



SREB/High Schools That Work

Enhanced CT

Project Unit Template

Project Title: Solar Stirling Engine

Essential Question: Are alternatives to traditional power sources really more effective?

Technical Content Standards:

Power, structural & technical systems career pathway:

1) Apply physical science principles and engineering applications to solve problems and improve performance in AFNR power, structural and technical systems.

The Project Description

Step One: Project Description Outline:

You are a solar power contractor

You are faced with having to set up a solar powered system that can pump irrigation water to an ebony plantation with our the need for fuel or on line electricity.

You must:

Technical: Construction of a solar powered hot air engine capable of sustaining power to operate a small water pump. Design a low pressure drip system that can deliver sufficient water for the Ebony trees.

Research, Read and Write:

Available Stirling engine designs and construction materials and methods, building a parabolic reflector, designing an irrigation drip system.

Setting up sustainable growth plantations to harvest the fruit and lumber of endangered Ebony trees.

Science: Thermodynamics—first and second law, Entropy, gravitational energy, Carnots theorem.

Math: Measuring, the metric system, volume and displacement, ohms, amps volts.

Once you are decided upon a course of action, you will a write a design brief for the construction of a solar powered stirling engine as a more efficient system when compared to photovoltaic cells as a way to run irrigation systems without the use of fuel. You will present your design to a group of a government trade group from the countries of Tanzania and Kenya who will approve your design and cost-benefit analysis.

Step Two: Project Description

The Ebony tree is on the endangered species list. A relative to the persimmon Ebony has a long growing period (up to sixty years before a tree reaches maturity) before it can be used commercially as lumber. A solar powered irrigation system using the Stirling cycle engine could provide power to operate irrigation equipment and do so without the use of traditional fuels.

Ebony forests in Kenya and Tanzania are heavily exploited to meet a growing world demand for ebony. The tree is also used domestically as fuel and raw material for tools and utensils. Domestic wood carving industries provide a cash business in the form of carvings that are sought after by tourists. By using a solar powered irrigation system that is mechanically simple and easy to maintain plantations can be managed and irrigated without the use of petroleum based fuels or the use of wood or coal fired equipment.
(<http://www1.american.edu/ted/ebony.htm>)

The technical tasks would include the design and construction of a Stirling engine and a parabolic disc powerful enough to run a pump for irrigation purposes. The students will also need to figure how much water can be delivered from such a system and how many trees could be sustained per solar Stirling plant.

Are alternatives to traditional power sources really more effective? After researching professional journals and periodicals on stirling engines as an alternative energy source and participating in enabling learning activities intended to assist you in the design, building, and testing, write a design brief in which you discuss the advantages of using stirling engines and evaluating them as an effective alternative energy source. Support your position with evidence from the texts and participating in the enabling learning activities.

The students would write a design brief detailing the design and construction of the Stirling engine and parabolic disc and the type of pump and irrigation system necessary to sustain an Ebony tree. The students must also develop a cost-benefit analysis to support their claim of the stirling engine being a more effective alternative for drip irrigation systems when compared to photovoltaic cells for power. It is important that the student research and present the audience with the real world threat that the Ebony tree may become extinct if no actions is taken. A close look at the poverty and needs of both Kenya and Tanzania should be investigated, as poverty is one of the reasons for exploitation. The Technology incorporated in the parabolic disc, stirling engine and irrigation drip system is useless without understanding the social, economic and environmental forces aimed at the Ebony tree. The end result of student research and experimentation will be writing a proposal to send to the Tanzania and Kenyan governments.

List CCTC or Specific CTE Content (and Skill) Standards:

Environmental Service systems career pathway
(All) CCSS.AG-ENV

Natural Resources career pathway
All CCSS.AG-NR

Identify CCSS Reading and Writing Standards:

Key Ideas and Details

- [CCSS.ELA-Literacy.CCRA.R.1](#) Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.
- [CCSS.ELA-Literacy.CCRA.R.2](#) Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas.

Craft and Structure

- [CCSS.ELA-Literacy.CCRA.R.4](#) Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.
- [CCSS.ELA-Literacy.CCRA.R.5](#) Analyze the structure of texts, including how specific sentences, paragraphs, and larger portions of the text (e.g., a section, chapter, scene, or stanza) relate to each other and the whole.
- [CCSS.ELA-Literacy.CCRA.R.6](#) Assess how point of view or purpose shapes the content and style of a text.

Integration of Knowledge and Ideas

- [CCSS.ELA-Literacy.CCRA.R.7](#) Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words.¹
- [CCSS.ELA-Literacy.CCRA.R.8](#) Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence.
- [CCSS.ELA-Literacy.CCRA.R.9](#) Analyze how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take.

Range of Reading and Level of Text Complexity

- [CCSS.ELA-Literacy.CCRA.R.10](#) Read and comprehend complex literary and informational texts independently and proficiently.

Text Types and Purposes¹

- [CCSS.ELA-Literacy.CCRA.W.1](#) Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence.
- [CCSS.ELA-Literacy.CCRA.W.2](#) Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.

Production and Distribution of Writing

Commented [ES1]:

- [CCSS.ELA-Literacy.CCRA.W.4](#) Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
- [CCSS.ELA-Literacy.CCRA.W.5](#) Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.
- [CCSS.ELA-Literacy.CCRA.W.6](#) Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.

Research to Build and Present Knowledge

- [CCSS.ELA-Literacy.CCRA.W.7](#) Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.
- [CCSS.ELA-Literacy.CCRA.W.8](#) Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.
- [CCSS.ELA-Literacy.CCRA.W.9](#) Draw evidence from literary or informational texts to support analysis, reflection, and research.

Range of Writing

- [CCSS.ELA-Literacy.CCRA.W.10](#) Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

Identification of Mathematical Skills and Content:

Number and quantity overview: The real number system

3. Use properties of rational and irrational numbers.

The complex number system: Perform arithmetic operations with complex numbers.

Geometric measurement and dimension: Explain Volume formulas and use the to solve problems.

Visualize relationships between two-dimensional and three dimensional objects.

Workforce Readiness Standards:

- Act as a responsible and contributing citizen and employee.
- Apply appropriate academic and technical skills.
- Communicate clearly and effectively and with reason.
- Consider the environmental, social and economic impacts of decisions.
- Demonstrate creativity and innovation.
- Employ valid and reliable research strategies.
- Utilize critical thinking to make sense of problems and persevere in solving them.
- Model integrity, ethical leadership and effective management.
- Use technology to enhance productivity.
- Work productively in teams while using cultural global competence