Solar Transportation Unit Outline

Author: Clayton Hudiburg

Project Description:

One of the biggest obstacles we face in our transition to low-carbon, sustainable energy resources is a reliable and cost-competitive substitute for transportation fuels. I would like for my students to begin exploring possible solar-photovoltaic solutions to the transportation dilemma. In particular, I think there is potential to use photovoltaic technology in tandem with existing technology to help with extending battery life for battery Operated Vehicles (BEVs), generating hydrogen as a fuel source, or increasing the electricity proportion in hybrid vehicles.

The project is tailored for high school students (10-12 grades) who have already completed units in energy and climate change. However, minor adjustments could be made to make the lesson accessible to any high school student regardless of background knowledge.

Students will utilize the “Engineering Design Loop” to design, test, and assess possibilities for photovoltaic inclusion with existing alternative transportation energy solutions.

Lesson 1: Define the Problem (1.5 days)

Of particular importance in defining the problem will be to help students to understand or grasp the concept of energy density. The primary difficulty with replacing gasoline or diesel fuel is the fact that the cost of the fuel is nearly negligible compared to the amount of work done per unit of volume of that fuel due to the incomparably high energy density of fossil fuels. Existing biofuel, hydrogen fuel cells, and battery technology simply aren’t competitive yet; at least not at the scale needed to truly make a noticeable impact. Likewise, current photovoltaic technology is not by itself sufficient.

Students will explore the question: How can photovoltaic technology be used in tandem with existing alternative transportation energy/fuels?

Lesson Two: Background Research (1.5 days)
Before delving to exploration of using photovoltaic technology, students will first require background information for BEVs, hybrid technology, hydrogen fuel cells, and hydrogen combustion. Students will list pros and cons of each and begin to make a decision with

regard to which they think will best partner with photovoltaic technology to improve performance and increase competitiveness with traditional gasoline or diesel vehicles.

Lesson Three: Identifying Constraints (1 day)
Students will be introduced to fundamentals of power, energy, and energy storage as they pertain to photovoltaics and battery storage. This day starts with some front-loaded information for students regarding series and parallel wiring, along with power and energy. Students then experiment with miniature solar modules to test the effects of various wiring scenarios (series and parallel) to gain further insight in to how to build arrays to accomplish desired voltage and amperage. Students will then use the data they collect and extrapolate the numbers to apply to larger power and energy needs like providing the energy needed to power a vehicle for a determined amount of time.

Lesson Four: System Design (2 days)
In this lesson, students will begin to apply some of what they have learned with regard to series and parallel wiring, along with voltage, amperage, and battery charging requirements. The basic idea is for student groups to draw a diagram for how they could wire together fifteen 3V, 1A solar modules in order to charge a 12V, 35Ah lead-acid battery. Once identifying the optimal wiring strategy, the class will test one method and predict the amount of energy that can be produced over a 5-hour period. Students will then use the battery to power a room air conditioner and time how long the appliance will run on the accumulated charge. This lesson is a bridge between the theoretical knowledge they have built in the previous three lessons and their final project.

Lesson Five: Solution Design (5-7 days)
In this lesson, the students will take their knowledge gained in the previous activities to innovate design solutions that will allow PV technology to plan an increased role in the transportation sector. The challenge given to them is to design a BEV that maximizes the use of PV technology in a practical and scalable way. The primary goal is for the students to create a product that will allow for full replacement of fossil fuels with minimal disruption to the convenience and costs generally associated with gasoline and diesel powered vehicles.

BONNEVILLE ENVIRONMENTAL FOUNDATION
240 SW 1st Avenue
Portland OR 97204
503-248-1905
www.b-e-f.org