

ENERGY EFFICIENCY EXPLORATION



This guide links the *Energy Efficiency Exploration* unit to the Texas Essential Knowledge and Skills (TEKS) for fifth graders. *Energy Efficiency Exploration* is a science unit that allows students to study renewable and non-renewable energy sources and how humans use energy in daily life. *Energy Efficiency Exploration* also has interdisciplinary connections to English language arts and reading and social studies disciplines. For example, students will write expository or informational texts, as outlined in the English Language Arts and Reading TEKS, and understand how people adapt to and modify the environment, as described in the Social Studies TEKS. The following document includes the applicable TEKS and the details of the *Energy Efficiency Exploration* unit. The final section of this document presents the applicable Texas College and Career Readiness Standards adopted by the Texas Higher Education Coordinating Board (THECB) on January 24, 2008.

Description of Unit

Students study renewable and non-renewable energy sources and how people use energy in daily life. After taking an inventory of all of the devices in the home and school environments that consume electricity, and conducting Internet research to determine possible sources for the energy, students identify ways to reduce consumption of non-renewable energy sources and/or increase energy efficiency. Students' research alternative energy sources, energy conservation, and/or lifestyle-patterns related to energy use and design experiments to test changes that they hypothesize might lead to more efficient or sustainable systems. Products may include:

- inventions designed to increase energy efficiency,
- interventions or product modifications that incorporate alternative, renewable energy sources, or
- messaging campaign (e.g., public service announcement) designed to encourage people to modify lifestyle choices and behaviors to reduce energy consumption.

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Goals

Students will meet these goals in their explorations:

- Become familiar with renewable and non-renewable energy sources
- Gain awareness of ways that energy is wasted or lost and identify ways to conserve energy
- Develop guiding questions and hypothesis
- Design an experiment and conduct original research using the scientific method
- Develop the essential skills of communicating, creative problem solving, and logical thinking

Phase I. Learning Experiences

1. Introduce students to the energy unit by conducting a web-quest with the U.S. Energy Information Administration's *Energy Kids* website at <http://www.eia.gov/kids/index.cfm>. Ask students to complete a KWL chart for three non-renewable and three renewable energy sources found at the site. Another excellent website to introduce students to the unit is [Ruth Borchardt Elementary Library's 5th Grade Alternative Energy Inquiry Activity](#).
2. Using an electronics circuitry kit such as [littleBits](#), guide student explorations into the role of a power supply unit in human-made machines and electronics. Ask students to hypothesize what the original sources of energy for these power supply units might be? What happens when the power supply is deprived of energy?
3. Tour the school campus with notepads or journals and take an inventory of all of the possible devices that require energy to operate. Remember to account for items not easily in view such as hot water heaters and air conditioners. With the help of the librarian or media specialist, facilitate student research with books and Internet sites to determine the energy sources used by items in the inventory. One source for information on energy use and conservation is the [Energy Star Kids' Site](#). Conduct a Round-Robin for reporting findings and lead the class in a large group discussion.
4. Invite a speaker from an alternative energy company, a local utilities company, or the city electrical services unit. Take a virtual tour of a [power-plant](#) and/or watch the videos on the operation of turbines or [gasoline combustion engines](#).
5. Repeat the energy-use inventory at home, locating the devices and possible energy sources. Brainstorm a list of alternative sources.
6. Research ways to conserve energy around the house. One possible website for information is the U.S. Department of Energy's [Kids Saving Energy site](#). Complete the *Easy Energy Action Plan* found on the site.
7. Investigate some of the scientific properties of alternative energy sources through one of the [experiments](#) at the [Energy Kids](#) site.

8. Imagine an invention that harnesses a renewable energy source to power something small such as a portable video game player or a cell phone. Sketch out your ideas and explain how it might work.

Phase II. Independent Research

A. Research process

1. Selecting a topic. Students should select at least one energy-related area to investigate during an independent, long-term experiment. Design an experiment with the goal of reducing the amount of energy used in either the classroom or home. Depending upon student interest, the experiment may involve an investigation into an alternative energy source, an intervention aimed at improving conservation, and/or a campaign to reduce overall use by classmates and/or family members.
2. Asking guiding questions. Some questions to consider might include:
 - In what ways is this energy source attractive for consumer use?
 - How might the energy source be replenished or conserved through careful planning?
 - How does the energy source generate electricity and convert energy into usable work?
 - In what ways is the energy source wasted or lost during the process?
 - What might be some of the dangers or by-products related to this energy source?
 - How much energy is consumed in this environment (e.g., home or school)? How might you measure consumption? What trends in the measurements exist over a period of several months (e.g., through a review of meter readings or utility statements)?
 - What seasonal changes might contribute to increased or decreased energy use?
 - What lifestyle changes might contribute to increased or decreased energy use?

Each student will develop a hypothesis on how to increase energy efficiency in their environment through either: 1) a switch to, or supplement with, an alternative energy source, 2) a modification to the environment, structure, or usage patterns that increase efficiency, or 3) a change in habits or behaviors that results in decreased consumption.

3. Creating a research proposal. Students should identify their topic, 3-5 guiding questions, and the hypothesis their research will explore. Additionally, students will need to design and plan for how they will conduct their experiments. Questions to consider include:
 - What materials will the experiment require?
 - How will the student record data?
 - What variables will be constant and what variables will change?
 - What are the steps of the experiment's procedure and how will the student ensure that the steps are followed and accurately described?
 - How might students document the experimental design for other scientists?
 - Why might it be important in science to conduct experiments multiple times?

An experimental design rubric, as well as supporting documents can be found on the Connally Independent School District's website at <http://www.connally.org/Page/2843>. The TPSP Assessment Rubric is an excellent example as well.

4. Conducting the research. Students will conduct their experiments over the identified time periods. In addition to identified materials and tools, students will need to collect data in scientific notebooks or journals and may need graph paper, chart paper, or index cards for analyzing and organizing their data. You will need to guide students in selecting measurable variables and identifying constraints to the scope of their projects to all the experiments to be doable within the time frame and context of the class.
5. Developing conclusions and sharing findings. Each student will create a multimedia presentation to share his/her findings with a wider audience.

B. The product

Each student conducts background research into the chosen topic, develops a hypothesis, designs an experiment, collects data, and presents the work to classmates through multiple presentation formats. Elements of the presentation might include the following:

- PowerPoint or Keynote presentation,
- Public service announcement video,
- Aligned brochure or poster set,
- White paper article summarizing the research,
- Technical drawings for an energy-saving device, and/or
- Experimental design and procedure

C. Communication

Each group presents the energy report to classmates using appropriate vocabulary. The group should take questions or comments at the end of the report. The Q&A session should be impromptu and unscripted in order to reflect student learning accurately.

D. A completed project consists of:

1. Energy Use Inventory (from home or classroom environments)
2. Notes from background research
3. Hypothesis and research questions
4. Scientific notebook/journal with collected raw data
5. Multimedia presentation (e.g., PowerPoint, brochure/posters, white paper, drawings)
6. Video or audio of the presentation, including the Q&A session

Internet Resources

http://governor.state.tx.us/files/ecodev/Renewable_Energy.pdf

<http://www.eia.gov/kids/index.cfm>

http://www.eia.gov/kids/energy.cfm?page=sf_experiments

<http://www1.eere.energy.gov/kids/>
<http://www.howstuffworks.com/engine.htm>
http://energyclassroom.com/powerplanttour/ec_tour1_10_main.html
http://www.energystar.gov/index.cfm?c=kids.kids_index
<http://littlebits.cc/>
<http://borchardtlibrary.edublogs.org/2011/09/25/5th-grade-alternative-energy-inquiry-activity/>
<http://www.nature.org/greenliving/carboncalculator/index.htm> <http://www.energyeducation.tx.gov/>
<http://sciencenetlinks.com/lessons/renewable-energy-sources/>
http://www.nrel.gov/learning/re_basics.html
<http://www.energyquest.ca.gov/story/index.html>

Texas Essential Knowledge and Skills

The unit may address the following TEKS:

English Language Arts and Reading:

- 5.1 Reads grade-level text with fluency and comprehension
- 5.2 Understands new vocabulary and use it when reading and writing
- 5.7 Understands, makes inferences and draws conclusions about the varied structural patterns and features of literary nonfiction and provides evidence from text to support their understanding
- 5.9 Reads independently for sustained periods of time and produces evidence of their reading
- 5.10 Analyzes, makes inferences and draws conclusions about the author's purpose in cultural, historical, and contemporary contexts and provides evidence from the text to support their understanding
- 5.11 Analyzes, makes inferences and draws conclusions about expository text and provides evidence from text to support their understanding
- 5.13 Understands how to glean and uses information in procedural texts and documents
- 5.14 Uses comprehension skills to analyze how words, images, graphics, and sounds work together in various forms to impact meaning
- 5.15 Uses elements of the writing process (planning, drafting, revising, editing, and publishing) to compose text
- 5.16 Writes literary texts to express their ideas and feelings about real or imagined people, events, and ideas
- 5.18 Writes expository and procedural or work-related texts to communicate ideas and information to specific audiences for specific purposes
- 5.20 understands the function of and uses the conventions of academic language when speaking and writing
- 5.21 Writes legibly and uses appropriate capitalization and punctuation conventions in their compositions
- 5.23 Asks open-ended research questions and develops a plan for answering them
- 5.24 Determines, locates, and explores the full range of relevant sources addressing a research question and systematically records the information they gather

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- 5.25 Clarifies research questions and evaluates and synthesizes collected information
- 5.26 Organizes and presents their ideas and information according to the purpose of the research and their audience
- 5.27 Uses comprehension skills to listen attentively to others in formal and informal settings
- 5.28 Speaks clearly and to the point, using the conventions of language
- 5.29 Works productively with others in teams

Science:

- 5.1 Conducts classroom and outdoor investigations following home and school safety procedures and environmentally appropriate and ethical practices
- 5.2 Uses scientific methods during laboratory and outdoor investigations
- 5.3 Uses critical thinking and scientific problem solving to make informed decisions
- 5.4 Knows how to use a variety of tools and methods to conduct science inquiry
- 5.6 Knows that energy occurs in many forms and can be observed in cycles, patterns, and systems
- 5.7 Knows Earth's surface is constantly changing and consists of useful resources
- 5.9 Knows that there are relationships, systems, and cycles within environments

Social Studies:

- 5.4 Understands political, economic, and social changes that occurred in the United States during the 19th century
- 5.5 Understands important issues, events, and individuals in the United States during the 20th and 21st centuries
- 5.6 Uses geographic tools to collect, analyze, and interpret data
- 5.7 Understands the concept of regions in the United States
- 5.8 Understands the location and patterns of settlement and the geographic factors that influence where people live
- 5.9 Understands how people adapt to and modify their environment
- 5.10 Understands the basic economic patterns of early societies in the United States
- 5.13 Understands patterns of work and economic activities in the United States
- 5.19 Understands the importance of effective leadership in a constitutional republic
- 5.20 Understands the fundamental rights of American citizens guaranteed in the Bill of Rights and other amendments to the U.S. Constitution
- 5.23 Understands the impact of science and technology on society in the United States
- 5.24 Applies critical-thinking skills to organize and use information acquired from a variety of valid sources, including electronic technology
- 5.25 Communicates in written, oral, and visual forms
- 5.26 Uses problem-solving and decision-making skills, working independently and with others, in a variety of settings

Texas College and Career Readiness Standards

This unit may address the following Texas College and Career Readiness Standards:

English Language Arts:

- I.A.2 Generates ideas and gathers information relevant to the topic and purpose, keeping careful records of outside sources
- I.A.3 Evaluates relevance, quality, sufficiency, and depth of preliminary ideas and information, organizes material generated, and formulates thesis
- I.A.4 Recognizes the importance of revision as the key to effective writing
- I.A.5 Edits writing for proper voice, tense, and syntax, assuring that it conforms to standard English, when appropriate
- II.A.1 Uses effective reading strategies to determine a written work's purpose and intended audience
- II.A.2 Uses text features and graphics to form an overview of informational texts and to determine where to locate information
- II.A.4 Draws and supports complex inferences from text to summarize, draw conclusions, and distinguish facts from simple assertions and opinions
- II.A.5 Analyzes the presentation of information and the strength and quality of evidence used by the author, and judges the coherence and logic of the presentation and the credibility of an argument
- II.A.11 Identifies, analyzes, and evaluates similarities and differences in how multiple texts present information, argue a position, or relate a theme
- II.B.1 Identifies new words and concepts acquired through study of their relationships to other words and concepts
- II.B.2 Applies knowledge of roots and affixes to infer the meanings of new words
- II.B.3 Uses reference guides to confirm the meanings of new words or concepts
- II.D.1 Describes insights gained about oneself, others, or the world from reading specific texts
- III.A.1 Understands how style and content of spoken language varies in different contexts and influences the listener's understanding
- III.A.2 Adjusts presentation (delivery, vocabulary, length) to particular audiences and purposes
- III.B.1 Participates actively and effectively in one-on-one oral communication situations
- III.B.2 Participates actively and effectively in group discussions
- III.B.3 Plans and delivers focused and coherent presentations that convey clear and distinct perspectives and demonstrates solid reasoning
- IV.A.1 Analyzes and evaluates the effectiveness of a public presentation
- IV.A.2 Interprets a speaker's message; identifies the position taken and the evidence in support of that position
- IV.A.3 Uses a variety of strategies to enhance listening comprehension
- IV.B.1 Listens critically and responds appropriately to presentations
- IV.B.2 Listens actively and effectively in one-on-one communication situations

- IV.B.3 Listens actively and effectively in group discussions
- V.A.1 Formulates research questions
- V.A.2 Explores a research topic
- V.A.3 Refines research topic and devises a timeline for completing work
- V.B.1 Gathers relevant sources
- V.B.2 Evaluates the validity and reliability of sources
- V.B.3 Synthesizes and organizes information effectively
- V.C.1 Designs and presents an effective product
- V.C.2 Uses source material ethically

Mathematics:

- I.B.1 Performs computations with real and complex numbers
- I.C.1 Uses estimation to check for errors and reasonableness of solutions
- IV.A.1 Selects or uses the appropriate type of unit for the attribute being measured
- IV.B.1 Converts from one measurement system to another
- IV.D.2 Applies probabilistic measures to practical situations to make an informed decision
- VI.A.1 Plans a study
- VI.B.1 Determines types of data
- VI.B.2 Selects and applies appropriate visual representations of data
- VI.B.3 Computes and describes summary statistics of data
- VI.B.4 Describes patterns and departure from patterns in a set of data
- VI.C.1 Makes predictions and draws inferences using summary statistics
- VI.C.4 Recognizes reliability of statistical results
- VII.C.1 Applies known function models
- VII.C.2 Develops a function to model a situation
- VIII.A.1 Analyzes given information
- VIII.A.2 Formulates a plan or strategy
- VIII.A.3 Determines a solution
- VIII.A.4 Justifies the solution
- VIII.A.5 Evaluates the problem-solving process
- VIII.B.1 Develops and evaluates convincing arguments
- VIII.B.2 Uses various types of reasoning
- VIII.C.2 Uses a function to model a real-world situation
- VIII.C.3 Evaluates the problem solving process
- IX.A.3 Uses mathematics as a language for reasoning, problem solving, making connections, and generalizing
- IX.B.2 Summarizes and interprets mathematical information provided orally, visually, or in written form within the given context

- IX.C.1 Communicates mathematical ideas, reasoning, and their implications using symbols, diagrams, graphs, and words
- IX.C.2 Creates and uses representations to organize, record, and communicate mathematical ideas
- IX.C.3 Explains, displays, or justifies mathematical ideas and arguments using precise mathematical language in written or oral communications
- X.A.2 Connects mathematics to the study of other disciplines
- X.B.1 Uses multiple representations to demonstrate links between mathematical and real-world situations
- X.B.2 Understands and uses appropriate mathematical models in the natural, physical, and social sciences
- X.B.3 Knows and understands the use of mathematics in a variety of careers and professions

Science:

- I.B.1 Designs and conducts scientific investigations in which hypotheses are formulated and tested
- I.C.1 Collaborates on joint projects
- I.C.2 Understands and applies safe procedures in the laboratory and field, including chemical, electrical, and fire safety and safe handling of live or preserved organisms
- I.C.3 Demonstrates skill in the safe use of a wide variety of apparatuses, equipment, techniques, and procedures
- I.D.1 Demonstrates literacy in computer use
- I.D.2 Uses computer models, applications, and simulations
- I.D.3 Demonstrates appropriate use of a wide variety of apparatuses, equipment, techniques, and procedures for collecting quantitative and qualitative data
- I.E.1 Uses several modes of expression to describe or characterize natural patterns and phenomena. These modes of expression include narrative, numerical, graphical, pictorial, symbolic, and kinesthetic
- I.E.2 Uses essential vocabulary of the discipline being studied
- III.A.1 Uses correct applications of writing practices in scientific communication
- III.B.1 Reads technical and scientific articles to gain understanding of interpretations, apparatuses, techniques or procedures, and data
- III.B.3 Recognizes scientific and technical vocabulary in the field of study and uses this vocabulary to enhance clarity of communication
- III.B.4 Lists, uses and gives examples of specific strategies before, during, and after reading to improve comprehension
- III.C.1 Prepares and represents scientific/technical information in appropriate formats for various audiences
- III.D.1 Uses search engines, databases, and other digital electronic tools effectively to locate information
- III.D.2 Evaluates quality, accuracy, completeness, reliability, and currency of information from any source

- IV.B.1 Understands how scientific research and technology have an impact on ethical and legal practices
- IV.B.2 Understands how commonly held ethical beliefs impact scientific research
- IV.C.1 Understands the historical development of major theories in science
- IV.C.2 Recognizes the role of people in important contributions to scientific knowledge
- V.C.1 Recognizes patterns of change
- V.E.1 Uses models to make predictions
- V.E.2 Uses scale to relate models and structures
- VI.C.1 Knows multiple categories of evidence for evolutionary change and how this evidence is used to infer evolutionary relationships among organisms
- X.B.2 Knows the various sources of energy for humans and other biological systems
- X.C.1 Recognizes variations in population sizes, including human population and extinction, and describe mechanisms and conditions that produce these variations
- X.D.2 Understands the types, uses and regulations of the various natural resources
- X.E.1 Describes the different uses for land
- X.E.2 Understands the use and consequences of pest management
- X.E.3 Knows the different methods used to increase food production
- X.E.4 Understands land and water usage and management practices
- X.E.5 Understands how human practices affect air, water, and soil quality

Social Studies:

- I.A.1 Uses the tools and concepts of geography appropriately and accurately
- I.A.2 Analyzes the interaction between human communities and the environment
- I.A.3 Analyzes how physical and cultural processes have shaped human communities over time
- I.A.4 Evaluates the causes and effects of human migration patterns over time
- I.A.5 Analyzes how various cultural regions have changed over time
- I.A.6 Analyzes the relationship between geography and the development of human communities
- I.B.2 Identifies and evaluates sources and patterns of change and continuity across time and place
- I.B.3 Analyzes causes and effects of major political, economic, and social changes in U.S. and world history
- I.C.1 Evaluates different governmental systems and functions
- I.C.2 Evaluates changes in the functions and structures of government across time
- I.E.2 Defines the concept of socialization and analyzes the role socialization plays in human development and behavior
- I.F.1 Uses a variety of research and analytical tools to explore questions or issues thoroughly and fairly
- I.F.2 Analyzes ethical issues in historical, cultural, and social contexts
- II.A.1 Defines a “multicultural society” and considers both the positive and negative qualities of multiculturalism
- II.A.2 Evaluates the experiences and contributions of diverse groups to multicultural societies

- II.B.4 Evaluates how major philosophical and intellectual concepts influence human behavior or identity
- II.B.5 Explains the concepts of socioeconomic status and stratification
- II.B.6 Analyzes how individual and group identities are established and change over time
- III.A.1 Distinguishes spatial patterns of human communities that exist between or within contemporary political boundaries
- III.A.2 Connects regional or local developments to global ones
- III.A.3 Analyzes how and why diverse communities interact and become dependent on each other
- III.B.1 Applies social science methodologies to compare societies and cultures
- IV.A.1 Identifies and analyzes the main idea(s) and point(s) of view in sources
- IV.A.2 Situates an informational source in its appropriate contexts
- IV.A.3 Evaluates sources from multiple perspectives
- IV.A.4 Understands the differences between a primary and secondary source and uses each appropriately to conduct research and construct arguments
- IV.A.5 Reads narrative texts critically
- IV.A.6 Reads research data critically
- IV.B.1 Uses established research methodologies
- IV.B.2 Explains how historians and other social scientists develop new and competing views of past phenomena
- IV.B.3 Gathers, organizes, and displays the results of data and research
- IV.B.4 Identifies and collects sources
- IV.C.1 Understands/interprets presentations critically
- IV.D.1 Constructs a thesis that is supported by evidence
- IV.D.2 Recognizes and evaluates counter-arguments
- V.A.1 Uses appropriate oral communication techniques depending on the context or nature of the interaction
- V.A.2 Uses conventions of standard written English
- V.B.1 Attributes ideas and information to source materials and authors

Cross-Disciplinary Standards:

- I.A.1 Engages in scholarly inquiry and dialogue
- I.A.2 Accepts constructive criticism and revises personal views when valid evidence warrants
- I.B.1 Considers arguments and conclusions of self and others
- I.B.2 Constructs well-reasoned arguments to explain phenomena, validate conjectures, or support positions
- I.B.3 Gathers evidence to support arguments, findings, or lines of reasoning
- I.B.4 Supports or modifies claims based on the results of an inquiry
- I.C.1 Analyzes a situation to identify a problem to be solved
- I.C.2 Develops and applies multiple strategies to solving a problem

- I.C.3 Collects evidence and data systematically and directly related to solving a problem
- I.D.1 Self-monitors learning needs and seeks assistance when needed
- I.D.2 Uses study habits necessary to manage academic pursuits and requirements
- I.D.3 Strives for accuracy and precision
- I.D.4 Perseveres to complete and master tasks
- I.E.1 Works independently
- I.E.2 Works collaboratively
- I.F.1 Attributes ideas and information to source materials and people
- I.F.2 Evaluates sources for quality of content, validity, credibility, and relevance
- I.F.3 Includes the ideas of others and the complexities of the debate, issue, or problem
- I.F.4 Understands and adheres to ethical codes of conduct
- II.A.1 Uses effective prereading strategies
- II.A.2 Uses a variety of strategies to understand the meanings of new words
- II.A.3 Identifies the intended purpose and audience of the text
- II.A.4 Identifies the key information and supporting details
- II.A.5 Analyzes textual information critically
- II.C.1 Understands which topics or questions are to be investigated
- II.C.2 Explores a research topic
- II.C.3 Refines research topic based on preliminary research and devises a timeline for completing work
- II.C.4 Evaluates the validity and reliability of sources
- II.C.5 Synthesizes and organizes information effectively
- II.C.6 Designs and presents an effective product
- II.C.7 Integrates source material
- II.C.8 Presents final product
- II.D.1 Identifies patterns or departures from patterns among data
- II.D.2 Uses statistical and probabilistic skills necessary for planning an investigation, and collecting, analyzing, and interpreting data
- II.D.3 Presents analyzed data and communicates findings in a variety of formats
- II.E.1 Uses technology to gather information
- II.E.2 Uses technology to organize, manage, and analyze information
- II.E.3 Uses technology to communicate and display findings in a clear and coherent manner
- II.E.4 Uses technology appropriately