



# SOCIETY OF PHYSICS STUDENTS

An organization of the American Institute of Physics

## Marsh W. White Award Proposal

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Project Proposal Title	Renewable Energy in Units Anyone Can Understand
Name of School	Hamline University
SPS Chapter Number	2641
Total Amount Requested	\$500.00

### Abstract

Our goal at Hamline University is to develop youth understanding of the current efficiency of renewable energy and how much better it can be. We are motivated by the importance of innovations in this field, as well as the necessity of getting young students to think about sustainability.

# Proposal Statement

## Overview of Proposed Project/Activity/Event

- **Brief Description:** For this project we will incorporate a small, smart home-like design, shown in Figure 1(a), that can obtain **wind, solar and hydro energy**. The roof of the small home will contain 10 solar panels with a size of roughly 5cm by 3cm. The front lawn will contain six 10cm by 10cm wind turbines, three to the left of the front door walkway, and three to the right. The backyard will contain a water turbine that will look like a waterfall with a USB water pump pumping the water up from a reservoir. The backyard will have four more wind turbines. All three types of renewable energy will be connected to a battery, as well as a Raspberry Pi that is hidden within the house. The battery will store energy so one can demonstrate how a surplus in energy captured previously can be used when there is an energy shortage. The Raspberry Pi (13.75 W), powered by the renewable energy systems and the battery, will read the voltages and power from each system through its GPIO pins. The readings will then be communicated to a 7-inch monitor to illustrate the power values from three renewable energy systems. Figure 1(b) shows how every part of the smart house will be connected in order for it to function.

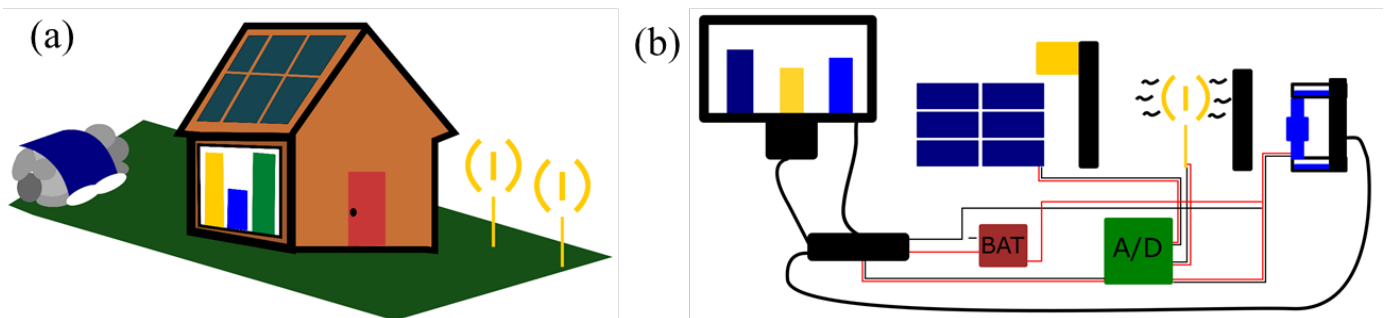


Figure 1. Smart home concept (a) and electronic setup within home design (b).

- **Goals of the Project:** The goals for this project are to get kids thinking quantitatively of renewable energy in terms they can understand. The visuals obtained from the bar graphs can be used to describe how many cell phones the output can charge using both actual output and imagining they were life size units. Xboxes, TVs, and lightbulbs will also be used. The students will be told how much nonrenewable resources would be saved with that amount of energy, with a bar graph on the screen. Another goal for this project is to display how much each type of renewable energy produces per flow of input. By increasing the amount of light going into the solar cells, wind going to the turbines and water being pumped, and looking at the bars for that renewable system, the students can tell how much each system changes with a change in the input.
- **Intended audience:** The main audience is middle and elementary school students. Due to its relatively small design, we plan to bring the smart house around to local schools and present it to them. We also hope to hold demonstrations at the Science Museum of Minnesota in Saint Paul. The content of the presentation can be upscaled for high school demonstrations. The project will be in a display in our science center when not presenting to kids so that college students can get a better understanding of renewable energy systems.
- **Background and motivation:** The motivation of this project is to show kids the importance of renewable energy by displaying how innovations in engineering via physic principles can help our environment. Students here at Hamline wish that they were given a better understanding of renewable energy relatable terms while in lower education. We believe that the relatability of this project will motivate kids by helping them understand how far renewable energy has come and, with innovations in physics, how far it can still go. We believe we are well positioned for this project due to our connections to the Science Museum of Minnesota, and with Hamline Elementary, an elementary school related to our University.

## How Proposed Activity Promotes Interest in Physics

The proposed activity promotes interest in physics by taking a usually complex topic, quantitatively understanding renewable energy efficiency, and putting it in terms students can understand. By showing students how well renewable energy works now and explaining the innovations in physics that have gotten it to this point, we think kids will realize that with knowledge in physics, they can be the innovators of their generation in a field that will greatly impact day to day lives. We think that the more kids understand a topic, the cooler and more interesting they find it. We are hoping that by explaining the steps taken by previous physicists and the current efficiency of renewable systems in terms they can relate to, they will see that they can innovate in this field.

## Plan for Carrying Out Proposed Project/Activity/Event

- Personnel: Zachary Pearson, Opeyemi Arogundade, and Elizabeth Gregorio are the SPS student leaders at the Hamline chapter and will therefore lead this project. They will have bi-monthly meetings with Dr. Lifeng Dong, the SPS faculty advisor, about the progress of the project. Goals will be placed before each meeting, and if they are not met, the group will discuss how to get back on track.
- Marketing: The project will be marketed to the Hamline elementary school, other elementary schools, and the Science Museum of Minnesota as renewable energy measured in units everyone can understand.
- SPS member participation: 12 members of SPS Hamline Chapter have emailed showing interest in participating in this project. There will also be at least 2 members of Hamline's Fine Arts department participating in the design and structural build of the house.
- Expertise: Zachary has been working at a company that uses open CV for monitoring traffic via live video. This will be used to display the live input of the devices. He has also had an internship where he built prototypes with Raspberry Pi's and other Linux based devices that utilize inputs from analog sensors, analyze the input, and perform tasks based on the type of input. All SPS members working on the project have taken at least one higher level electronics course. Dr. Dong is the Emma K. and Carl R. N. Malmstrom Endowed Chair in Physics at Hamline University. He is the recipient of 18 patents and has published over 180 peer-reviewed articles and book chapters in the fields of nanoscale materials and devices for energy conversion and storage (i.e., lithium batteries, supercapacitors, and solar cells) as well as water purification and desalination. The Fine Arts department has many higher-level classes on building sculptures from many types of material, including wood. This will be used to build the wooden house and its base.

## Project/Activity/Event Timeline

January 10, 2018: Order materials, organize first SPS meeting for this project with fine arts students.

January 17, 2018: Meet fine arts students to make home enclosure.

February 7, 2018: Electronics portion of the project completed.

February 13, 2018: Start scheduling with elementary schools and Science Museum for presentations.

February 28, 2018: Entire project completed.

March 7, 2018: Create an effective presentation with SPS volunteers.

March 16, 2018: Finalize dates for presentations, mostly be in April and May.

March 23, 2018: SPS members present the project to Hamline students and receive feedback.

May 15, 2018: At least 3 presentations completed, and feedback received.

May 31, 2018: Outreach progress report turned in.

We will also be meeting every other Friday with faculty advisor to make sure these goals stay on track.

## Activity Evaluation Plan

The first way the Hamline Chapter is going to evaluate the project's success is through a form that supervisors/teachers of the participating students will be asked to fill out a week after the presentation. The form will ask how many students asked questions regarding the project after the presentation, how well they think it relates to their students, and other related questions. We will also encourage age-appropriate students to send an email to our SPS chapter stating what they learned from the presentation, what we could have done better to relate to their age group, and whether the presentation gave them an understanding of how innovations in physics can take the field of renewable energy to a new level. Finally, we will use the change in numbers of attendance and number of presentations given from year to year to see if our presentation and project are gaining interest.

## Budget Justification

Almost every item listed in our Marsh W. White Award Proposal Budget is needed to build the Smart Home we plan to present to students. These parts will provide the necessary amount of power to the system, plus two extra panels and water and wind turbines in case of malfunction. We also will order an extra battery and Raspberry Pi for the same reason. The only items we are purchasing that will not be in the presentation are the fluorescent lights and fans. These items will stay in the enclosure we have on campus for when the device is shown to Hamline community and prospective students. These are needed since there won't be any type of breeze in the cabinet and the lights in the building will go out at night. They are also necessary for making sure the battery is fully charged when we take it out for a presentation.