Solana: Renewable Solar Energy in Your Neck of the . . . Desert: Close Reading

Directions

Part 1.

A. Number the paragraphs excerpted from several recent articles (Article 1 and Article 2 below
B. Read the articles one at a time, annotating in the following way:

a. underline the main idea in each paragraph
b. circle any vocabulary words that relate to class concepts
c. write a question mark next to or above any vocabulary words that you do not know

C. Read the articles again and pause after each paragraph to write a one sentence summary in the space below each paragraph. Then write a question in the margin next to each paragraph. Your question should explore the topic beyond the text of the paragraph.

Part 2. STOP: Wait for your teacher's instructions for discussion.

Directions: After reading for the second time and writing your sentence summaries or questions, answer the following questions individually. You will be prompted by your instructor to share your responses.

Discussion Questions

1. Which of the following types of energy are harnessed, transformed or utilized in the parabolic trough system? Circle all that apply.

Nuclear Chemical Electrical Electrochemical Thermal (heat) Mechanical Electromagnetic (light)

2. List the major components of solar parabolic trough system and explain how the system transforms energy from the sun ultimately into usable electrical energy.

3. Hot oil in pipes heated by the trough system can reach temperatures of 750 ˚F. What is this temperature in Celsius? In the space below, convert 750°F to Celsius using the following equation: ˚C = (˚F -32) ÷ 1.8.

4. The trough system can use as much as 400 gallons of water per Megawatt hour. How much heat would need to be transferred from the hot oil in the pipes to boil 400 gallons of water for steam to run turbines? **Hints**: the temperature of the water must be raised from room temperature (20 ˚C) to its boiling point. Also, 1 gallon = 3785 g.

5. The Solana plant has a 280 Megawatts capacity. If a plant runs at full capacity for **one year**, how many Joules are produced by the power plant? 1 Megawatt = 10^6 watts and 1watt- hour = 3600 J.

6. The author of the first article claims that “Solana will generate clean energy equivalent to that needed to power 70,000 households and will prevent about half a million tons of carbon dioxide (CO_2) from being emitted into the atmosphere per year. The construction of Solana led to the creation of more than 2,000 jobs and a national supply chain that spans 165 companies in 29 states.” Now reread the information in question.

7. Can you think of reasons that people may be opposed to solar technology?

8. The heat transfer fluid (oil) used in the pipes typically has the following properties: (a) high heat capacity, (b) low viscosity, and is (c) typically chemically inert (nonreactive). Pick one of these properties and explain why it is necessary for the fluid to have this property.

9. Molten (liquid) salts are used in the trough system to retain heat energy that can be transferred to oil in the pipes so that power can be continually generated at night. Molten salts must be stored in insulating tanks so that the heat is not lost at night. What material properties must the tanks have to function efficiently?

10. Reread the main ideas of Article 1 and Article 2, the one sentence summaries, and your answers to the discussion questions above. Now write a summary in five to seven sentences in the space below. Be sure to include concepts that are directly tied to our last unit of study. Explain what you have learned in this assignment and list any questions you still have.

ARTICLE 1:

World's Largest Parabolic Trough Solar Plant Begins Operation

Published on 10 October 2013 on http://www.solarnovus.com/world-s-largest-parabolic-trough-solar-plant-begins-operation_N7079.html

Abengoa, the international company that applies innovative technology solutions for **sustainability** in the energy and environment sectors, has announced that Solana, the world´s largest **parabolic trough plant** with a total installed capacity of 280 gross **megawatts** (MW) and also the first solar plant in the United States with thermal energy storage, has successfully passed commercial operation tests. This milestone marks a major accomplishment for Abengoa and the **concentrating solar power** (CSP) industry.

Solana is the first solar plant in the US with a thermal energy storage system that is able to generate electricity for six hours without the concurrent use of the solar field. This is a turning point for **renewable energy** in this the U.S., serving as a tangible demonstration that solar energy can be stored and dispatched upon demand.

Solana, located near Gila Bend and about 70 miles southwest of Phoenix, Arizona, began construction in 2010 and, on Monday, 7 October, successfully fulfilled production forecasts required to-date and testing for commercial operation. These tests included operating at the turbine's full capacity while charging the thermal storage system, continuing to produce electricity after the sun goes down, and starting up the plant and producing six hours of electricity using only the thermal storage system. These tests successfully demonstrated the various operation modes of the plant's operation.

Abengoa's first utility-scale solar plant in the United States uses **parabolic trough technology**. This technology consists of parabolic shaped mirrors mounted on structures that track the sun and concentrate the sun's heat, later transforming water into steam and powering a conventional steam turbine. This mature technology has additional value since the heat can also be stored and used to produce clean electricity after the sun goes down or during a transitory period.

This ability to generate electricity when needed, or dispatchability, is one of the unique characteristics of concentrating solar power versus other types of renewables. The six hours of clean energy generated by Solana's thermal storage system without the use of the solar field will satisfy Arizona's peak electricity demands during the summer evenings and early nighttime hours. Dispatchability also eliminates

intermittency issues that other renewables, such as wind and **photovoltaics**, contend with, providing stability to the grid and thus increasing the value of the energy generated by CSP.

Arizona Public Service (APS), the largest utility in Arizona, will purchase all of the electricity produced by the solar plant for 30 years through a power purchase agreement with Abengoa.

Solana will generate clean energy equivalent to that needed to power 70,000 households and will prevent about half a million tons of carbon dioxide (CO_2) from being emitted into the atmosphere per year. The construction of Solana led to the creation of more than 2,000 jobs and a national supply chain that spans 165 companies in 29 states.

The total investment of the plant is approximately two billion dollars and during financing, Solana received a federal loan guarantee for $1.45 billion from the United States Department of Energy Federal Loan Guarantee Program. This support made the construction of Solana possible, creating or maintaining thousands of jobs both in the building of the plant as well as those direct and indirect jobs in the supply chain, as well as providing the Southwest with clean, sustainable energy using innovative technology.

Abengoa currently has 1,223 MW of concentrating solar power in operation and 430 MW under construction. It is the largest CSP company in the world and one of the few that constructs and operates both solar tower and parabolic trough plants.

ARTICLE 2:

Concentrating Solar Power (CSP) Technologies
(excerpted from http://solareis.anl.gov/guide/solar/csp/)

Concentrating Solar Power (CSP) technologies use mirrors to concentrate (focus) the sun's light energy and convert it into heat to create steam to drive a turbine that generates electrical power.

CSP technology utilizes **focused sunlight**. CSP plants generate electric power by using mirrors to concentrate (focus) the sun's energy and convert it into high-temperature heat. That heat is then channeled through a conventional generator. The plants consist of two parts: one that collects solar energy and converts it to heat, and another that converts the heat energy to electricity.

Within the United States, CSP plants have been operating reliably for more than 15 years. All CSP technological approaches require large areas for solar radiation collection when used to produce electricity at commercial scale.

CSP technology utilizes three alternative technological approaches: trough systems, power tower systems, and dish/engine systems.

Trough Systems

Trough systems use large, U-shaped (parabolic) reflectors (focusing mirrors) that have oil-filled pipes running along their center, or focal point, as shown in Figure 1. The mirrored reflectors are tilted toward the sun, and focus sunlight on the pipes to heat the oil inside to as much as 750°F. The hot oil is then used to boil water, which makes steam to run conventional steam turbines and generators.

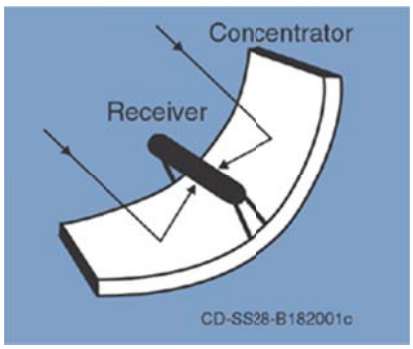

Figure 1: Parabolic Trough System Schematic Diagram

Figure 2: Parabolic trough system.