Solar Hydrogen Regenerative Cell Phone Charging Station

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Mission Statement

To design, fabricate, and deliver a prototype renewable 24/7 charging system, which includes five key components: Fuel Cell, Solar Cell, Electrolysis Cell, Hydrogen Storage, and Power Electronics. This charging station aims to provide 24/7, continuous cellphone charging capability on Campus.

Introduction

The goal to provide energy with zero greenhouse gas emissions is one of the greatest challenges our society faces today. In order to curb greenhouse gas emissions and to protect our environment, researchers and engineers across the globe are designing new systems that are completely renewable and can be implemented into our daily lives. The construction and design of this solar hydrogen powered charge station is novel in that it is tailored specifically to the charging of all cellular devices at any time.

System Design

The system is designed to provide both night and day charging for cellular devices and consists of five major components for operation: Fuel Cell, Solar Cell, Electrolysis Cell, Hydrogen Storage, and Power Electronics. The solar cells provide power for daylight operation, which includes cellphone charging and hydrogen generation through water electrolysis. Hydrogen and oxygen gases generated by the electrolysis cell are stored in gravity-assisted containers. At night, both gases are delivered to the fuel cell. The fuel converts the chemical energy stored in the hydrogen to electricity to charge the cellphone. These five components were integrated into a unitized system.

Challenges

(1) The primary challenge placed on the system design was to meet voltage and current requirements for cellphone charging. Power output of the system was measured for several different phones by using a multi-meter and power supply. (2) The second key challenge was integrating each electric component with power electronics components. Namely, the voltage booster, variable resistor, and relay components were tested and integrated to enable continuous operation of the system. (3) The last key challenge was conditioning and operating the fuel cell stack at its designed power output. An in-house-designed humidification and oxygenation chamber was used to improve the fuel cell performance.

Bill of Materials

Part	Quantity	Cost	Total	Part	Quantity	Cost	Total
Hydrogen Fuel Cell Kit	1	$219.00	$219.00	Three-way valve	2	$20.61	$41.22
Voltage Booster	1	$9.00	$9.00	Solar Panels	4	$59.00	$236.00
Electrolyzis Cell	1	$40.50	$40.50	USB Cable	1	$14.49	$14.49
Graduated Cylinders	2	$7.27	$14.54	Relay	1	$9.68	$9.68
Squeeze Bottles	2	$7.83	$15.66	Housing	1	$96.61	$96.61
				(Wires Tubing etc.)		$49.77	$49.77
				Grand Total			**$746.47**

Future Works

Through this project, we have developed and designed a prototype solar hydrogen regenerative charging station. This system can be further improved by (1) an automated power electronic control system, (2) increased hydrogen storage capacity, (3) the ability to charge multiple phones and also laptops, (4) a health monitoring system.

Acknowledgements

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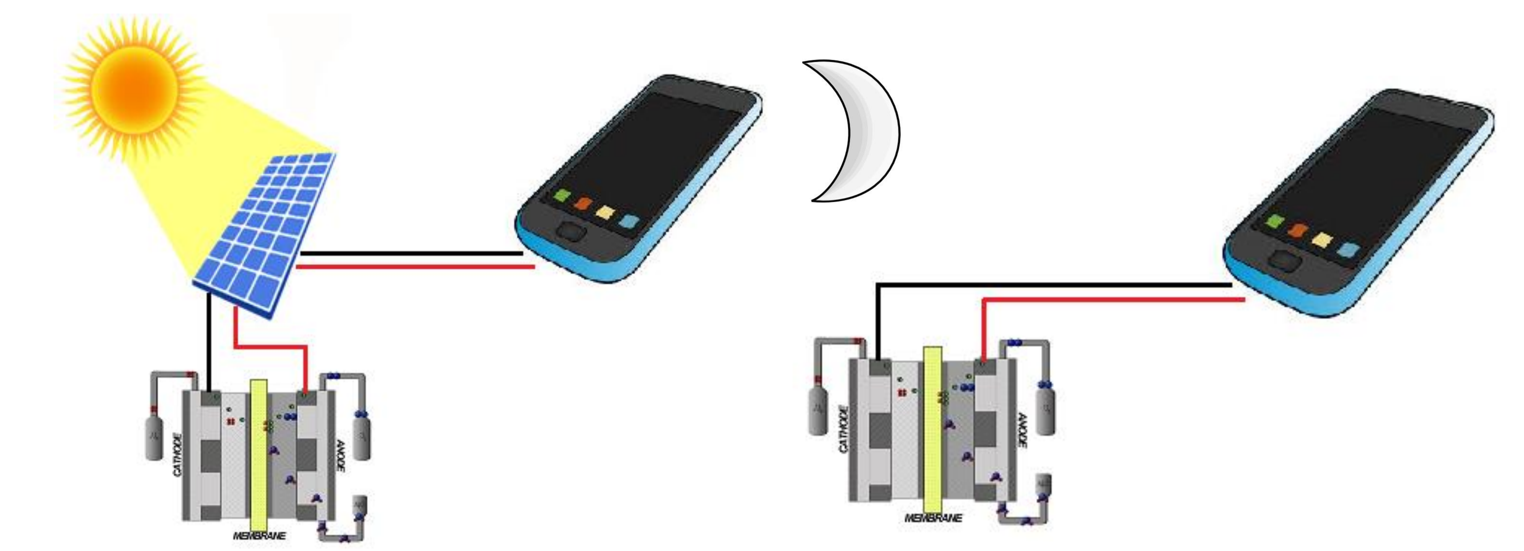
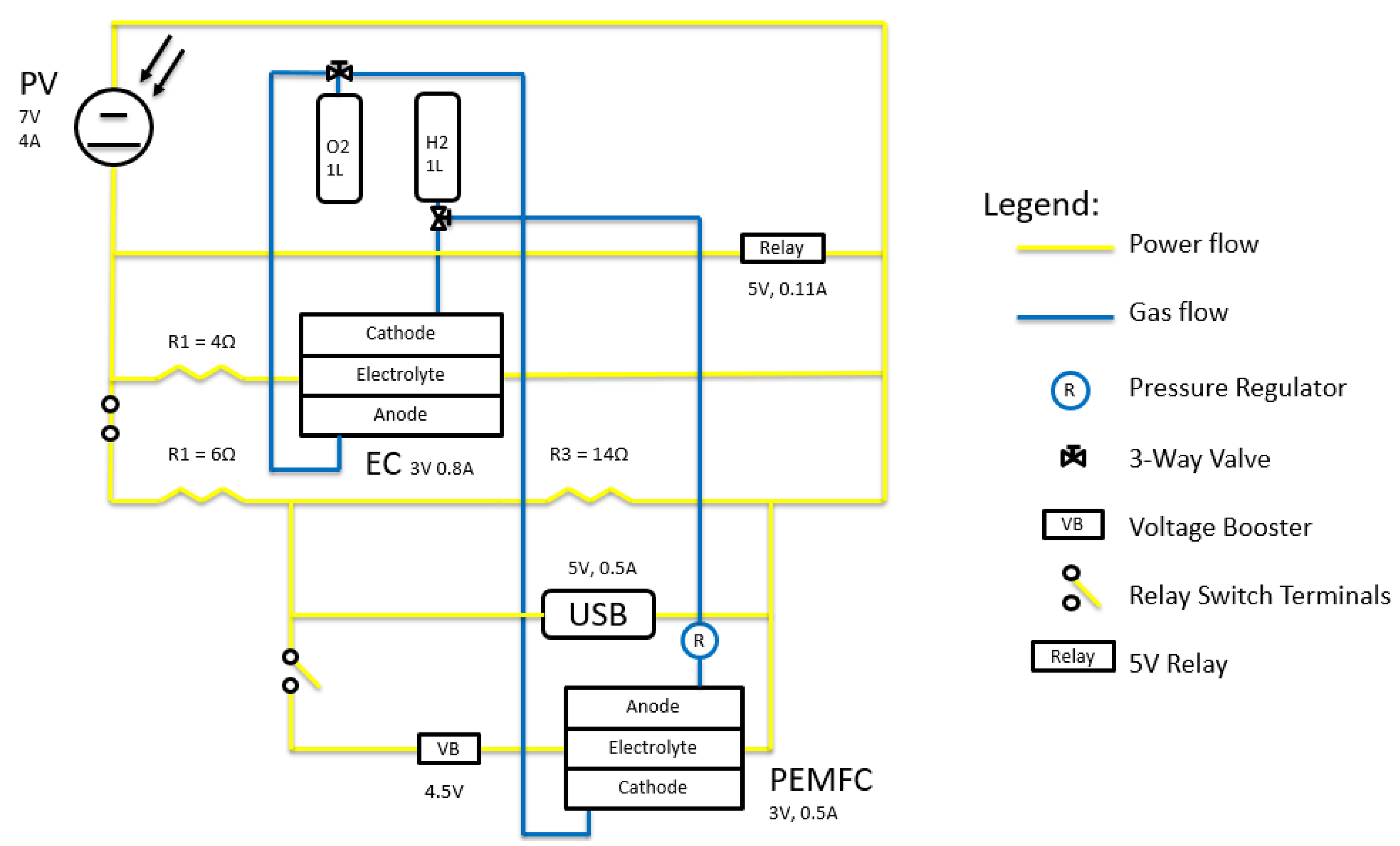
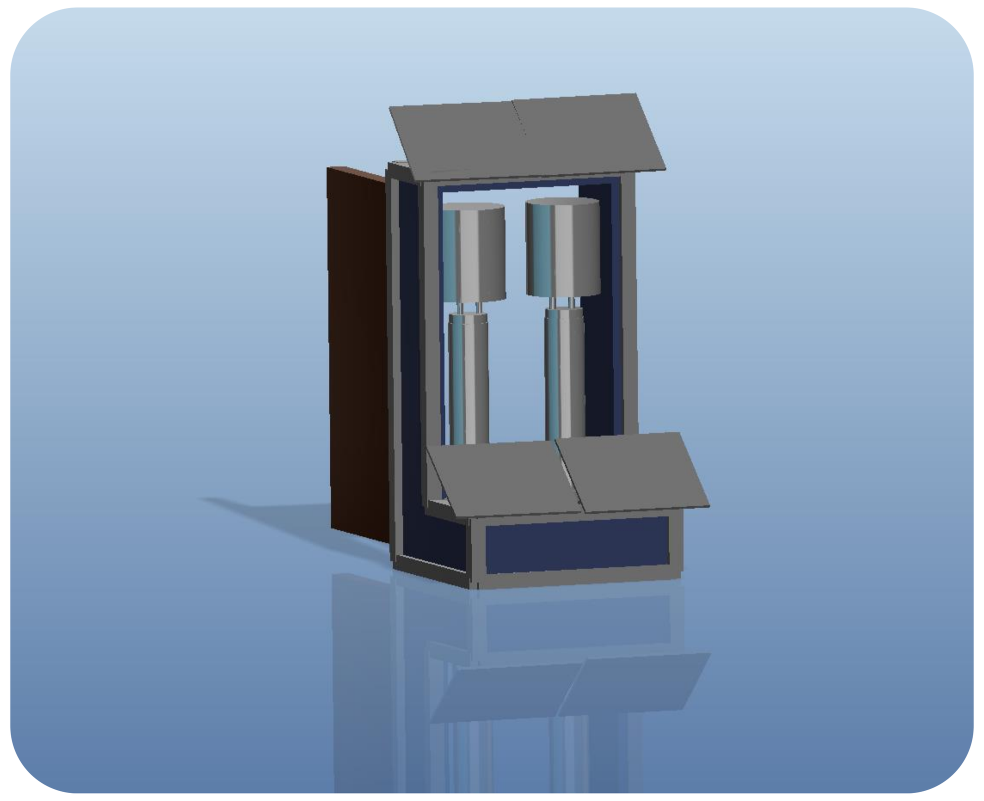
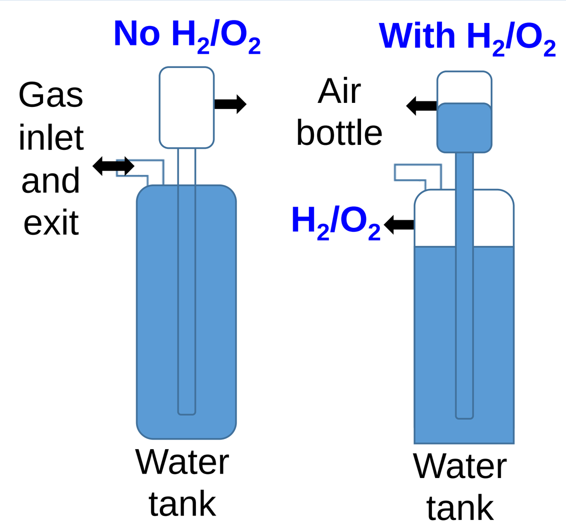






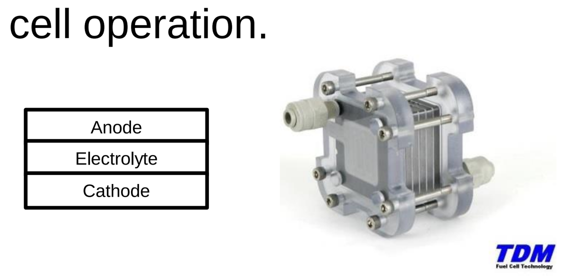
Hydrogen and Oxygen Storage



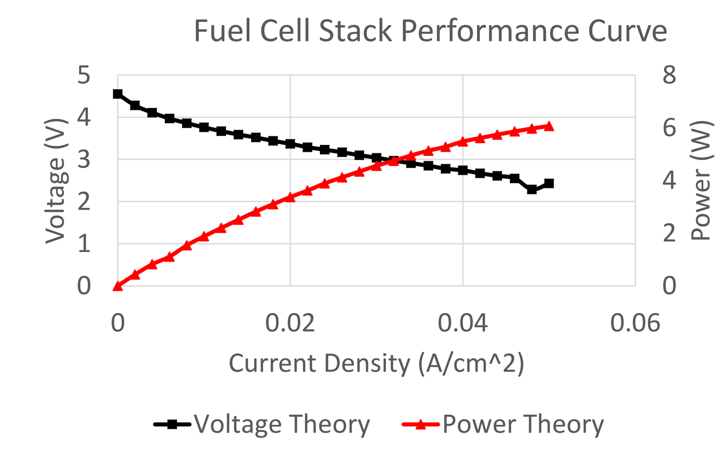
The gravity-assisted gas storage system was illustrated on the left. The gas generated from the electrolyzer flows into the water tank from the top and displaced water into the top air bottle from the connecting tube. To supply hydrogen, the gas was pushed by the water in the air bottle (top) and flowed to the fuel cell for electricity generation. The two-tank system was sealed by silicon to ensure minimum gas leakage. The current capacity of gas tank is 1000 ml for demonstration and takes around 2 hours to fill completely.

Fuel Cell

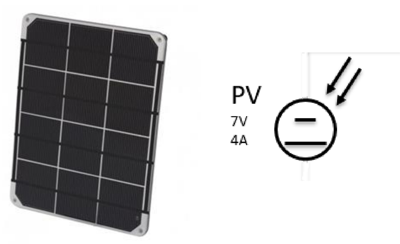
A fuel cell is an electrochemical device which combines hydrogen and oxygen to generate electricity, with water and heat as byproducts. We combined the fuel cell with a voltage booster to provide cellphone charging at 4.5 V with a current ranging from 200 – 400 mA. This component proved the most difficult to implement as operating conditions are paramount to proper operation. Our newly designed humidified and oxygenated chamber provides a solution for improved fuel cell operation.



Parameter	Value
Operating Current (A)	0.442
Operating Voltage (V)	3.05
Hydrogen Consumption	20 ccm
Active area	50 cm^2



Solar Cell

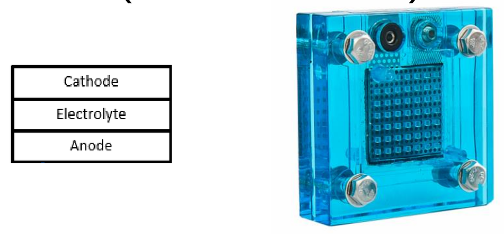


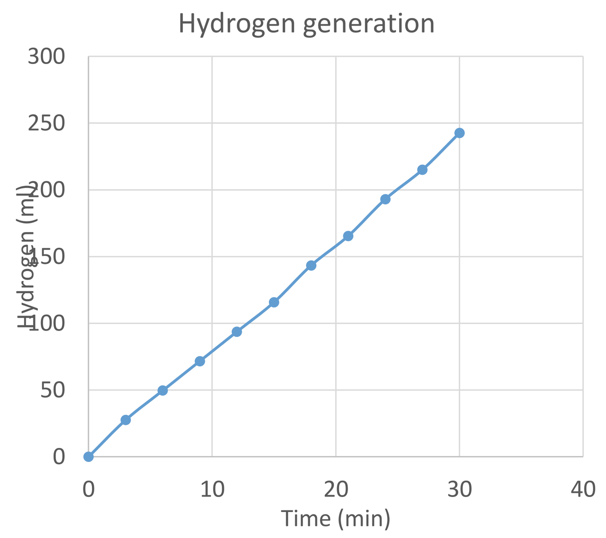
Parameter	Value
Peak Voltage	6 Volt
Peak Current	1 Amp

Sunlight is absorbed by the solar cells and this energy knocks electrons from the semiconductor; the freed electrons then flow in a specific direction in which a current is produced. Our requirements called for 6 Volts and 3 amps for the system. In our design, we placed 4 panels in parallel to provide 6 Volts and 4 amps, which accounts for variation in solar energy intensity.

Electrolysis Cell

The electrolyzer is also an electrochemical cell, which converts electricity to chemical energy. In our design, we used electricity from the solar panels to split water into hydrogen and oxygen. Using the Horizon Technologies electrolyzer shown below, we generate hydrogen at a rate of 500mL per hour operating at its peak performance (3V and 0.784A).





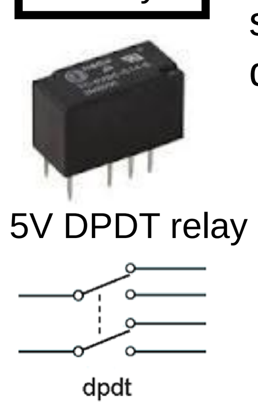
Major Electronic Components

VB

5V voltage booster

Voltage booster used to step the Fuel Cell output from 3.4V to the required 4.5V to charge a phone

Relay



5V DPDT relay

Relay used to automatically switch between night and day electrical circuits

Parameter	Value
Circuit Config.	DPDT
Output Type	AC, DC
Power Draw	106mA
Voltage – Input	5 VDC
Voltage – Load	0~125 VDC