FUEL YOUR

PROJECT PROPOSAL

SOL

CLIENT

Price Center, UCSD
La Jolla, CA

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September 9, 2018

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INTRODUCTION

AIChE Projects was first founded in 2015 at the University of California - San Diego, the first program of its kind and one meant to connect students and the community.

The vision of AIChE Projects is to open both the minds and hearts of engineers to the impacts that they can have, and meanwhile provide a stimulating environment for students to grow not only as technical-minded professionals, but also as ethical contributors to society. The program currently directs five project teams, amidst initiating a sixth, toward accomplishing their goals.

One of those teams is ours: the fuel cell team.

BACKGROUND

First started in the fall of 2016, the fuel cell team was simply an offshoot of the Campus Renewable Energy project group that wanted to utilize a hydrogen fuel cell as a renewable battery that would connect to a standalone solar panel and directly provide power. However, further research has shown the need for the reversible aspect of the hydrogen fuel cell, which was simply not feasibly from the original design. As such, we needed to redesign the fuel cell plates and adjust our setup to allow for the creation/storage and use of hydrogen as a power source and storage unit.

The goal of the fuel cell team is to design and build efficient, renewable energy sources that can be placed around the UCSD campus, notably building off of the previous AIChE Project design: the organic photo-voltaic umbrella, which harnesses solar power to charge cell phones. The implementation of our reversible fuel cell would allow the fuel cell to serve both as a power source if the umbrella is inactive or as a power storage unit if no phones are being charged, preventing waste.

Our overall goal is to implement more renewable energy sources around campus and thus lower the campus' dependence on fossil fuels and non-renewable energy. By doing so, we also explore further avenues of renewable energy and seek a cleaner, green environment for the future.

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PROJECT SUMMARY

Our project consists of a freestanding outlet connected to a reversible fuel cell and a solar panel. Through direct water splitting via solar energy from the solar panel, hydrogen gas will be produced by the electrolyzer mode of the fuel cell, which is powered by the solar panel, then supplied to the PEM fuel cell. The fuel cell uses hydrogen gas and an electrolyte to generate electricity. This energy is harvested, stored, and made accessible to students in Price Center via charging stations to charge electronic devices.

PROBLEM STATEMENT

When people think of problems related to global sustainability, they usually think of gasoline reserves running dry, power plants discharging toxic waste, etc. A power plant burns non-renewable fuel in order to provide the power to outlets which charge our phones and laptops. This connection to the main power grid perpetuates the use of non-renewable fuels that have negatively impacted the environment for decades. Arguably, it is also a issue of personal responsibility, as each device connected to the grid creates a demand for the easily accessible but unsustainable energy created by power plants. The damage is done not just through the resulting large-scale environmental impact but also the heavy reliance on the conventional power grid, which necessitates the use of unsustainable energies. Our proposed system at the very least will initiate a change regarding our reliance on unsustainable fuel. Our hope is that it will yield more aware energy users who will initiate their own changes.

This project would build off of the success of the OPV umbrella and further prevent waste by passively charging when the umbrella is not directly plugged in as a power source. Our charging station will utilize a hybrid alternative energy system that is environmentally friendly. It will consist of the solar panel, fuel cell, wiring, controller, inverter, and other supporting components. It will not emit any greenhouse gases nor use any fossil fuels, and will increase access to outlets at campus facilities which are constantly occupied. Thus far we have completed a fuel cell prototype, but have been unable to finalize the hydrogen storage designs and ensure proper reversibility.

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THEORY

A fuel cell operates through the separation of H2 into its component protons and electrons: the electrons provide energy, while the protons react with gaseous O2 to create water. On one side of the membrane is the gaseous H2 input, and on the other side is the gaseous O2 input, but the membrane acts as both a catalyst and a semi-permeable barrier that forces the H2 stream to remain isolated, but the O2 stream converts partially into H2O.

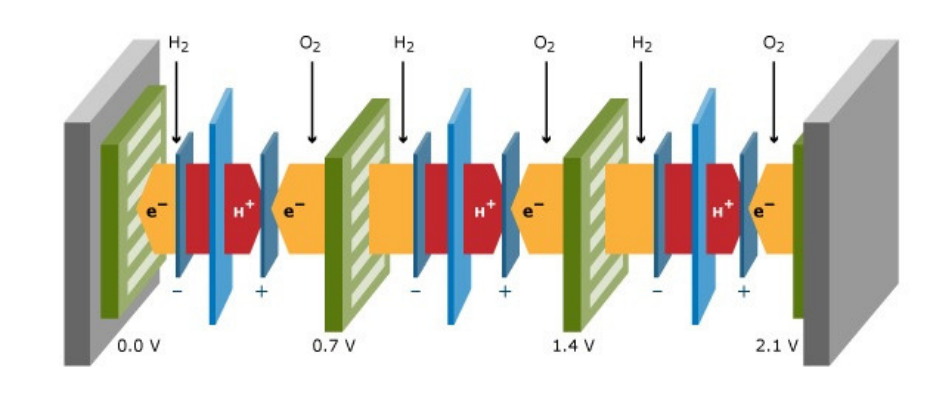
The reversible reaction shifts the O2 input to a water input, and applies a voltage to completely reverse the forward reaction: water breaks into O- (which reforms O2), and the proton and electron return to gaseous H2.

The bipolar plates are used to maximize the flow stream's contact with the proton exchange membrane, and allows for the stacking of separate fuel cells. Stacking each fuel cell increases the total voltage additively, since the voltage difference across each one remains constant, and the poles are aligned to maintain a consistent gradient that allows for the generation of a stronger charge.

DESIGN SPECIFICATIONS

The structure of our fuel cell is fairly standard, and follows the basic layer of a proton exchange membrane surrounded by rubber gasketing and then by the mono/bipolar plate respectively: the outermost plates should be monopolar since they only process the reaction on one side, but the innermost plates should all be bipolar to run the reactions as much as possible to maximize efficiency.

The green plates represent the bipolar plates, with the larger blue rectangles being the PEM, while the dark blue on either side is the rubber gasketing.



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BUDGET

Funding	Item	Quantity	Cost+Tax	Source
TGIF	Nickel Paint	1	$38	Amazon
	Electroplating Kit	1	$42	Eastwood
	Tubing, clear	5 ft	$12	Fuel Cell Store
	Stack Connectors	2	$4	Amazon
	Ball Valve	1	$7	Amazon
	Flow Splitter	1	$9	Fuel Cell Store
	Voltage Supply	1	$79.95	Amazon
	Total:		$191.95	

Funding is provided by TGIF, and is sustained through the annual application, where the team lists the itemized budget and describes in detail the purpose of the project.

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PROCESS

Research is done on an individual basis, but it is expected that each week's findings are shared during the weekly meetings. If no headway is being made in a specific topic, more members may be asked to join their fellows in researching that topic so that progress remains consistent and smooth.

In addition to verbal reports on their findings, members are asked to record any information they may have gathered and any sources they use, so that others may clearly follow their logic and gain a deeper understanding of the material.

TIMELINE

Milestone	Projected Completion Date
Initial Design & Prototyping I (Plate design, reversibility)	Jan 2018 - Jun 2018
Revisionary Research	Sept 2018 - Nov 2018
1st Funding Installment	Dec-18
Prototyping II (Hydrogen Storage) and Revision	Dec 2018 - Feb 2019
Final Full Scale Design Period	Apr-19
2nd Funding Installment	May 2019 - June 2019
Submission of Final Project to TGIF Directors	May-19
Implementation/Project Completion	May-19

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EXPECTED RESULTS

The expected outcome of this project is a fully actualized, sustainable charging station that primarily utilizes solar power to charge phones and other common electronics, but that switches to the stored fuel cell's power when solar power is not being directly produced. The fuel cell's power is ideally derived from the solar cell when no other electronics are plugged in to charge, and so reduces wasted electric potential.

Depending on the experimental voltage across each fuel cell, we may need to create a larger fuel cell stack to increase the voltage and allow phones and other electronics to be powered more efficiently, but realistically it is fairly simple to add to a stack by adding more components.

Once we are able to design and create our reversible fuel cell and attached hydrogen storage unit, it would be set up in the Price Center, for accessibility to the student populace and thus allow for a potentially sustainable source of energy to be used rather than the average outlet.

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Fuel Cell Team
Organization: AIChE
Sponsors: TGIF, AIChE

REFERENCES

"AIChE Projects at UC San Diego." AIChE Projects at UC San Diego, American Institute of Chemical Engineers at UCSD, www.aicheprojects.org/.