Campus Energy Team Project Proposal

Winter 2016

Client

Geisel Library, UCSD

La Jolla, CA

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Table of Contents

Project Summary

Our project seeks to address the constantly high demand for nonrenewable energy in hospitals. Not only are they at risk of blackouts due to their dependence on main power grid systems, but this dependence also harms our environment while endangering patients' lives. Therefore, our goal is to put a local hospital on a reliable, sustainable grid that is effectively independent of the main power source.

"Fuel Your Sol" ultimately aims to create a microgrid, a small scale power grid based on a hybrid renewable energy system, which will power the UC San Diego Medical Center. We plan to test our system by first designing a charging station for UCSD's Geisel Library. Our stations will be powered by a hybrid alternative energy system based on solar and fuel cells and will greatly benefit the UCSD community. In addition, it will also serve as a pilot study for our hospital's microgrid. Through direct solar water splitting, hydrogen gas produced by the solar panel will be consumed by the PEM fuel cell. The electricity generated by the fuel cell will be accessible to students in Geisel to charge their electronic devices. If successful, the charging station's design will be used as a reference for a scaled-up design to accommodate for a hospital. Beyond powering our school library, our vision is to power a hospital in the San Diego community.

"Fuel Your Sol" offers invaluable benefits to UCSD's students in this growing technological age where students are highly dependent on electronic devices. Consequently, the power demand from popular places like Geisel library increases. This hybrid system will provide more outlets that are independent of Geisel's main power supply, thus making it more convenient for them to charge their devices. Moreover, it will raise awareness of hybrid renewable energy systems among UCSD students and visitors. A potential economic benefit includes long term monetary savings from the proposed energy system. By utilizing UC San Diego's year-round supply of sunlight and Geisel's empty roof, we can become more economically efficient and environmentally responsible. Our project promotes the efforts in combatting the global energy problem and simultaneously helping UCSD meet its long-term goal to become a greener campus.

Problem Statement

Although University of California, San Diego is currently powered through a microgrid, it continues to rely on non-renewable fuel to power the entire campus. Geisel Library is one of the top ranked public academic libraries in our nation and the heart of UC San Diego. It attracts both students and guests with its tranquil ambience and abundant resources. On average, Geisel consumes 475,271 kWh per month to provide its visitors and students with light, electricity, and comfort. This is approximately five hundred times the power consumption of an average household. Thus, we saw a need to provide Geisel with alternative energy sources to ease its dependence on the school's microgrid. In particular, a significant part of Geisel's power consumption stems from charging electronic devices. With this in mind, we plan to implement freestanding charging stations and outlets connected to a solar-fuel cell hybrid system.

Design Specifications

Our outlet and charging station will utilize a hybrid alternative energy system (Proton Exchange Membrane fuel cell and photovoltaic system), which is environmentally friendly since it does not emit greenhouse gases or consume fossil fuels. It will increase access to the currently limited amount of desired outlet stations at Geisel and decrease the library's dependence on UCSD's main power grid.

The use of solar panels have been widely implemented all across UCSD's campus. One imminent problem with solar panels is its inability to produce electricity during periods of little sunlight. However, Geisel continues to operate even on days in which sunlight exposure is decreased due to unfavorable weather conditions. This calls for an additional energy supply that is not heavily reliant on optimal weather conditions. We incorporated the PEM fuel cell to combat these issues. Our design includes a hydrogen tank as a storage component for the fuel cell, which provides energy for the system after sunset and during non-ideal weather.

The solar array will output a maximum power of approximately 600W. A majority of this power will be regulated and supplied to the charging station and back up battery. The rest of the energy will be used to power an electrolyzer, which converts the water supply into hydrogen that will be stored into the fuel cell. The oxygen byproduct will be deposited into the atmosphere. The system will be configured and regulated such that during low sunlight periods, the system will shift its power source to the PEM fuel cell. The PEM uses the hydrogen and oxygen from the air to undergo a chemical reaction that produces water and electrical energy which will be harvested and supplied to the charging stations. The water will be partly recycled and the remainder will be deposited into the atmosphere. The design diagram is attached on the next page (Figure 1).

The major materials required to build our charging station are the following: polycrystalline solar panels, stainless steel plates with nuts and bolts, heat-resistant nylon black wiring, and some chemicals. In addition, we intend to use a small solar-fuel cell model car to collect data and determine the amount of power input and output. The total approximate cost can be found in the attachment below. Our aspiration beyond this project is to leave a positive mark on our community and to raise awareness of the importance of renewable energy.

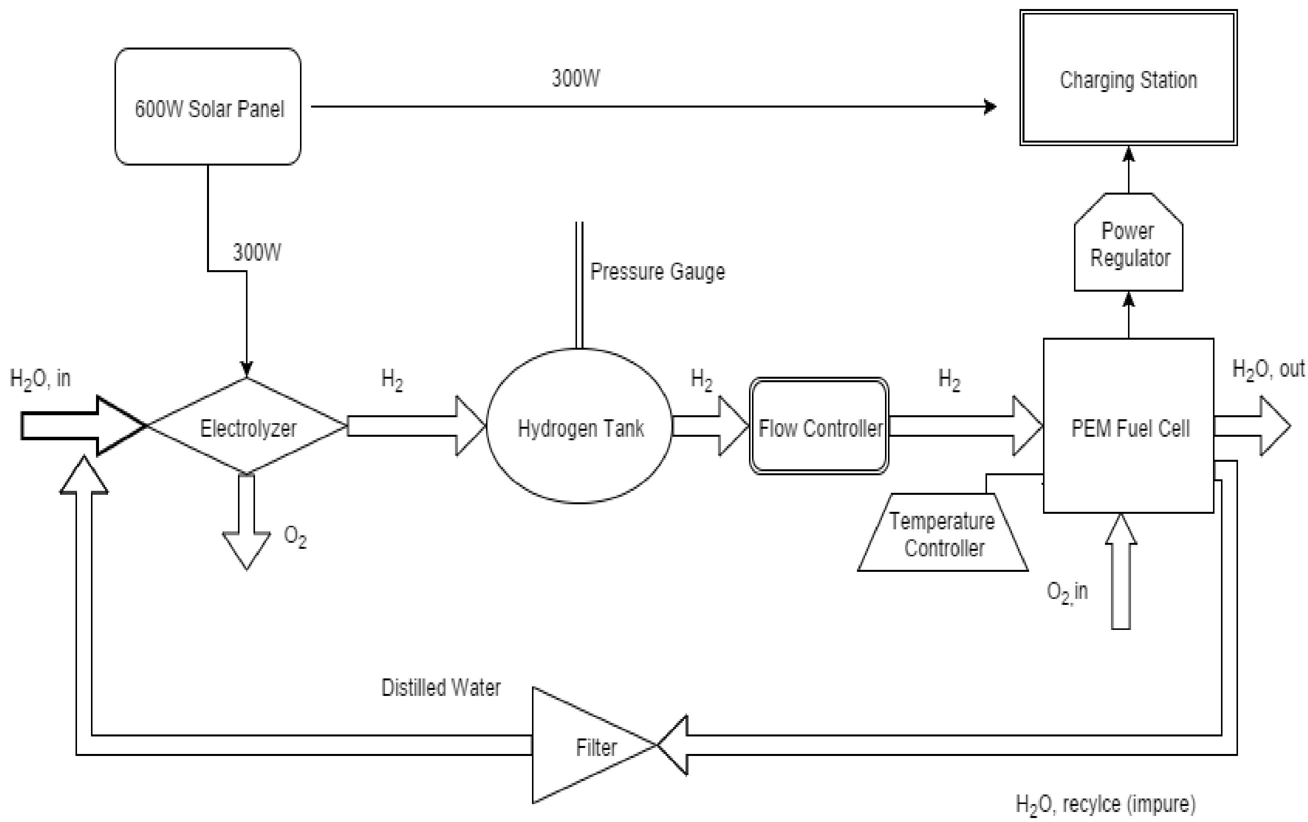


Figure 1: Design Diagram for 'Fuel Your Sol'

Budget and Feasibility

Based on simulation results from HOMER, our system with one fuel cell is able to provide 174 kWh per year. This translates to approximately 14.5 kWh/month which can account for 3% of Geisel's energy demand. To amplify this power contribution, we have two options. One option is to connect the fuel cells in series which will yield a higher output voltage which will be capable of charging electronic devices with higher energy demand. The other option is to implement multiple charging stations. The biggest burden on our budget is the cost of the PEM fuel cell as seen in Figure 2 below. The estimated budget list outlined in Table 1 entails all the items we need to construct our own PEM fuel cell. Assembling our own fuel cell stack can potentially lower the total expenditure, allow us to customize its size and performance, and award us with an excellent engineering experience. However, this method demands significantly more time to produce a fully functioning stack. We are currently performing our own analysis and consulting with an expert about any other cost effective alternatives.

In addition to our simulation results from HOMER, we also paid close attention to the design and progress of the marine laboratory at Humboldt State University that employs a hybridized energy system similar to our own.

Item	Cost	Quantity
Stainless steel plate	$264.44	1
Steel nuts and bolts	$22.99	1
Metal cutting service	$55	1
Chemical expenses	$110	1
Southwire THHN black copper wiring (1 gauge)	$751.00	500 feet
Solar panel, polycrystalline	$291.49	2
Hydrogen Tank (100L)	$258	1
Total	**$1780.82**	

Table 1 : Budget for constructing a PEM fuel cell

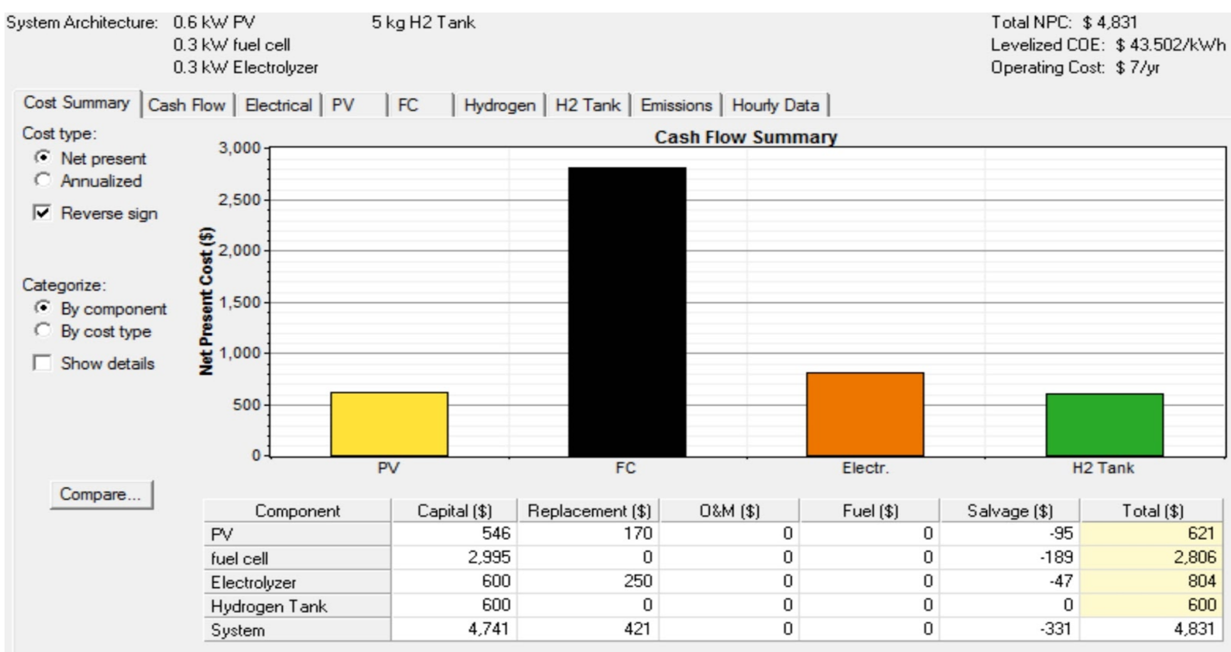
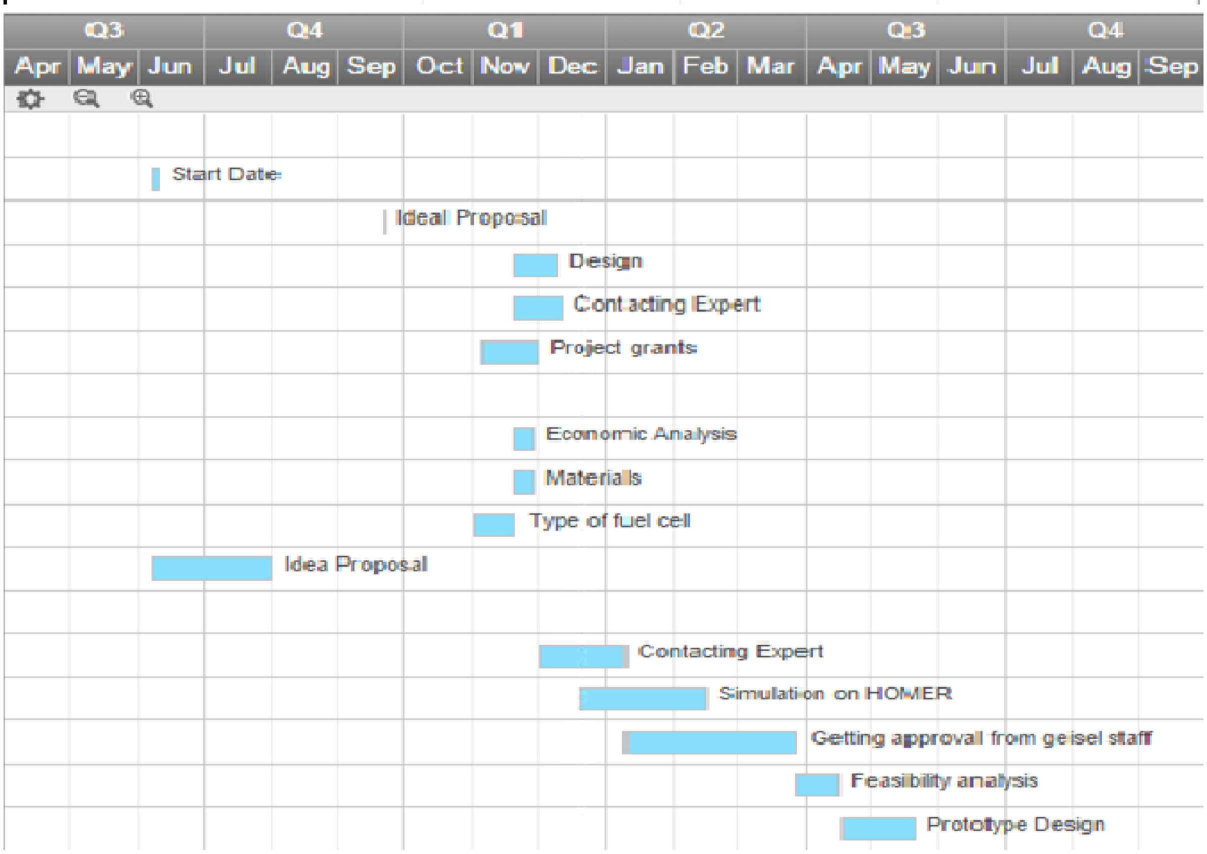


Figure 2: HOMER economic simulation result

Timeline

Task Name	Start Date	Finish Date	Assigned to
Preparation			
Start Date	06/07/15	06/10/15	Josh and Maggie
Ideal Proposal	6/31/2015	09/21/15	Everyone
Design	11/20/15	12/09/15	Everyone
Contacting Expert	11/20/15	12/11/15	Giahan
Project grants	11/04/15	11/30/15	Everyone
Research			
Economic Analysis	11/20/15	11/28/15	Khanh
Materials	11/20/15	11/28/15	Nathaniel
Type of fuel cell	11/01/15	11/20/15	Chanh
Idea Proposal	06/07/15	07/31/15	Everyone
Creating the prototype			
Contacting Expert	12/01/15	01/09/16	Serina
Simulation on HOMER	12/20/15	02/15/16	Alan
Getting approval from geisel staff	01/09/16	03/28/16	Maggie
Feasibility analysis	03/28/16	04/15/16	Everyone
Prototype Design	04/16/16	05/20/16	Everyone



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Campus Energy Team

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Performing Organization: AIChE Projects

Sponsors: TGIF, TESC, AIChE

Other: Geisel Library Users, UCSD students