



# Wisconsin K-12 Energy Education Program

A Conceptual Guide to K-12 Energy Education in Wisconsin





# Wisconsin K-12 Energy Education Program (KEEP)

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# What is the Wisconsin K-12 Energy Education Program?

The Wisconsin K-12 Energy Education Program (KEEP) was created to help promote energy education in Wisconsin. In 1993, the Wisconsin Center for Environmental Education (WCEE) proposed that a comprehensive guide to K-12 energy education in Wisconsin be developed. In 1995, the Energy Center of Wisconsin, a nonprofit energy efficiency research organization based in Madison, agreed to fund the project. The Wisconsin Environmental Education Board and the University of Wisconsin-Stevens Point also provided support.

KEEP receives its primary funding through Focus on Energy, a public-private partnership offering energy information and services to energy utility customers throughout Wisconsin. These services are delivered by a group of firms contracted by the Wisconsin Department of Administration's Division of Energy. The goals of this program are to encourage energy efficiency and use of renewable energy, enhance the environment, and ensure the future supply of energy for Wisconsin. For information about Focus on Energy services and programs, call 1.800.762.7077 or visit them online at [www.focusonenergy.com](http://www.focusonenergy.com). Focus on Energy Funds for KEEP are administered through the Wisconsin Energy Conservation Corporation (WECC).

## **Mission Statement**

The mission of KEEP is to initiate and facilitate the development, dissemination, implementation, and evaluation of energy education programs within Wisconsin schools.

## **Goal**

The goal of KEEP is to improve and increase energy education in Wisconsin.

## **KEEP Accomplishments**

**A Conceptual Guide to K-12 Energy Education in Wisconsin:** Identifies important energy concepts that students should know and understand.

**Activity Guide:** Contains hands-on, interdisciplinary lessons that are aligned with Wisconsin's academic standards and make energy relevant to students' lives.

**Inservice Course for K-12 Teachers:** Provides teachers with hands-on experience teaching lessons from the Activity Guide and introduces them to additional energy-related teaching resources. The course increases teachers' energy literacy and increases the likelihood that they will implement KEEP materials in their classrooms.

**Web-based Energy Literacy Course:** Energy education via the Internet; the content of this interactive course is available at no charge to teachers year-round via the KEEP website and is offered for credit several times during the year.

**Renewable Energy Education:** Activity guides, support materials, and inservice courses provide teachers with background information about renewable energy they can share with students.

**Competent Energy Educators:** Over 2,000 teachers throughout the state have participated in KEEP courses and activities. These teachers are in turn increasing the quality and quantity of energy education for thousands of Wisconsin K-12 students. These teachers report that they now have the knowledge and experience to teach about energy and that their classroom teaching includes more activities and lessons about energy.

**Statewide Network of Energy Educators:** KEEP provides continued support for teachers through updates (print and online newsletters, website, conferences), support materials (energy education resource trunk), student involvement opportunities (compact fluorescent light bulb fundraiser, bookmark contests, regional events), and new initiatives that evolve out of teacher recommendations and partnership support.

**Partnerships in Energy Education:** Working collaboratively with Focus on Energy, utilities, and various energy resource professionals, KEEP promotes energy education and efficiency in homes, schools, and communities.

# A Rationale for Energy Education

Ask people to talk about energy; what would they say? Some would talk about the cost of energy and mention the price of gasoline or the cost of heating their homes in winter. Some might wonder how utilities can keep enough energy on hand to satisfy growing populations and if we'll need to build more power plants. Others might say that the widespread use of fossil fuels pollutes the air, causes acid rain, and leads to global warming, and that we should turn to cleaner, alternative energy sources to solve these problems. Some would recall the energy crisis of the 1970s, when the United States faced an oil embargo by the nations of the Middle East and a resulting sudden rise in the price of oil. They might say that if we continue to import oil, we must develop domestic energy resources to protect ourselves from future disruptions. Still others would have nothing to say—they simply take energy for granted and assume that it will always be there to maintain their health and lifestyles.

Energy is more than an individual economic, environmental, or political issue. It is the agent upon which all processes on Earth and throughout the universe depend. Without energy there would be no stars, no planets, no life. Every interaction among living and nonliving things is accompanied by the transfer and conversion of energy. Energy is the underlying “currency” that governs everything humans do with each other and with the natural environment that supports them.

If you understand energy and how it influences every aspect of our lives, you understand how issues like energy prices, the environment, utilities, imported oil, and a myriad others are interconnected. You might see how a solution to one issue could lead to the solution of another. If you drive a fuel-efficient car, for example, you might not only save yourself money on gasoline, you might help reduce pollution and even decrease this country's dependence on foreign oil.

Energy is certainly an important and complicated issue. The future of Wisconsin depends on people making wise energy policies and choices. That's why a comprehensive foundation in energy education is vital for Wisconsin. In the past, curriculum developers and teachers in Wisconsin included energy education in curricula and developed energy-related activities. But many Wisconsin educators believe more needs to be done if energy education is to be widely and consistently applied throughout the state. This *Conceptual Guide to K-12 Energy Education in Wisconsin* helps meet that need, whether you use it to update an existing curriculum or to develop a whole new program for energy education. We have designed this guide so that educators can use it to provide Wisconsin students of every grade level the opportunity to receive a logically sequenced, comprehensive education about energy.

## **Purpose of this Publication**

1. Identify and present concepts that can help people understand energy and make decisions about energy issues.
2. Provide guidance for teachers to incorporate energy education into their curricula.
3. Direct the development of energy education programs and support materials.



# Energy Education Conceptual Framework



# Conceptual Framework

## Introduction

This energy education conceptual framework is not a curriculum in itself, rather, it is a skeleton that provides the foundation for a curriculum. Just as the bones of a skeleton provide strength and structure to a body, the concepts that make up the framework provide the basis for a strong, organized, and comprehensive curriculum. We have endeavored to provide concepts that address a variety of different issues and viewpoints.

These concepts were derived from energy-related frameworks designed by other educational organizations (National Energy Foundation, 1988; North American Association for Environmental Education, 1990) and from physical and environmental science texts. We developed additional concepts to reflect issues specific to Wisconsin. Throughout this process, the KEEP Steering Committee and two focus groups—consisting of energy resource management specialists, curriculum planners, and educators—reviewed and evaluated the framework. Their assistance helps ensure that the concepts in this framework form the basis of a logically sequenced, comprehensive energy education.

This framework is designed to evolve as energy education evolves. For example, this latest revision of the framework includes renewable energy concepts. These concepts were identified and validated by a Delphi panel comprised of renewable energy resource experts and educators. The renewable energy concepts are noted in the framework with an icon.



We encourage teachers and curriculum developers to assist with this evolution by modifying and adding to this framework as they build a curriculum that best fits the needs of their educational programs.

## Framework Organization

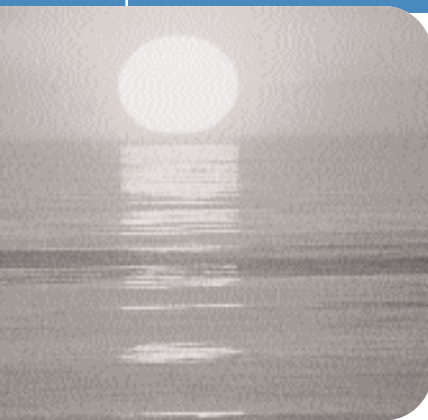
The concepts within the framework are organized under four themes. Each theme consists of concepts which are further organized into subthemes.

The themes are arranged so that they build upon each other. The information in the first theme lends understanding to concepts in the second theme, and so forth. The first theme, We Need Energy, defines energy, describes how energy is transferred and converted from one form to another according to the laws of thermodynamics, and explains how energy flows through living and nonliving systems. Developing Energy Resources addresses the sources of energy and how humans, through technology, use energy to meet societal wants and needs. It also shows how humans have come to treat energy as a resource. Effects of Energy Resource Development covers how using energy resources affects human societies and the environment. Finally, Managing Energy Resource Use identifies strategies we can use to help resolve many of the issues presented in the third theme. In addition, this theme discusses how today's energy related decisions and actions influence the future availability of energy resources.

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# We Need Energy



The concepts within this theme provide students with a fundamental knowledge about energy and help students appreciate the nature of energy in their everyday lives. This provides students with an awareness of how energy is used to maintain, organize, and change systems that affect their lives. These concepts also provide the foundation upon which the concepts in the following themes are built.

## Definition of energy

Understanding these concepts helps students to identify forms of energy.

1. Energy is the ability to organize or change matter or “the ability to do work.”
2. Energy exists in two main forms: potential energy (energy stored in matter) and kinetic energy (energy of motion). More specific forms of energy include thermal, elastic, electromagnetic (such as light, electrical, and magnetic energy), gravitational, chemical, and nuclear energy.
3. Energy can be measured and quantified. Different units of measure can be used to quantify energy. One unit can be converted to another. Units of measure for energy include calories and kilowatt-hours.
4. Power is the rate at which energy is used. Units of measure for power include horsepower and watts.

## Natural laws that govern energy

Mastering these concepts helps students interpret how energy is transferred and converted. It also helps them recognize that there are natural limitations to the amount of energy that anyone or anything can use.

5. Energy can be transferred from one location to another, as in when the sun’s energy travels through space to Earth. The two ways that energy can be transferred are by doing work (such as pushing an object) and by transferring heat (conduction, convection, and radiation).
6. Energy can neither be created nor destroyed, it can only be converted from one form to another. This is the first law of thermodynamics. For example, the chemical energy stored in coal can be converted into thermal energy.
7. With each energy conversion from one form to another, some of the energy becomes unavailable for further use. This is the second law of thermodynamics. For example, the thermal energy released by burning coal is eventually dispersed into the environment and cannot be used again. The measure of this dispersal of energy is called “entropy.” For example, the entropy of an unburned piece of coal and its surroundings is lower than the entropy of the ashes, cinders, and the warmed surroundings due to burning that piece of coal.



## Energy flow in systems

Comprehending these concepts helps students interpret the natural laws that govern energy flow through living and nonliving systems.

8. All systems obey the natural laws that govern energy.
9. Some of the energy converted by systems flows through them. The rest is stored within them for seconds or even millions of years. Some systems convert energy more efficiently than others.

## Energy flow in nonliving systems

Understanding these concepts helps students explain how energy creates weather patterns and shapes Earth's surface.

10. Energy flows through and is stored within a variety of nonliving systems.
  - Solar energy absorbed and distributed on Earth's surface gives rise to weather systems and ocean currents.
  - The thermal energy stored in Earth's interior shapes and moves Earth's crust as in earthquakes, mountain building, and volcanic activity.

## Energy flow in living systems

By mastering these concepts, students should be able to illustrate how humans and other organisms get the energy they need to survive.

11. Living systems use energy to grow, change, maintain health, move, and reproduce. Some of the energy acquired by living systems is stored for later use.
  - Plants and other autotrophs convert solar energy to chemical energy via photosynthesis.
  - Animals and other heterotrophs convert chemical energy in plants or in other animals to chemical energy they can use via cellular respiration.
  - Energy is needed for maintaining the health—nutrition and the quality and quantity of food—of all organisms, including humans.
12. Living systems differ in how fast they use energy. Some living systems—such as birds—use energy quickly for growth and metabolism, and therefore must replace it quickly. Others—such as turtles—use energy more slowly and, therefore, need to replace it less frequently.

## Energy flow in ecosystems, including human societies

Fully comprehending these concepts helps students recognize how energy flows through and characterizes ecosystems. It also helps students appreciate that the world around them—including human societies—depends on a continuous supply of energy.

- 13.** Ecosystems use energy to maintain biogeochemical cycles—such as the sedimentary, gaseous, and hydrologic cycles—between living and nonliving systems.
- 14.** Ecosystems are characterized by:
  - Types and quantities of available energy sources, such as the chemical energy stored in plants.
  - Types and characteristics of energy flows, such as food webs.
  - Energy budgets, which are the amount of energy available with respect to the amount of energy used by an ecosystem. The total energy budget of an ecosystem determines its carrying capacity.
  - An ability to use energy to maintain a balanced or steady state.
- 15.** Wisconsin has five main biological communities: northern forest, southern forests, prairies, oak savanne and aquatic.
- 16.** Human societies, like natural ecosystems, need energy to organize and maintain themselves. The human use of energy follows the natural laws that govern energy flow in all systems.
- 17.** Human societies range from hunter-gatherer to industrial and can be classified by the amount of energy they use and the rate at which they use it.
  - Hunter-gatherer societies are adapted to their natural environments. They depend on energy and materials available directly from nature, and their rates of consumption of the energy and materials they use are often in balance with nature.
  - Non-industrial agricultural societies modify their natural environments primarily to domesticate food sources. They depend on modest technologies to provide energy and materials.
  - Industrial societies attempt to remake and control their natural environment. They have high rates of energy consumption, depend on sophisticated technologies, and require a substantial energy subsidy to provide energy and materials for residential, commercial, industrial, agricultural, and transportation needs.
- 18.** In general, Wisconsin and the rest of the United States is an industrial, technologically advanced, high-energy-use society.

# Developing Energy Resources

This theme helps students realize how they and other humans have become more and more dependent on the development and use of energy resources to satisfy their standard of living. Understanding what energy is and how it flows through systems is necessary to appreciate how humans have come to value and treat energy as a resource.

## Development of energy resources

Understanding these concepts helps students explain how humans have used technology to further their ability to use energy. It also helps students identify and compare different energy resources—such as renewable and nonrenewable—and appreciate the importance of energy-related technologies.

**19.** Primary energy sources are those that are either found or stored in nature.

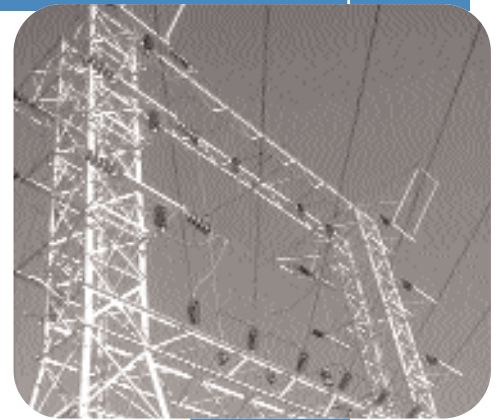
- See concept 20 for secondary energy resources.
- See concept 25 for renewable and nonrenewable energy resources.
- The sun is a primary energy source and the principal source of Earth's energy. Energy from the sun is stored in other primary energy sources such as coal, oil, natural gas, and biomass (such as wood). Solar energy is also responsible for the energy in the wind and in the water cycle (the hydrologic cycle).
- See concept 13 for the hydrologic and other biogeochemical cycles.
- Other primary energy sources found on Earth include nuclear energy from radioactive substances, thermal energy stored in Earth's interior, and potential energy due to Earth's gravity.

**20.** Secondary energy resources are produced from primary energy resources using technology. For example, we produce electricity—a secondary resource—by burning coal in a power plant or by using photovoltaic cells to harness solar energy. We can also produce alcohol fuel from crops.

**21.** Energy sources are considered to be energy resources by individuals and society when they serve societal needs and wants. Examples of using resources are burning wood for warmth as well as extracting and refining oil to produce fuel for transportation or materials such as plastic.

**22.** Human societies have obtained energy resources in the following ways:

- Hunter-gatherer societies get their energy from decentralized energy systems—as in gathering wood from a forest and burning it to cook food.
- Nonindustrial agricultural societies also get their energy from decentralized energy systems—such as using windmills to grind grain—although these systems are more centralized than those of hunter-gatherer societies.
- Industrial societies get their energy from a mix of centralized energy systems (power plants) and decentralized energy systems (solar panels on rooftops), with centralized energy systems being the dominant energy system. Most of these energy systems are developed by understanding the natural laws that govern energy and applying this knowledge to create sophisticated energy technologies.



**23.** Some energy sources are concentrated, such as the nuclear energy stored in enriched uranium used in a nuclear power plant, and others are diffuse, such as thermal energy stored in the oceans.

**24.** Geographically, Earth's energy sources are unevenly distributed.

**25.** Energy resources are described as nonrenewable and renewable.

- Nonrenewable resources are either replaced very slowly or are not replaced at all by natural processes. Nonrenewable resources include fossil fuels—coal, oil, and natural gas—and nuclear fuels such as uranium.
- Renewable energy resources can be replaced quickly by natural processes. Renewable resources include solar energy,

wind, hydropower, and biomass. Even some of these resources can be depleted when their rate of use exceeds their rate of replacement.

- Concepts related to renewable energy resources are provided on page 21.

**26.** Wisconsin has primary energy sources.

**27.** Most of the energy resources currently used in Wisconsin are fossil and nuclear fuels, all of which are imported into the state. Other resources used in Wisconsin include biomass, hydropower, solar energy, and wind, all of which are renewable and can be found within the state.

## Consumption of energy resources

Mastering these concepts helps students assess modern human societies' dependence on energy and analyze how we have come to value energy as a resource.

**28.** Supply and demand influence energy resource discovery, development, and use. The supply and demand for an energy resource is determined by resource availability, level of technological development, and societal factors such as lifestyle, health and safety, economics, politics, and culture.

- See the next theme, Effects of Energy Resource Use for concepts that address the economic and sociopolitical effects of energy consumption.

**29.** Global demands for energy resources are increasing. This is due to human population growth and increasing worldwide consumption. As certain energy resources are depleted and demand increases, competition for these resources also increases. This is especially true of non-renewable resources, such as fossil fuels.

# Developing Renewable Energy Resources

These concepts further describe concept 25. They help students realize how they and other humans develop and use renewable energy resources to satisfy their standard of living. Understanding what renewable energy is and how it flows through systems is necessary to appreciate how humans have come to value and treat renewable energy as a resource.

## Development of renewable energy resources

Mastering these concepts helps students comprehend renewable energy.

**25.1.** Renewable energy resources come from sources that can be continuously replenished.

**25.2.** Renewable resources people commonly use are solar, wind, hydropower, biomass, and geothermal.

**25.3.** Human societies have used renewable resources to meet their energy needs throughout history.

**25.4.** Renewable energy is a reliable energy source for many residential and commercial applications, including heat generation, electricity generation, and vehicle fuel.

**25.5.** Each renewable energy resource has inherent qualities that make it more suitable for some applications than others.

**25.6.** The efficiency of converting renewable energy sources to useable energy varies according to the source and/or technology used.

**25.7.** The availability of renewable energy varies; some renewable resources are in constant supply, while others are intermittent. Intermittent energy can be stored for future use.

**25.8.** Renewable energy systems can be centralized or decentralized. A centralized energy system is one in which large amounts of an energy resource are converted from one form into another form in one location.

A decentralized energy system is one in

which small amounts of an energy resource are converted from one form into another form in many locations by individuals or small groups of consumers.

### Solar Energy

Comprehending these concepts helps students understand solar energy.

**25.9.** Solar energy is the radiation from the sun that reaches Earth's surface.

**25.10.** Solar energy is used to generate electricity or to heat air or water. Solar heating can be passive or active. A passive solar heating system captures the sun's energy within a structure and converts it into low-temperature heat, which then naturally circulates. In an active solar heating system, collectors absorb solar energy, and pumps or other devices are used to circulate the heated fluid.

### Wind Energy

Comprehending these concepts helps students understand wind energy.

**25.11.** Wind is air in motion and is produced by the unequal heating of Earth's surface by the sun.

**25.12.** Wind energy is used to generate electricity, grind grain, and pump water. Wind speed increases above Earth's surface, so wind turbines are mounted on tall towers.



**Hydropower**

Comprehending these concepts helps students understand hydropower energy.

**25.13.** Hydropower is the kinetic energy generated by falling water. The water's flow (volume) and fall (height) determine the amount of available energy in moving water.

**25.14.** Hydropower plants capture the kinetic energy of falling water to generate electricity. People capture the energy by damming a river, creating an artificial reservoir, or channeling a portion of a river through a generating facility.

**Biomass**

Comprehending these concepts helps students understand biomass energy.

**25.15.** Biomass energy is the energy released from living or recently living organic matter (as opposed to fossil fuels). People release the energy in organic matter through processes such as burning and fermentation.

**25.16.** Biomass can be used for a variety of purposes. It can be burned to generate electricity and heat and can be processed to produce fuel.

**Geothermal Energy**

Comprehending these concepts helps students understand geothermal energy.

**25.17.** Geothermal energy is heat energy that originates within Earth. Geothermal resources range from shallow ground sources (low temperature) to hot water, steam and rock miles below Earth's surface (high temperature).

**25.18.** Geothermal resources can be used for a variety of purposes. Low temperature geothermal resources use the relatively constant temperature of the soil or surface water as a heat source and sink for a heat pump, which heats and cools buildings. High temperature geothermal resources are underground reservoirs of hot water or steam that can be tapped for electrical power production.

# Effects of Energy Resource Development

Concepts in this theme help students investigate how energy use has affected their lives. Recognizing these effects increases students' awareness of why and how they use energy and promotes an understanding of why it's important to manage energy resource use.

## Quality of life

Understanding these concepts helps students analyze current energy-use practices and evaluate how they affect quality of life.

### Lifestyles

**30.** A driving factor in the development of energy-related technology has been people's desire for comfort, convenience, and entertainment.

- See concepts 58-61 for how comfort, convenience, and entertainment relate to cultural aspects of energy development and use.

**31.** Technologies that support people's lifestyles may lead to the inefficient use of energy resources, depending on how these technologies are designed and used.

**32.** Individuals can purchase renewable energy from centralized sources such as power utilities. Using renewable energy from these sources requires no modification of lifestyle.

**33.** Individuals and businesses can create their own renewable energy from decentralized systems such as a wind system. Using renewable energy from a decentralized system may require the following lifestyle modifications:

- Monitoring and maintaining the system
- Employing energy efficient building construction techniques
- Using energy efficient appliances and lights
- Monitoring and managing their energy use

**34.** The reasons people choose to use renewable energy include the following: environmental concerns, economic concerns, ethical concerns, interest in technology, desire to be self-sufficient, and concerns about electrical reliability.

### Health and safety

**35.** There are personal and community health and safety factors associated with the development and use of energy resources. Energy resource development and use may pose direct risks to personal and community health and safety. By affecting the quality of the environment, energy use may pose indirect risks to personal and community health and safety.

- See concept 65 for environmental risks to the health and well-being of human and nonhuman life.



**36.** The health and safety of Wisconsin citizens is related to the development and use of energy resources.


**37.** Using renewable energy will reduce some personal and community health risks since it generally releases fewer pollutants into the environment than fossil fuels.


**38.** Decentralized renewable energy systems require proper maintenance to be safe.





### **Economic**

- 39.** The availability and use of energy resources influence the economic growth and well-being of society.
- 40.** Many occupations, businesses, and public services—such as utilities—result from the development and use of energy resources.
- 41.** The market price of energy includes the cost of energy resource exploration, recovery, refining, pollution control, distribution, and transportation, as well as taxes and other fees.
- 42.** Other costs that are not part of the market price of energy (called externality costs) are due to factors such as environmental damage, property damage, civil unrest, war, and health care.
- 43.** The rate of energy consumption is influenced by energy prices and externality costs.
- 44.** The cost of energy is a factor in Wisconsin's economic development and affects the household budget of Wisconsin citizens.
-  **45.** When consumers consider purchasing renewable energy systems, they are often concerned about payback. Payback refers to recovering the initial cost of purchasing and installing a renewable energy system through its production of energy.
-  **46.** With the current prices of energy, some decentralized renewable energy systems will accomplish a full payback within their lifespan. Factors that influence payback include the type of technology, resource used, and location. If demand, production, and technological advances in renewable energy increase, equipment and installation prices will be reduced and the likelihood of payback will increase.

 **47.** When comparing the cost of renewable energy to non-renewable energy, externality costs associated with non-renewable energy should be considered.

 **48.** Many occupations, businesses, and public services (such as utilities) result from the development and use of renewable energy resources.


 **49.** Most renewable energy sources are free. Therefore, development and production investments go toward materials and labor rather than purchasing fuel. This money is often spent within the United States and is frequently spent within the same state or town where the resource is located.

 **50.** Using renewable energy allows the United States to become more energy independent.


### **Sociopolitical**

- 51.** Sociopolitical processes result in laws and regulations that govern energy development, availability, and use. Sociopolitical processes have usually governed centralized energy systems such as public utilities.
- 52.** The demand for energy resources influences relationships—alliances and conflicts—among states, regions, and nations.
- 53.** The positive and negative effects of energy resource development and use are not shared equally among states, regions, nations, and individuals, although sociopolitical processes have made some effort to address this.
- 54.** Wisconsin's sociopolitical processes result in laws and regulations that govern energy development, availability, and use.






**55.** Support for renewable energy development is influenced by society and politics. In the United States, renewable energy resource development has been governed by the energy policies of political administrations.



**56.** Sociopolitical processes result in laws and regulations that govern renewable energy development, availability, and use. Access and zoning laws have been developed to guide renewable energy system placement and installation.



**57.** Renewable energy systems can be owned by individuals, communities, and governments.


#### **Cultural**

**58.** The availability of energy resources has shaped cultures, and each culture has value systems that influence how energy resources are used.


**59.** Energy use by cultures is expressed through art, architecture, urban planning, music, language and literature, theater, dance, other forms of media, sports, and religion.

**60.** Because society's understanding of and relationship with energy changes over time, cultural expressions of energy use changes over time as well. For example, ancient Egyptians worshiped the sun, while modern societies associate the sun with a positive mood, recreation, and nature.


**61.** Wisconsin's culture has been, and will continue to be, shaped in part by available energy resources.



**62.** Support for renewable energy varies within and among countries, cultures, and governments.



**63.** Using renewable energy can help mitigate the effects of extracting fossil fuels. Extracting fossil fuels affects the cultures, environments, and health of individuals.



**64.** Many third world countries are benefiting from the development and deployment of renewable energy equipment from industrialized nations.

## **Quality of the environment**


By comprehending these concepts, students will be able to explain how current energy practices affect the quality of the environment and the health of organisms living in the environment.

**65.** Energy resource development and use can alter environmental conditions leading to, for example, reduced air and water quality, deforestation, and changes in land use due to road building. These altered environmental conditions may pose risks to the health and well-being of human and other life forms.


**66.** The faster and more extensively energy resources are developed and used, the more likely it is that environmental conditions will be altered to a greater degree.

**67.** It takes less energy and less money to preserve the environment than it does to restore the environment after it has been altered.

**68.** Wisconsin's environment has been, and continues to be, altered by energy resource development and use.



**69.** Renewable energy technologies use clean sources of energy that have a lower environmental impact than nonrenewable energy sources.



**70.** There are environmental costs and benefits involved in the development, manufacture, distribution, and installation of renewable energy technologies. Each renewable energy technology and its application (e.g. centralized or decentralized) has unique environmental costs and benefits.

# Managing Energy Resource Use



Concepts in this theme help students identify ways to ensure that energy resources will be available for future users. For students to willingly and effectively take action to manage energy resource use, they must have a thorough understanding and appreciation of what energy is, how it flows through systems, its value as a resource, and the effects its use has on human societies and the environment.

## Management of energy resource use

By mastering these concepts, students will recognize their ability to make decisions regarding which resources to use and how those decisions influence the future availability of resources. Students will also identify actions they can take based on these decisions.

- 71.** The choice of energy resource and how it is used influences how energy resources are managed.
- 72.** Energy resources may be managed through conservation, which includes reducing wasteful energy use, using energy for a given purpose more efficiently, or reducing energy use altogether. Energy conservation prolongs the availability of energy resources and contributes to the development of a sustainable society.
- 73.** A citizen, acting individually or as part of a group or organization, may make decisions (such as deciding to ride a bicycle instead of driving a car) and take actions (riding the bicycle) that determine how the energy they use will be managed. Citizens may also affect the actions of other individuals, groups, or organizations to determine how the energy they use will be managed. This can be accomplished by ecomanagement (physical action), education, persuasion, consumer action, political action, or legal action.
- 74.** The decisions and actions taken by societies and their citizens depend on the barriers and incentives associated with energy management choices. Examples of barriers include high energy costs, lack of access to new technologies, and laws that discourage the development or use of certain energy resources. Examples of incentives include rebates, building codes that promote energy conservation, and appliance efficiency standards.
- 75.** Energy management products and programs are available to help Wisconsin citizens use energy resources more efficiently, such as through conservation programs, home heating fuel options, and programs that promote certain lifestyles. These products and programs also help maintain the quality of the environment within and beyond Wisconsin.
- 76.** Using renewable energy resources helps prolong the availability of nonrenewable energy resources.
- 77.** Actions supporting renewable energy use can range from simple and inexpensive (e.g., purchasing solar powered calculators) to more advanced and expensive (e.g., installing a home wind system).
- 78.** The use of decentralized renewable energy systems is usually a personal choice rather than a government mandate, although there are government programs that provide incentives for using renewable energy.

## Future outlooks for the development and use of energy resources

By understanding these concepts, students can evaluate how their actions affect the quality of life and the environment of their community, nation, and world. Students will also predict how scientific, technological, and social changes will influence future energy resource availability.

**79.** New energy resources, new ways of managing resources, and new energy technologies will be developed in the future.

**80.** Choices made today about energy resource management will affect the future quality of life and the environment.

**81.** New types of societies—such as a sustainable society or a postindustrial society whose economy is based on information and service—may emerge as energy resource development and use changes.



**82.** Renewable energy use is growing worldwide.



**83.** Renewable energy technologies continue to improve and become more efficient.



**84.** New energy resources, new ways of managing energy resources, and new renewable technologies will be developed in the future.



# Suggested Scope and Sequence



# Suggested Scope and Sequence

## Introduction

This section provides guidelines showing when and to what extent energy concepts could be integrated into school curricula. The Wisconsin K-12 Energy Education Program (KEEP) developed this suggested scope and sequence with the help of K-12 teachers who attended the KEEP Building an Energy Education Curriculum workshop in October 1995 and a Scope and Sequence workshop in 2003. You can use this section as a guide for when (grade level) and where (subject area) energy concepts can be incorporated into a curriculum.

Note that this scope and sequence is not a one-size-fits-all solution to energy education; educators and curriculum designers in each school system will need to determine the best ways to introduce concepts into their curricula. For example, they may find that after surveying existing curricula, many of these concepts are already being addressed. If a particular concept is not covered, then courses may need to be revised to include them. The companion Activity Guide contains interdisciplinary energy-related activities that can be used by educators to bring energy concepts into their lessons.

## Scope and Sequence Organization

### Wisconsin Model Academic Standards

The Wisconsin Model Academic Standards were developed by the Wisconsin Department of Public Instruction. The standards specify what students should know and be able to do by certain points in their K-12 education. School districts may use the academic standards as guides for developing local grade-by-grade curricula. The concepts in this framework have been correlated with the standards to enhance ease of use for educators. The five subject areas cited (science, environmental education, social studies, technology education, and family and consumer education) have the most direct correlation to the concepts. Other subject areas will be covered and listed in the Activity Guide. Full text of the standards cited in the scope and sequence can be found after the scope and sequence.

### How to use the following diagrams

All of the concepts have been placed on the diagrams under the four theme headings. The purpose of this structure is to visibly represent at which grade levels (K-4, 5-8, 9-12) KEEP recommends the concepts should be developed and mastered. In other grade levels, the concepts can be either introduced or enriched. The appropriate performance standards are listed at each grade level for reference.

# Example Diagram

Theme heading and explanation

## We Need Energy



The concepts within this theme provide students with a fundamental knowledge about energy and help students appreciate the nature of energy in their everyday lives. This provides students with an awareness of how energy is used to maintain, organize, and change systems that affect their lives. These concepts also provide the foundation upon which the concepts in the following themes are built.

Subtheme related to theme

Standards addressed

Numbers in parenthesis are the concept(s) correlated with a particular standard

Concepts related to each subtheme are placed at recommended grade level

Standards	Definition of energy	Natural laws that govern energy
<b>Grade K-4</b> SC: B.4.3 (17); D.4.4 (5-6, 11, 12); E.4.4 (10); E.4.7 (16) EE: B.4.1 (10,11,12); B.4.4 (14); B.4.5 (15) SS: A.4.6 (10); A.4.4 (17); B.4.2 (17); B.4.8 (17) TE: A.4.6 (17); A.4.7 (17) FCE: A.1 & 2 (11)		
<b>Grade 5-8</b> SC: A.8.1 (3, 4, 8-12); D.8.8 (10); D.8.9 (5-7, 10-13); E.8.2 (10) EE: B.8.1 (5,6,7); B.8.6 (15); B.8.24 (17) SS: A.8.10 (5,6,7,17); B.8.7 (5,6,7,17); B.8.4 (18)	1. Energy is the ability to organize or change matter or "the ability to do work."  2. Energy exists in two main forms: potential energy (energy stored in matter) and kinetic energy (energy of motion). More specific forms of energy include thermal, elastic, electromagnetic (such as light, electrical, and magnetic energy), gravitational, chemical, and nuclear energy.	5. Energy can be transferred from one location to another, as in when the sun's energy travels through space to Earth. The two ways that energy can be transferred are by doing work (such as pushing an object) and by transferring heat (conduction, convection, and radiation).  6. Energy can neither be created nor destroyed, it can only be converted from one form to another. This is the first law of thermodynamics. For example, the chemical energy stored in coal can be converted into thermal energy.
<b>Grade 9-12</b> SC: D.12.3 (7); D.12.6 (11); D.12.12 (10,11); F.12.9 (11); F.12.10 (11,12) EE: B.12.1 (1,5-9,11-14,17,18); C.12.3 (17) SS: A.12.10 (17); A.12.11 (17); B.12.9 (17); B.12.10 (17)	3. Energy can be measured and quantified. Different units of measure can be used to quantify energy. One unit can be converted to another. Units of measure for energy include calories and kilowatt- hours.  4. Power is the rate at which energy is used. Units of measure for power include horsepower and watts.	7. With each energy conversion from one form to another, some of the energy becomes unavailable for further use.

### Key to standards\* abbreviations:

SC: science  
 EE: environmental education  
 SS: social studies  
 TE: technology education  
 FCE: family and consumer education

\*Standards in other subject areas, such as language arts, mathematics, and visual arts, are addressed in the activity guide.

# We Need Energy



The concepts within this theme provide students with a fundamental knowledge about energy and help students appreciate the nature of energy in their everyday lives. This provides students with an awareness of how energy is used to maintain, organize, and change systems that affect their lives. These concepts also provide the foundation upon which the concepts in the following themes are built.

Standards	Definition of energy	Natural laws that govern energy
<p><b>Grade K-4</b>  <b>SC:</b> B.4.3 (17); D.4.4 (5-6, 11, 12); E.4.4 (10); E.4.7 (16)  <b>EE:</b> B.4.1 (10,11,12); B.4.4 (14); B.4.5 (15)  <b>SS:</b> A.4.6 (10); A.4.4 (17); B.4.2 (17); B.4.8 (17)  <b>TE:</b> A.4.6 (17); A.4.7 (17)  <b>FCE:</b> A.1 &amp; 2 (11)</p>		
<p><b>Grade 5-8</b>  <b>SC:</b> A.8.1 (3, 4, 8-12); D.8.8 (10); D.8.9 (5-7; 10-13); E.8.2 (10)  <b>EE:</b> B.8.1 (5,6,7); B.8.6 (15); B.8.24 (17)  <b>SS:</b> A.8.10 (5,6,7,17); B.8.7 (5,6,7,17); B.8.4 (18)</p>	<p>1. Energy is the ability to organize or change matter or "the ability to do work."</p> <p>2. Energy exists in two main forms: potential energy (energy stored in matter) and kinetic energy (energy of motion). More specific forms of energy include thermal, elastic, electromagnetic (such as light, electrical, and magnetic energy), gravitational, chemical, and nuclear energy.</p>	<p>5. Energy can be transferred from one location to another, as in when the sun's energy travels through space to Earth. The two ways that energy can be transferred are by doing work (such as pushing an object) and by transferring heat (conduction, convection, and radiation).</p> <p>6. Energy can neither be created nor destroyed, it can only be converted from one form to another. This is the first law of thermodynamics. For example, the chemical energy stored in coal can be converted into thermal energy.</p>
<p><b>Grade 9-12</b>  <b>SC:</b> D.12.3 (7); D.12.6 (11); D.12.12 (10,11); F.12.9 (11); F.12.10 (11,12)  <b>EE:</b> B.12.1 (1,5-9,11-14,17,18); C.12.3 (17)  <b>SS:</b> A.12.10 (17); A.12.11 (17); B.12.9 (17); B.12.10 (17)</p>	<p>3. Energy can be measured and quantified. Different units of measure can be used to quantify energy. One unit can be converted to another. Units of measure for energy include calories and kilowatt- hours.</p> <p>4. Power is the rate at which energy is used. Units of measure for power include horsepower and watts.</p>	<p>7. With each energy conversion from one form to another, some of the energy becomes unavailable for further use.</p>



**Energy flow in systems/living and nonliving****Energy flow in ecosystems**

11. Living systems use energy to grow, change, maintain health, move, and reproduce. Some of the energy acquired by living systems is stored for later use.

16. Human societies, like natural systems, need energy to organize and maintain themselves.

17. Human societies range from hunter-gatherer to industrial and can be classified by the amount of energy they use and the rate at which they use it.

8. All systems obey the natural laws that govern energy.

10. Energy flows through and is stored within a variety of nonliving systems.

18. In general, Wisconsin and the rest of the United States is an industrial, technologically advanced, high energy- use society.

9. Some of the energy converted by systems flows through them. The rest is stored within them for seconds or even millions of years. Some systems convert energy more efficiently than others.

12. Living systems differ in how fast they use energy. Some living systems—such as birds—use energy quickly for growth and metabolism, and therefore must replace it quickly. Others—such as turtles—use energy more slowly and, therefore, need to replace it less frequently.

13. Ecosystems use energy to maintain biogeochemical cycles between living and nonliving systems.

14. Ecosystems are characterized by types and quantities of energy flows, energy budgets, and ability to use energy to maintain a balanced or steady state.

15. Wisconsin has five main biological communities: northern forests, southern forests, prairies, oak savanne and aquatic.

# Developing Energy Resources



This theme helps students realize how they and other humans have become more and more dependent on the development and use of energy resources to satisfy their standard of living. Understanding what energy is and how it flows through systems is necessary to appreciate how humans have come to value and treat energy as a resource.

Standards	Development of energy resources	Consumption of energy resources
<p><b>Grade K-4</b></p> <p><b>SC:</b> A.4.3 (25.6); B.4.3 (22); E.4.7 (22,25.2,25.4)</p> <p><b>EE:</b> B.4.1 (19); B.4.2 (25.2-25.4); B.4.3 (19,21-23,25,25.1-25.2,27); B.4.8 (19,21); B.4.9 (25,25.1, 25.2); B.4.10 (25.3-25.4); C.4.1 (29); C.4.5 (25)</p> <p><b>SS:</b> A.4.4 (22); A.4.6 (19); A.4.8 (22); A.4.9 (22,25,25.10); B.4.2 (22); B.4.4 (25.3); B.4.8 (19-20, 22-23,25,25.3,25.4,27,29); B.4.9 (25.8)</p> <p><b>TE:</b> A.4.6 (22,25.3); A.4.7 (22); B.4.1 (25.8,25.10), B.4.2 (25.12, 25.14,25.16,25.18); D.4.5 (25)</p>	<p>19. Primary energy sources are those that are either found or stored in nature.</p> <p>20. Secondary energy resources are produced from primary energy resources using technology.</p> <p>26. Wisconsin has primary energy sources.</p>	
<p><b>Grade 5-8</b></p> <p><b>SC:</b> B.8.5 (25.3); D.8.8 (25.10, 25.12,25.14-25.16,25.18); D.8.9 (25.10,25.12,25.14-25.16,25.18); E.8.3 (19); E.8.6 (22,25.2-25.4, 29); G.8.3 (25.3)</p> <p><b>EE:</b> B.8.5 (29); B.8.10 (29); B.8.13 (24); B.8.14 (27); B.8.15 (29); B.8.16 (25,28,29); B.8.24 (22)</p> <p><b>SS:</b> A.8.4 (26,27,29); A.8.10 (22,25.4,28,29); A.8.11 (28,29); B.8.7 (19,20,22); B.8.8 (25.9-25.18); D.8.7 (24); E.8.5 (25.3-25.4,25.8)</p> <p><b>TE:</b> A.8.3 (28); A.8.7 (25,25.3); B.8.5 (25.8), B.8.6 (25.5-25.6); D.8.3 (25)</p>	<p>22. Human societies have obtained energy resources in a variety of ways.</p> <p>25. Certain energy resources are renewable because they can be replaced by natural processes quickly. Other energy resources are nonrenewable because they are either replaced very slowly or are not replaced at all by natural processes.</p> <p>26. Wisconsin has primary energy sources.</p> <p>27. Most of the energy resources currently used in Wisconsin are fossil and nuclear fuels, all of which are imported into the state. Other resources used in Wisconsin include biomass, hydropower, solar energy, and wind, all of which are renewable and can be found within the state.</p>	<p>29. Global demands for energy due to human population growth and increasing worldwide consumption. As certain energy resources are depleted and demand increases, competition for these resources also increases. This is especially true of nonrenewable resources, such as fossil fuels.</p>
<p><b>Grade 9-12</b></p> <p><b>SC:</b> E.12.1 (19); G.12.5 (25)</p> <p><b>EE:</b> B.12.1 (25.8); B.12.6 (19); B.12.10 (25.4); B.12.11 (29); B.12.15 (29); B.12.16 (24); C.12.3 (22)</p> <p><b>SS:</b> A.12.4 (29); A.12.10 (22); A.12.11 (22); B.12.9 (22); B.12.10 (29)</p> <p><b>TE:</b> D.12.4 (25.5-25.7)</p>	<p>21. Energy sources are considered to be energy resources by individuals and society when they serve societal needs and wants.</p> <p>23. Some energy sources are concentrated and others are diffuse.</p> <p>24. Geographically, Earth's energy sources are unevenly distributed.</p>	<p>28. Supply and demand influence energy resource discovery, development, and use. The supply and demand for an energy resource is determined by resource availability, level of technological development, and societal factors such as lifestyle, health and safety, economics, politics, and culture.</p>

## Development of renewable energy resources

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- 25.1 Renewable energy resources come from sources that can be continuously replenished.
  - 25.2 Renewable resources people use are solar, wind, hydropower, biomass, and geothermal.
  - 25.3 Human societies have used renewable resources to meet throughout history.
  - 25.9 Solar energy is the radiation from the sun that reaches Earth's surface.
- 

- 25.4 Renewable energy is a reliable energy source for many applications.
  - 25.7 The availability of renewable energy varies.
  - 25.10 Solar energy is used to generate electricity or to heat air or water.
  - 25.11 Wind is air in motion and is produced by the unequal heating of Earth's surface by the sun.
  - 25.12 Wind energy is used to generate electricity, grind grain, and pump water.
  - 25.13 Hydropower is the kinetic energy generated by falling water.
  - 25.14 Hydropower plants capture the kinetic energy of falling water to generate electricity
  - 25.15 Biomass energy is the energy released from living or recently living organic matter
  - 25.16 Biomass can be used for a variety of purposes.
  - 25.17 Geothermal energy is heat energy that originates within Earth.
  - 25.18 Geothermal resources can be used for a variety of purposes.
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- 25.5 Each renewable energy resource has qualities that make it suitable for certain applications.
  - 25.6 The efficiency of converting renewable energy sources to useable energy varies.
  - 25.8 Renewable energy systems can be centralized or decentralized.
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# Effects of Energy Resource Development



Concepts in this theme help students investigate how energy use has affected their lives. Recognizing these effects increases students' awareness of why and how they use energy and promotes an understanding of why it is important to manage energy resource use.

Standards	Quality of the environment	Sociopolitical
<p><b>Grades K-4</b></p> <p><b>SC:</b> A.4.2 (37, 69), F.4.4 (37), G.4.1 (48); H.4.2 (42, 65); H.4.3 (30, 31)</p> <p><b>EE:</b> B.4.2 (30,31); B.4.10 (30,31); B.4.11 (40,48), B.4.12 (65-66,69-70); C.4.1 (35,65,66,67); C.4.4 (34)</p> <p><b>SS:</b> A.4.4 (33), A.4.8 (40,59,65,66,68); A.4.9 (34), B.4.8 (31,32,37,40,44,47, 48,49,50,63,65,66,68,69); B.4.9 (47,50), C.4.5 (63), D.4.7 (39,40,47,48,49,50)</p> <p><b>TE:</b> A.4.4 (30); A.4.5 (30,39); B.4.1 (30); B.4.3 (38), B.4.4 (70), D.4.1 (70), D.4.2 (30,35,65,66); D.4.4 (37,65,66,68-70); D.4.5 (30,31,35, 36,40,52,53,65,66,68,70)</p> <p><b>FCE:</b> A.1 (63), A.2(67); C.2 (34)</p>	<p>65. Energy resource development and use can alter environmental conditions.</p>	
<p><b>Grades 5-8</b></p> <p><b>SC:</b> E.8.6 (62-63); F.8.10 (55-56,65-67); G.8.2 (40,48); G.8.3 (32-33,37,40,65,47-48,63-64,69-70); H.8.3 (37)</p> <p><b>EE:</b> B.8.5 (37,69); B.8.9 (58,59,62); B.8.10 (65,66,70); B.8.12 (62); B.8.15 (37,70); B.8.17 (65,66,68); B.8.18 (65); B.8.21 (32,37,65); B.8.22 (40,48); D.8.3 (34); D.8.4 (51,54); D.8.5 (32-33,37,55); D.8.7 (34); D.8.8 (39-40,44,51-56)</p> <p><b>SS:</b> A.8.4 (61,65,66,68); A.8.7 (64); A.8.10 (31,32,33,37,47,65,66); A.8.11 (30,32,43, 53,65,66); B.8.7 (32,39-43,58); B.8.8 (37,47-50,63-64,69); B.8.9 (51,52,53,54,65,66); B.8.10 (53); C.8.3 (53); D.8.2 (40-43,45-46); D.8.4 (47,65); D.8.5 (51,54); D.8.7 (49-50); D.8.11 (37,63,69-70)</p> <p><b>TE:</b> A.8.2 (32,65); A.8.4 (51); A.8.5 (62); B.8.6 (45,69-70); D.8.3 (30,31,36,40, 52,53,65, 66,68,70); D.8.4 (52,53,63); D.8.5 (34,64)</p> <p><b>FCE:</b> A.1 (63)</p>	<p>66. Faster energy resources development will affect environmental damage more extensively.</p> <p>68. Wisconsin's environment is altered by energy resource development and use.</p> <p>69. Renewable energy technologies use clean sources of energy that have a lower environmental impact than nonrenewable energy sources.</p>	<p>52. The demand for energy resources influences relationships—alliances and conflicts—among states, regions, and nations.</p> <p>57. Renewable energy systems can be owned by individuals, communities, and governments.</p>
<p><b>Grades 9-12</b></p> <p><b>SC:</b> A.12.5 (32-34); B.12.2 (39,40); E.12.4 (66); F.12.10 (37,47,69-70); G.12.3 (70); G.12.4 (30,31); H.12.3 (55); H.12.5 (37,69-70)</p> <p><b>EE:</b> B.12.12 (51-53,70); B.12.13 (51,55-57,62); B.12.16 (52,53,63-64); B.12.18 (37); B.12.19 (39); B.12.21 (48); D.12.2 (34), D.12.6 (34), D.12.7 (55-56); D.12.9 (44,51)</p> <p><b>SS:</b> A.12.5 (53); A.12.9 (33-34,40,45,56,59,63,66); A.12.10 (62); A.12.11 (32,37,63-66,69-70); A.12.12 (61); B.12.9 (32,40,50,53,65,68); C.12.9 (55); C.12.11 (55); D.12.2 (41); D.12.4 (69-70); D.12.10 (46,48)</p> <p><b>TE:</b> A.12.2 (34-35,66); A.12.3 (53); B.12.3 (40); D.12.2 (47,53); D.12.3 (62), D.12.4 (70)</p> <p><b>FCE:</b> A.1 (63)</p>	<p>67. It takes less energy and less money to preserve the environment than it does to restore the environment after it has been altered.</p> <p>70. There are environmental costs and benefits involved in the development, manufacture, distribution, and installation of renewable energy technologies.</p>	<p>51. Sociopolitical processes result in laws and regulations that govern energy.</p> <p>53. The effects of energy resource development and use are not shared equally.</p> <p>54. Wisconsin's sociopolitical processes result in laws and regulations.</p> <p>55. Support for renewable energy is influenced by society and politics.</p> <p>56. Sociopolitical processes govern renewable energy development, availability, and use.</p>

Economic	Lifestyles/Health/Cultural
	<p>35. There health and safety factors associated with energy development and use.</p> <p>36. The health and safety of Wisconsin citizens is related energy development and use.</p> <p>59. Energy use by cultures is expressed through art, language and literature, and religion.</p>
<p>39. The availability and use of energy resources influence the economic growth.</p> <p>40. Many occupations and businesses result from the development and use of energy resources.</p> <p>44. The cost of energy is a factor in Wisconsin’s economic development.</p> <p>48. Many occupations and businesses result from the development and use of renewable energy.</p> <p>50. Using renewable energy allows the United States to become more energy independent.</p>	<p>31. Technologies that support people’s lifestyles may lead to the inefficient use of energy.</p> <p>32. Individuals can purchase renewable energy from centralized sources such as power utilities.</p> <p>34. People choose renewable energy for a variety of reasons.</p> <p>37. Using renewable energy will reduce some personal and community health risks.</p> <p>61. Wisconsin’s culture is shaped in part by available energy resources.</p> <p>62. Support for renewable energy varies within and among countries, cultures, and governments.</p>
<p>41. The market price of energy includes the cost of exploration, pollution control, and other fees.</p> <p>42. Externality costs (environment and health damage) are not included in energy’s market price.</p> <p>43. The rate of energy consumption is influenced by energy prices and externality costs.</p> <p>45. Consumers considering purchasing renewable energy are often concerned about payback.</p> <p>46. Some decentralized renewable energy systems will accomplish payback within their lifespan.</p> <p>47. Consider non-renewable energy externality costs when comparing costs of renewable energy.</p> <p>49. Investments of renewable energy development go toward materials and labor rather than fuel.</p>	<p>30. Development of energy-related technology drives people’s desire for comfort, convenience, and entertainment.</p> <p>33. Renewable energy can be created from decentralized systems.</p> <p>38. Decentralized renewable energy systems require proper maintenance to be safe.</p> <p>58. The availability of energy resources has shaped cultures.</p> <p>60. Because society’s understanding of and relationship with energy changes over time, cultural expressions of energy use changes over time.</p> <p>63. Using renewable energy can help mitigate the effects of extracting fossil fuels.</p> <p>64. Many third world countries benefit from renewable energy development and deployment.</p>

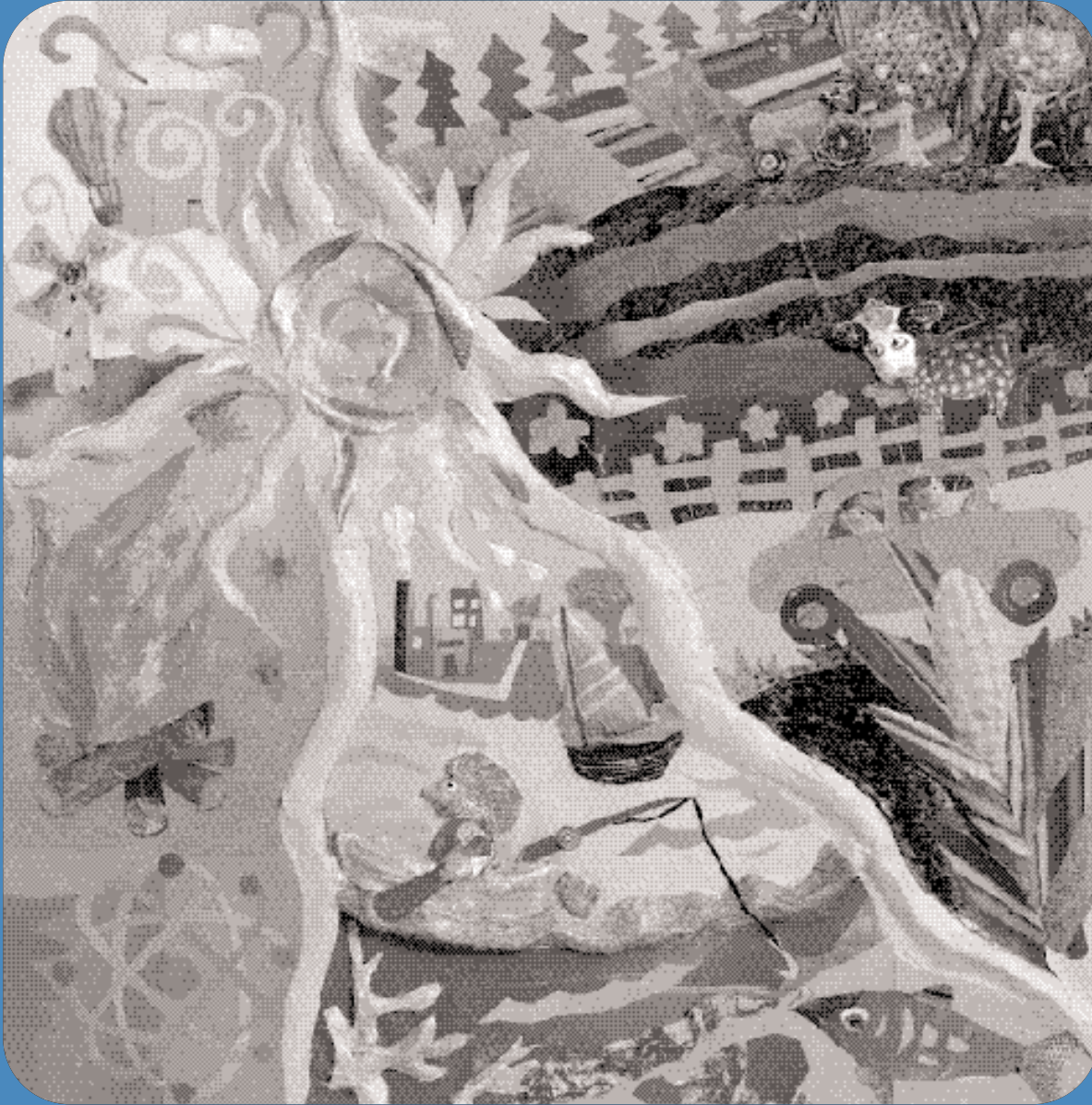
# Managing Energy Resource Use



Concepts in this theme help students identify ways to ensure that energy resources will be available for future users. For students to willingly and effectively take action to manage energy resource use, they must have a thorough understanding and appreciation of what energy is, how it flows through systems, its value as a resource, and the effects its use has on human societies and the environment.

Standards	Management of energy resource use	Future outlooks for the development and use of energy resources
<p><b>Grade K-4</b>  <b>EE:</b> C.4.2 (79-81); C.4.4 (72-75); D.4.3 (72-73,77); D.4.5 (73,77); E.4.1 (73,77); E.4.2 (72-73,77)  <b>SS:</b> A.4.9 (72,75); B.4.8 (76)  <b>FCE:</b> A.2 (76); D.1 (73)</p>		<p>79. New energy resources, new ways of managing energy resources, and new energy technologies will be developed in the future.</p> <p>82. Renewable energy use is growing worldwide.</p>
<p><b>Grade 5-8</b>  <b>SC:</b> B.8.5 (83-84); D.8.7 (72-73); F.8.10 (82); G.8.2 (83-84)  <b>EE:</b> B.8.16 (76); D.8.5 (72-73,76-77); D.8.8 (72-73)  <b>SS:</b> A.8.11 (71-74,79,81); B.8.8 (76); D.8.5 (78); D.8.11 (72-75); E.8.4 (73)  <b>TE:</b> A.8.1 (83-84); D.8.5 (77)  <b>FCE:</b> A.2 (72,76); D.1 (73); D.2 (77)</p>	<p>71. The choice of energy resource and how it is used influences how energy resources are managed.</p> <p>72. Energy resources may be managed through conservation, using energy for a given purpose more efficiently, or reducing energy use altogether.</p> <p>75. Energy management products and programs are available to help Wisconsin citizens use energy resources more efficiently.</p> <p>76. Using renewable energy resources helps prolong the availability of nonrenewable energy resources.</p> <p>77. Actions supporting renewable energy use can range from simple and inexpensive (e.g., purchasing solar powered calculators) to more advanced and expensive (e.g., installing a home wind system).</p>	<p>80. Choices made today about energy resource management will affect the future quality of life and the environment.</p> <p>83. Renewable energy technologies continue to improve and become more efficient.</p>
<p><b>Grade 9-12</b>  <b>SC:</b> A.12.1 (80); A.12.5 (73); B.12.4 (79,83-84); E.12.4 (72,80); H.12.4 (73)  <b>EE:</b> B.12.9 (83-84); B.12.11 (79,83-84); B.12.12 (76); D.12.2 (73); D.12.4 (71); E.12.3 (77)  <b>SS:</b> A.12.4 (76); C.12.10 (73); E.12.6 (73)  <b>TE:</b> A.12.6 (79-81); A.12.7 (72-73); B.12.1 (72-73)  <b>FCE:</b> A.2 (72,76); D.1 (73)</p>	<p>73. A citizen, acting individually or as part of a group or organization, may make decisions and take actions that determine how the energy they use will be managed.</p> <p>74. The decisions and actions taken by societies and their citizens depend on the barriers and incentives associated with energy management choices.</p> <p>78. The use of decentralized renewable energy systems is usually a personal choice rather than a government mandate, although there are government programs that provide incentives for using renewable energy.</p>	<p>81. New types of societies may emerge as energy resource development and use changes.</p> <p>84. New energy resources, new ways of managing energy resources, and new renewable technologies will be developed in the future.</p>

# Wisconsin Model Academic Standards



# Wisconsin Model Academic Standards

Wisconsin Department of Public Instruction, [www.dpi.state.wi.us/dpi/standards](http://www.dpi.state.wi.us/dpi/standards)

## Science

A.4.2 When faced with a science-related problem, decide what evidence, models, or explanations previously studied can be used to better understand what is happening now

A.4.3 When investigating a science-related problem, decide what data can be collected to determine the most useful explanations

A.8.1 Develop their understanding of the science themes by using the themes to frame questions about science-related issues and problems

A.12.1 Apply the underlying themes of science to develop defensible visions of the future

A.12.5 Show how the ideas and themes of science can be used to make real-life decisions about careers, work places, life-styles, and use of resources

B.4.3 Show how the major developments of scientific knowledge in the earth and space, life and environmental, and physical sciences have changed over time

B.8.5 Explain ways in which science knowledge is shared, checked, and extended, and show how these processes change over time

B.12.2 Identify the cultural conditions that are usually present during great periods of discovery, scientific development, and invention

B.12.4 Show how basic research and applied research contribute to new discoveries, inventions, and applications

D.4.4 Observe and describe changes in form, temperature, color, speed, and direction of objects and construct explanations for the changes

D.8.7 While conducting investigations of common physical and chemical interactions occurring in the laboratory and the outside world, use commonly accepted definitions of energy and the idea of energy conservation

D.8.8 Describe and investigate the properties of light, heat, gravity, radio waves, magnetic fields, electrical fields, and sound waves as they interact with material objects in common situations

D.8.9 Explain the behaviors of various forms of energy by using the models of energy transmission, both in the laboratory and in real-life situations

D.12.2 Explain the forces that hold the atom together and illustrate how nuclear interactions change the atom

D.12.3 Explain exchanges of energy in chemical interactions and exchange of mass and energy in atomic/nuclear reactions

D.12.6 Through investigations, identify the types of chemical interactions, including endothermic, exothermic, oxidation, photosynthesis, and acid/base reactions

E.4.4 Identify celestial objects (stars, sun, moon, planets) in the sky, noting changes in patterns of those objects over time

E.4.7 Using the science themes, describe resources used in the home, community, and nation as a whole

E.8.2 Describe underlying structures of the earth that cause changes in the earth's surface



E.8.3 Using the science themes during investigations, describe climate, weather, ocean currents, soil movements, and changes in the forces acting on the earth

E.8.6 Describe through investigations the use of the earth's resources by humans in both past and current cultures, particularly how changes in the resources used for the past 100 years are the basis for efforts to conserve and recycle renewable and nonrenewable resources

E. 12.1 Using the science themes, distinguish between internal energies (decay of radioactive isotopes, gravity) and external energies (sun) in the earth's systems and show how these sources of energy have an impact on those systems

E.12.4 Analyze the benefits, costs, and limitations of past, present, and projected use of resources and technology and explain the consequences to the environment

F.4.4 Using the science themes, develop explanations for the connections among living and nonliving things in various environments

F.8.10 Project how current trends in human resource use and population growth will influence the natural environment, and show how current policies affect those trends

F.12.9 Using the science themes, investigate energy systems (related to food chains) to show how energy is stored in food (plants and animals) and how energy is released by digestion and metabolism

F.12.10 Understand the impact of energy on organisms in living systems

G.4.1 Identify the technology used by someone employed in a job or position in Wisconsin and explain how the technology helps

G.8.2 Explain how current scientific and technological discoveries have an influence on the work people do and how some of these discoveries also lead to new careers

G.8.3 Illustrate the impact that science and technology have had, both good and bad, on careers, systems, society, environment, and quality of life

G.12.3 Analyze the costs, benefits, or problems resulting from a scientific or technological innovation, including implications for the individual and the community

G.12.4 Show how a major scientific or technological change has had an impact on work, leisure, or the home

G.12.5 Choose a specific problem in our society, identify alternative scientific or technological solutions to that problem and argue its merits

H.4.2 Using the science themes, identify local and state issues that are helped by science and technology and explain how science and technology can also cause a problem

H.4.3 Show how science has contributed to meeting personal needs, including hygiene, nutrition, exercise, safety, and health care

H.8.3 Understand the consequences of decisions affecting personal health and safety

H.12.3 Show how policy decisions in science depend on many factors, including social values, ethics, beliefs, time-frames, and considerations of science and technology

H.12.4 Advocate a solution or combination of solutions to a problem in science or technology

H.12.5 Investigate how current plans or proposals concerning resource management, scientific knowledge, or technological development will have an impact on the environment, ecology, and quality of life in a community or region

#### **Environmental Education Standards**

B.4.1 Describe the flow of energy in natural systems, citing the sun as the source of energy on the earth; e.g., a food chain

B.4.2 Illustrate how they use energy in their daily lives

B.4.3 List sources of energy, distinguishing between renewable and nonrenewable sources

B.4.4 List the components of an ecosystem, including the qualities of a healthy habitat

B.4.5 Describe natural and human-built ecosystems in Wisconsin

B.4.8 Describe and give examples of natural resources; e.g., water, minerals, soils, air

B.4.9 Distinguish between renewable and nonrenewable resources

B.4.10 Describe how they use natural resources in their daily lives

B.4.11 List jobs in the community that result from or are influenced by processing and using natural resources

B.4.12 Determine the cause of different types of pollution

B.8.1 Describe the flow of energy in a natural and a human-built ecosystem using the laws of thermodynamics

B.8.5 Give examples of human impact on various ecosystems

B.8.6 Describe major ecosystems of Wisconsin

B.8.9 Explain how the environment is perceived differently by various cultures

B.8.10 Explain and cite examples of how humans shape the environment

B.8.12 Provide examples of how different cultures use natural resources reflecting the economic, aesthetic, and other values of that culture

B.8.13 Diagram how resources are distributed around the world

B.8.14 Identify the natural resources that are found in Wisconsin and those that are imported

B.8.15 Analyze how people impact their environment through resource use

B.8.16 Recognize the economic, environmental, and other factors that impact resource availability and explain why certain resources are becoming depleted

B.8.17 Explain how human resource use can impact the environment; e.g., erosion, burning fossil fuels

B.8.18 Identify major air, water, or land pollutants and their sources

B.8.21 Identify and analyze individual, local, regional, national, and global effects of pollution on plant, animal, and human health

B.8.24 Create a timeline of Wisconsin history in resource management

B.8.22 Identify careers related to natural resources and environmental concerns

B.8.24 Create a timeline of Wisconsin history in resource management

B.12.1 Evaluate the relationship of matter and energy and the flow of energy in natural, managed, and built systems

B.12.9 Evaluate ways in which technology has expanded our ability to alter the environment and its capacity to support humans and other living organisms

B.12.10 Identify and evaluate multiple uses of natural resources and how society is influenced by the availability of these resources

B.12.11 Assess how changes in the availability and use of natural resources (especially water and energy sources) will affect society and human activities; such as, transportation, agricultural systems, manufacturing

B.12.12 Evaluate the environmental and societal costs and benefits of allocating resources in various ways and identify management strategies to maintain economic and environmental sustainability

B.12.13 Analyze how different political and governmental systems manage resource development, distribution, consumption, and waste disposal

B.12.15 Describe changes in the rates of human population growth in various societies and the factors associated with those changes related to economic and environmental sustainability

B.12.16 Analyze how natural resource ownership and trade influences relationships in local, national, and global economies

B.12.18 Analyze cause and effect relationships of pollutants and other environmental changes on human health

B.12.19 Illustrate how environmental quality affects the economic well-being of a community

B.12.21 Research the roles of various careers related to natural resource management and other environmental fields

C.4.1 Identify environmental problems and issues

C.4.2 Apply ideas of past, present, and future to specific environmental issues

C.4.4 Identify some of the decisions and actions related to the issue

C.4.5 Identify proposed solutions to the issue and discuss arguments for and against the issue

C.12.3 Maintain a historical perspective when researching environmental issues; include past, present, and future considerations

D.4.3 Identify two or more ways to take positive environmental action; e.g., posters, letters, and speeches

D.4.5 Explain how they can influence an environmental issue

D.8.3 List reasons why an individual or group chooses to participate or not participate in an environmental activity in the home, school, or community

D.8.4 Explain the political, legal, and budgetary options for resolving local, state, and national environmental issues

D.8.5 Explain how personal actions can impact an environmental issue; e.g., doing volunteer work in conservation

D.8.7 Identify examples of how personal beliefs can influence environmental decisions

D.8.8 Give examples of education, economic, and government institutions' influence on an environmental issue, and the role of citizens in policy formation

D.12.2 Evaluate reasons for participation or nonparticipation in an environmental activity in the home, school, or community

D.12.4 Describe the rights and responsibilities of citizenship in regard to environmental problems and issues

D.12.6 Identify and analyze examples of the impact beliefs and values have on environmental decisions

D.12.7 Analyze political, educational, economic, and governmental influences on environmental issues, and identify the role of citizens in policy formation

D.12.9 Describe the regulatory and economic approaches to improving the environment and explain the advantages and disadvantages of each

E.4.1 Identify and describe examples of their environmental civic responsibilities and the actions they take to meet them

E.4.2 Understand how their personal actions impact their civic responsibilities toward the environment

E.12.3 Take action in regard to environmental issues in the home, school, or communities

### **Social Science**

A.4.4 Describe and give examples of ways in which people interact with the physical environment, including use of land, location of communities, methods of construction, and design of shelters

A.4.6 Identify and distinguish between predictable environmental changes, such as weather patterns and seasons, and unpredictable changes, such as floods and droughts, and describe the social and economic effects of these changes

A.4.8 Identify major changes in the local community that have been caused by human beings, such as a construction project, a new highway, a building torn down, or a fire; discuss reasons for these changes; and explain their probable effects on the community and the environment

A.4.9 Give examples to show how scientific and technological knowledge has led to environmental changes, such as pollution prevention measures, air-conditioning, and solar heating

A.8.4 Conduct a historical study to analyze the use of the local environment in a Wisconsin community and to explain the effect of this use on the environment

A.8.7 Describe the movement of people, ideas, diseases, and products throughout the world

A.8.10 Identify major discoveries in science and technology and describe their social and economic effects on the physical and human environment

A.8.11 Give examples of the causes and consequences of current global issues, such as the expansion of global markets, the urbanization of the developing world, the consumption of natural resources, and the extinction of species, and suggest possible responses by various individuals, groups, and nations

A.12.4 Analyze the short-term and long-term effects that major changes in population in various parts of the world have had or might have on the environment

A.12.5 Use a variety of geographic information and resources to analyze and illustrate the ways in which the unequal global distribution of natural resources influences trade and shapes economic patterns

A.12.9 Identify and analyze cultural factors, such as human needs, values, ideals, and public policies, that influence the design of places, such as an urban center, an industrial park, a public project, or a planned neighborhood

A.12.10 Analyze the effect of cultural ethics and values in various parts of the world on scientific and technological development

A.12.11 Describe scientific and technological development in various regions of the world and analyze the ways in which development affects environment and culture

A.12.12 Assess the advantages and disadvantages of selected land use policies in the local community, Wisconsin, the United States, and the world

B.4.2 Use a timeline to select, organize, and sequence information describing eras in history

B.4.4 Compare and contrast changes in contemporary life with life in the past by looking at social, economic, political, and cultural roles played by individuals and groups

B.4.8 Compare past and present technologies related to energy, transportation, and communications, and describe the effects of technological change, either beneficial or harmful, on people and the environment

B.4.9 Describe examples of cooperation and interdependence among individuals, groups, and nations

B.8.4 Explain how and why events may be interpreted differently depending upon the perspectives of participants, witnesses, reporters, and historians

B.8.7 Identify significant events and people in the major eras of United States and world history

B.8.8 Identify major scientific discoveries and technological innovations and describe their social and economic effects on society

B.8.9 Explain the need for laws and policies to regulate science and technology

B.8.10 Analyze examples of conflict, cooperation, and interdependence among groups, societies, or nations

B.12.9 Select significant changes caused by technology, industrialization, urbanization, and population growth, and analyze the effects of these changes in the United States and the world

B.12.10 Select instances of scientific, intellectual, and religious change in various regions of the world at different times in history and discuss the impact those changes had on beliefs and values

C.4.5 Explain how various forms of civic action such as running for political office, voting, signing an initiative, and speaking at hearings, can contribute to the well-being of the community

C.8.3 Explain how laws are developed, how the purposes of government are established, and how the powers of government are acquired, maintained, justified, and sometimes abused

C.12.9 Identify and evaluate the means through which advocates influence public policy

C.12.10 Identify ways people may participate effectively in community affairs and the political process

C.12.11 Evaluate the ways in which public opinion can be used to influence and shape public policy

D.4.7 Describe how personal economic decisions, such as deciding what to buy, what to recycle, or how much to contribute to people in need, can affect the lives of people in Wisconsin, the United States, and the world

D.8.2 Identify and explain basic economic concepts: supply, demand, production, exchange, and consumption; labor, wages, and capital; inflation and deflation; market economy and command economy; public and private goods and services

D.8.4 Describe how investments in human and physical capital, including new technology, affect standard of living and quality of life

D.8.5 Give examples to show how government provides for national defense; health, safety, and environmental protection; defense of property rights; and the maintenance of free and fair market activity

D.8.7 Identify the location of concentrations of selected natural resources and describe how their acquisition and distribution generates trade and shapes economic patterns

D.8.11 Describe how personal decisions can have a global impact on issues such as trade agreements, recycling, and conserving the environment

D.12.2 Use basic economic concepts (such as supply and demand; production, distribution, and consumption; labor, wages, and capital; inflation and deflation; market economy and command economy) to compare and contrast local, regional, and national economies across time and at the present time

D.12.4 Explain and evaluate the effects of new technology, global economic interdependence, and competition on the development of national policies and on the lives of individuals and families in the United States and the world

D.12.10 Analyze the ways in which supply and demand, competition, prices, incentives, and profits influence what is produced and distributed in a competitive market system

E.8.4 Describe and explain the means by which individuals, groups, and institutions may contribute to social continuity and change within a community

E.8.5 Describe and explain the means by which groups and institutions meet the needs of individuals and societies

E.12.6 Analyze the means by which and extent to which groups and institutions can influence people, events, and cultures in both historical and contemporary settings

### **Technology Education**

A.4.4 Explain that the purpose of a designed object is to solve a problem or enhance the quality of life

A.4.5 Determine that humans have always developed tools to communicate, build, move things, and reshape their environment to meet their wants and needs

A.4.6 Illustrate how technology has evolved throughout human history

A.4.7 Research how different groups in the world use technology

A.8.1 Show that technology has allowed us to further the efforts of science and, in turn, science has enabled us to develop better technology

A.8.2 Explain the need for and application of knowledge and skills from other disciplines when engaging in technological activities

A.8.3 Identify and contrast the connections and differences between technology and other disciplines

A.8.4 Determine that technological knowledge is valuable but not always available to everyone on an equal basis

A.8.5 Analyze how cultures and groups value technology differently and how these values influence the development and acceptance of technology

A.8.6 Analyze the distribution and access of various technologies and explain how inequities occur because of social and political systems

A.8.7 Discover that human will or desire can lead to the design of new technology in order to seize an opportunity or solve a problem

A.12.2 Understand that humans are faced with moral and ethical issues because technology is enabling very significant modifications to the natural world

A.12.3 Explain why decisions regarding the use of technology are dependent on the situation, application, or perception of the group using it

A.12.6 Use accepted methods of forecasting and projecting to develop scenarios of future technology needs and uses

A.12.7 Explain how scientific and technological research can contribute to improved quality of life and a better standard of living

B.4.1 Identify and categorize systems that provide food, clothing, shelter, entertainment, health care, security, and other necessities and comforts of life

B.4.2 Identify the parts of a system and explain how the parts working together allow the system to do things the individual parts are unable to do alone

B.4.3 Describe various reasons systems may fail; such as, overuse, lack of proper maintenance or management, improper design, or other natural or unnatural factors that may occur

B.4.4 Explain how systems depend on a variety of resources to produce a desirable outcome

B.8.2 Analyze various systems and identify the ways in which they are controlled to produce a desired outcome

B.8.5 Evaluate large and complex systems to determine the ways in which they are creations of human ingenuity

B.8.6 Identify all the resources necessary for a given system; analyze how the use of the resources will be affected by consideration for cost, availability, appropriate application, and regard for the environment

B.12.1 Identify and explain the ways technological systems have evolved and will continue to evolve to satisfy human needs and desires

B.12.3 Explain how enterprises apply technological systems for generating wealth by providing goods and services

D.4.1 Identify new problems which result from using tools, materials, and processes to solve existing problems

D.4.2 Explain how given technologies make life and work easier, but also how they may make them more complicated

D.4.4 Evaluate and explain the impact people have had on the earth, including plant and animal life, through the development and introduction of technologies

D.4.5 Identify the advantages, disadvantages, risks, and benefits of given technologies

D.8.3 Contrast the advantages and disadvantages of given technology and make adjustments or develop new technologies if disadvantages outweigh the advantages

D.8.4 Explain why people must think about how a new technology might affect other people, societies, and the ecosystem in which we live

D.8.5 Explain that people can control the technologies they develop and use and that people are responsible for the effects their technology has on society and the environment

D.12.2 Illustrate how a technology can become controversial when people think the cost of the technology is not being equally shared by those who will benefit most from the technology

D.12.3 Analyze how the values and beliefs of different people can influence the perceived risks and benefits of a given technology

D.12.4 Evaluate the relative appropriateness of a given technology by comparing the risks with the benefits or the advantages with the disadvantages

### **Family and Consumer Education**

A.1. Explain the personal and social significance of the family in meeting family members' needs for food, clothing, shelter, and economic resources; nurturing the development of all family members throughout life; and taking action to improve conditions in the home, workplace, neighborhood, community, and world



A.2. Describe and give examples of continuing concerns of the family, such as what should be done to

- learn ways to interact and communicate with others
- cultivate feelings of respect about oneself and others
- provide adequately for the family's food, clothing, health, and safety
- relate to others within and outside the family
- maintain cooperative attitudes and ways of working within the family
- learn ways to think for oneself and make decisions
- conserve natural resources

C.2. Understand and use reflection in everyday life

- use reflection to identify and evaluate personal attitudes, beliefs, and patterns of thinking and acting
- test the validity of personal attitudes, beliefs, and behaviors, and describe how one might go about changing those that have problematic consequences, such as those that interfere

with communication or prevent creative and critical thinking in the family

- identify cultural assumptions contained in various media; such as notions about parent-child relations, beauty, violence, economic progress, or consumerism in stories, advertising, television programs, or videos
- explain how cultural assumptions influence human development and why these assumptions should be examined publicly

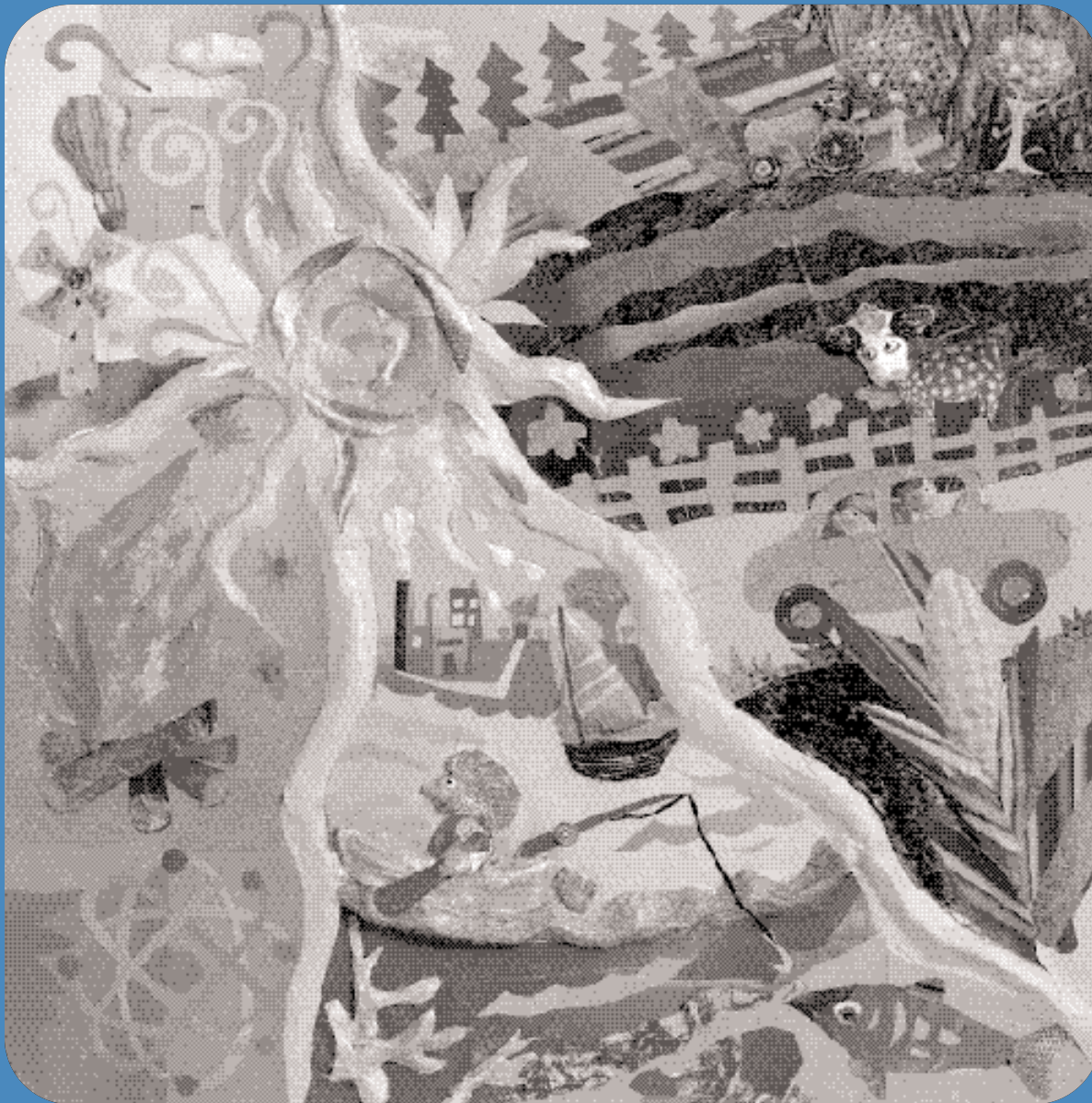
D.1. Explain what it means to assume personal and social responsibility as a family member and citizen

D.2. Use practical reasoning in making choices about an individual, small group, or classroom action project

- define an existing individual, family, or community need or concern
- determine the best course of action to take in the situation



# Sample Activities



# What the Wind Does for Me



## Objective

Students will be able to identify ways the wind contributes to their lives.

## Background

The sun is the primary source of energy, and it influences many activities on Earth. The sun heats Earth's surface and the energy is re-radiated heating the surrounding air molecules. The "energized" molecules move more quickly and spread apart. Cooler, denser air can flow in displacing the warmed air. This movement of air masses is one of the causes of wind. Therefore, the sun helps create wind. Both a feather floating in the breeze and a tornado blasting through the countryside illustrate that wind has energy. Of the sun's energy that reaches Earth, about two percent is converted to wind energy.

Wind energy has been used for hundreds of years. Farmers and ranchers have used windmills to pump water to fields and livestock in remote locations. Today wind turbines provide electricity for operating lights and appliances and mechanical power for pumping water.

For information about the wind, see Refreshing Refrigerator Experiment and the following KEEP activities and Energy Sparks:

- Sun, Wind, Water
- Waterwheels, Windmills, and Turbines
- Windy Wonders

## Procedure

1. Ask students to describe the wind and how they think wind is created; note their responses. See Refreshing Refrigerator Experiment to provide an introduction to wind formation. Have students share their ideas on the blackboard. Did they think of other ideas during the discussion? Add them to the list.

2. Have students generate ideas about ways the wind affects them. Example:



NOTE: Pre-literate students can construct pictures using art supplies.

## Summary:

Students illustrate ways the wind contributes to their lives.

**Grade level:** K-4

**Subject Areas:** Earth and Physical Science, Language Arts, Art

**Setting:** Classroom or outdoor work area.

**Time:** Preparation: 20 minutes  
Activity: 50-minute period

**Vocabulary:** Sun, Wind, Molecule, High Pressure System

## Related KEEP

**Activities:** In "Sun, Wind, Water," students use art skills to emphasize the role of energy in the water cycle. For more fun sun activities, check out the KEEP Energy Spark "Windy Wonders."

## Refreshing Refrigerator Experiment

Does this sound familiar? It is unbearably hot outside so you go inside and open the refrigerator or freezer to get a cool drink, and you feel the cold, refreshing air rush out. An experiment for kids to try at home to learn more about wind is the **Refreshing Refrigerator Experiment**. On the next warm day, tell the students to note where they feel the cold air when they open the refrigerator. If they were wearing shorts, they should have felt the cold air move over their legs and feet. What the students felt is "wind!"

Have the class talk about why they think the cold air moves out of the refrigerator, and why the warm air doesn't seem to move in. Explain that like all material, air is made up of tiny particles called molecules. The cold air molecules are closer together and will sink because they are pulled by gravity. Warmer air is less dense, so it is more active and its molecules are more spread out. Ask students what heats the air and makes it warm (the sun).

Explain that depending on its location (e.g., over water, land, farms, and cities), air heats up at different rates so there is warmer and cooler air. Cooler air is denser and can displace warmer air, creating wind.

**NOTE:** Air moves from high pressure to low pressure areas, meaning the cold, heavier air (high pressure system or more dense air) "flows" in and displaces the warm air (low pressure system or less dense air). The movement of air between pressure systems is one factor that causes wind. The greater the difference in air pressure, the harder the wind blows. In the Northern Hemisphere, wind flows clockwise around high pressure systems and counterclockwise around low pressure systems.

3. Take students outside and have them use all of their senses to describe wind. Can they see wind? Feel it? Smell it? Hear it? Taste it? How do we know it is there? What evidence can they provide to support their descriptions of wind?

Have students record their findings using the following descriptions:

**Date of observation:** \_\_\_\_\_

**I can see** \_\_\_\_\_

**I can feel** \_\_\_\_\_

**I can smell** \_\_\_\_\_

**I can hear** \_\_\_\_\_

**I can taste** \_\_\_\_\_

4. After students have had time to describe wind individually, ask them to share their descriptions. Students should begin to look for patterns in these observations. Do their observations raise any additional questions?
5. Ask students to describe how hard the wind is blowing. Ask them how they can know if the wind is blowing softer or harder. What signs should they look for? Have students create a scale to categorize levels of windiness and signs they look for to identify each category.
6. To celebrate the wind, have students create a wind chime.

## Assessment

- Have students list or draw jobs that the wind does for them.
- Ask students how they discriminate between a gentle breeze and a strong wind.
- Challenge students to listen to the sounds of the chimes in different levels of wind and to create their own wind scale.



# Energy Divide

## Objective

Students will be able to explain why they might concern themselves with the needs of future energy users.

## Background

"It's mine!"

"No! It's mine!"

"Now, kids, what have I told you about sharing?"

How many times have we heard or even participated in similar conversations? There are many things we share in life, including energy resources. When something in common is shared without consideration of other people, problems or tragedies may arise. This "Tragedy of the Commons" idea—expressed in a writing by William Forster Lloyd in 1833—was expanded by Garrett Hardin to illustrate challenges to sustaining our natural resources.

In terms of modern energy use, the "Commons" is energy resources, primarily fossil fuels such as coal, natural gas, and petroleum. The "Tragedy" is that although energy resources are developed and used for the good of society, these practices often involve inefficient use and overconsumption. These practices can lead to environmental problems and depletion of the resource. Over the past hundred years, our use of fossil fuels has increased significantly. Projections of when these fuels will run out vary from 50 to 200 years. Regardless of the depletion date used, the fact is, there is a limited amount of fossil fuels and eventually there will not be enough to meet our growing demands.

Both conservation practices and investments in renewable resources can help Wisconsin promote sustainable energy generation and use, and thereby avoid the tragedies of overconsuming and wasting our common energy. Modern technologies and advances have afforded most Wisconsin citizens with lifestyles our grandparents would only have dreamed of. We, in turn, need to consider how our consumptive practices will affect future energy users. Each of us should consider using energy today with the needs of tomorrow's energy users in mind.

**Summary:** Students play a competitive game to simulate consumption of energy resources and explore how energy conservation (reduction of use and waste) can help to sustain future energy supplies.

**Grade level:** 5-8

**Subject Areas:** Science (Environmental), Social Studies

**Setting:** Classroom

## Time:

Preparation: 30 minutes

Activity: 50 minutes

**Vocabulary:** Conservation, Efficiency, Finite, Nonrenewable energy resource, Renewable energy resource

## Materials:

- Each group of students will need a bag of candy, containing about 200 pieces of candy (butterscotch) in wrappers

## Related KEEP

**Activities:** Have students use the survey "At Watt Rate?" to analyze the ways they use energy. Students can learn more about each of these resources through activities such as "Digging for Coal," "Get That Gasoline!" and "Harnessing Nuclear Energy." Use activities such as "Energy Futures" to have students envision how scenarios developed during this activity could be applied to future societies.

## Ground Rules for Energy Divide

- The candies represent Energy Units.
- Each of you in this group represents a different energy consumer (this can be a large consumer, such as a country, or small one, such as an individual or a household).
- You are not allowed to talk to each other.
- The object of the game is to obtain enough energy resource units to support your basic life or operational functions.
- You will have four 5-second rounds in which to collect energy. Each round represents 20 years of energy use. You will be notified when to start and stop each round.

## Resources

O'Connor, Maura. Living Lightly on the Planet: A Global Environmental Education Curriculum Guide for Grades 10-12, Volume II. Milwaukee: Schlitz Audubon Center, n.d.

Tourtillot, Leeann. Conserve and Renew: An Energy Education Guide for Grades 4-6. Rohnert Park, Calif.: California Energy Extension Service, 1990.

## Procedure

1. Have students list different sources of energy. Write their responses on the board. If necessary, review the different resources and what is involved in developing them for various end uses (for example, coal is mined and transported to a power plant where it is burned to generate electricity).
2. Divide the class into groups of five or six students each. Tell them they are going to be participating in an activity called "Energy Divide." Scatter a bag of candy on a table or a designated spot on the floor in front of each group.
3. Tell the class the basic rules (see Ground Rules for the Energy Divide). Begin the first round, and call time after 5 seconds. Wait a few seconds and begin the second round, and so forth. Continue with all four rounds even if they run out of candy. When the last round is over, instruct the groups to return the candy.
4. Discuss the results of the game. For example, what does it mean if they ran out of candy? Request explanations for why Energy Units were used up or left over. If some Energy Units were left over, are there enough units for 20 or 40 more years of energy use?
5. Ask students to provide suggestions on what they would do if they were to participate in the "Energy Divide" again. Have the class develop a set of recommendations that would ensure that each member of the group had enough energy to last through the four rounds. For example, they might recommend that consumers take no more than ten Energy Units in each round.

## Assessment

Have students develop a personal energy use plan for today and for 20 years from now. Have students evaluate each other's plans, identifying things they do and do not like, providing justifications for their comments.



# Advertising Energy

## Objectives

Students will be able to:

- analyze the effectiveness of energy-related advertisements;
- determine if energy-related advertisements promote energy efficiency; and
- design an advertisement for energy that encourages efficient energy use.

## Background

You see them in newspapers and magazines, hear them on the radio, watch them on television, and click on their icons on the Internet. Wherever mass media appears, advertisements are almost sure to follow: each one waiting for a break in the action or for a page to be turned; each one persuading us to buy a product, adopt an opinion, vote for a candidate, or support a cause. Since every product we buy involves the development and consumption of energy, it should come as no surprise that advertising influences our purchases, our actions, and ultimately the way we develop and use energy.

With energy, the "product" is often a source of energy (oil, natural gas, batteries, solar panels), a service (retrofitting your home, bringing natural gas to your home, installing solar panels), or a device that uses energy (furnace, automobile, stove). All these products involve the development or consumption of an energy resource. Therefore, energy advertisements promote the development and consumption of energy resources because their aim is to sell energy-related products.

## Procedure

1. Show students samples of energy-related advertisements. Identify the types of products that are usually found in energy advertisements. Review the different categories of advertisements (see Background) and help students place the samples in one or more categories.
2. Emphasize that energy advertisements promote the development or consumption of an energy resource, because they sell products that use energy. Briefly discuss issues related to energy development and consumption. Ask students to provide a definition for efficient use of energy and why it is important.
3. Divide the class into working groups of two to four students. Provide each group with energy-related advertisements or have them use ads they collected themselves.

**Summary:** Students evaluate and categorize advertisements that promote the development and consumption of energy.

**Grade level:** 5-8

**Subject Areas:** Family and Consumer Education, Fine Arts, Language Arts

**Setting:** Classroom

### Time:

Preparation: up to two weeks

Activity: three 50-minute periods

**Vocabulary:** Advertising, Energy efficiency

### Materials:

- Energy-related advertisements
- Scissors
- Copies of Analyzing Energy Advertisements

### Related KEEP

**Activities:** Students can investigate how advertisements influence what products they buy. Adapt the activity "Energy Use Then and Now" to compare energy-related advertisements from previous years.



## Resources

Burton, Philip Ward, and Scott Purvis. Which Ad Pulled Best? Fifty Case Histories on How to Write and Design Ads That Work, 8th Edition. Lincolnwood, Ill.: NTC Business Books, 1996.

4. As a class, develop three characteristics that are common among advertisements that promote energy efficiency.

Possible characteristics:

- Provides information about efficiency
- Highlights economic incentives for using efficient products
- Emphasizes convenience and comfort the consumer receives from using the product
- Stresses environmental benefits of using the product
- Mentions the durability of the product
- Features technological quality of the product

5. Have students analyze the advertisements (see below). When they have answered all the questions, ask one student from each group to post the "efficient" advertisements along one wall in the classroom and the "inefficient" advertisements along another wall. (You may need a sign on a third wall titled "not applicable.") Ask a spokesperson from each group to explain why the ads do or do not promote efficiency. Have students summarize what general messages energy advertisements convey about energy production and use.

## Assessment

Have groups of students create a service, product, or company that uses or sells energy. Instruct groups to exchange their creations with each other. Challenge the groups to design an advertisement for the imaginary service, product, or company that promotes efficient use of energy.

## Analyzing Energy Advertisements

1. What energy product is being advertised?
2. Write a brief description of the advertisement, including its purpose.
3. What strategies are used in this advertisement? (Consider design elements such as artwork, visual images, music and color.)
4. To what type of audience does this advertisement appeal? Why?
5. How does this advertisement affect you? (What does it make you think or feel?)
6. What is your definition of efficient energy use? (If the class worked together to develop a definition, use that definition.)
7. Does this advertisement promote efficient use of energy? Why or why not?



# Why Use Renewable Energy?

## Objectives

Students will be able to

- identify factors that influence home and business owners to use renewable energy; and
- discuss the pros and cons of using renewable energy resources to meet current and future energy needs.

## Background

A growing number of people in Wisconsin use the sun to heat their homes and businesses at night. How can this be? Are they able to make the sun shine at night? No. Many of these home and business owners have houses and buildings that are designed to store the sun's heat during the day and reradiate it throughout the evening. Other homes and businesses burn firewood. Wood contains stored energy from the sun (trees convert solar energy to chemical energy through the process of photosynthesis). Some homeowners and business owners use sunlight to generate electricity, or they may use the wind, which is created by the sun. In other words, these people are using renewable energy in their homes and businesses.

## Procedure

1. Tell students that a number of homes and businesses in Wisconsin use renewable energy resources as their primary energy source.
2. Have students list factors that they think influence people to choose renewable energy and provide a brief description of each influence.
3. Inform the class that they will find out for themselves which of these influences lead people to use renewables. Students will analyze interviews to determine which values are prevalent in their responses.
4. Ask students if they know of any businesses or homeowners who use renewable energy. Otherwise, contact local homebuilders associations, Focus on Energy, or the Midwest Renewable Energy Association for information about renewable energy facilities.
5. Work with the class to develop an interviewing format and discuss strategies to best approach home or business owners to request interviews. Give students a timeline for contacting the home or business owners and conducting the interviews.

**Summary:** Students analyze the results of interviews with home and business owners to determine why they use renewable energy.

**Grade level:** 9-12

**Subject Areas:** Family and Consumer Education, Language Arts, Science, Social Studies

**Setting:** Classroom and community

**Time:** Preparation: one hour  
Activity: one 50-minute period to one week, depending on whether students conduct interviews

**Vocabulary:** Active solar heating, Hydropower, Passive solar heating, Photovoltaics

## Related KEEP

**Activities:** Complementary activities include "Shoobox Solar Cooker" and "The Miracle of Solar Cells."

### Resources:

Focus on Energy, 211 South Patterson Street, Madison, WI 53703, phone, 800.762.7077, [www.focusonenergy.com](http://www.focusonenergy.com).

Midwest Renewable Energy Association (MREA), 7558 Deer Road, Custer, WI 54423. Phone: 715.592.6595; [www.the-mrea.org](http://www.the-mrea.org). Contact MREA for information about a tour of homes that use renewable energy in Wisconsin.

6. After the interviews are complete, revisit the reasons for using renewable energy developed earlier in the activity. Have students present the results of their analysis, identifying which influences were most prevalent or how the chart needed to be adjusted to better represent what they learned.

7. Ask students if they would use renewable energy resources in their future home or business. Students' defense of their reasoning can be used to evaluate their understanding of the reasons why people choose to use renewable energy resources.

### Assessment

Have students predict the percentage of home and business owners who will use renewable energy resources for heat and electricity 20 years from now. What about in 50 or 100 years? Students can defend their predictions in a debate.

### Sample Survey for Renewable Energy Users

Home or business owner's name: \_\_\_\_\_

Address: \_\_\_\_\_

Date of interview: \_\_\_\_\_

a) Which renewable energy resource(s) do you use in your home or business?

b) Why did you decide to use renewable energy in your home or business?

c) What, if any, adjustments to your lifestyle have you made to live/work comfortably in your home or business? Which do you like? Which do you find inconvenient?

d) How would you respond if someone said to you: "I've often thought about using renewable energy resource, but \_\_\_\_\_?"

(Fill in the blank with one or more reasons you've heard or can think of why people don't use renewables. Then provide a response for each reason.)



# Concept Map



# Concept Map

## **Introduction**

The framework in this document is a list of concepts. Another approach to presenting the concepts is to use a concept map that shows how thoughts and ideas are organized in the mind.

Concept maps are becoming popular instruments in many aspects of learning, including curriculum development. By creating and revising these maps, curriculum developers and teachers illustrate meaningful interconnections among concepts. The map serves as a guide during curriculum development, ensuring that the content is integrated and cohesive.

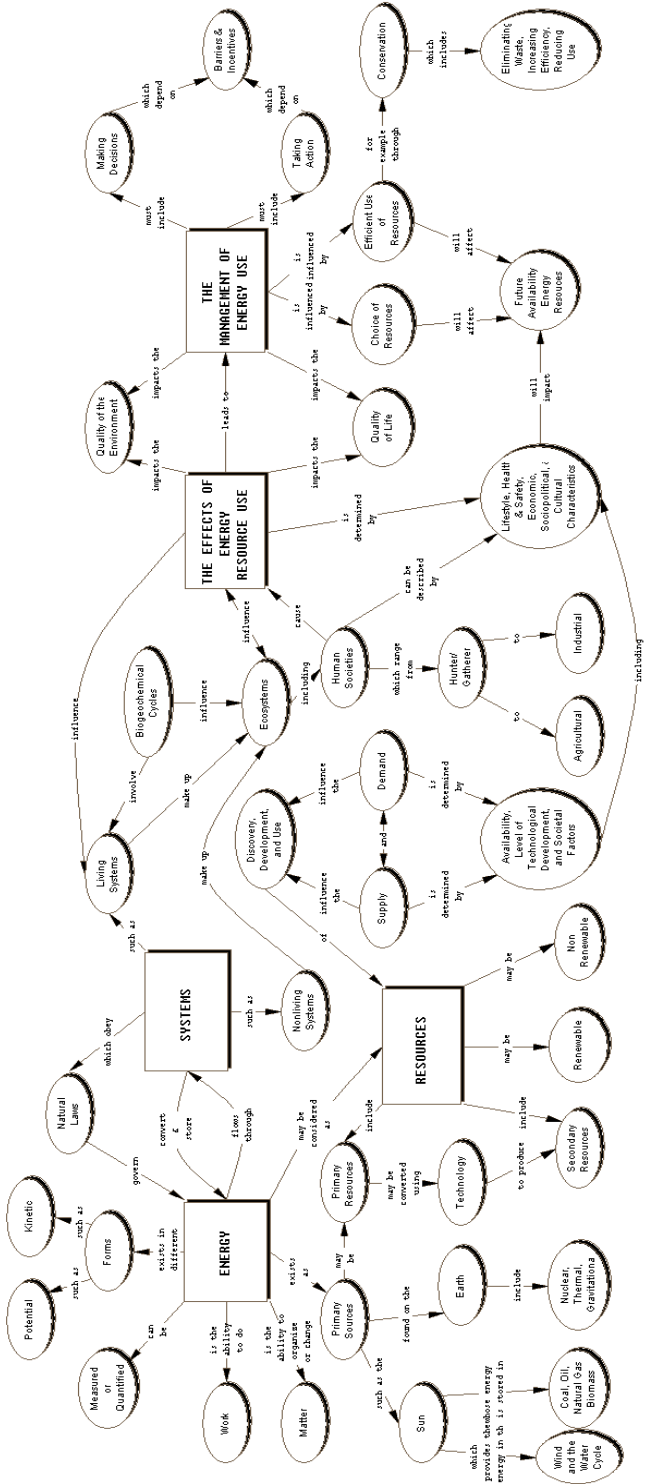
## **Organization**

Our concept map visually represents the themes and selected concepts presented in the framework. It shows that the concepts are not isolated, fragmented ideas. Rather, they are integral components of the framework and are complementary, connected, and interrelated.

We encourage educators and curriculum planners to investigate and revise this map or create one of their own as they develop an energy education curriculum or incorporate energy-related concepts into existing curricula.

# Explanation of Concept Map

The squares are themes; ovals represent subthemes and subordinate concepts. Concepts flow from themes, such as Energy, to subordinate concepts, such as Sun. Arrows with short descriptions connect the concepts and show how they are related (for example, "Energy" flows through "Systems").



# Glossary

## **Autotroph**

Organism capable of synthesizing its own food from inorganic substances using light or chemical energy. Examples of autotrophs include plants and some protozoans.

## **Active solar heating**

A solar heating system that uses a mechanical system to transfer the sun's heat from a solar collector to various parts of a home or building for space heating and water heating.

## **Biogeochemical cycle**

Natural processes that cycle nutrients in various chemical forms from the environment, to organisms, and then back to the environment. Examples are the carbon, oxygen, nitrogen, phosphorous, and hydrologic cycles.

## **Biomass**

Plant or animal matter. Biomass can be burned directly as a source of heat or converted to a more convenient gaseous or liquid fuel. Examples include wood and animal waste.

## **Centralized energy system**

Energy system where large amounts of an energy resource are converted from one form to another in a central location. The energy is then distributed to and used by a large number of consumers located within a large area. Electricity generated by a nuclear power plant and distributed by transmission lines to a large number of homes and businesses is an example of a centralized system.

## **Conservation**

Wise use and careful management of resources, so as to obtain the maximum possible social benefits from them for present and future generations. Energy resources can be conserved by reducing wasteful energy use, using energy for a given purpose more efficiently, or by reducing energy use altogether.

## **Decentralized energy system**

Energy system where small amounts of an energy resource are converted from one form to another for use by a small number of people. The conversion and consumption of the energy resource usually occurs in the same location. An example is a solar water heater used to provide hot water for a home.

## **Ecomanagement**

Positive physical action taken by an individual or group that improves or maintains some part of the environment. An example would be creating a recycling center in a community.

## **Ecosystem**

Self-regulating natural community of organisms (e.g., plants, animals, bacteria) interacting with one another and with their nonliving environment. Wetlands, forests, and lakes are examples.

## **Energy**

The ability to organize or change matter; the ability to do work.

## **Energy efficiency**

The ratio or percentage of useful work or energy output to total work or energy input in any energy system. For example, the efficiency of a home heating system is equal to the percentage of energy in the fuel or other source that is converted into useful heat.

**Lift flap to view concept map**



**Energy forms**

Fundamental kinds of energy that are distinct from each other. Two main forms of energy are potential energy (the energy stored in matter) and kinetic energy (the energy of motion). More specific forms of energy include thermal, elastic, electromagnetic (light, electrical, magnetic), gravitational, chemical, and nuclear energy.

**Energy resource**

Energy source that is used to meet the needs of a human society. For example, oil is an energy resource because it is used to produce fuel for transportation and heating.

**Energy source**

Matter or system from which one or more forms of energy can be obtained. Natural gas, for example, is a source of thermal energy; sugarcane is a source of chemical energy.

**Energy storage**

The process of storing or converting energy from one form to another for later use; storage devices and systems including batteries, conventional and pumped storage hydroelectric, flywheels, compressed gas, and thermal mass.

**Entropy**

(1) A measure of the dispersal or degradation of energy. (2) A measure of the disorder or randomness in a closed system. For example, the entropy of an unburned piece of wood and its surroundings is lower than the entropy of the ashes, burnt remains, and the warmed surroundings due to burning that piece of wood.

**Externality cost**

Portion of the cost of production and marketing of a product that is borne by society, not by the producer, and thus is not included in the price of the product. For example, the cost of cleaning up a beach after an oil spill is usually not included in the market price of motor oil.

**First law of thermodynamics**

Energy cannot be created or destroyed; it can only be converted from one form to another. For example, the chemical energy stored in coal can be converted into thermal energy.

**Fossil fuels**

Carbon-rich fuel formed from the remains of ancient animals and plants. Coal, oil, and natural gas are all fossil fuels.

**Fuel**

Substances that are burned or consumed by some means to produce energy. Examples of fuels include coal, food, natural gas, oil, and fissionable uranium.

**Geothermal energy**

Energy produced by the internal heat of the earth; geothermal heat sources include: hydrothermal convective systems; pressurized water reservoirs; hot dry rocks; manual gradients; and magma. Geothermal energy can be used directly for heating or to produce electric power.

**Heterotroph**

An organism, such as a mammal, that cannot synthesize its own food and is dependent on complex organic substances for nutrition.

**Hydropower**

Electricity or mechanical energy produced by the conversion of energy from falling water. Sometimes used to refer only to the production of electricity from falling water.

**Nonrenewable energy resource**

Energy resource that is either replenished very slowly or not replenished at all by natural processes. A nonrenewable resource can ultimately be totally depleted or depleted to the point where it is too expensive to extract and process for human use. Fossil fuels are nonrenewable resources.

**Passive solar heater**

A solar water or space-heating system in which solar energy is collected, and/or moved by natural convection without using pumps or fans. Passive systems are typically integral collector/storage (ICS; or batch collectors) or thermosyphon systems. The major advantage of these systems is that they do not use controls, pumps, sensors, or other mechanical parts, so little or no maintenance is required over the lifetime of the system.

**Payback**

The amount of time required for positive cash flows to equal the total investment costs.

**Photovoltaic cell (abbrs. PV, PV cell)**

A device that converts solar energy directly into electricity. For example, photovoltaic cells provide electricity for handheld calculators, watches, battery chargers, homes, and satellites.

**Photovoltaic (Solar) system**

A complete PV power system composed of the module (or array), and balance-of-system (BOS) components including the array supports, electrical conductors/wiring, fuses, safety disconnects, and grounds, charge controllers, inverters, battery storage, etc.

**Primary energy source**

Source of energy either found or stored in nature, such as the sun, coal, and oil.

**Renewable energy resource**

Energy resource that can be quickly replenished. Some renewable resources—such as solar energy—will always be available no matter how they are used. Others—such as wood—can be depleted when their rate of use exceeds their rate of replacement.

**Second law of thermodynamics**

(1) Each time energy is converted from one form to another, some of the energy is always degraded to a lower-quality, more dispersed, and less useful form. (2) No system can convert energy from one useful form to another with 100 percent efficiency. (3) Energy cannot be spontaneously transferred from a cold body to a hot body. (4) The entropy of a closed system increases over time.

**Secondary energy resource**

Energy resource that is produced from a primary energy resource using technology, such as electricity produced from solar energy by photovoltaic cells.

**Solar energy**

Electromagnetic energy transmitted from the sun (solar radiation). The amount that reaches the earth is equal to one billionth of total solar energy generated, or the equivalent of about 420 trillion kilowatt-hours.

**Sustainable society**

Society based on working with nature by recycling and reusing discarded matter, by conserving matter and energy resources, through reducing unnecessary waste and use, and by building things that are easy to recycle, reuse, and repair.

**System**

(1) A group of interacting, interrelated, or interdependent parts made up of matter and energy that form a complex whole. (2) Anything that uses matter and energy to organize, maintain, or change itself. A system, for example, can be the sun, a glass of water, a frog, or a city.

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