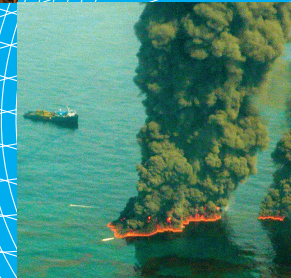
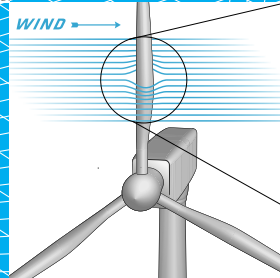
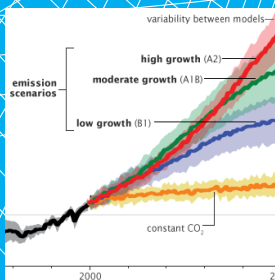
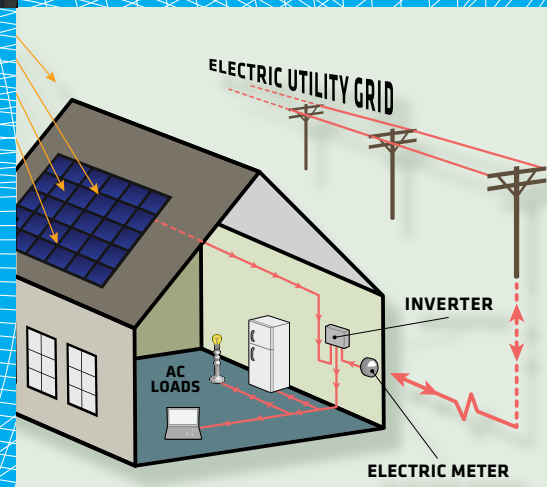
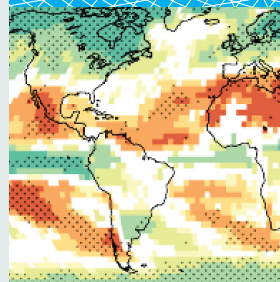
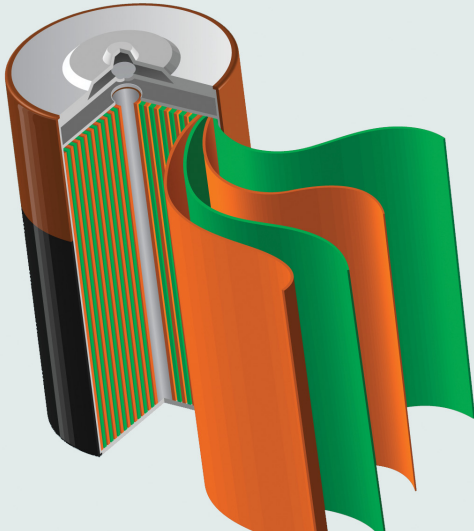
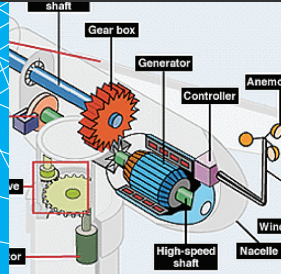




CleanTech

Inspiring High School Students in STEM, Sustainability, and Careers in the Emerging Green Economy

ENERGY





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ENERGY

ACKNOWLEDGMENTS

ABOUT GREEN DESIGN LAB

Solar One's K-12 Education Program – Green Design Lab™ – promotes experiential learning opportunities through science, technology and design. Solar One's programs increase environmental knowledge about Energy, Water, Materials Science and Food, while fostering sustainable behaviors and stewardship. Using the school as a learning laboratory, Solar One's K-12 programs introduce students to hands-on real world experience, support the development of creative thinking and problem solving skills, and turn students into advocates for sustainability projects in their schools.

Cleantech is Solar One's High School curriculum that engages students in sustainable design and innovation in the emerging green sector. Cleantech was made possible through generous funding provided by The Rockefeller Foundation and the National Science Foundation under Grant No. DRL-1139308.

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VISIT US ONLINE AT THEGREENDESIGNLAB.ORG

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INTRODUCTION

CLEANTECH ENERGY is an innovative, multidisciplinary high-school level curriculum that was designed to increase student knowledge, awareness and understanding of the rapidly evolving field of energy. Beginning with the fundamentals of energy and energy sources, the curriculum follows the arc of energy production, distribution and usage, investigating the environmental, social and economic impacts of each. CleanTech’s unique holistic approach incorporates science, engineering and economic models to examine energy issues such as global trends and consequences of our energy systems and climate change, while local energy use is explored through the lens of building science. Using the school building as a learning laboratory, students will have the opportunity to assess the building with an eye towards increasing efficiency and reducing negative impacts on human health, the environment and climate. Finally, CleanTech introduces the science, emerging technologies and policy of renewable energy sources such as wind, solar and biomass. Complete with a wealth of hands-on activities and student-led investigations, each CleanTech Module contains concepts that support Science, Technology, Engineering and Math (STEM) skills with an emphasis on problem-solving, design, innovation and pathways for career exploration.

MODULE 1: INTRO TO ELECTRICITY introduces the basics of energy as a physical concept and the laws that govern it. The focus then shifts to energy sources, with an in-depth look at the origin, production and use of fossil fuels. Using maps and independent research, students will develop energy profiles of specific countries and develop a strategic energy plan for each.

MODULE 2: ELECTRICITY PRODUCTION AND THE GRID is a study of modern electricity production and distribution. Lessons encompass the history and mechanics of electricity as well as emerging smart grid technology and policy. Activities range from constructing simple circuits and generators to conducting cost-benefit analyses of power plants.

MODULE 3: CLIMATE CHANGE explores the relationship between our energy use and the Earth’s changing climate as well as the projected social, environmental and economic impacts. The Module also explores responses to climate change on a global, national and local level. Students will use Paleolithic ice core data to analyze historic CO₂ levels and will develop maps to identify global climate trends.

MODULE 4: BUILDING SCIENCE focuses on energy use in buildings. Students will employ concepts and techniques of Building Performance to evaluate the air flow and electricity use of their classroom and school building, identifying areas needing improvements and avenues of remediation. In this hands-on oriented module, students learn to use several “tools of the trade” including a watt-meter and infrared thermometer. Students will conduct a building audit of the school and generate a full report with recommendations.

INTRODUCTION

MODULE 5: RENEWABLE ENERGY introduces students to the mechanics and applications of various forms of renewable energy. Students will investigate the benefits, challenges, science and emerging technologies of each as well as renewable energy policy and career pathways in this dynamic sector. Several engaging activities include, creating biofuel, building solar thermal water heaters and constructing batteries.

MODULE 6: WRAP UP brings together all of the topics students have explored throughout the CleanTech Energy Unit. CleanTech wrap up activities build on design, engineering, policy and economic skills students learned throughout the Unit, encouraging students to apply what they have learned to a final project. These activities can be done as independent team projects or as extended classroom lessons.

HOW TO USE THE CURRICULUM MAP

CleanTech offers a wide array of activities and resources, covering topics ranging from energy policy to the science of climate change to the mechanics of building HVAC systems. The modular design of CleanTech allows teachers to tailor the curriculum to meet the individual needs of their classroom. The curriculum activities are grouped into three categories:

GENERAL ACTIVITIES emphasize the foundational knowledge and general concepts of each module. Hands-on projects and investigations stress comprehension and application of classroom knowledge. These activities are appropriate for all grades as an introduction to the topic.

ACCELERATOR ACTIVITIES center on the policy, economics and new technology of the energy industry, with the purpose of introducing students to the complexities and evolving nature of the field. The research-oriented nature of these activities encourages students to synthesize and evaluate information from a variety of sources. Accelerator activities involve data analysis and complex math and may be appropriate for older grades. Computer access is strongly advised for certain activities.

GREEN SKILLS ACTIVITIES are modeled on career and technical training for careers in the green industry. They focus on developing hard skills in fields such as building performance and renewables through real-world application of classroom knowledge.

THE CURRICULUM MAP is intended as a guide to help schools and teachers navigate the curriculum to develop dynamic and engaging study for their students. For all participating classes, it is encouraged to try as many activities as possible.

CLEAN TECH CURRICULUM MAP

INTRO TO ENERGY	General	Accelerator	Green Skills
Lesson 1: What is Energy? How do we use it?			
Activity 1A: Energy Transfers	•		
Activity 1B: Everyday Energy	•	•	
Lesson 2: Sources of Energy and Self-Sufficiency			
Activity 2A: The Quest for Oil		•	
Activity 2B: Technology and the Fossil Fuel Era	•		
Activity 2C: Energy Independence		•	
ELECTRICITY PRODUCTION AND THE GRID			
Lesson 1: Electricity Production: The Power Plant			
Activity 1A: Power Plant Hookup	•		
Activity 1B: Build a Generator	•		•
Activity 1C: Cost Benefit Analysis/Debate on Electrical Generation		•	
Activity 1D: The Air You Breathe		•	
Activity 1E: Nuclear Power Plant Case Study		•	
Lesson 2: Moving Electricity: Circuitry			
Activity 2A: Research Edison and Tesla	•		
Activity 2B: Series and Parallel Circuits	•		•
Activity 2C: Electric Current		•	•
Lesson 3: Electricity Distribution and the Grid			
Activity 3A: Efficiency Calculations	•		•
Activity 3B: Peak Load		•	
Activity 3C: NY City Blackout	•		
Activity 3D: The Smart Grid		•	
CLIMATE CHANGE			
Lesson 1: An Introduction to the Climate System			
Activity 1A: It's Getting Hot in Here: The Greenhouse Effect in a Bottle	•		
Activity 1B: Charting the CO ₂ Data		•	
Lesson 2: Emissions, Indicators and Effects			
Activity 2A: Straight to the Source: Global Greenhouse Gas Emissions	•		
Activity 2B: Connecting the Climate Dots	•	•	
Lesson 3: Responding to Climate Change			
Activity 3A: Mapping Climate Change: Contributors, Fragilities and Hotspots		•	
Activity 3B: Reducing Your Carbon Emissions	•	•	

CLEAN TECH CURRICULUM MAP

BUILDING SCIENCE	General	Accelerator	Green Skills
Lesson 1: Building Science: Why Does It Matter?			
Activity 1A: Building Energy Use Mapping	•	•	
Activity 1B: Can a Skyscraper Go Green?	•		
Lesson 2: Building Science: Lighting and Appliances			
Activity 2A: Watt Game	•		
Activity 2B: Light Bulb Lab	•		•
Activity 2C: Too Bright or Just Right			•
Activity 2D: Classroom Electrical Appliance Lab	•	•	•
Lesson 3: Heating and Cooling			
Activity 3A: Measuring Conductive Heat Transfer	•		
Activity 3B: Measuring Air Flow			•
Activity 3C: School Boiler Room Tour	•	•	•
Lesson 4: Building Occupants: People and Energy Consumption			
Activity 4A: Changing the Energy Culture	•		
Activity 4B: Reading an Electricity Meter	•		•
Activity 4C: Follow the Exit Sign for Energy Savings	•	•	•
Lesson 5: School Building Energy Audit			
Part I: Lighting Audit (Prerequisite: Activity 2A)	•	•	•
Part II: Appliance Audit (Prerequisite: Activity 2C)	•	•	•
Part III: HVAC and Building Envelope Inspection (Prerequisite: Lesson 3 Reader)	•	•	•
RENEWABLE ENERGY			
Lesson 1: Introduction to Renewable Energy			
Activity 1A: Making Batteries	•		•
Lesson 2: Photovoltaics and Solar Thermal			
Activity 2A: Solar Path Finder: Assessing Solar Potential			•
Activity 2B: Solar Card Game	•		
Activity 2C: Solar Field Study	•	•	•
Activity 2D: Solar Installation Modelling			•
Activity 2E: Solar Map Activity		•	
Activity 2F: Solar Thermal Water Heater Design			•
Activity 2G: Build a Solar USB Charger		•	•
Activity 2H: Feed-in Tariff Case Studies		•	
Lesson 3: Wind			
Activity 3A: Wind Speed		•	
Activity 3B: Locating Sites for Wind Turbines	•		•
Activity 3C: Wind Turbine Blades	•		•
Lesson 4: Biomass			
Activity 4A: Your Biomass Feedstock	•		
Activity 4B: Comparison of Ethanol Feedstocks		•	
Activity 4C: Creating Biofuel	•		•

CLEANTECH, SOLAR ONE'S HIGH SCHOOL CURRICULUM,

engages students in sustainable design, problem solving, and innovation. Using the school as a laboratory for hands-on learning and behavioral change, students explore emerging clean technologies and sustainability-related policy and economic issues at the local, national and global level. Cleantech is designed to inspire the next generation of green engineers, scientists, architects, building system managers, energy auditors, economists and entrepreneurs.

Cleantech is an integral part of Solar One's Green Design Lab™, the only curricular blueprint of its kind that looks at the school building as both a laboratory for learning and a tool for environmental change. CleanTech expands on the core concepts of the existing Green Design Lab interactive curriculum with more advanced and technical content. It introduces students to the Cleantech industry through STEM (Science, Technology, Engineering & Math) focused reading material, research projects and hands-on labs. Through four units – Energy, Materials, Water and Food – students learn about topics like electric grid transmission, renewable energy, battery storage, demand management water technologies, biomimicry, stormwater management, and hydroponics, to name a few. In addition to addressing the foundational aspects of these four subjects, CleanTech offers Accelerator activities that cover a broad range of science, economic and policy research topics, and Green Skills activities that focus on developing hard skills in such areas as building performance and renewables.

The Energy Unit introduces students to the dynamic clean energy economy. It increases student knowledge and awareness of energy fundamentals, as well as production, usage and impacts on society, economy and the environment. The Unit includes an Introduction to Energy, the Electrical Grid, Climate Change, Building Science, and Renewable Energy. All Unit modules focus on emerging technologies, challenges and opportunities in smart grid transmission, thin film solar, battery storage, demand management, smart buildings, and much more!

