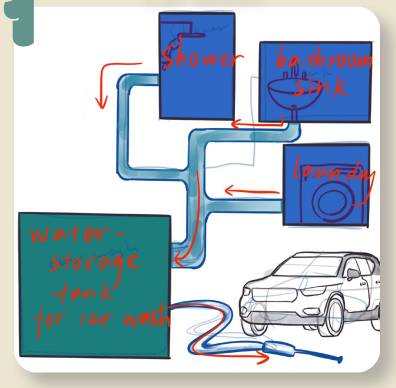
WATERTIGHT

Enhancing Water Resilience through reusing grey water

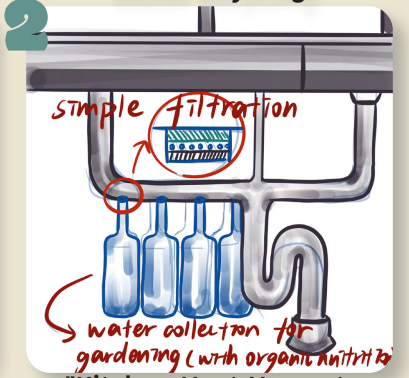
Group Domain: managing contaminated water

15 selected concepts

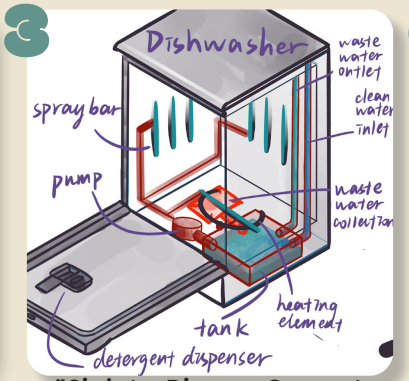
"Detergent Greywater - Eco Car Wash"



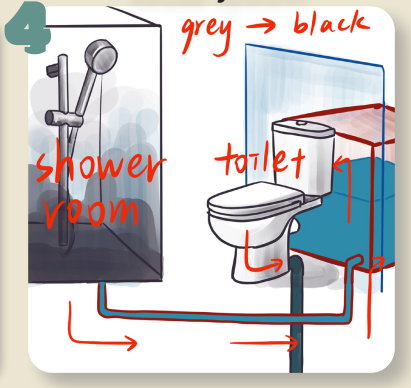
"Dish-to-Plant: Kitchen Water Recycling"



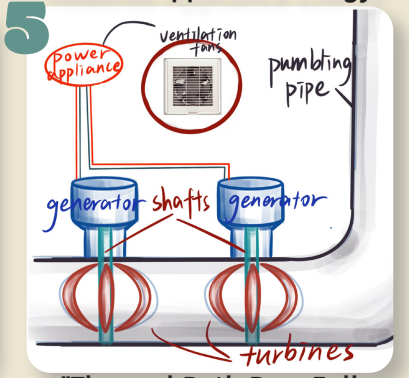
"Dishwater Reuse System"



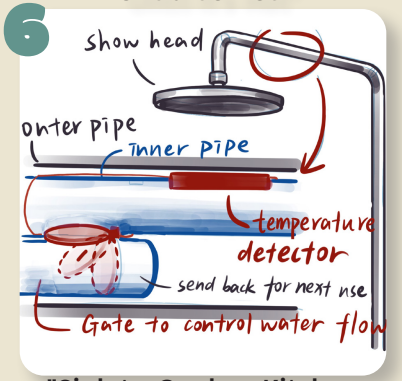
"Shower-to-Toilet: Greywater Reuse System"



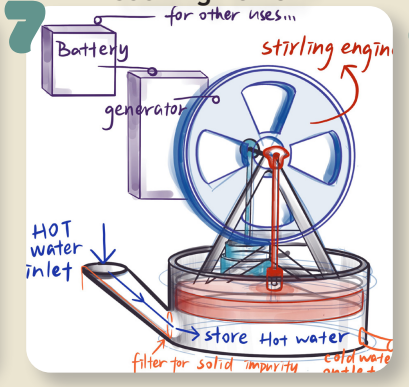
"HydroKinetic Tube: Water-Powered Appliance Energy"



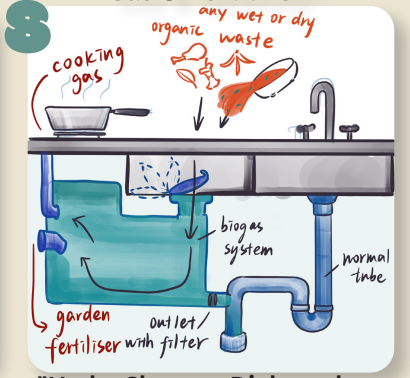
"TempRecycle Shower: Save Until It's Hot"



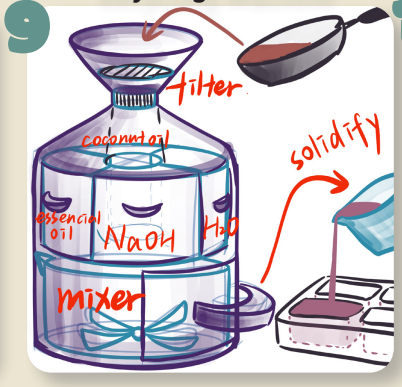
"Kitchen Heat Harvest: Stirling Engine for Post-Cooking Power"



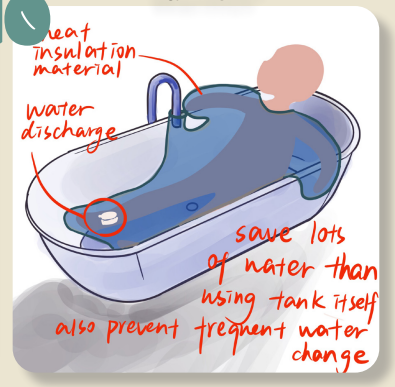
"Sink-to-Biogas: Convert Kitchen Waste into Cooking Gas & Fertilizer"



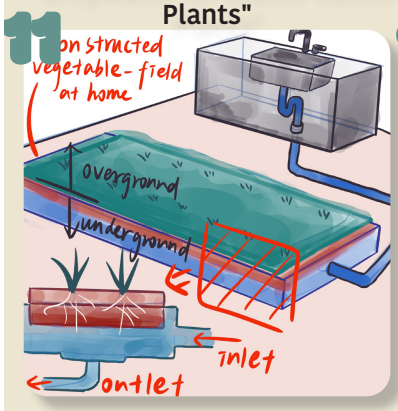
"Waste-to-Soap: Fry Oil Recycling Machine"



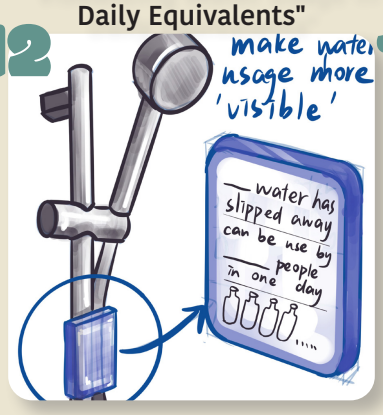
"Thermal Bath Bag: Full Coverage, Less Water, More Warmth"



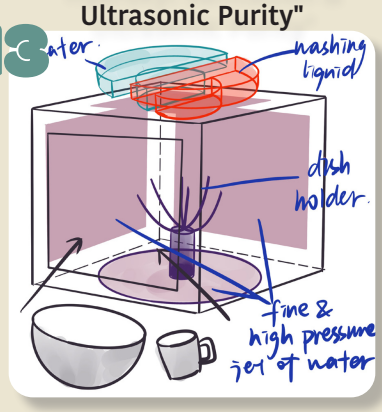
"Sink-to-Garden: Kitchen Greywater for Indoor Edible Plants"



"Visualizing Water Usage in Daily Equivalents"

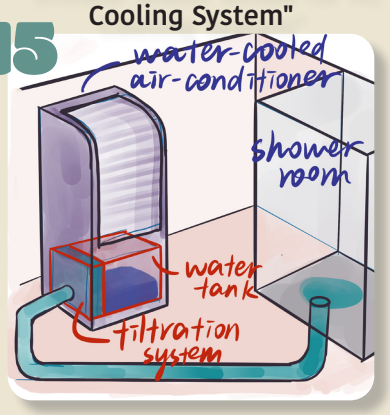


"HydroCleanse Dishwasher: Hydroxyl Sanitation & Ultrasonic Purity"



"Water-Mist Jet: Max Contact, Minimum Use"

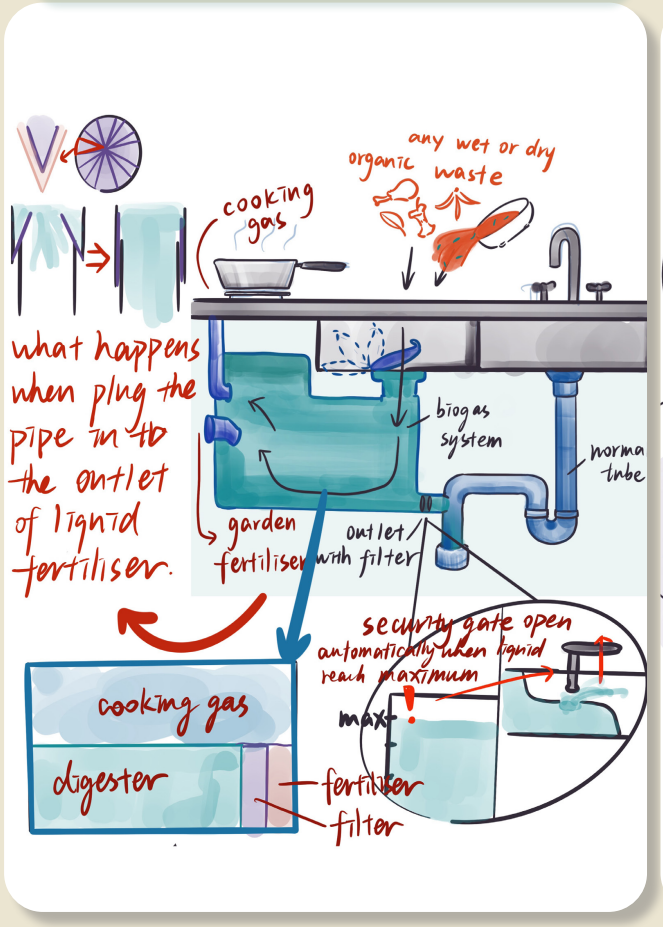
"Shower Water Reuse for AC Cooling System"



3 detailed concepts

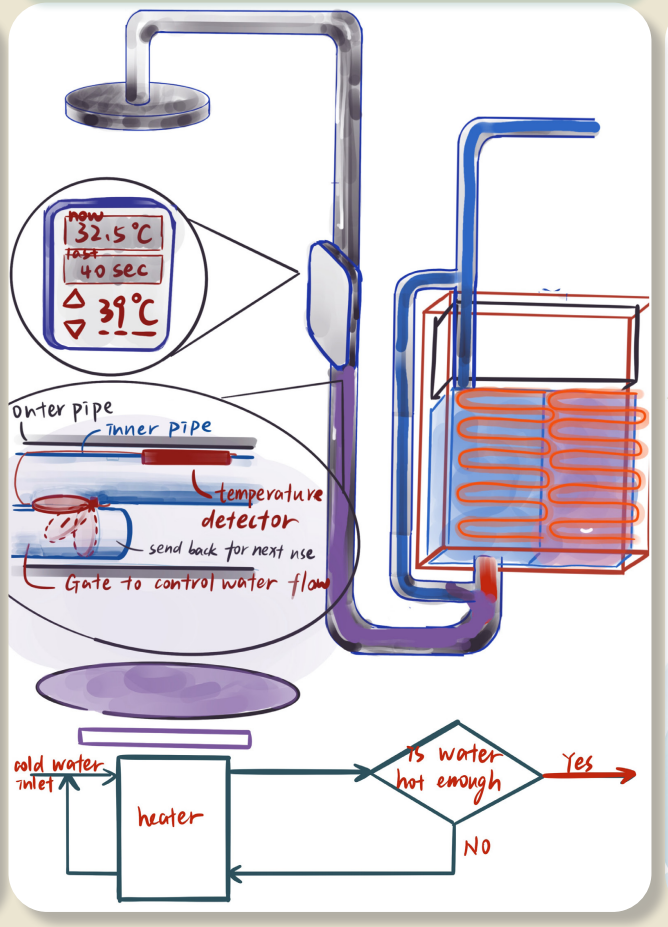
"Sink-to-Biogas: Convert Kitchen Waste into Cooking Gas & Fertilizer"

a system designed to sit under the kitchen cupboard, converting organic waste and wastewater into liquid fertilizer and cooking gas.
Its working principle is very similar to that of a cow's stomach. The lower part of the device is a digester, where wastewater and organic matter are 'digested'. The resulting fertilizer, after filtration, can be collected from a tap for use. Natural gas generated in the process is collected in the upper part of the equipment and piped to the stove for use.



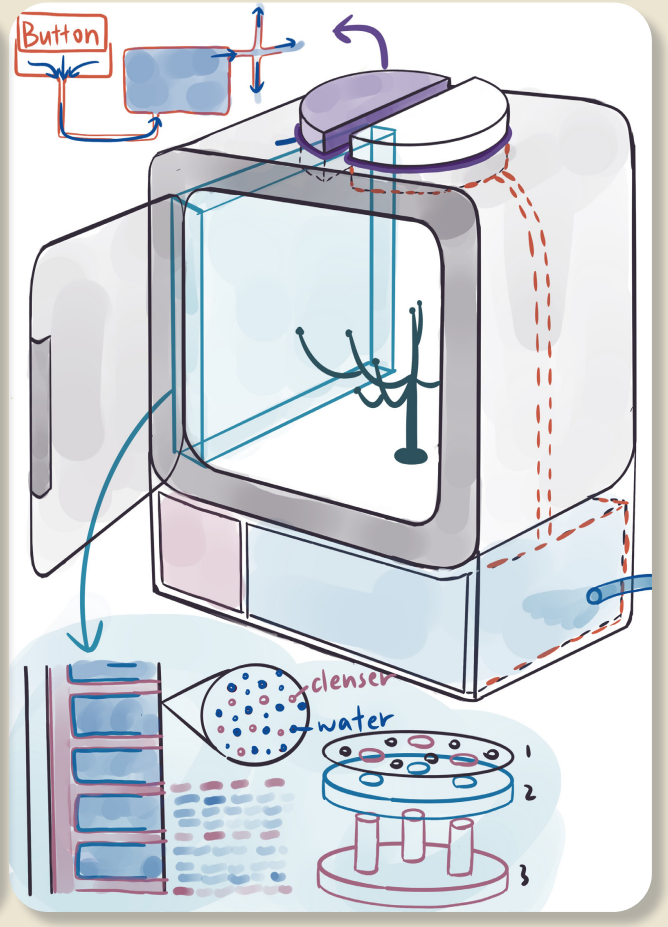
"TempRecycle Shower: Save Until It's Hot"

Do people often get frustrated waiting for the hot water to come out before taking a shower, wasting a lot of clean cold water in the process? This design aims to solve that problem. It's a system based on an existing shower setup. It works by detecting the temperature of the water flowing through the pipes and controlling a valve accordingly. This valve determines whether the water flows out of the showerhead or returns to the heater for further heating for next use. Ideally, the user would turn on the shower and only have to wait a short while to receive water at their desired temperature.



"Press & Clean: Single-Press, Water-Efficient, No Electricity needed"

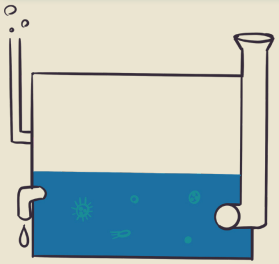
The 'Press & Clean' is a manual dishwasher, compact and eco-friendly, ideal for cleaning a few dishes without wasting resources. It operates without electricity, utilizing a hand-pressed mechanism to generate a high-pressure water and cleanser jet, efficiently cleaning dishes with a fraction of the water normally used. Its see-through structure ensures users can watch as their dishes get sparkling clean, also let user know wether they will need more cleanser. it will integrat smart,



Prototyping

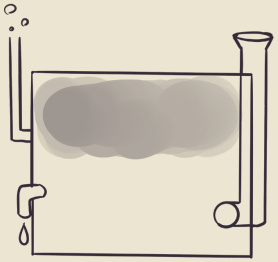
"Sink-to-Biogas: Convert Kitchen Waste into Cooking Gas & Fertilizer"

The core working principle of this design is already very clear and well-referenced, hence I didn't develop its work-like prototype, instead I focused on the the prototyping of the other 2 concepts.



1.Biodigestion

This is the process by which hungry bacteria break down organic waste, like food scraps, producing biogas.



1.Gas Storage

Bacteria in the digester turns the organic waste into biogas that is collected, filtered and stored in the safe and gas storage bag.

3.ready to use cooking gas and fertiliser

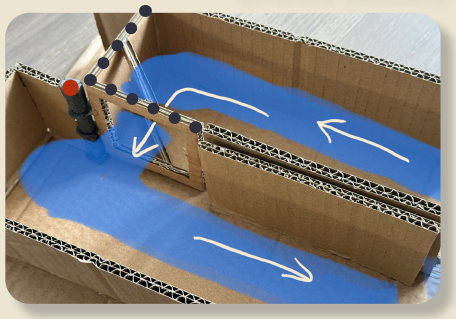
Concerns:

- More households in UK are choosing to use an **induction or electric ceramic hob** instead of an open-flame hob
- Cabinets are generally very small, greatly limiting the size of this system, which **requires greater capacity**
- Lack of innovation
- This device will take up a lot of storage space
- Storing large quantities of flammable gases indoors poses a safety risk

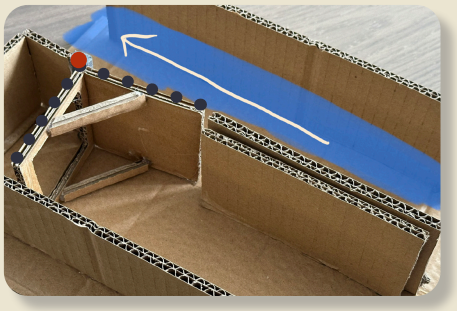
"TempRecycle Shower: Save Until It's Hot"

The purpose of this prototyping is to investigate the optimal water return system, specifically how to send cold water back to the heater.

This is a right-angled rotary gate that rotates 90 degrees around an axis. Due to one side being open and the other closed, it can precisely achieve water diversion at two different positions.



When the water HASN'T reached the set temp-erature



When the water reached the set temperature

What's next?

1st Improvement: The return water system should not be installed in a single pipeline; instead, it should be built into the wall using seperate pipes.

2nd Improvement: Recycling the unused cold water (in small quantities) in the pipelines is not effective for water conservation. Instead, we should recycle and utilize the relatively clean greywater produced during the showering process.

"Press & Clean: Single-Press, Water-Efficient, No Electricity Needed"

This prototyping to simulate how users interact with the dishwasher, and the process of usage.

clean!

Working Principle:

Each press of the button applies pressure to the water chamber. Utilizing the principle that liquid transmits pressure in a sealed container according to Pascal's Law, detergent and clean water are expelled. They are then sprayed onto the dishes from all directions in the form of high-pressure, fine water jets, allowing for cleaning to be completed with just a few presses.

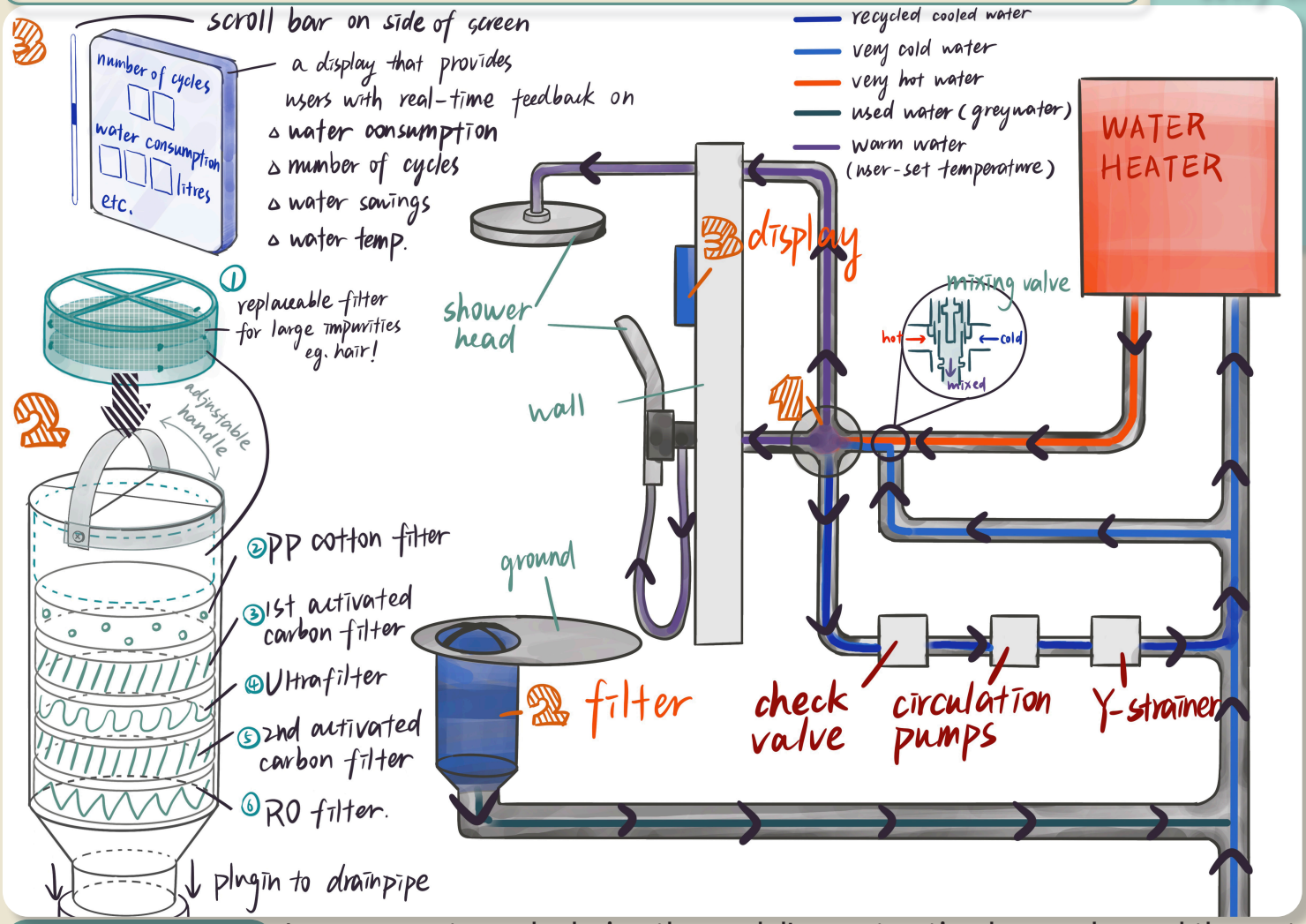
it reuses water by performing simple filtration after rinsing, so there's no need to worry about wasting more water with multiple presses.

Concerns:

- Are people motivated to choose this water-saving machine over simple rinsing.
- Does it effectively clean dishes while conserving water?
- As it is a compact cleaning device, is frequent manual cleaning and maintenance required?

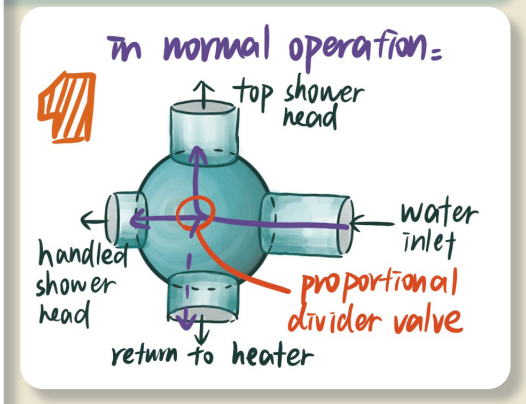
Development of 1 concept

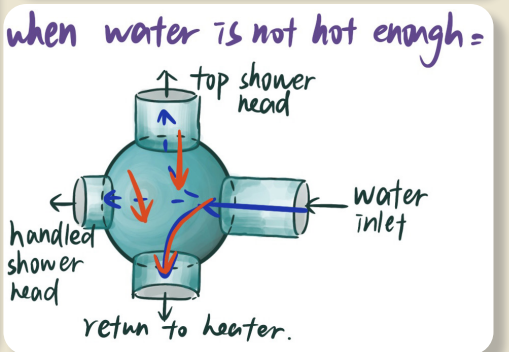
SmartSave Shower: Zero Cold-Water, WasteWater Recycling & Usage Tracking



Why this concept was selected?

This design, compared to the other two, has a significant advantage in terms of the amount of greywater it recycles, and it requires no learning curve for the user, even though it may have some installation difficulties.Moreover, this design, during the prototype manufacturing phase, revealed the most areas worthy of improvement, thereby enhancing its feasibility.





concept improvement

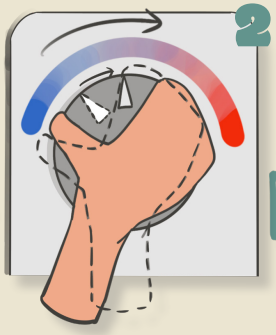
Improvements made during the model's construction have enhanced the system's completeness. The design now minimizes water loss during showers to approximately the system's capacity(water that fulfill all the pipes and heater). This efficiency is achieved by recycling unused and partially heated water for reheating. Additionally, used water is purified through a drinking-grade filter system for reuse. The filtration system features easily replaceable cartridges, including a hair filter for frequent changes. The system also includes a custom display for real-time monitoring of water usage, temperature, and other relevant user information.

Storyboard

This story describes a user's regular bathing routine and also shows how the system saves water and how the system provides real-time feedback to the user

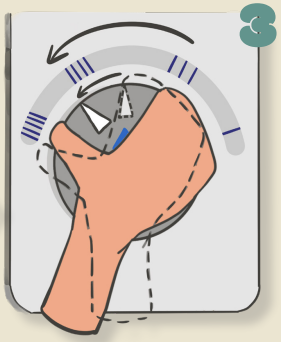
1

Get ready for a hot shower!



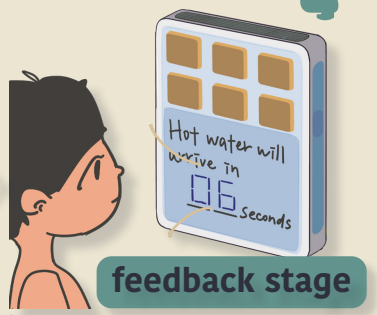
2

Adjust to a perfect temperature



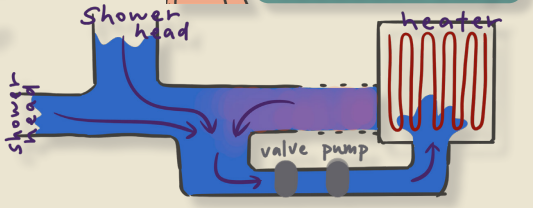
3

Turn on the tap

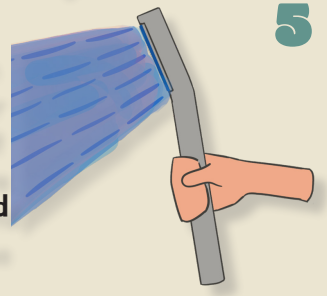


4

feedback stage

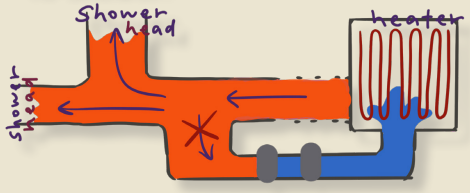


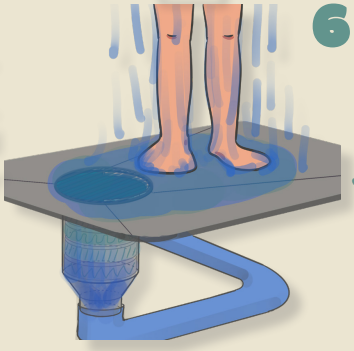
Then the display shows the time it takes for hot water to arrive, while cool water and partially heated water in the pipes are being recycled.



5

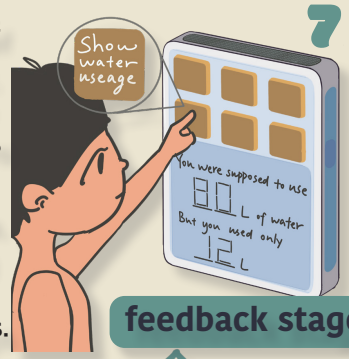
The countdown ends, water at the right temperature flows out, and now it's time to shower.





6

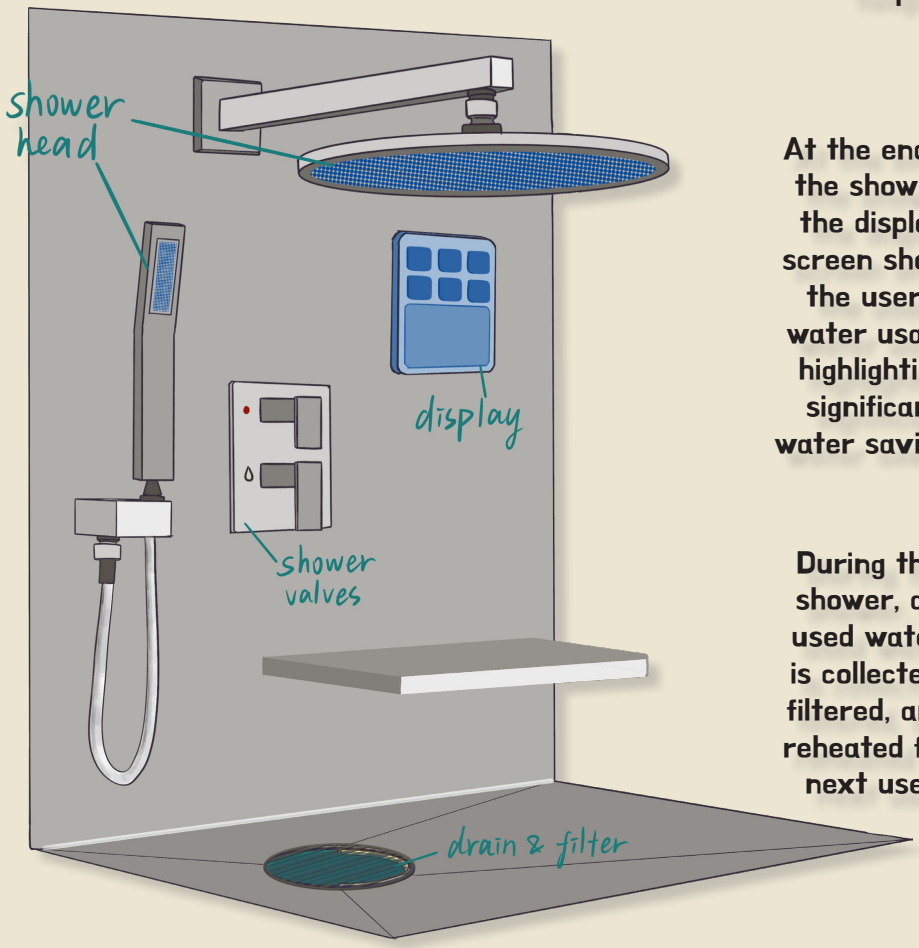
During the shower, all used water is collected, filtered, and reheated for next use.



7

At the end of the shower, the display screen shows the user's water usage, highlighting significant water savings.

feedback stage

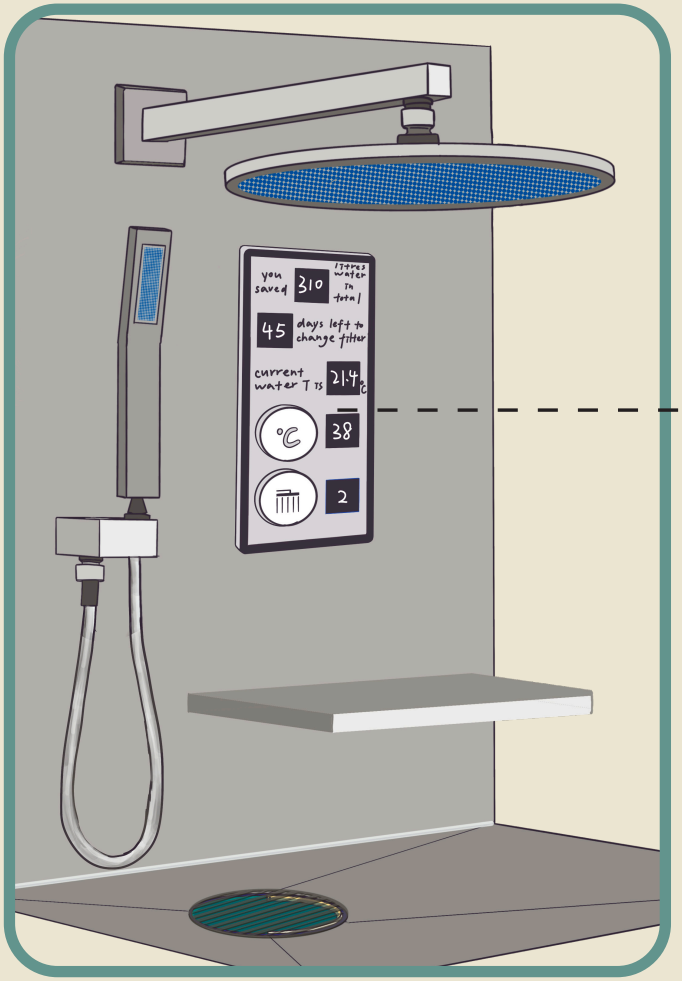


Final Design Concept

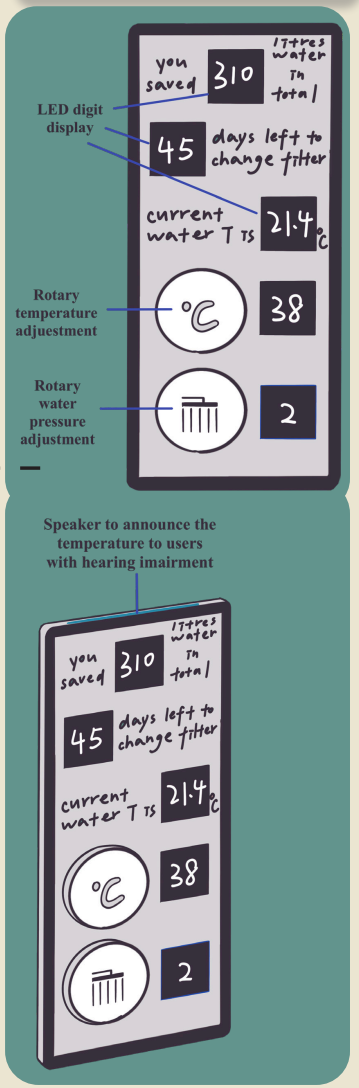
SmartSave Shower: Zero Cold-Water, WasteWater Reusing & Usage Tracking

Product appearance

The part that directly interact with the user.

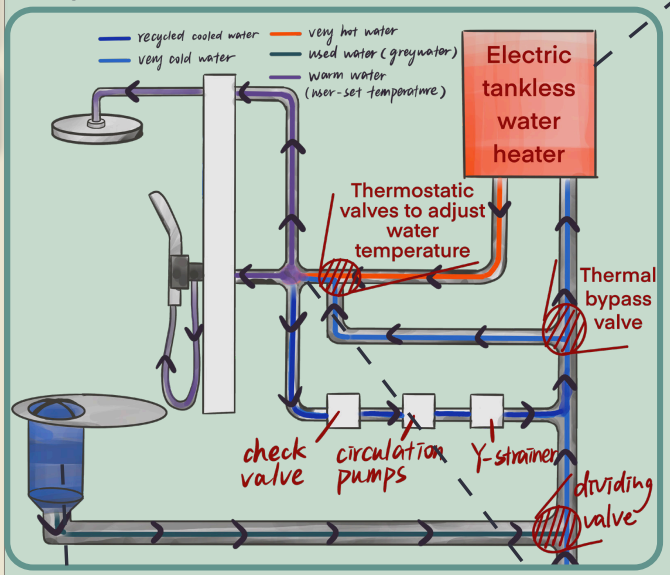


Visual display, showerswitch and temperature control



Componets inside the wall

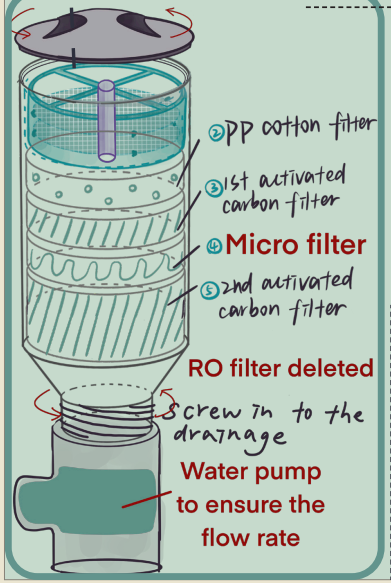
The part is invisible to users.



Plumbing system

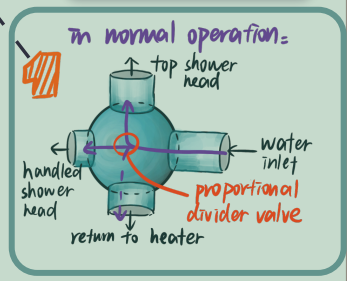
In addition to basic electronic shower functions. this system also reheat water left from previous use, eliminating the wait for cold water to clear. Also, It filters and recycles used water. The system includes a heat bypass valve to divert water that's already warm enough, reducing energy waste from heating . Furthermore, a dividing valve at the cold water inlet mixes fresh with recycled water, ensuring the water supply remains clean.

filtration system

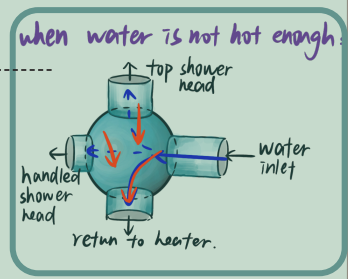


The used water, after passing through multi-stage filtration, effectively removes chemicals, metals, and solid impurities. A water pump is installed in the pipes to ensure that the water flow does not decrease due to the filter.

Dividng valve

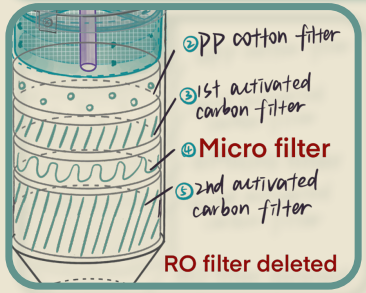


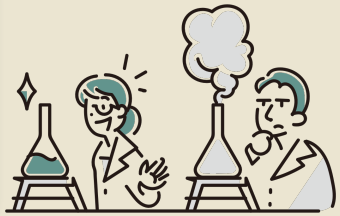
This diverter valve directs the water flow to the return pipe for reheating based on the incoming water temperature, or directly to the showerhead when the temperature is sufficient.



Concept Validation

Can the filter purify bath water to meet the safety and hygiene standards of tap water?





type of filters	what do they removed from water?
Largefilter	**human hairs** and very large particals
PP cotton filter	**large particles** of impurities in the water, avoiding blockage in next levels
Activated carbon filter	**14** of the most common **pesticides**
	32 identified **organic contaminants** including by-products from **chlorine**.
Statistical data from EPA (the Environmental Protection Agency)	**90%** of the **phosphates** from the water
	70% - 90% of **heavy metals**
Microfilter	**All bacteria** and small amout of virus

How to test the water quality

Collect bath water samples, filter them using the said filter, and then **collect samples** of the filtered water.

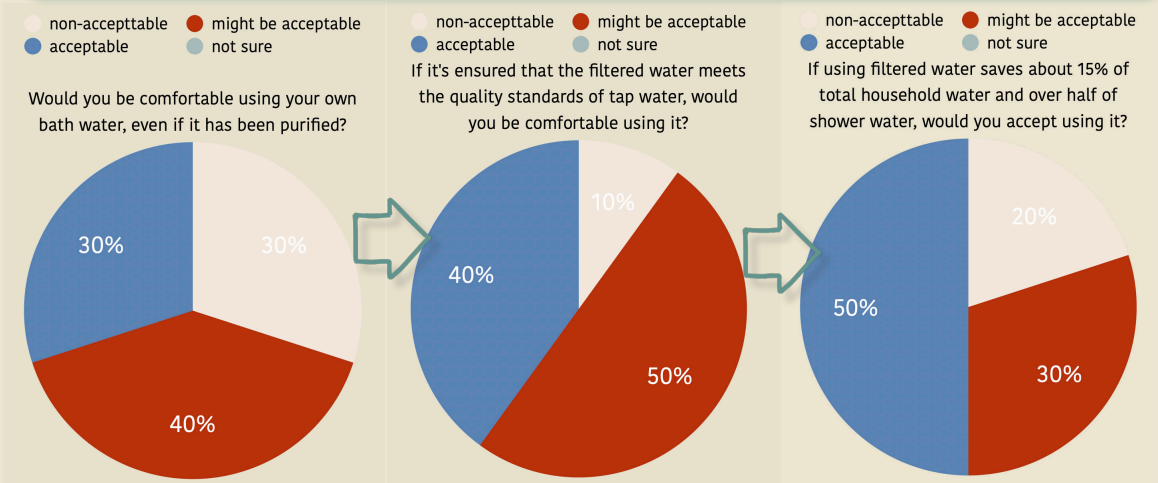
Send samples of water to an **authorised institution**, eg. (Environment Agency)

test for **substances present** in the water

Compare whether the substance content meets the **standards for tap water quality**

Scottish Water - Water quality standards:
listed the maximum permissible limits (PCV)of substance in water sample for water quality tests

Will this design concept be acceptable to users?



I conducted a survey on user acceptance of reusing filtered water. Initially, most people were not comfortable with recycling bath water. However, as they gradually learned that the quality and safety of filtered water are assured, and about the system's significant water-saving performance, acceptance gradually increased from one-third to half. Unfortunately, one-fifth of users still entirely reject the idea.

Concerns:

Water flow rate out of the filter is not secured

Filter replacement cycle has not been identified yet

Installation issue

- Even with a water pump installed to maintain flow rate, it cannot be guaranteed and should be tested to determine.
- Experiments are also needed to ascertain the filter replacement cycle. research results show that turbidity and TDS sensors, which require calibration and are easy to damage in water, are unsuitable for use in flowing pipelines. Therefore, it's currently impossible to precisely test water quality and provide real-time feedback to remind user using these methods.
- Due to the complexity of the system, the current design can only be installed in unfurnished bathrooms. Therefore, It's necessary to figure out a solutions for existing bathrooms, potentially by making the filter a separate, easily installable, and compatible unit.