Rainwater Harvesting System

Design Recommendation E-Poster

Team: H-4

Hannah Cha, Joshua Riefman, Yuhan Qiu, Yasin Kurji, Kushagra Sharma, Simon Huang

Introduction

Our Goal:

Design an efficient and sustainable rainwater harvesting system that can cater to the needs of remote and coastal communities in British Columbia.

Our Recommendation

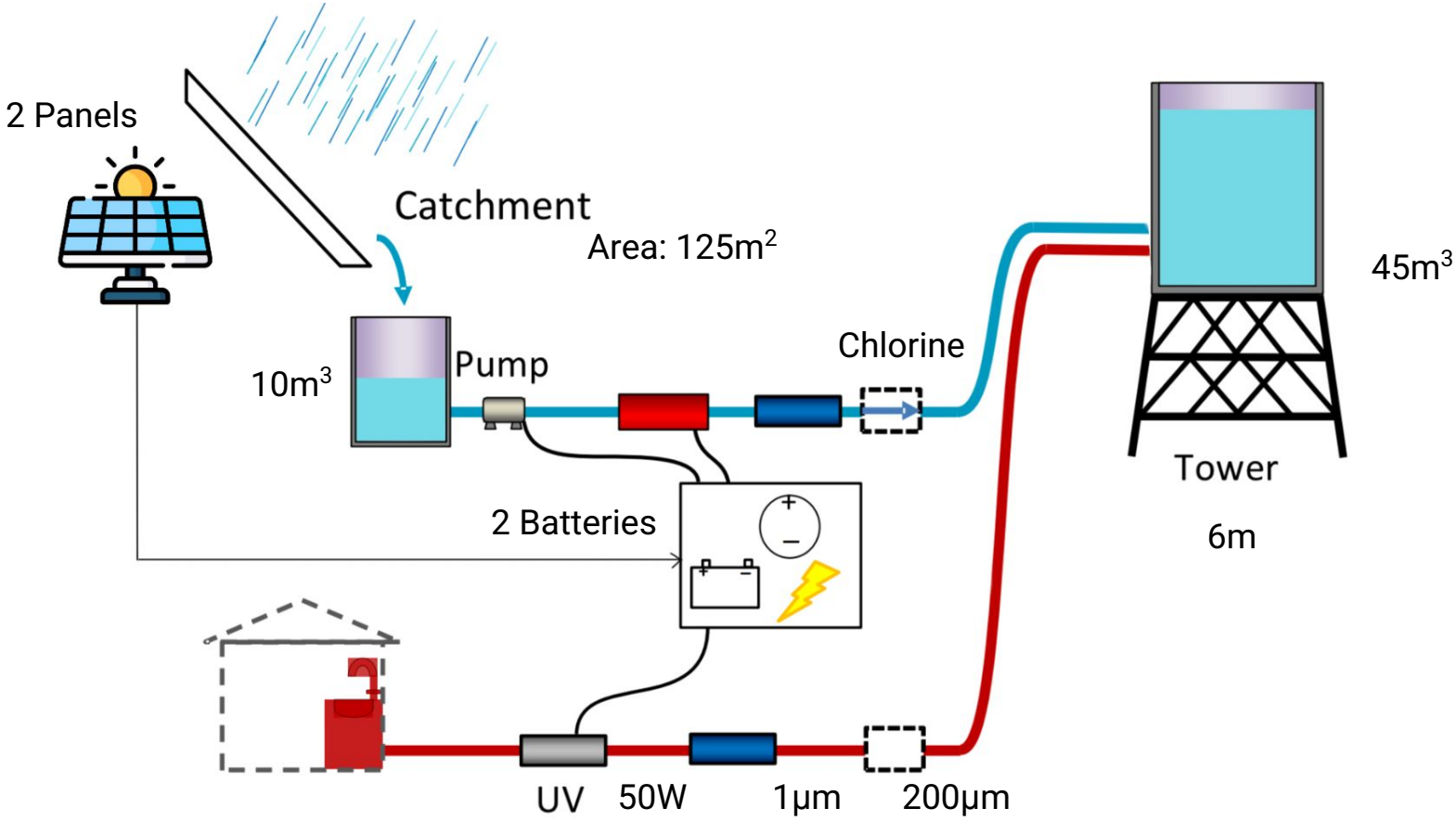
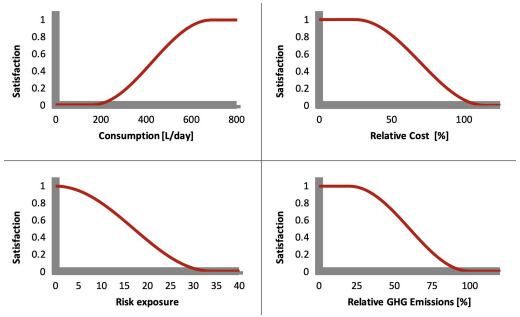


Table of Contents

Team Decision - Design Process



*The Rainwater Harvesting System is a **Complex, Deterministic System***

*Quantitative Analysis via **Satisfaction Curves***

The Decision Making Tool - Spreadsheet

Google Sheets - a *semi - comprehensive, virtual* prototype of our rainwater harvesting system.

Area	1.6	[m^2]
Efficiency	0.17	[%]
Number of Panels	2	[]
Solar Irradiance	350	[W/m^2]
Battery Efficiency In	0.96	[%]
Battery Efficiency Out	0.96	[%]
Battery Capacity	4000	[Wh]
Using Solar?	1	[]
Sufficient Power?	1	

Month [int]	Daylight Time [hr]
1	8.5
2	10
3	11.8
4	13.6
5	15.3
6	16
7	15.8
8	14.2
9	12.5
10	10.8
11	9
12	8.3

Day [date]	Month [int]	Daylight Time [hr]	Energy Captured [Wh]	Energy Captured [Wh]	Energy Stored [Wh]	Energy Out [Wh]
1/1/2014	1	8.5	1618.4	1553.664	1311	242.2054903
1/2/2014	1	8.5	1618.4	1553.664	2610	255.088761
1/3/2014	1	8.5	1618.4	1553.664	4000	0
1/4/2014	1	8.5	1618.4	1553.664	4000	0
1/5/2014	1	8.5	1618.4	1553.664	4000	0
1/6/2014	1	8.5	1618.4	1553.664	4000	64.4163538
1/7/2014	1	8.5	1618.4	1553.664	4000	262.8187235
1/8/2014	1	8.5	1618.4	1553.664	4000	319.5051148
1/9/2014	1	8.5	1618.4	1553.664	4000	438.0312058
1/10/2014	1	8.5	1618.4	1553.664	4000	574.5938759
1/11/2014	1	8.5	1618.4	1553.664	4000	185.5190989
1/12/2014	1	8.5	1618.4	1553.664	4000	646.7401921
1/13/2014	1	8.5	1618.4	1553.664	4000	123.6793993

Parameters

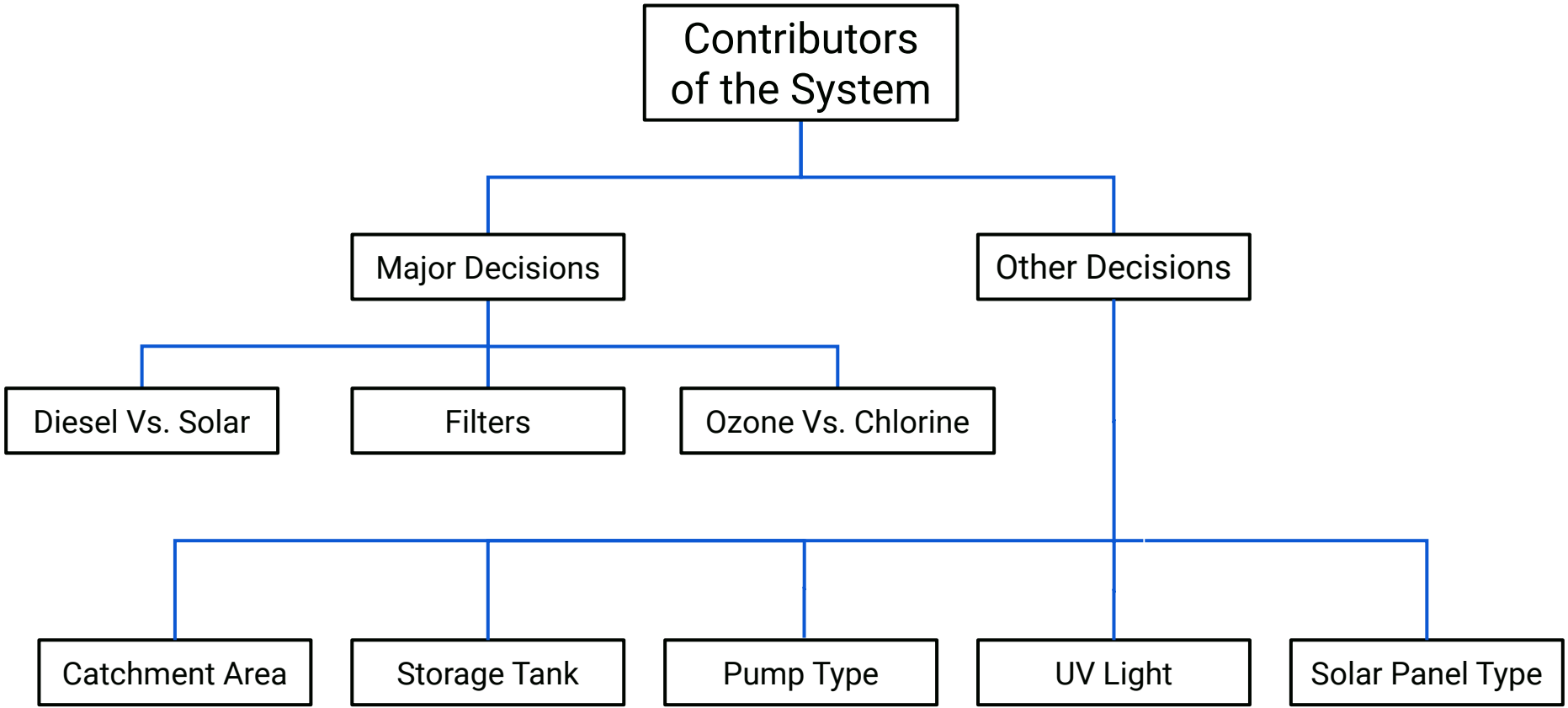
↓

Calculations Sheets

↓

Satisfaction Outputs

Design Decisions



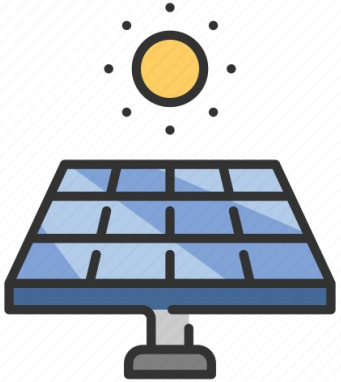
Power Supply

Diesel Generator

- Adaptable-to-need energy production
- Environmentally unfriendly

Solar Power

- Weather-dependent energy production
- Lower continuous environmental impact



Our power needs can be most sustainably met with **solar power**.

Disinfection

Ozone

- Extraordinary power demand
- Low health and environmental risk
- High upfront cost

Chlorine

- High health and environmental risk
- Doesn’t require power
- Requires shipments of hazardous chemicals

Our Decision: Despite the health risk, **chlorine disinfection** works best with solar power as it doesn’t require much energy to operate.

Filtration

Filtration is an important element in purifying rainwater to a drinkable standard.

Filter Options

200µm

5µm

1µm

Our decision also impacts cost and reliability!

Filteration Maintenance Tracker

Dates [date]	Volume in Day [m^3]	200µm filter Total Volume [m^3]	200µm filter Maintenance Needed?	5µm filter Total Volume [m^3]	5µm filter Maintenance Needed?	1µm filter Total Volume [m^3]	1µm filter Maintenance Needed?	Was Today a Maintenance Day? (1 --> yes, 0 --> no)
1/1/2014	0	0	0	NULL	NULL	0	ø	0
1/2/2014	0	0	0	NULL	NULL	0	0	0
1/3/2014	0	0	0	NULL	NULL	0	0	0
1/4/2014	0	0	0	NULL	NULL	0	0	0
1/5/2014	0	0	0	NULL	NULL	0	0	0
1/6/2014	0	0	0	NULL	NULL	0	0	0
1/7/2014	0	0	0	NULL	NULL	0	0	0
1/8/2014	0	0	0	NULL	NULL	0	0	0
1/9/2014	0	0	0	NULL	NULL	0	0	0
1/10/2014	0	0	0	NULL	NULL	0	0	0
1/11/2014	0	0	0	NULL	NULL	0	0	0
1/12/2014	0	0	0	NULL	NULL	0	0	0
1/13/2014	0	0	0	NULL	NULL	0	0	0

Total # of Maintenance Days:	117
Total # of Maintenances per Filter:	
200	52
5	0
1	69

UV Disinfection

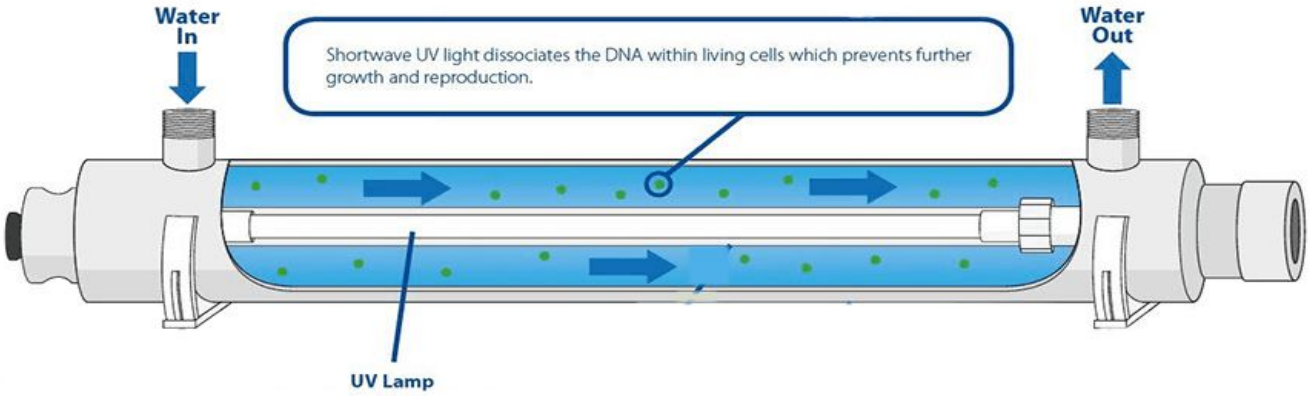
UV disinfection is required to sterilize water before it reaches the residence.

Options

36W

50W

Higher power can support higher flow rate.



Assumptions

Weather

- Data sourced from select locations and years
- Actual annual rainfall for a given location could vary significantly.

Irradiance

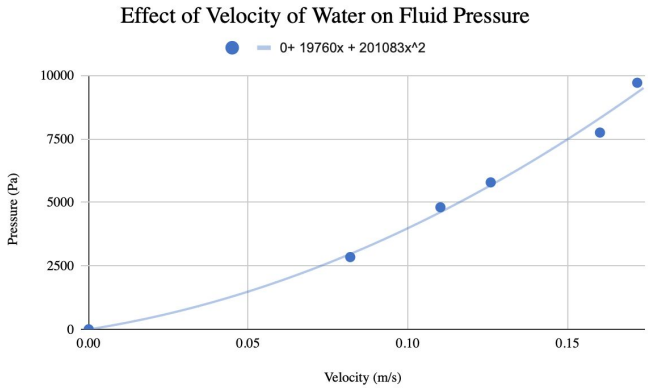
- Assumed a **constant** solar irradiance for our solar panels
- Actual irradiance varies according to weather conditions (eg. cloud cover)

Compensation: Affected components were adjusted to be more capable than what is shown by our simulation as necessary

Calculations and Prototypes

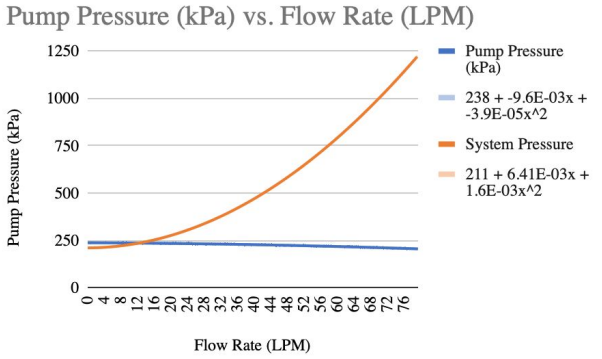
Filtration Pressure Loss

- Experimental value for pressure loss from filtration calculated with *physical, focused prototype.*



Pressure and Flow Rate

- Automatic equation solver calculates for values such as pressure and flow rate which are dependent on a system of equations.



Pressure	Flow Rate
235944.6742	12.5

Numerical Parameters

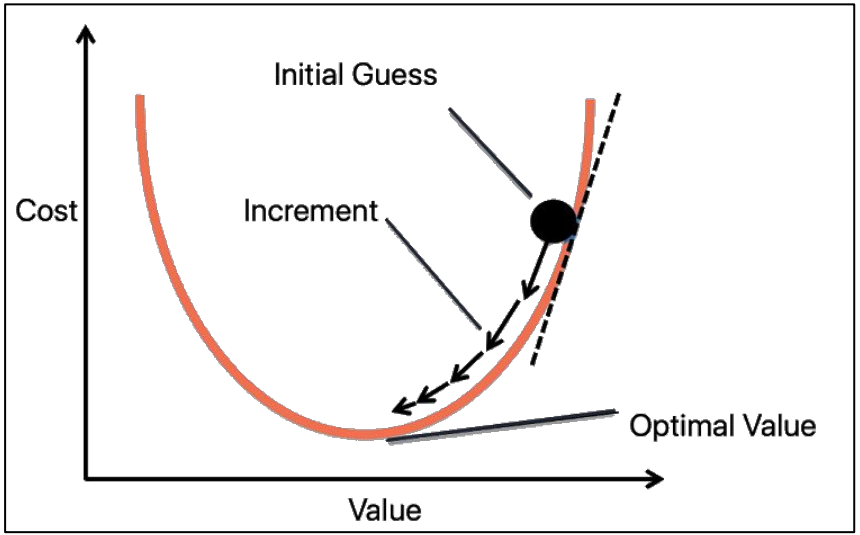
Numerical parameters were optimized with a gradient descent-like optimization strategy.

Storage Tank Tower: **6m**

Extra Catchment Area: **25m^2**

Catchment Tank Volume: **10m^3**

Storage Tank Volume: **45m^3**



Summary

Roof catchment	◯ None ◯ Half roof ✓ Whole roof
Additional catchment	◯ y/n area = 25 m^2 Location: x = 0 m y = 0 m
Collection tank	◯ None ◯ 400 L ◯ 1,500 L ◯ 2,500 L ✓ 10,000 L
Storage tank volume	Volume = 45 m^3
Storage tank location on property	x = 5 m y = -10 m
Storage tank tower?	◯ y/n h_{tower} = 5 m

Pump	Pump Choice: ◯ Pump A ✓ Pump B ◯ Pump C ◯ None
Filter Location	✓ Filter -> Storage Tank ◯ Storage Tank -> Filter
Filtration components	✓ 1µm Cartridge ◯ 5µm Cartridge ✓ 200µm Bag Filter
UV Disinfection System	◯ 36W UV System ✓ 50W UV System
Chemical Disinfection	✓ Chlorine disinfection ◯ Ozone disinfection
Power Strategy	✓ Solar ◯ Diesel Generator
Number of Batteries	Qty = 2 batteries

Thank You For Listening!

Team H-4