

WATERTIGHT

Enhancing
Water
Resilience
through
reusing
grey water



Group
Domain:
managing
contaminated
water

Initial Exploration

Waterborne Diseases



829,000 people die from diarrhea each year due to unsafe drinking water.

Global Water Stress



2/3 of the world's population could be under water-stressed conditions by 2025.

In Energy Production



3.5 liters of water are needed. For every liters of gasoline refined from crude oil.

Freshwater Scarcity



2.2 billion people lack safely managed drinking water.

Agriculture's Water Use



70% of global freshwater is consumed by agriculture.

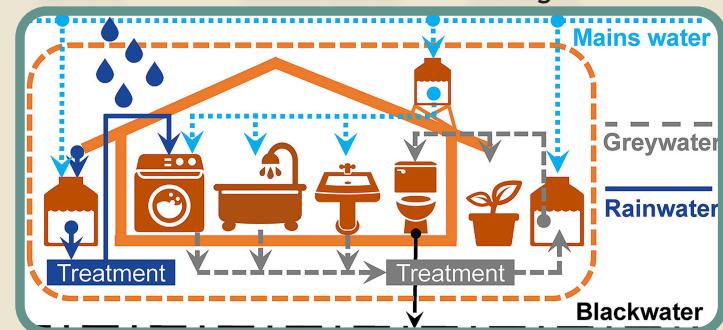
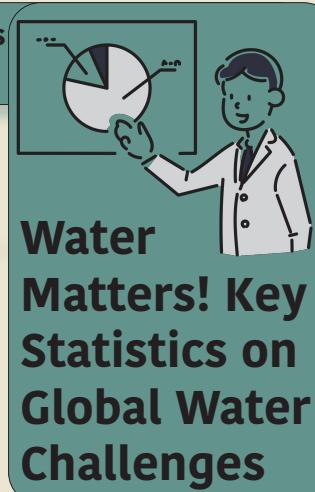


Research on Greywater

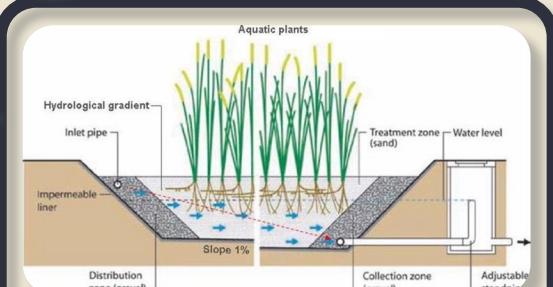
70% of people never heard of 'grey water' before

Greywater represents 43-70% of total domestic wastewater

low adoption rate of grey water systems in residential settings



CONSTRUCTED WETLAND



contaminated water

plant roots and the substrate



remove the larger particles

bacteria and plants

Pollutants and nutrients are removed

sedimentation of solids

TURN YOUR WASTE INTO COOKING GAS & BIOFERTILIZER



- Kitchen scraps

- Animal manure

- Human waste

which may potentially produce contaminated water

HOME BIOGAS

Cooking gas
Liquid fertilizer

GREYWATER 2 blackwater



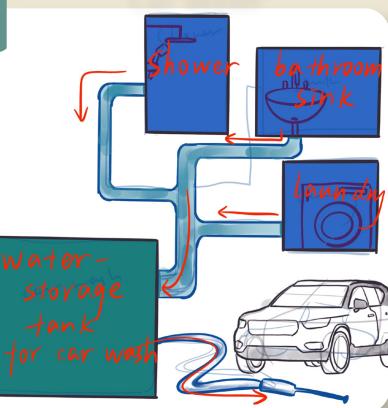
Concerns on existing projects...

- All of these products are expensive...
- Wetland is limited by climates...
- Homebiogas need a large space...

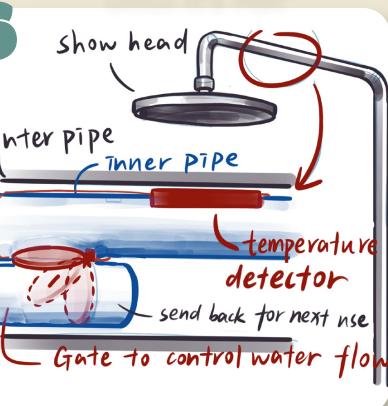
What projects have been done before?

15 selected concepts

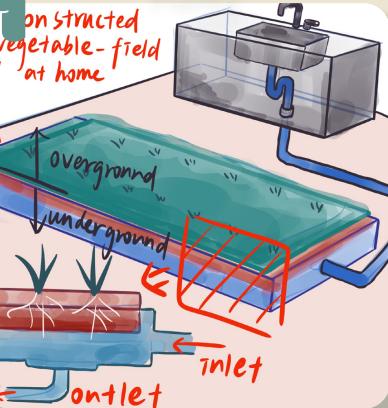
"Detergent Greywater - Eco Car Wash"



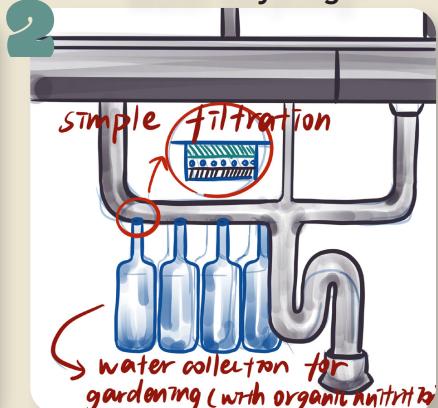
"TempRecycle Shower: Save Until It's Hot"



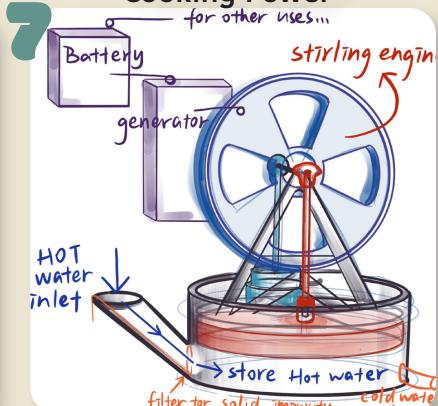
"Sink-to-Garden: Kitchen Greywater for Indoor Edible Plants"



"Dish-to-Plant: Kitchen Water Recycling"



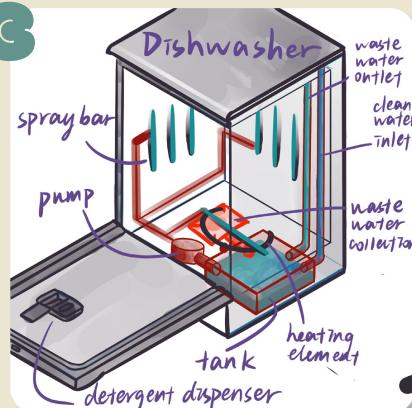
"Kitchen Heat Harvest: Stirling Engine for Post-Cooking Power"



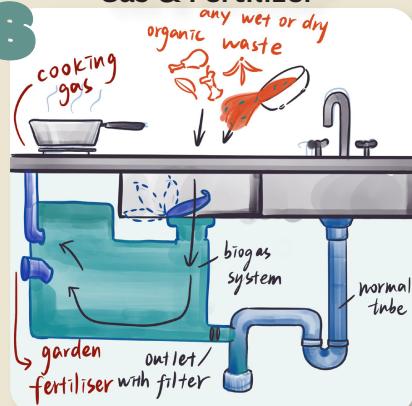
"Visualizing Water Usage in Daily Equivalents"



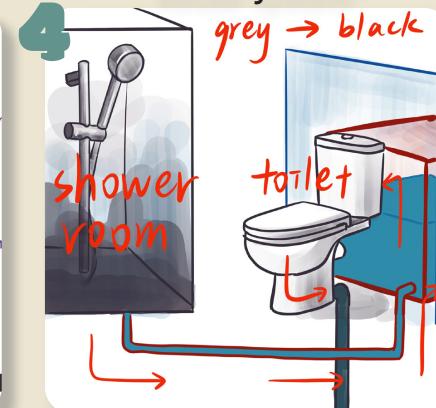
"Dishwater Reuse System"



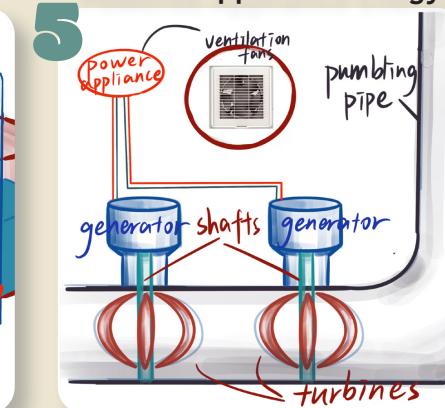
"Sink-to-Biogas: Convert Kitchen Waste into Cooking Gas & Fertilizer"



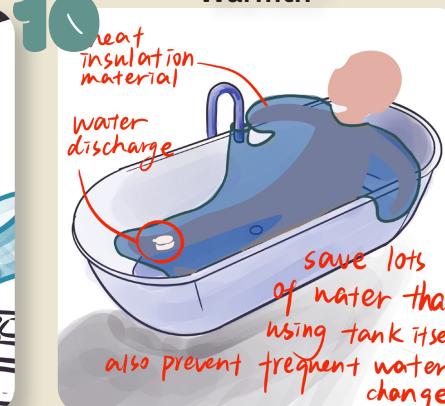
"Shower-to-Toilet: Greywater Reuse System"



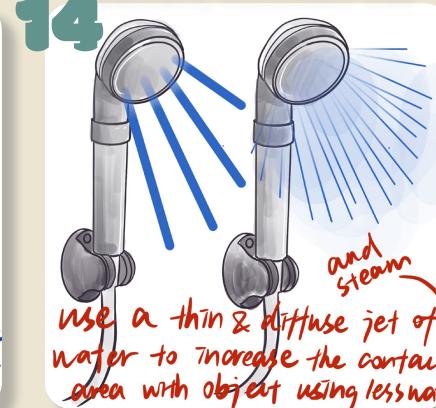
"HydroKinetic Tube: Water-Powered Appliance Energy"



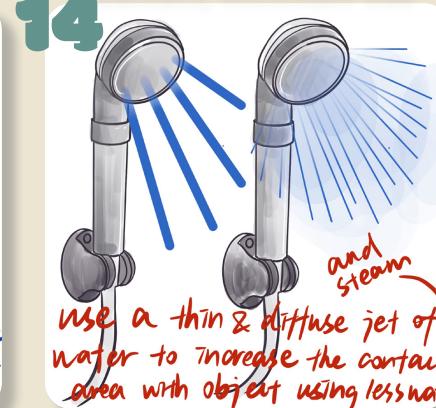
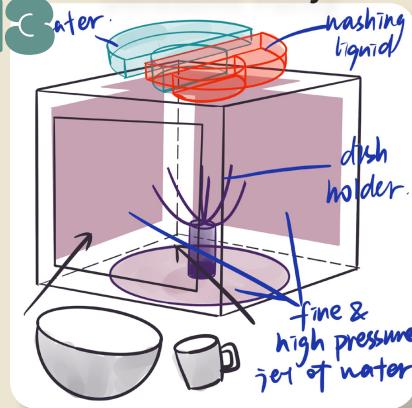
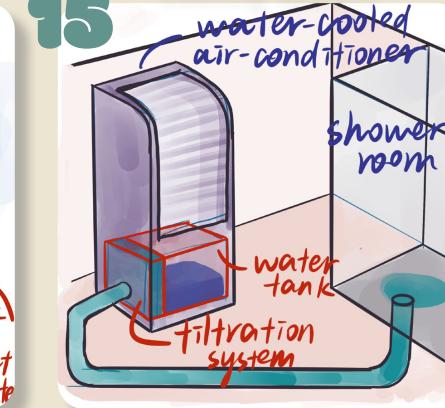
"Thermal Bath Bag: Full Coverage, Less Water, More Warmth"



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



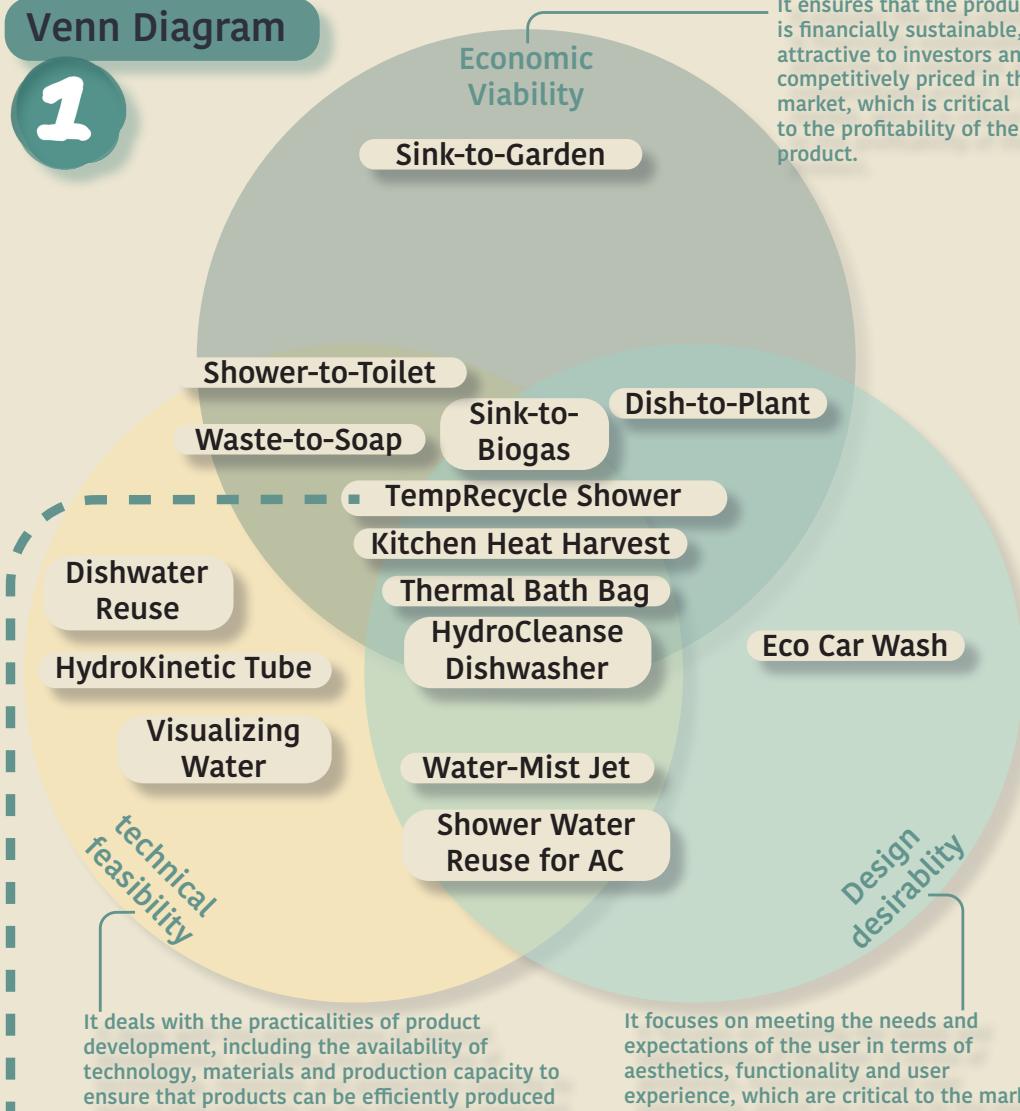
"Shower Water Reuse for AC Cooling System"



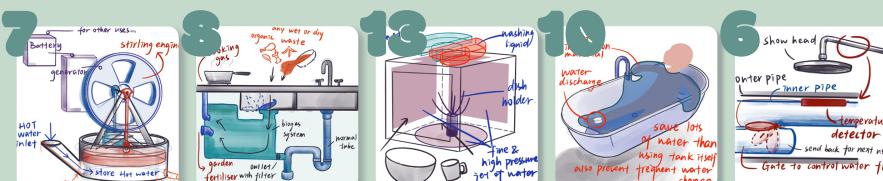
assessment of ideas

Venn Diagram

1



Five concepts for detailed design



Design decision matrix

2

See the supplementary page for other definitions of evaluation criteria

	☆	☆☆	☆☆☆	☆☆☆☆
Frequency of Use	< 4 times a month	once a week	2-3 times a week	almost everyday
Automation Level	Requires full human intervention for each use, with no automated components.	Automated processes is involved, but still requires significant human interaction and oversight.	Majority of operations are automated, with minimal human input needed for initiation or supervision.	Completely self-operating, capable of autonomous decision-making and adaptation.

criteria	concept numbers	User Experience & Practicality Evaluation				
		6	7	8	10	13
Frequency of Use	****	***	***	*	***	
Easy to use	***	*	***	***	***	
Visual Appeal		**				
Innovation	***	**	**	***	**	
Ease of Installation		**		***	***	
Cost Estimation	***	***	**	***	***	
Learning Curve	**	***	****	****	**	
Maintenance Simplicity	***	**	*	***	***	
Real-time Feedback	****	***	***	*	***	
Automation Level	****	**	***	*	***	
Eco-friendly Disposal			**		**	
Total Mark	35	23	26	25	30	

The three highest scoring designs

Three concepts for detailed design



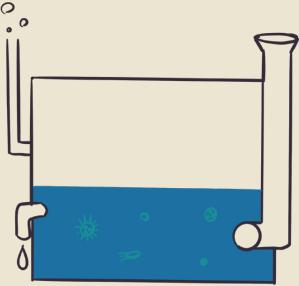
decision matrix description

These scores represent the average ratings given by a group of individuals with diverse knowledge and backgrounds, based on the above evaluation criteria.

Prototyping

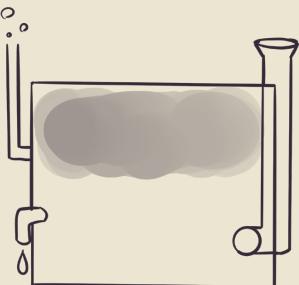
"Sink-to-Biogas: Convert Kitchen Waste into Cooking Gas & Fertilizer"

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 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:

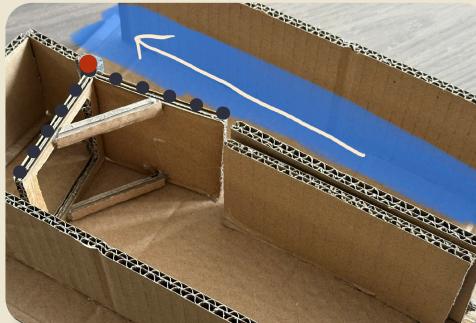
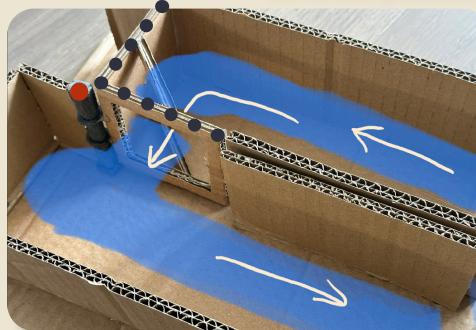
- More households in UK are choosing to use an **induction or electric ceramic hob** instead of an open-flame hob
- Cabinets are generally very small, greatly limiting the size of this system, which **requires greater capacity**
- Lack of innovation
- This device will take up a lot of storage space
-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

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 separate 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"



clean!

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

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.

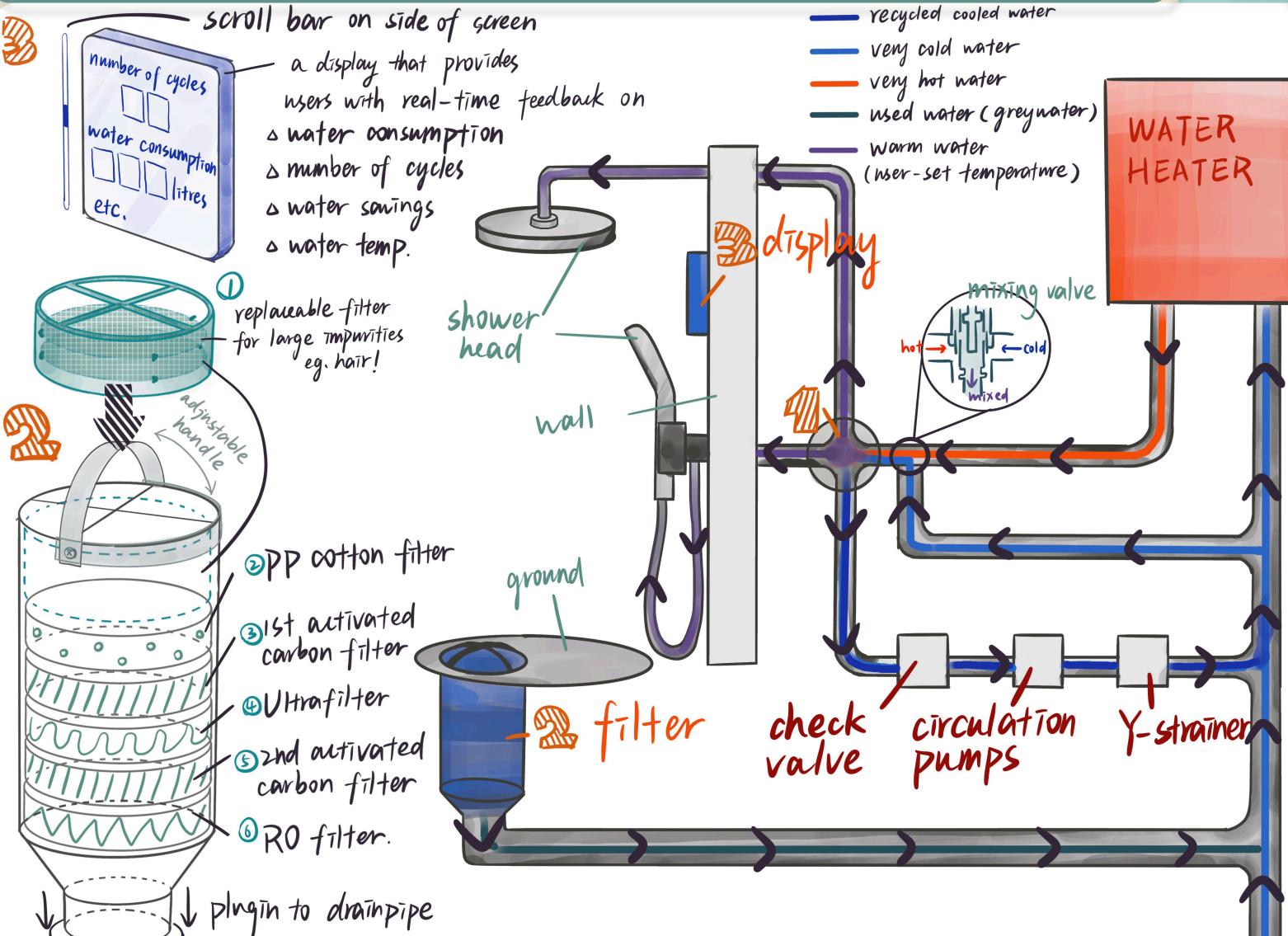
Concerns:

- 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?

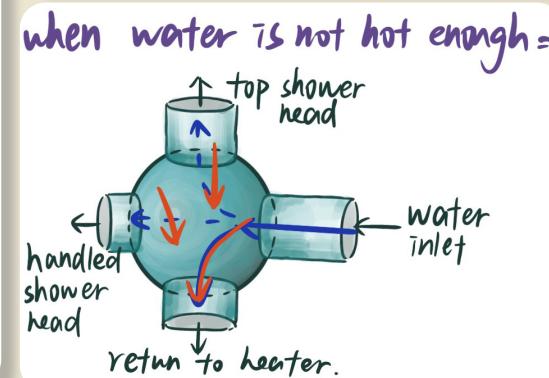
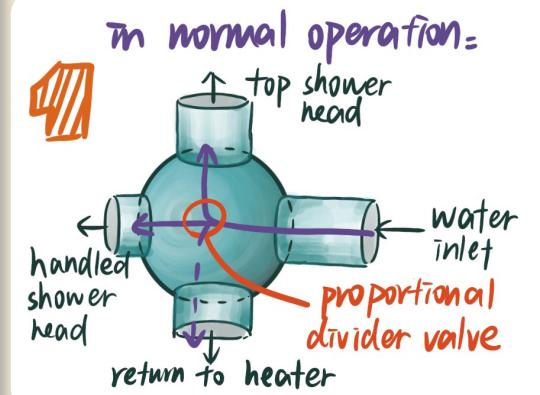
Development of 1 concept

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.



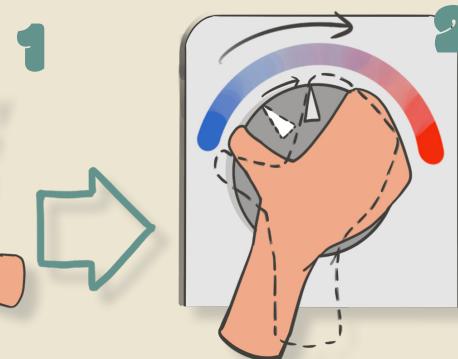
Improvements made during the model's construction have enhanced the system's completeness. The design now minimizes water loss during showers to approximately the system's capacity (water that fulfill all the pipes and heater). This efficiency is achieved by recycling unused and partially heated water 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

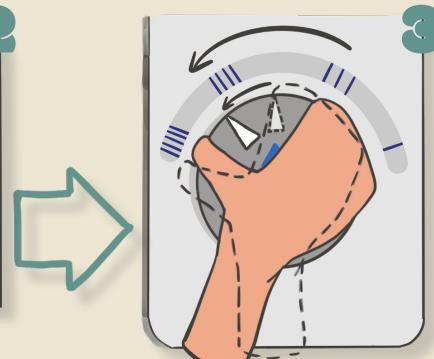
This story describes a user's regular bathing routine and also shows how the system saves water and how the system provides real-time feedback to the user



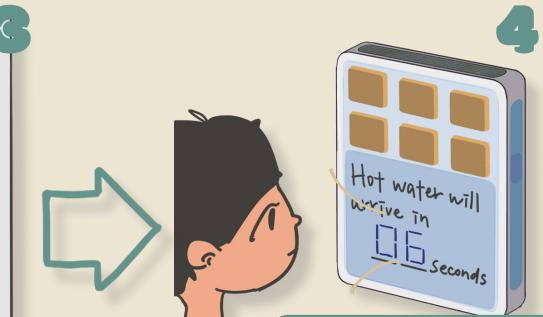
Get ready for a hot shower!



Adjust to a perfect temperature

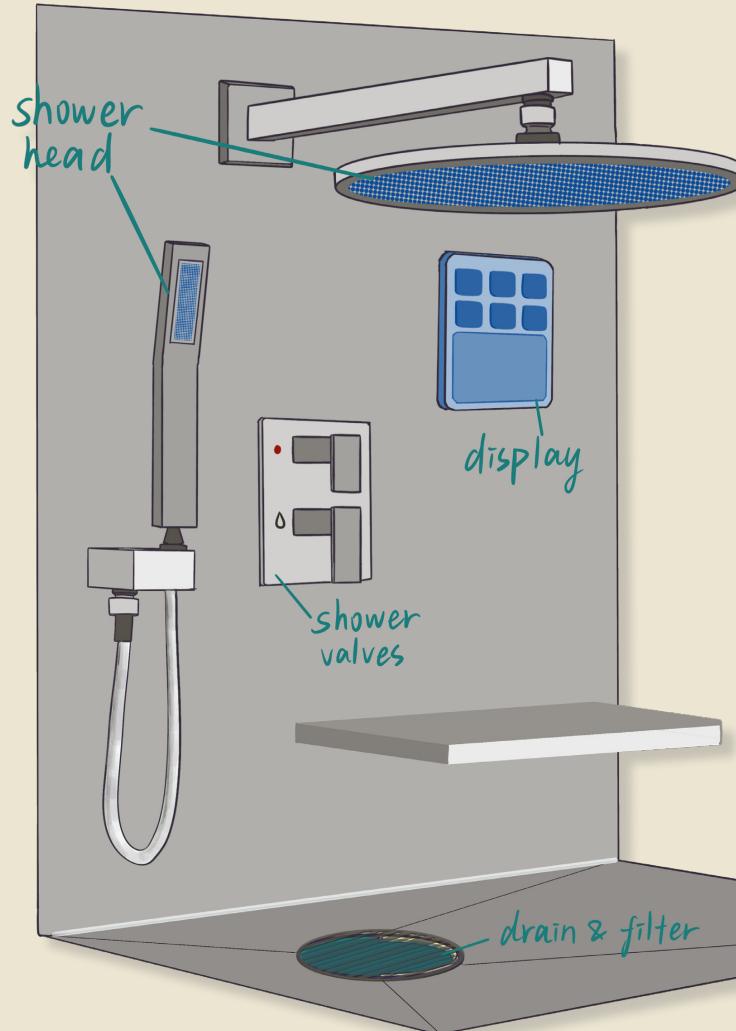
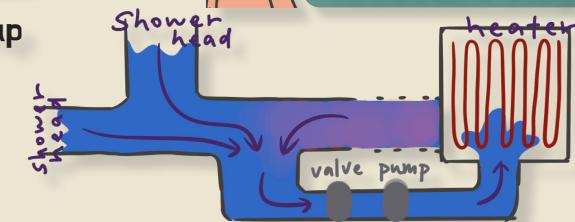


Turn on the tap

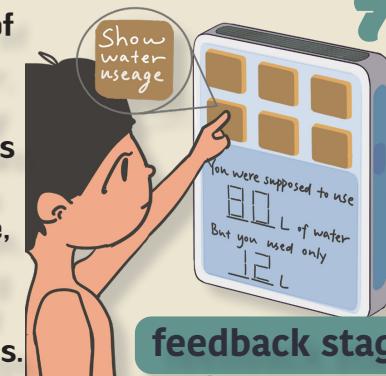


feedback stage

Hot water will arrive in 06 Seconds



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



feedback stage

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

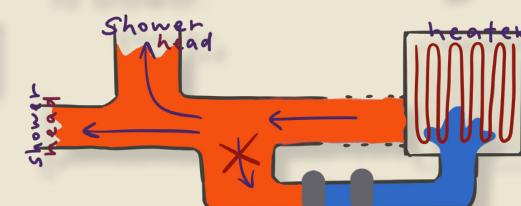


6

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.



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



4

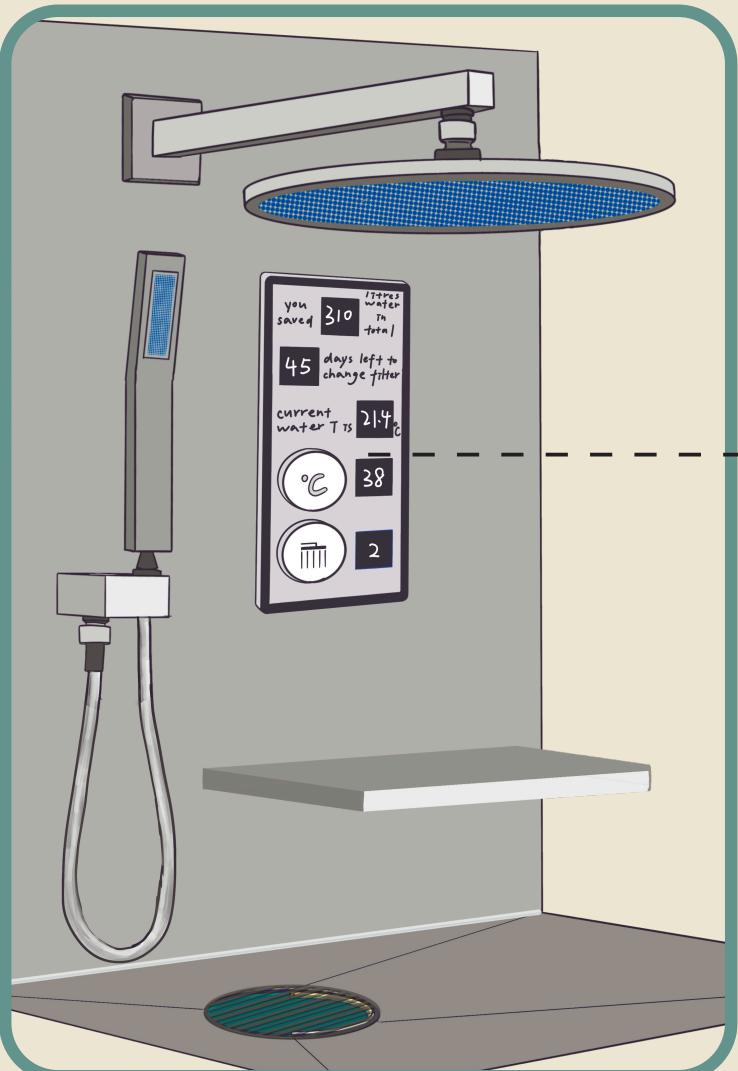
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Final Design Concept

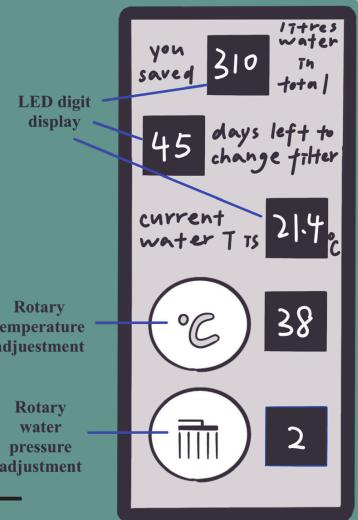
SmartSave Shower: Zero Cold-Water, WasteWater Reusing & Usage Tracking

Product appearance

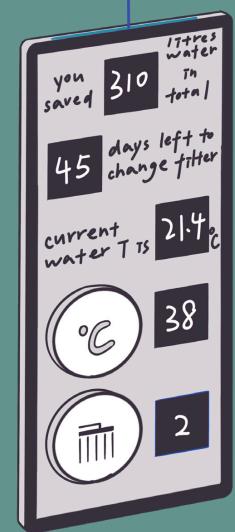
The part that directly interact with the user.



Visual display, showerswitch and temperature control

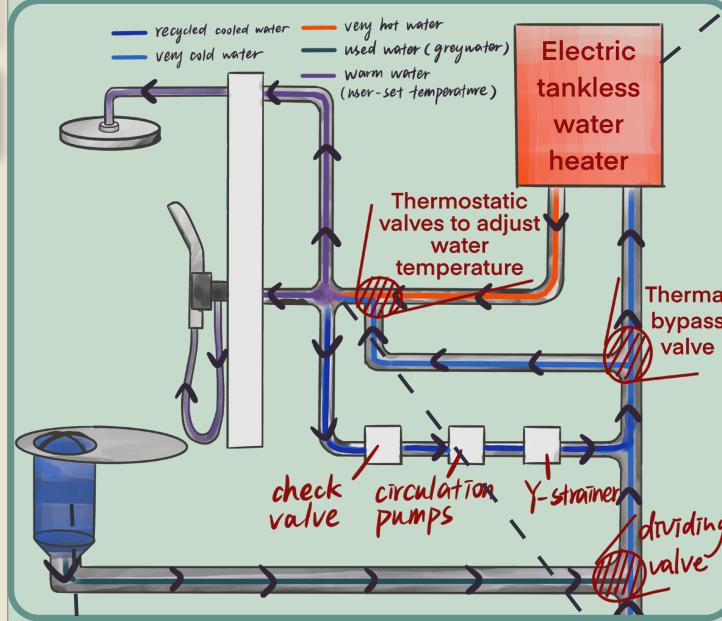


Speaker to announce the temperature to users with hearing impairment

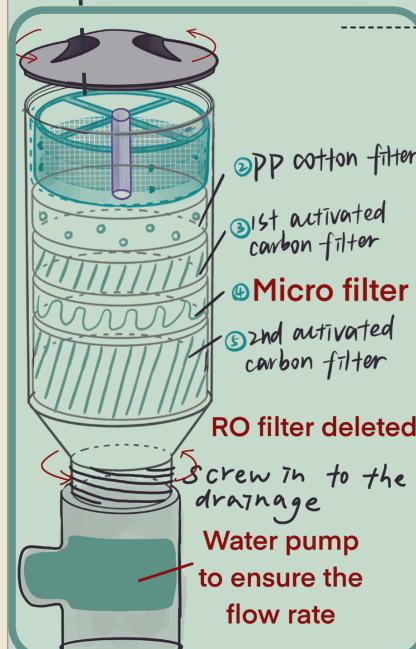


Components inside the wall

The part is invisible to users.



filtration system



RO filter deleted
Screw in to the drainage
Water pump to ensure the flow rate

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.

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.

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.

Dividing valve

