Solar Cookers
Effective Tools for 3-D Learning

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by
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PART 1
The Solar Sisters Project
GDSnonprofit

Working to promote solar cookers as tools for education, wellness, economic empowerment, and ecosystem recovery.

Our mission is to connect and support those working at the grass-roots level to solve quality of life issues in ways consistent with the principles and goals of GDS.

Do good well.
GDSnonprofit.org

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Visit gdsnonprofit.org/solar-cooker-education for session slides, solar cooking lessons, experiments, & patterns, and to learn about our mission work.

Mission
To spread solar thermal cooking technology to benefit people and environments.

solarcookers.org
Visit solarcooking.wikia.com for great educational information on the solar cooking movement.
How I Discovered the Wonder of Solar Cooking in 1996
Solar Energy

Can you build a solar cooker?

Design and construct a solar cooker to cook your potato. Use any materials that you can find on your own. How long did it take to cook your potato?

For Discussion:
1. How well does your solar cooker work?
2. How could you improve your cooker? Is there anything you could make the potato cook even faster?
15 YEARS
100 students per year = 1,500 students
RESEARCHED DESIGNED BUILT TESTED their own unique solar ovens.
What I loved about using Solar Cooking as the theme for 3-Dimensional and Cross Curricular learning.

- Many differentiated learning opportunities.
- Students experience how knowledge and skills can be applied.
- Provides opportunity for intercultural understanding.
- There's food involved.
- Reinforces understanding of core ideas.
- Promotes deeper understanding of content.
- Concepts transfer more readily.
- Eliminates discipline issues.
- Motivates.
- Develops better relationships with co-workers.
- Topic lends itself to several disciplines.
- Students see tangible results of their planning, designing, and constructing.
- Students understand how technology can benefit people.
- Work cooperatively with co-workers in a supportive manner.
- Students witness teachers cooperating and can use this example for their own work ethic.
- Challenges creativity.
- Students understand the benefit of collaboration.
- Opportunity to develop altruism.
- Gives rise to authentic purpose for learning.
- Multiple applications.
- Students recall the experience years later.
Basic Introduction to Solar Cooking
Sample of Early Solar Ovens

W Adams 1878 Bombay, India
Eight mirrors reflect light into wooden box.

Horace de Saussure's hot box - 1767

Samuel Langley 1884
Design of 1950'S box oven by Maria Telkes, physical chemist & biophysicist.
Source: Arizona State University

EnergyProfessionalSymposium.com

SolarCooking.org
Transform sunlight to heat energy. Retain it for cooking. 
SUNLIGHT IS YOUR FUEL

Direct extra sunlight
One or more shiny surfaces reflect extra sunlight onto the cooking pan, increasing its heat potential.

Absorb light and convert to heat
Dark surfaces get very hot in sunlight, whereas light surfaces don’t. Food cooks best in dark, shallow, thin metal pots with dark, tight-fitting lids to hold in heat and moisture.

Retain heat
A transparent heat trap around the dark pot lets in sunlight, but won’t let the heat out. For panel ovens, use a clear oven bag or inverted glass bowls. For box oven, use insulation and a transparent window.

Eat and enjoy your solar cooked food.
Eat and enjoy healthy and nutritious food cooked with the cleanest burning fuel there is.

“DARE to cook with sunshine!”
TheSolarSisters, GDSnonprofit.org
BOX OVEN

• Box ovens use reflectors to direct sunlight into the cooking space.
• The oven interior includes one or more black walls.
• The oven is well insulated to retain heat.
• Box ovens can reach temperatures of 325°F in a direct sun.
BOX OVEN

Gluten Free Lemon Cake
John Buchenic, USA
PANEL OVEN

• Uses reflective material to direct sunlight into a cooking space.
• Cooking space holds a black cooking pan that absorbs sunlight and converts it to heat.
• Heat is retained by using a transparent enclosure such as an oven bag or inverted pyrex bowls.
• Approximate Range: 200° F – 325° F
PANEL OVEN

Steamed Rice
Wade Steene, USA
PANEL OVEN

Baked Pork Chop
Mary Buchenic, USA
**EVACUATED TUBE**

• Double layers of glass with no air in between.
• Food is placed inside the tube.
• The dark interior part of the tube absorbs the light and converts it to heat.
• The evacuated space between the glass layers prevents heat loss.
• Approximate range 250° F – 400° F
EVACUATED TUBE

Chicken
Mary Buchenic, USA
EVACUATED TUBE

Bread
Mary Buchenic, USA
**PARABOLIC OVEN**

- Concentrates many rays of light onto a black cooking pan.
- The amount of concentrated light can result in heating the food similar to placing it on a burner.
- Deep parabolics spread the concentrated light around the cooking pan.
- Shallow parabolics focus light more tightly.
PARABOLIC

Frying Food
Janos Baglyios, Hungary
PARABOLIC

Popcorn
John Buchenic, USA
SAFETY

• Do not look directly at the sun.
• Do not look into the glare of the reflectors.
• Use oven mitts to handle hot pots and pans.
• Use a thermometer to test for safe internal temperature of meats.
• Keep hands and food preparation areas clean.
• Be aware of allergies when preparing food.
• Solar cooking requires sunshine. Do not attempt to cook on a cloudy day.
Solar Cookers are 3-Dimensional!

The Next Generation Science Standards were released in 2013.

“Lessons and units aligned to the standards should be three-dimensional; that is, they should allow students to actively engage with the practices and apply the crosscutting concepts to deepen their understanding of core ideas across science disciplines.” nextgenscience.org

Solar Cooker themed lessons align easily with the concept of three dimensional learning.
Dimension 1

DISCIPLINARY CORE IDEAS

Key ideas in science that build on each other

GROUPED BY FOUR DOMAINS

Physical Science
Life Science
Earth and Space Science
Engineering, Technology & Application

nextgenscience.org

Rank the domains from most relevant to least in relation to a solar cooking themed lesson.
Dimension 2
CROSSCUTTING CONCEPTS
Connections across the four domains

SEVEN CONCEPTS
Patterns
Cause and effect
Scale, proportion, and quantity
Systems and system models
Energy and matter
Structure and function
Stability and change

How can the crosscutting concepts be explored through a solar cooking themed lesson?
Dimension 3
PRACTICES
Investigate the natural world. Design and build systems.

SCIENCE AND ENGINEERING PRACTICES
Ask questions and define problems
Develop and use models
Plan and carry out investigations
Analyze and interpret data
Use math and computational thinking
Construct explanations and design solutions
Base arguments from evidence
Communicate information

nextgenscience.org

How can a solar cooking themed lesson reinforce every science and engineering practice?
Disciplinary Core Ideas

Crosscutting Concepts

Practices

Physical Science
PS 1: Matter & its interactions
PS 2: Motion & stability: Forces & interactions
PS 3: Energy
PS 4: Waves & their applications in technologies for information transfer

Life Sciences
LS 1: From molecules to organisms: structures & functions
LS 2: Ecosystems: interactions, energy, & information
LS 3: Heredity & variation of traits
LS 4: Biological populations: Unity & diversity

Earth & Space Sciences
ESS 1: Earth & the universe
ESS 2: Earth history
ESS 3: Earth & human activity

Engineering, Technology, & the Application of Science
ETS 1: Engineering design
ETS 2: Links among engineering, technology, science, & society

nextgenscience.org
Disciplinary Core Ideas
- Physical Science
  - PS 1: Matter & its interactions
  - PS 2: Motion & stability: Forces & interactions
  - PS 3: Energy
  - PS 4: Waves & their applications in technologies for information transfer

Life Sciences
- LS 1: From molecules to organisms: structures & processes
- LS 2: Ecosystems: Interactions, energy, & dynamics
- LS 3: Heredity: Inheritance & variation of traits
- LS 4: Biological evaluation: Unity & diversity

Earth & Space Sciences
- ESS 1: Earth in the universe
- ESS 2: Earth’s place in the universe
- ESS 3: Energy & its applications in technologies for information transfer

Engineering, Technology, & the Application of Science
- ETS 1: Engineering design
- ETS 2: Linking Engineering, technology, & society

Crosscutting Concepts
- Science and Engineering Practices
- Disciplinary Core Ideas
- Science and Engineering Practices
- Disciplinary Core Ideas
- Science and Engineering Practices

HS-LS-2-1 Ecosystems: Interactions, Energy, and Dynamics

Students who demonstrate understanding can:

MS-LS2-1: Analyze and interpret data to provide evidence for the effects of resources availability on organisms and populations of organisms in an ecosystem. (Clarification Statement: Emphasis is on cause and effect relationships between resources and growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant and scarce resources.)

Science and Engineering Practices
- Analyzing and interpreting data
- Developing and using models
- Using mathematics
- Identifying limiting factors
- Obtaining, evaluating, and communicating information

Disciplinary Core Ideas
- Ecosystems: Interactions, energy, and dynamics

Crosscutting Concepts
- Systems, systems, and system services
- Development and use of models

HS-LS-2-7 Ecosystems: Interactions, Energy, and Dynamics

Students who demonstrate understanding can:

MS-LS2-7: Design, evaluate, and refine a technology prototype to solve a problem (Clarification Statement: Examples of human activities that involve engineering include infrastructure and service systems, medical treatment and prevention, and information technology.)

Science and Engineering Practices
- Identifying limiting factors
- Obtaining, evaluating, and communicating information

Disciplinary Core Ideas
- Ecosystems: Interactions, energy, and dynamics

Crosscutting Concepts
- Systems, systems, and system services
- Development and use of models

nextgenscience.org
Solar oven themed lessons in practice
INTRODUCE SOLAR COOKING AS AN ENGINEERING DESIGN CHALLENGE

Identify Problem or Need
Researchers at the Polar Environment Atmospheric Research Laboratory in the Arctic Circle on Ellesmere Island, Canada want to conserve and reduce cooking fuel. It is difficult to transport this fuel to the Research Lab. Researchers also want to reduce the pollutants they are releasing into the air in this environment.

Design Brief
Statement
With your team, design a solar oven model for use at the Polar Environment Atmospheric Research Laboratory. Label how the oven is designed to direct sunlight, absorb sunlight and convert to heat, and retain heat. Remember DARE (Direct, Absorb, Retain, Eat)

Specifications
The oven must utilize reflectivity to gain as much sunlight as possible at low angle. The oven must include an insulated cooking space so it does not lose thermal energy to the outside. The oven must cook at temperatures that are safe for food. The oven must be made of materials that are durable and sturdy. The oven must withstand windy days and occasional wind gusts.

Technology Should Serve Humanity, Not the Other Way Around.
Tim Cook

Identify Problem or Need
Natural disasters can knock out power to a home and community for days and even weeks. Without power, food cannot be refrigerated or cooked using a conventional indoor stove. People may need to rely on dried goods such as rice, beans, and root vegetables.

Identify Problem or Need
A church in Haiti cooks daily for about 50 school children. The church would like to learn to use solar ovens to reduce the money spent on charcoal for cooking. With the money they save, they will buy nutritious food for the children.
Students conduct experiments and participate in class activities that reinforce Disciplinary Core Ideas.

What effect will focusing light on a penny inside a jar of water have on the temperature of the water?

(This experiment and more can be found at GDSnonprofit.org/education)
Students use Disciplinary Core Ideas as the basis for Engineering Design.
SCIENCE AND ENGINEERING PRACTICES

Build a prototype that is your team’s solution to the problem.
TEST AND EVALUATE

Students conduct temperature and time tests to evaluate ovens. Discuss changes that can be made.
COMMUNICATE
SOLUTIONS
Students discuss solar oven construction with each other, other classes, and adults. Write ideas in science journals.

Representative from the office of Congressman Tim Ryan.
These sample questions from a state standardized test demonstrate how a solar cooking themed lesson can prepare students to understand related concepts.
These sample questions from a state standardized test demonstrate how a solar cooking themed lesson can prepare students to understand related concepts.
The need for teaching skills in a relevant context is universal.

Examples of solar cookers as tools for STEM education here and abroad.
Teaching about solar cooking concepts in Haiti at Institucion Mere Delia with WeCaretoShare.

Latè planèt nou an se planèt la twasyèm soti nan solèy la.
Nou se 150 milyon kilomèt soti nan solèy la.

Our planet earth is the third planet from the sun. We are 150 million kilometers away from the sun.
Camily and Gaudenzia Wedende of Eldoret, Kenya, teach children and adults the basic concepts of solar cooking and its many uses with support from Student Solar Cooking Science Projects and GDSnonprofit.
Students at Korando Educational Center in Kisumu, Kenya learn about integrated cooking, including solar, from instructors Faustine Odaba and John Amayo through a GDS sponsored three day workshop.

Students gather round their new SolSource, donated by Hubbard, Ohio Rotary Club, at Korando Educational Center in Kisumu, Kenya. Training program sponsored by GDS.
The Solar Sisters, GDSnonprofit conduct workshops on solar cooking for students at Learning Streams International Institute at Hiram College. Students from USA, Pakistan and Dominican Republic attend.
Teachers and students in Pakistan learn about solar cookers as part of Learning Streams International's ecology education program. Workshop conducted by John Buchenic of GDSnonprofit.
Bethel Business and Community Development Centre is a commercial and technical school located in a remote rural district of Lesotho.

Mission

To design and manage innovative learning environments for young people in Lesotho that elicit general engineering skills, business savvy, manual capabilities, applied sciences, systems thinking, leadership and management abilities that address the needs of career and business development in Lesotho.

Photo Credit: Ivan Yaholnitsky
PART 2
Susan Schleith and Penny Hall
Mission: To research and develop energy technologies that enhance Florida’s and the nation’s economy and environment and to educate the public, students and practitioners on the results.
Professional Development for Teachers

**Solar Cooker Workshops**

- Curriculum – concepts, standards, resources and implementation
- Hands-on, team-driven, problem/project-based
Solar Energy Cook-off

Students share their projects

- EnergyWhiz & EnergyWhiz Expo Events
- Demonstration, showcase and competition for student team projects
- Awards in Design, Culinary, Fresh from Florida & WOW
Designed and Built by Students

Box Cookers
Designed and Built by Students

Panel Cookers
Designed and Built by Students

Parabolic Cookers
Designed and Built by Students

Solar Hybrid & Lens Cookers
Students Solar Cooking
Students Solar Cooking
Solar Culinary Arts

Delicious Creations!
Solar Culinary Arts

Fresh From Florida!
Solar Culinary Arts

More than S’mores!
WOW!
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Session powerpoint, cooker plans, curriculum (K-12), cooking tips, recipes & more

http://www.fsec.ucf.edu/download/Education