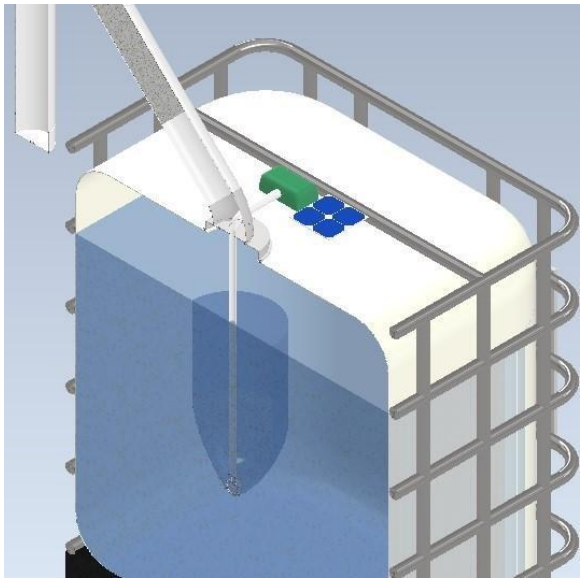
Water volume storage increase

As well, many IBC could be connected in series to increase SABUC total water storage volume with a minimal use of connection pipes. If the many additional IBC are connected in series, other solar water aeration with bubbles powered by a photovoltaic cell have to be added to ensure that the water at the interior of the total water storage is well oxygenated, this is crucial to sustain the water clean.

Photovoltaic water aeration

Aeration of water

The water aeration with bubbles inside the tank will prevent the harvested water rot. When water is stored without proper aeration, anaerobic conditions will increase the proliferation of harmful anaerobic bacteria. To avoid this a flux of bubbles will prompt high amounts of dissolved gases within the stored water thus enhancing the aerobic conditions and favoring a healthier water storage for human consumption.



Solar water aeration

The water aeration system is powered by a solar photovoltaic cell to make the SABUC system more autonomous, easy to instal and portable. The solar bubble aeration system will have all the parts integrated in a kit for easier use.

The bubbles

The bubbles will be introduced into the water by an air bubble diffuser stone. The air will be pumped into the strone by a plastic hose connected to an air pump that will introduce 120 liters of air bubbles per hour, the air pump will be powered by a photovoltaic cell. This system is designed to aerate ponds, so it will be sufficient to aerate a cubic meter of water. The air bubble diffuser stone will be located in the center of the IBC container at the maximum depth. The flux of bubbles at the stored water center will create a convection flow inside the tank creating a homogenous mix that will produce aerobic conditions inside the entire tank.

Ultraviolet light for disinfection

UVC LED for disinfection

UVC light is a short-wave germicidal ionizing radiation and can be produced by a UVC LED inside a water container to further purify the water because the ultraviolet light disrupts DNA bases and leads to the inactivation of bacteria, viruses, and protozoa.

Photovoltaic water aeration & UVC LED light

Photovoltaic water aeration & UVC LED light are two systems that work together. The solar panel powering the air pump can power the LED light and the convection flow of water created by the air bubbles will expose all the circulating water inside the container to the UVC LED light.

Instructions & Considerations

Some considerations must be taken into account to properly use SABUC. This set of instructions are easy to understand and can be performed by the low income house inhabitants.

1. The gutter and the plastic impervious cloth for rain capturing must be kept clean from dust, debris or toxic materials.
2. The length of the vertical end of the T pipe should be adjusted to gather a 10 min rainfall.
3. There should be a little hole in the cap at the end of the T pipe to drain the initial 10 minute rainfall, or the cap should be removed after each rain. This is important to keep the pipes clean and free from mosquito infestation.
4. The carbon filter must be clean regularly to avoid the growth or accumulation of pathogens. The filter can be cleaned with heat in an oven between 100 and 150 °C during 10 to 20 minutes, as well the activated carbon can be boiled in water for 10 minutes to be cleaned and disinfected.
5. The carbon supplier must ensure there aren't any contaminants or toxic substances in the charcoal. An organic carbon should be used for the filter.
6. All the parts of the T pipe, the carbon filter and the IBC container must be sealed from the outside to avoid the intrusion of pathogens and mosquitoes.
7. The second hand IBC container must have been only used to store foods or eatable products. The use of an IBC container used to store oils is not recommended.
8. The IBC container must be thoroughly cleaned before use and periodically washed with water and non toxic soaps such as dish soaps.
9. The IBC container must be located in a shaded and cool area to avoid the water heating by the son radiation. If the IBC container can only be placed in a sun exposed place, it will be advisable to cover the IBC container with a dark cloth or other shading objects.
10. If the water storage volume is augmented by adding more IBC containers, more aeration systems must be located in the other IBC containers.
11. Water recollection from SABUC must be preferably donde in the afternoon.
12. The solar panel must be kept clean to ensure the pump and the LED light are being powered enough.
13. A modification to the solar panel may be needed to power the air pump and the LED.
14. If needed, other types of water container could be used for a SABUC.

Budget

As set by Habitat for Humanity Challenge, the price of this project is under 210 USD. The prices were estimated in euros in an european web marketplace, this means that some of the materials used for SABUC could be found locally to reduce the cost further. Is important to comment that the total price does not cover taxes or cost of transportation. The item code matches the number on the blueprint. As well is important to point out that the shown prices

Item Code	Item	Quantity	Unit	Unit price Eur	Total Eur	Total USD
1	Plastic cloth	1	item	4.99	4.99	6.01
2	Gutter PVC	4	meter	2.49	9.95	11.99
3	Gutter mesh	1	item	4.00	4.00	4.82
4	Gutter drain PVC	1	item	3.45	3.45	4.16
5	Pipe PVC 100 mm	4	meter	3.63	14.50	17.47
6	T connection PVC	1	item	2.50	2.50	3.01
7	Cap PVC	1	item	0.70	0.70	0.84
8	Activated Carbon	2	kg	8.45	16.90	20.36
9	Flexible Pipe Joint	1	item	7.19	7.19	8.66
10	IBC 1000 liter	1	item	49.00	49.00	59.04
11,12,13,14	Solar Air Pump	1	kit	29.90	29.90	36.02
15	UVC LED	1	item	11.17	11.17	13.46
16	Glass pipe for LED	1	item	2.12	2.12	2.55
17	Gutter cap PVC	2	item	0.95	1.90	2.29
18	Suport gutter	3	item	2.00	6.00	7.23
19	Suport pipe	3	item	2.45	7.35	8.86
20	Brics	4	item	0.66	2.64	3.18
				Total Eur	**174.26**	**209.95**

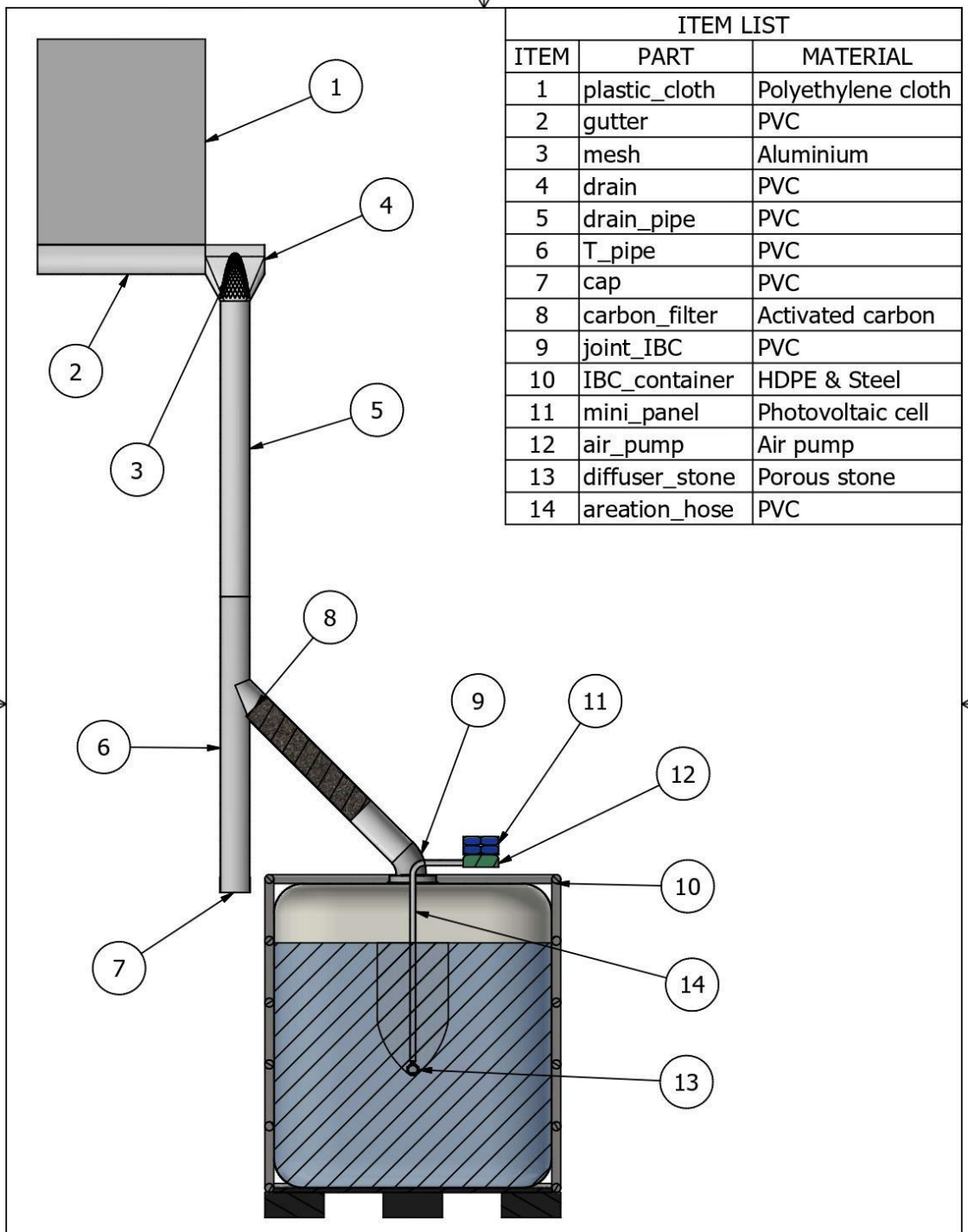
The 420 USD budget will cover the labor, tools for assembly and transportation. It will take less than a day to instal SABUC. The salary per month of a plumber is estimated at 660 USD in

developing countries, this means that a plumber could earn around 63% of his average monthly salary in less than a day installing SABUC at one household.

Conclusion

SABUC is an affordable, easy to instal and scalable solution to collect, clean and preserve rainwater. SABUC uses a diverse type of low cost technologies to treat water for human consumption in a micro scale using: screening with a mesh, sedimentation with a water trap, filtration with activated carbon, aeration with air bubbles and disinfection with ultraviolet light.
All this within the budget and requirements established for this challenge.

Blueprints



ITEM LIST		
ITEM	PART	MATERIAL
1	plastic_cloth	Polyethylene cloth
2	gutter	PVC
3	mesh	Aluminium
4	drain	PVC
5	drain_pipe	PVC
6	T_pipe	PVC
7	cap	PVC
8	carbon_filter	Activated carbon
9	joint_IBC	PVC
10	IBC_container	HDPE & Steel
11	mini_panel	Photovoltaic cell
12	air_pump	Air pump
13	diffuser_stone	Porous stone
14	areation_hose	PVC

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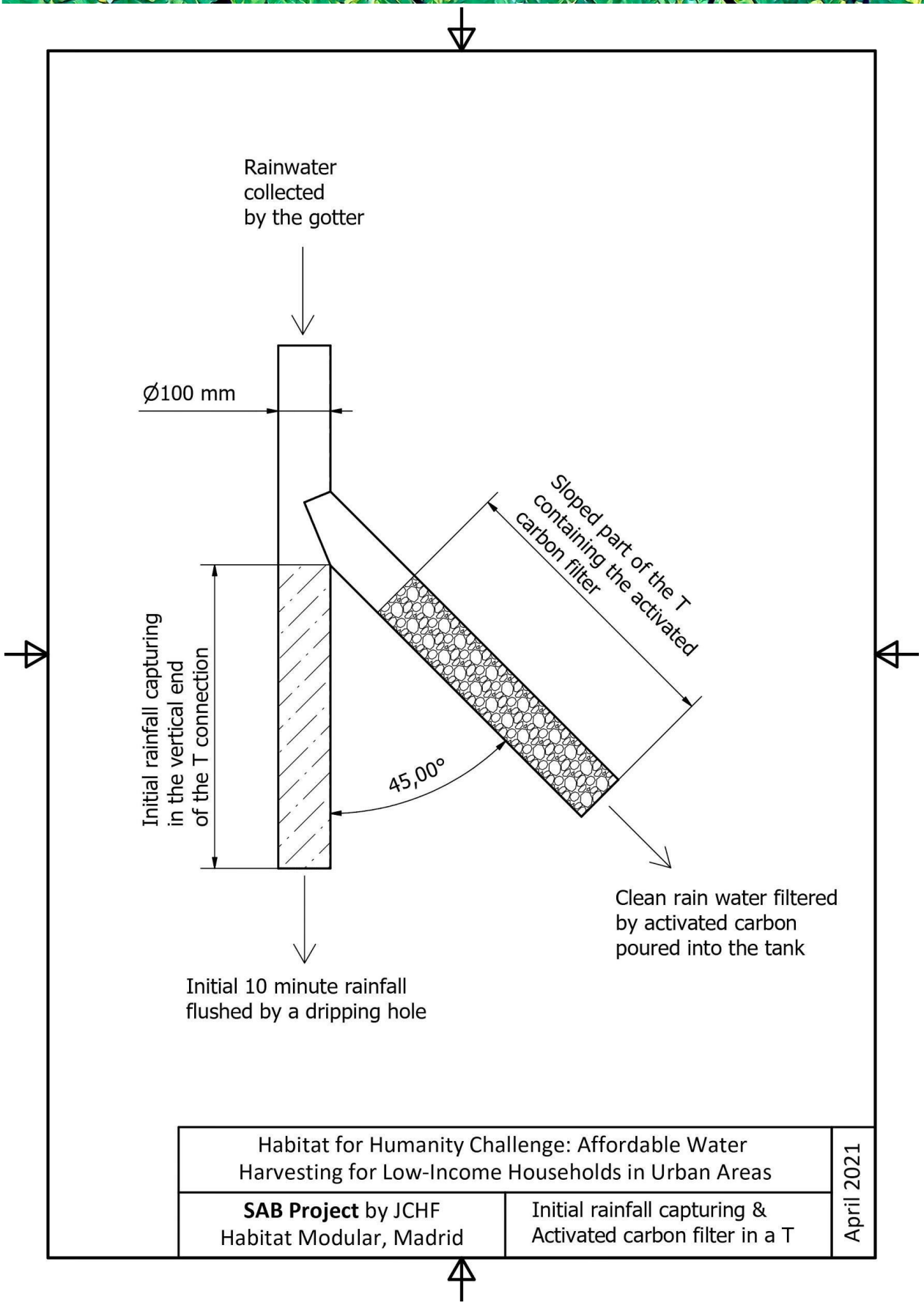
SAB Project by JCHF Habitat Modular, Madrid	Affordable rainwater harvesting system	


Rainwater
collected
by the gotter
Ø100 mm
Sloped part of the T
containing the activated
carbon filter
Initial rainfall capturing
in the vertical end
of the T connection
45,00°
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