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Teaching Renewable energy concepts by using reduced scale models

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Introduction

Since the industrial revolution the production and consumption of fuels and electricity has been one of the major components in economic and political decisions worldwide. About 30 years ago when crude oil was thought to be suddenly short on supply, researchers, engineers and companies began to investigate alternative energy sources.

At some point in time supplies for fossil fuel and crude oil will diminish to a critical level that is why it is important to teach students how use and incorporate renewable energy into their engineering projects independently of their majors.

This class will be offered as a 3 credit hour optative for juniors and seniors from different engineering majors, such as, mechanical, chemical, civil, electrical, biological, architectural and industrial to name a few. The class will require some background math and basic algebra concepts, students will be divided into group and each group will rotate using different models, exception will be the first and last experiments. This class will start with a powerhouse that includes different types of renewable energy to show the "big" picture and using different reduced scale models teach students will be able to study each type of renewable energy separately and as a final experiment they will go back to the powerhouse.

Technical Background

Renewable energy can be defined as energy generated from natural sources, such as, hydro electrical, Biomass/ Bio fuel, Solar, wind and Geothermal, renewable energy provides environmental benefits, jobs and increase in the economy, energy security and energy for the future generations.

In a global perspective the highest amount of electrical energy is still being produced by fossil fuels however there is an uncertainty related to the amount that is still available for use combined with a continuous growth of demand new sources of renewable energy.

Solar energy has many applications such as providing heat (thermal energy) and the production of electricity by the photovoltaic cells (PV) this effect first discovered by Albert Einstein is the responsible for converting solar radiation into direct current electricity (DC) and using an alternator converts it into alternative current (AC) that can be used to power equipment inside a house. Photovoltaic cells have to combine cost effectiveness with relatively high throughput energy yield production, in order to achieve this combination a couple of factors have to be counted in: Material of construction, location that the PV cell will be placed and energy conversion efficiency.

Even though there is a high initial cost to purchase and install Solar panels the financial return of investment is worth it besides it provides added home value.

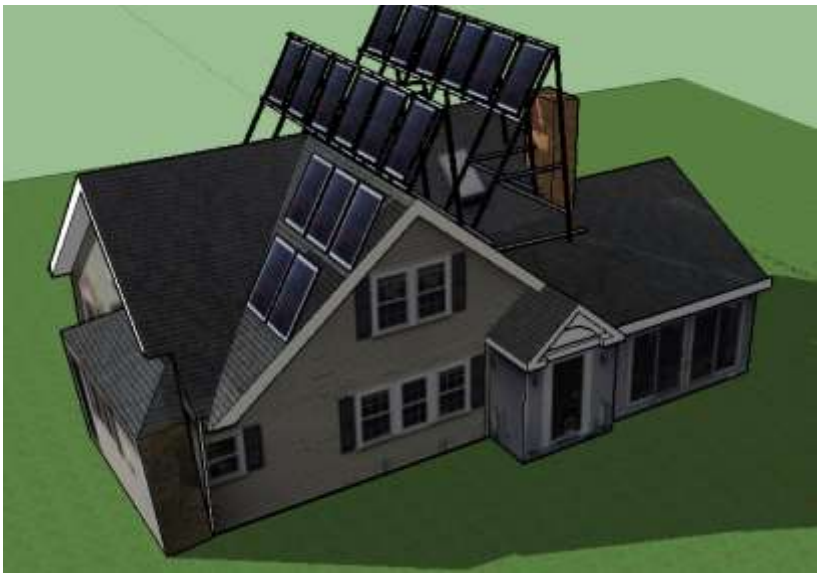

Figure 1. Solar Panels

Wind Energy

The usage of domestic wind turbines to generate energy for houses and farms is already a reality, and the advantages of recurring to this source of power goes from environment conservation to financial savings, which brings value to the community and to country's economy. However, there are some challenges to overcome to make the turbines efficient and robust enough to different locations, and environment conditions.

According to publications of the US energy department, small wind systems can reduce energy-cost up to 90 percent for houses located on at least one acre of land with strong wind resources. The average cost per consumption in the US on the year of 2012 was equal to 11.879128 cents/kW, and the average consumption was 903 kWh per month, resulting in an average bill cost of $ 107.28. If operated at maximum efficiency, a domestic turbine would be able to provide more than one thousand dollars savings per year. In the other hand, by using the wind power, less natural resources are consumed from exhaustible sources, and also the burning of fossil fuel is decreased, consequently reducing the impact to the environment.

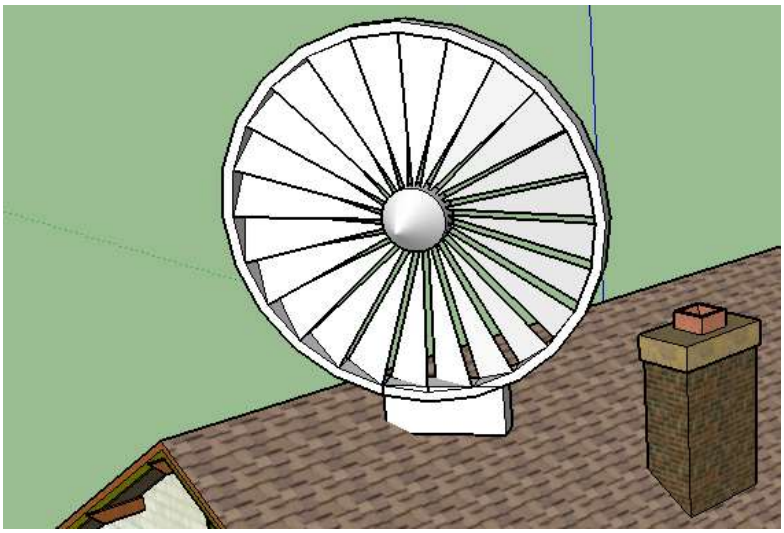

Figure 2 is the 3D representation of this design. As opposed to regular turbines, this design consists of several wind blades, instead of just a few, because it amplifies the energy generation across the electromagnetic field.

Geothermal

Geothermal energy is the heat that comes from the center of the earth in the form of hot water or vapor, it is a clean, renewable free resource that can be used around the world for multiple application; in the United States the largest reservoirs are located in west coast including Alaska and Hawaii.

Almost everywhere, the shallow ground or upper 10 feet of the Earth's surface maintains a nearly constant temperature between 50° and 60°F (10° and 16°C). Geothermal heat pumps can tap into this resource to heat and cool buildings. A geothermal heat pump system consists of a heat pump, an air delivery system (ductwork), and a heat exchanger-a system of pipes buried in the shallow ground near the building. In the winter, the heat pump removes heat from the heat exchanger and pumps it into the indoor air delivery system. In the summer, the process is reversed, and the heat pump moves heat from the indoor air into the heat exchanger.

Biomass

Biomass is a source of basic human need: food, feed, fuel, feedstock, fiber and fertilizer. If utilized with its maximum efficiency it can become the larger font of energy.

To produce fuel used oil as well as just extracted oil can be transformed to become Biodiesel which is very similar in composition to the current existent Diesel. Developing countries like Brazil use ethanol produced from sugar cane as a fuel for cars.

Farms can also use animals' excrements to generate by fermentation electrical energy.

Hydro electrical

Hydro resources are given by the nature, power plants are built to use the potential energy, provided by waterfalls, and transform it in electrical energy.

Even though the initial investment is high is built correctly it can generate energy for years with relatively low maintenance. The main problem with this type of energy is that the reduction in the volume of water will also reduce the amount of energy that is transformed. So a very detailed study of the region where the plant will be placed should be done as well as any environmental impact that may occur.

Class Structure

The class will be taught at one of the research labs provided by the university. In all sessions the students will learn the concepts by a hand on approach. Class attendees will be required to write a small one-page paper with a background research for each different experiment cycle..

The first reduced scale model to be used will be the power house because it incorporates most of the renewable energy sources. The definition of a power house is a house that requires little to no electricity from outside companies, it can have multiple forms of renewable energy on it, which is why the class is going to start there. The students should be able to look at the big picture of when different renewable energy types are combined in one experiment as well as with careful planning the house will be able to be self-sufficient. Based on the first experiments students will have a semester long project where they will be required to "create" their own model of a power house.

Figure 3. An Example of a reduced model for a power house

After the first experimental session the student will be separated into groups that will rotate upon the different sets of experiments. For example one group will be working with the wind mill while the other will be looking at solar panels; this is done so the amount of experimental kits required is reduced.

In the end of each experiment a laboratorial report is to be draft containing: introduction, materials, experiment results, discussion and conclusions. This report will be required to have a conference format so the undergraduates can practice writing papers.

At the end of the semester each group will present their Power Houses model as well as their written project. To access students learning progress as well as attribute grade a final written exam will be given.

The expected outcome of this class is to engage students in using renewable energy thru their professional careers showing that there is an alternative to traditional models.

Conclusion

Renewable energy resources are here to be explored, studied and improved. The main objective to this class is to get engineering students from different departments and teach them how these resources can be used in their projects as well as show them that a better Planet can be constructed if we do our part.

Multidisciplinary teams are interesting because each student will come with a different perspective on how to approach a problem, for example, mechanical engineering students will look more at the engines while industrial engineers tend to take care of the budget as well as implementing lean manufacture or six sigma. Another point is that this type of class can be used as an optional class in multiple majors optimizing resource use inside the university. Also some of the experiment ideas can be expanded and turned into final projects for graduation as well as a master project since they can be scaled up to a “real life” use.

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