

Date: February 12, 2008

To: Dr. Stephen Batill and Dr. Michael Stanisic

From: Rachel Paietta, Phillip Hicks, Kevin Kastenholz, Derek Lipp, Paul Nistler

Subject: Group Concept Selection

The four key components of the compact solar system we have chosen are the solar collector, conversion system (engine), generator and energy storage. The team will focus its design efforts on the collector and engine components of the solar power system because these elements focus on the mechanical aspects of converting solar radiation to a usable form of energy. The electrical components will not be designed by our team.

Design Selected:

The team has chosen a parabolic trough design for the solar collection component of the system because troughs are a mature concentrating solar power technology and require minimal tracking adjustments. To minimize the electrical use of our system, the solar trough will be adjusted by hand at the beginning of each day based on the date and the sun's angle as it moves across the sky. Parabolic troughs focus sunlight onto a line which runs the length of the trough as shown in Figure 1. In our trough design and prototype, we will purchase an evacuated solar tube to heat up at the focal point and to drive our heat engine. The solar tube must be kept at an angle of 30° to provide effective heat circulation, so a stable support structure to maintain the trough and solar tube at a 30° angle will be another element of this system that will be designed by the team.

A Stirling engine will utilize the heat collected by the solar trough to power the generator. Stirling engines can run on small temperature differences and do not require a working fluid (like steam) to generate mechanical work. Figure 2 shows the beta configuration, which was selected for this application for its compact nature. By using a Stirling engine we have eliminated any dangers associated with using steam power such as high temperature and high pressure fluids that may escape and injure people or may need replenishing.

The electrical energy storage system has already been chosen to be a battery or series of batteries, and the specifications of the generator have not been selected yet, but this component will be purchased from a supplier. These two components meet the design requirement of "recycled" technology. Our objective is to design a system that will convert solar energy into electrical energy; however, as the electrical generation and storage portions of the system have been designated and are well understood, the focus of our study will be the conversion of solar energy into the mechanical energy of a rotating shaft.

Key Technical Issues:

- Designing a stable structure to support the trough at a 30° angle. The stand will also support the Stirling engine and generator at the high end of the trough, so the unequal weight distribution from these added components will be incorporated into the design of the structure as well.
- The trough itself will be designed to have the highest allowable margin of tracking error without losses in the efficiency of the collector.
- Analyses will be done on the Stirling engine to determine the optimum mass and pressurization of the air inside as well as the appropriate compression ratio.
- The piston timing as a function of rpm will also be optimized for the Stirling engine.
- Designing and selecting the material for the pressure seal of the power piston will also be another technical issue considered in the design of the Stirling engine.
- The flywheel driven by the Stirling engine will be sized based on the output of the engine and the load of the generator.

- The heat sink on the cool side of the Stirling engine will be designed to maximize heat dissipation.

Provided there are no show stoppers encountered, the following milestones are our team deadlines throughout the design process:

- February 21 – Individual trade studies complete
- February 26 – Other details of the design not studied in individual trade studies complete
- February 28 – Prototype performance requirements set
CAD complete for individual components designed in trade studies
- March 1 – Major parts ordered for prototype
- April 3 – Documentation complete with exception of Abstract, feasibility conclusions and videos
All CAD assemblies complete
- April 8 – Prototype assembled
- April 15 – Documentation complete
Prototype demonstration

At this time our team does not have any noteworthy collaboration plans with consultants, customers or industry mentors.

Attachments

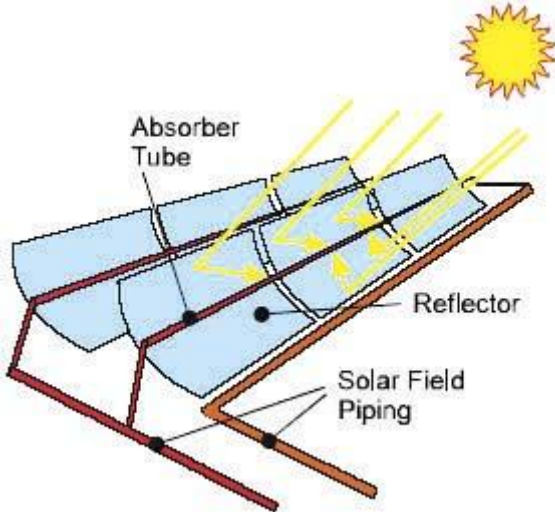


Figure 1: Schematic of Parabolic Trough

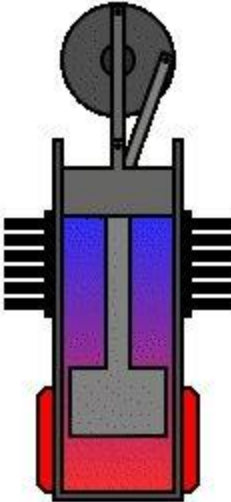


Figure 2: Beta Stirling Engine