Solar Shower

Team Members: Neg Motahari, Leonardo Sanabria, Alfred Moinuddin, Nader Aldosseri, MD Enamul Kabir Emon
Faculty Advisor: Dr.Samuel Landsberger
Shower of Grace Liaison: Pastor Sam Koh
Department of Mechanical Engineering
College of Engineering, Computer Science, and Technology
California State University, Los Angeles

PROJECT BACKGROUND

Project Objectives
To create a functional and reliable systems that delivers a comfortable shower to the end user while utilizing solar power in a portable shower.

The Solar Shower project is a portable shower system that uses solar energy to supplement an existing mobile shower system. Our sponsor customized a 14-foot trailer to house a mobile shower, that delivers 8 to 10 showers before needing to be resupplied. There are two main issues that need to be addressed as requested by Pastor Sam Koh the liaison for the "Solar Showers for All Project": the water pump burn-out and the lack of storage space in the trailer for more shower time, which limits the number of showers that can be given. There is also a desire to double the number of showers given while lowering the system's carbon footprint. Lastly, the system includes two types of batteries: An electric battery and an air-tank. The battery will be charged using solar panels, and the air-tank will be pressurized using an air compressor which draws power from the electric battery.

DESIGN REQUIREMENTS

The following are the requirements and restrictions were made by Solar Showers for All Project`

Table 1: Requirements of Water Delivery System

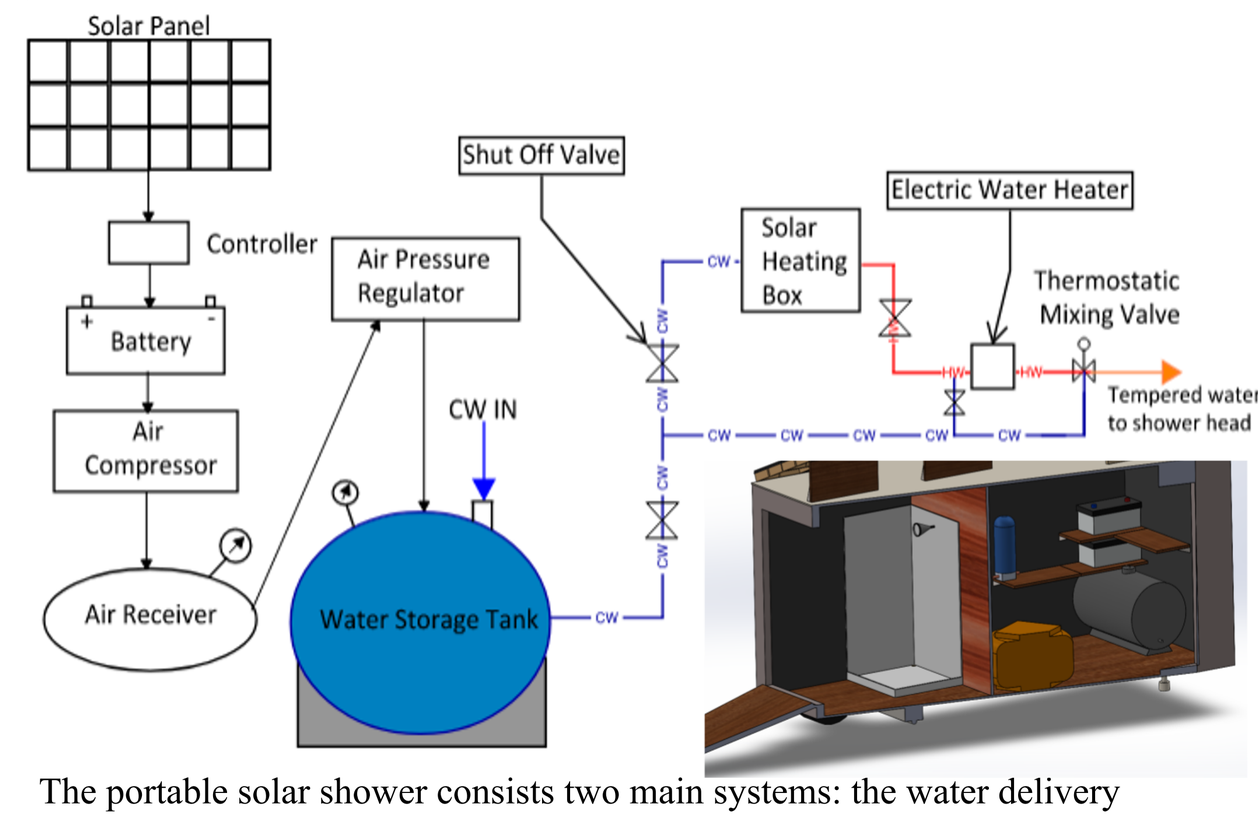
	Requirements
Showers given	Double the number of showers given to people
Battery	Eliminate burn out of battery
Environment	Reduce carbon footprint

Table 2: Restrictions of Water Delivery System

	Restrictions
Dimensions of trailer, inside	5.7'x13.5'x6.25'
Dimensions of trailer, outside	6'x14.5'x6.7'
Legal load width	8.5'
Legal max height limit	8.5'
Trailer weight limit	1715 lbf

DESIGN PROCESS AND METHODOLOGY

System Overview



The portable solar shower consists two main systems: the water delivery system, and the electrical system.

Water Delivery System





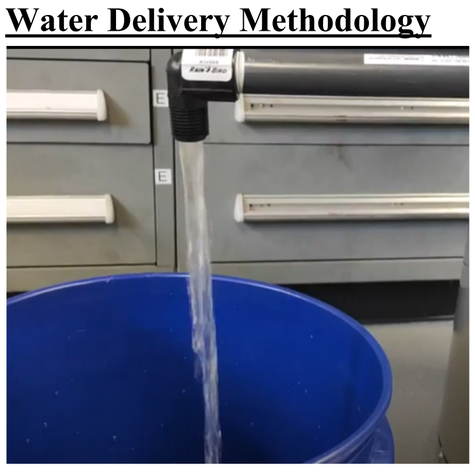
To reduce the use electricity, a 10-gallon air tank will be used to pressurize the system to 30 PSI. This will push the fluid to the shower valve. Since this system is very rigid as the tank has a max pressure of 120 PSI and the heating box, now a bladder, has a PSI rating of 300 PSI. The goal of the shower is to have 1.5 GPM flow for a total of 53 minutes of shower time. The water storage tank and bladder will have a combined storage of 80 gallons of water, or 664 pounds of water. Rigid pipe was chosen to reduce major and minor losses due to bends in the pipe. The water delivery system will be pressurized using an air battery that will be compressed using an air compressor before being loaded onto the trailer.

Electrical System



The electrical components are as follows: Solar panels, into the charger/inverter, into the batteries which power the air compressor. The 100W solar panels will be placed on top of the existing trailer, in series configuration due to manufacturing limitations. The solar panels will then be hooked up to the charger/inverted to charge a 12-volt battery. The 12-volt battery will then run the air compressor which will pressurize the air-storage tank.

Water Delivery Methodology



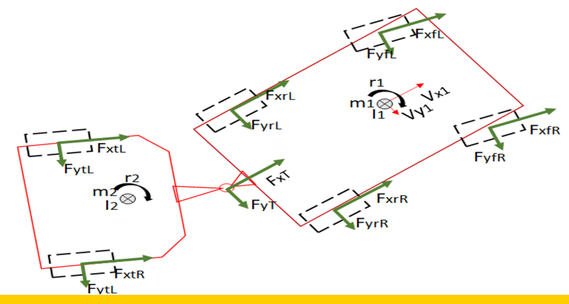
The water will be delivered via the established physical law that fluids are incompressible. When the air is filling up the water storage tank it will push the water through the piping system. When the water level drops the pressure in the water storage tank will also drop, and the air tank/receiver steps in. The air-tank will then regulate more air into the water storage tank to keep an acceptable pressure.

Heat Transfer to Solar Bag

The solar heating box will only function on sunny days where the weather is above 75°F. This means that if the weather of the day does not allow the solar heating box to function the back-up water heater will be used to heat up the water.

Stability of Trailer

It was found that for the trailer to be stable, most of the load had to be placed over the axel and close to the ball hitch.



EXPERIMENTAL RESULTS AND CONCLUSION

The Solar Shower has two main systems: The water delivery system and the electrical system. The water delivery system consisted of the water storage tank, solar heating box, back-up water heater, shut off valve, thermostatic mixing valves, and piping. The electrical system includes solar panels wired in series on top of the trailer, the inverter/charger, battery, and related wiring. Due to conflict of design interest, project being moved to a different testing location, and delays in the procurement of materials have caused delays that impacted the critical path of the project. The team manufactured a system that can deliver a 1.5 GPM shower with a total shower run time of 27 minutes.



Portable Shower

The solar shower will provide 64 shower minutes at 1.25 GPM, the solar heating box will function as a way to heat up water to reduce the use of the back-up water heater. The solar panels will provide the power required for the air compressor to compress the air-battery that will provide the air pressure necessary so that the water storage tank can deliver pressurized water to the shower head. The team is aiming to provide working and reliable water delivery system by the end of the semester, to help combat the symptoms of homelessness in the county of Los Angeles.