DOWNLOAD PDF INTRODUCTION TO SOLAR ENERGY FOR SCIENTISTS AND ENGINEERS

Chapter 1 : Solar Water: Heat it Up! - Activity - TeachEngineering

An introduction to solar energy that is specifically designed for junior- and senior-level science and engineering students who want a thorough understanding of the principles behind solar energy, as well as a solid preparation for more advanced study, this book is divided into four parts.

Imagine this scenario in the middle of winter! Or not having hot water for cleaning? Well, for billions of people, this is a reality. As engineers we can help improve the quality of life for communities like these around the world. We are going to start exploring engineering applications for a sustainable world by designing, building and testing our own solar water heaters! Technologies that are small-scale, energy efficient, environmentally sound, and typically implemented in developing communities. Transfer of energy between matter due to gradient in temperature. Usually associated within or between solids. Energy is transferred through the bulk flow of fluid, such as air or water. The ratio between useful output energy to input energy of a device. The larger the ratio the more efficient. Sometimes seen as a percent. The exchange of thermal energy between materials and systems. Electromagnetic radiation that is given off by a warm object and can be absorbed by another object, heating it up. The Earth is heated through radiation transfer from the Sun. Energy that comes from natural resources that can be naturally replenished over a reasonable time period. The amount of heat per unit mass needed to raise the temperature by one degree Celsius. Procedure Background In this day activity, student groups design, build and test their own solar water heaters while experiencing the entire cycle of the engineering design process. This activity goes beyond building a "model" solar water heater by reducing the number of constraints on materials and encouraging students to explore how different variables, such as material selection and device shape and volume, affect the overall efficiency of the devices. Students design their solar water heaters based on the materials needed, cost per material, and an overall cost of their devices. They use a detailed worksheet to help them calculate the efficiency of their solar water heaters during the initial and final tests. Then, they compare the efficiencies and costs from their initial and final designs. Exploratory questions are posed to groups to get them thinking about additional changes they would make to their designs if they did this project again with access to more materials. Students also think about how their efficiencies compare to commercial solar water heater models requiring them to do some online research. Before the Activity Make copies of the attached Materials Budget Worksheet , two per group students need one copy for the initial design and one for the final design. Before printing them, fill in appropriate price estimates for each of the materials provided example prices are included. Try to use the actual material costs to make the activity more realistic. Make copies of the attached Solar Water Heater Efficiency Analysis Worksheet , two per student students need one copy for the initial design and one for the final design. Make sure students are trained to knowledgeably and safely use the tools provided. Depending on their designs, students may need to use drills, hammers and hand saws. Divide the class into groups of three students each. With the Students Day 1: Show students the PowerPoint presentation slides using the following script: Slide 1 [Title slide] Slides [Appropriate technologies can improve Examples of appropriate technologies include the Q Drum, a container that is easy to roll so that water can be easily carried long distances, say from a river to a village. Another example of an appropriate technology is the Big Boda Load-Carrying Bicycle, a low-cost design that can transport hundreds of pounds of cargo. And this solar dish kitchen is used in rural communities throughout Mexico. The solar dish concentrates solar energy for cooking. Slide 4 [Alternative energy What are some examples of alternative energies that you can think of? Slide 5 [Alternative energy In a rural Peruvian home, engineers helped design and build a Trombe wall that absorbs solar energy and directs the heat to the inside of the home. They also built a solar water heater to heat water for bathing in the small bathroom outside. Slide 6 [Solar water heaters Slide 7 [Energy Efficiency] â€" To engineers, efficiency usually means maximizing the amount of work done or energy produced from a design while also minimizing resources used. For solar water heaters, efficiency is measured as the amount of heat

transferred to water divided by the amount of heat used by the solar water heater from the Sun or a heat lamp. This equation shows this in terms of heat energy out or heat absorbed by water divided by heat energy in or heat put into the solar water heater by the heat lamp. Engineers strive to get the most work done or energy produced using the least amount of input work or energy possible. In the developing world, reducing resources used and cost are important factors to consider in deciding on appropriate technologies. This is why we care about efficiency! Slide 8 [Heat Transfer Basics] â€" Heat can be transferred in three ways. Through conduction, heat travels through matter because of a gradient in temperature hot to cold , like a metal poker heating up near a fire. Another method of heat transfer is thermal radiation, which occurs when a warm object gives off energy that can be absorbed by another object. The final method of heat transfer is convection, which occurs when the molecules in a fluid, such as air, heat up and circulate to cooler areas. An example of convection is the hot air coming off of a campfire. Can you think of some heat transfer properties of different materials? For instance, think about wearing a black vs. Which absorbs more heat? Can you think of certain materials that heat up faster than others, say metal vs. Do some materials reflect energy better than others, such as shiny materials vs. Material properties are really important to consider designing devices that use solar energy to heat up water. Slide 9 [Solar Water Heaters! Students at this Peruvian school do not have access to warm water at home, so this system helps kids in the village take baths and wash their hands with warm water. We are going to design and build flat-plate solar water heaters of our own! Slide 10 [Constraints for the design The overall volume of your water heater must be between four to six cubic feet. You will need to cycle one gallon of water through the water heater two times in 45 minutes. You will be able to place two Watt heating lamps wherever you want, but they cannot be closer than 12 inches from any point on your design. Slide 11 [Testing Set-up] â€" This is the testing set-up. We are using heating lamps to simulate the un so that everything is as consistent as possible for determining and comparing the efficiencies of your solar water heaters. We will connect the testing station tubing to the inlet and outlet of your water heater. The water pump will be turned on in the collection reservoir and you will measure the initial water temperature and the water temperature every minute for the first 10 minutes, then every five minutes after that until the 45 minutes is up. You will then graph the water temperature vs. Then you will calculate the efficiency of your water heater, or how well you heated up the water given the amount of heat you had to put into the water heater. Finally, you will compare efficiencies between groups and with commercial models. Slide 12 [Project Timeline] â€" Now, I will explain how this project will work over the next couple of weeks. Today we are covering the details of this project and you will start to brainstorm ideas for your solar water heaters. On day 2, your group will need to submit detailed design drawings to scale that include two views, materials labels and dimensions. Also, be sure to note the purpose of each material on your drawings. For example, the insulation traps the heat in the water heater, or the foil reflects the light to the pipes to concentrate the heat. You will also need to fill out your budget worksheet to let me know how much of each material you need and the overall cost of your initial design. On days 3 through 5, you will build your solar water heaters. On day 6 you will conduct an initial leak test in order to seal up any leaks before you finalize your initial design. On day 7 you will have time to make any final modifications to your water heater before doing your initial test. Slide 13 [Project Timeline] â€" On day 8, you will conduct your initial solar water heater test. You will connect your device to the inlet and outlet hose at a testing station, take the initial water temperature, and turn on the water pump. You will record your results and make a graph that displays water temperature vs. Day 9 will be set aside for you to make any design modifications to improve efficiency or fix any problems. You will also need to calculate the overall efficiency of your water heater using a detailed worksheet that guides you through the process. The final testing will take place on day For your final solar water heater test, you will conduct the test and make temperature graphs the same way you did on the initial test day. Slide 14 [Project Timeline] â€" On days 11 and 12 you will calculate final design efficiencies and compile your results. You will need to make a six-minute presentation using PowerPoint on day Be sure to include pictures and drawings in your presentation. Everyone should contribute equally in making and giving the presentation. On day 13, all groups

will give a six-minute presentation to the class. Slide 15 [Materials List] â€" Here is the list of materials you can use. You will be given a budget worksheet that lists the cost of each material to help you make the budget for your heater. You can use as much of any material as you wantâ€" just keep in mind the overall cost of your device!

Chapter 2 : Solar Energy Systems Engineer

The U.S. Department of Energy's Office of Scientific and Technical Information.

Engineers offering their services directly to the public must be licensed. Continuing education to keep current with rapidly changing technology is an important aspect of their career. For example, their background may be in electrical or mechanical drafting, engineering technology, or HVAC heating, ventilation, and air conditioning. College graduates with a degree in a natural science or mathematics occasionally may qualify for these engineering jobs, especially in high-demand professions such as solar energy systems engineering. Some positions require a graduate degree in engineering. In addition, most employers in this area seek to hire engineers who have earned a PE professional engineer license. Solar energy systems engineering positions require a high level of computer skills and computer-aided design CAD capabilities. Applicants should have coursework in both computer science and CAD. Other Qualifications Engineers should be creative, inquisitive, analytical, and detail oriented. They should be able to work as part of a team and to communicate well, both orally and in writing. Communication abilities are becoming increasingly important as engineers interact more frequently with specialists in a wide range of fields outside engineering. Nature of the Work In this video , people in the solar energy field talk about what they do, what they find rewarding about their jobs, and what their career opportunities are. You can learn more about the kinds of courses to take to enter the field and what the typical salaries are. In this video , people in the solar energy field talk about what they do, what they find rewarding about their jobs, and what their career opportunities are. Solar energy systems engineers work to improve the energy efficiency of residential, commercial, and industrial buildings using solar energy systems. These engineers perform site-specific engineering analysis or evaluation of energy efficiency for their customers. After evaluating the energy efficiency of the new or existing structure, they design solar hot-water and space-heating systems, applying their knowledge of structural energy requirements, local climates, solar technology, and thermodynamics to the designs. During the design phase, solar energy systems engineers create diagrams and plans using computer-aided design or CAD software. They also create the supporting documentation required for their projects, such as building permits, selection and specification of components, and design of systems and mechanical and electrical points of connection. As part of their responsibilities, solar energy system engineers must lead and contribute to the writing of reports, studies, and analyses of projects and solar technologies. They work collaboratively with multidisciplinary teams to develop and communicate creative solutions to the client. Work Environment Solar energy systems engineers work in varied environments. Some engineers travel extensively to buildings or work sites in the U. On the Job Conduct engineering site audits to collect structural, electrical, and related site information for use in the design of residential or commercial solar power systems. Design or coordinate design of photovoltaic or solar thermal systems, including system components, for residential and commercial buildings. Create checklists for review or inspection of completed solar installation projects. Create electrical single-line diagrams, panel schedules, or connection diagrams for solar electric systems using computer-aided design CAD software. Create plans for solar energy system development, monitoring, and evaluation activities. Develop design specifications and functional requirements for residential, commercial, or industrial solar energy systems or components. Perform computer simulation of solar photovoltaic generation system performance or energy production to optimize efficiency. Provide technical direction or support to installation teams during installation, start-up, testing, system commissioning, or performance monitoring. Design or develop vacuum tube collector systems for solar applications. Develop standard operation procedures and quality or safety standards for solar installation work. Perform thermal, stress, or cost reduction analyses for solar systems. Review specifications and recommend engineering or manufacturing changes to achieve solar design objectives. Test or evaluate photovoltaic cells or modules.

DOWNLOAD PDF INTRODUCTION TO SOLAR ENERGY FOR SCIENTISTS AND ENGINEERS

Chapter 3 : Sol Wieder | Open Library

This is similar in the same manner as the solar coordinates in fixing the direction of the Sun's rays. The model used for tracing the Sun through the sky at any given location and duration of time.

Chapter 4 : An introduction to solar energy for scientists and engineers - ECU Libraries Catalog

An Introduction to Solar Energy for Scientists and Engineers by Sol Wieder starting at $ An Introduction to Solar Energy for Scientists and Engineers has 3 available editions to buy at Alibris.

Chapter 5 : Renewable Energy Living Lab: Smart Solar - Activity - TeachEngineering

Note: Citations are based on reference standards. However, formatting rules can vary widely between applications and fields of interest or study. The specific requirements or preferences of your reviewing publisher, classroom teacher, institution or organization should be applied.

Chapter 6 : an_introduction_to_solar_energy_for_scientists_and_engineers

download an introduction to solar energy for scientists and engineers Preface Hereby, we present the Ã¯Â¬â€rst version of our book Solar Energy: Fundamentals, Technology and Systems and hope that it will be a useful source that helps our readers to.