DOCUMENT RESUME

ED 416 068 SE 060 889

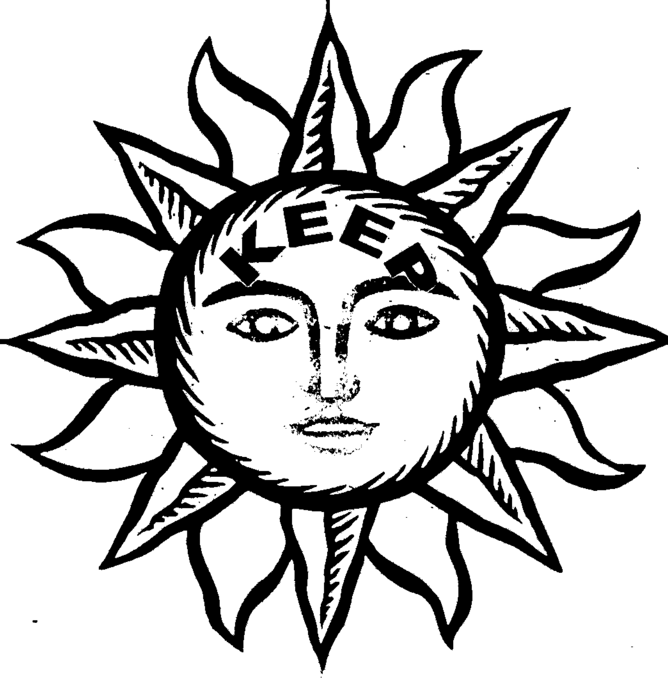
TITLE	K-12 Energy Education Program: A Conceptual Guide To K-12 Energy Education in Wisconsin.
INSTITUTION	Wisconsin Univ., Stevens Point. Energy Center of Wisconsin.
PUB DATE	1997-00-00
NOTE	42p.; Funding provided by the Wisconsin Environmental Education Board.
AVAILABLE FROM	Energy Center of Wisconsin, 595 Science Drive, Madison, WI 53711-1060.
PUB TYPE	Guides - Non-Classroom (055)
EDRS PRICE	MF01/PC02 Plus Postage.
DESCRIPTORS	Conservation Education; *Curriculum Development; Ecology; Elementary Secondary Education; *Energy Management; Environmental Education; Fuels; *Futures (of Society); Natural Resources; Physics; *Science Education; *Technology Education
IDENTIFIERS	Wisconsin

ABSTRACT

In addition to presenting concepts that can help students understand and make decisions about energy issues, this guide provides guidance for teachers to incorporate energy education into their curricula. The guide is divided into two major sections: (1) the Energy Education Conceptual Framework and (2) the Suggested Scope and Sequence. The conceptual framework is not a curriculum in itself; rather, it is a skeleton that provides the foundation for a curriculum. The concepts were derived from energy-related frameworks designed by other educational organizations and taken from physical and environmental science texts. Additional concepts were developed to reflect issues specific to Wisconsin. Concepts within the framework are organized under four themes that are arranged to build upon each other. Concepts within each theme are further organized into subthemes. Major themes include: (1) We Need Energy, which defines energy and describes how energy is transferred and converted from one form to another according to the laws of thermodynamics; (2) Developing Energy Resources, which addresses energy sources and how humans use energy to meet societal wants and needs through technology; (3) Effects of Energy Resource Development, which covers how using energy resources affects human societies and the environment; and (4) Managing Energy Resource Use, which identifies strategies to help resolve many of the issues presented in the third theme. The section on Scope and Sequence provides guidelines for when and to what extent the energy concepts could be integrated into school curricula. This guide also contains a concept map, glossary, a 13-item resources and references list, and an appendix of educational objectives. (PVD)

K-12 ENERGY EDUCATION PROGRAM

A CONCEPTUAL GUIDE TO K-12 ENERGY EDUCATION IN WISCONSIN



CONCEPTUAL FRAMEWORK AND SUGGESTED SCOPE AND SEQUENCE
PRODUCED BY THE WISCONSIN K-12
ENERGY EDUCATION PROGRAM
AND THE WISCONSIN CENTER FOR ENVIRONMENTAL EDUCATION

A PUBLICATION OF THE ENERGY CENTER OF WISCONSIN

Wisconsin K-12 Energy Education Program (KEEP)

414 LRC
University of Wisconsin-Stevens Point
Stevens Point, WI 54481
PH (715) 346-4770
FAX (715) 346-4698
Email: energy@uwsp.edu

Ginny Carlton, Energy Education Program Assistant
Steve Knudsen, Coordinator of Research
Jennie Lane, Coordinator of Curriculum Development
Corky McReynolds, Energy Education Team Leader
Randy Champeau, Energy Education Project Director

KEEP Financial Support

Energy Center of Wisconsin
Wisconsin Center for Environmental Education
Wisconsin Environmental Education Board
University of Wisconsin-Stevens Point

KEEP Steering Committee

Randy Champeau (Co-chair), Wisconsin Center for Environmental Education

Carolyn Amegashie, Wisconsin Department of Transportation

Okho Bohm, Wisconsin Power & Light Company

Shelly Fischer, Wisconsin Department of Public Instruction

Al Hovey, Longfellow Middle School

Pat Marinac, Wisconsin Association for Environmental Education

Chuck Mitchell, Alliance for Clean Energy Systems

Cheryl Parrino, Public Service Commission of Wisconsin

Susan Stein, Midwest Renewable Energy Association

Mark Hanson (Co-chair), Energy Center of Wisconsin

Tom Bobrofsky, Wisconsin Elementary Science Teachers

Floyd Henschel, Wisconsin Society of Science Teachers

James Jenson, Madison Gas & Electric Company

Corky McReynolds, Treehaven Environmental Center

Sharon Nelson, Wisconsin Society of Science Teachers

Barbara Samuel, Dept. of Administration, Division of Energy and Intergovernmental Relations

Al Stenstrup, Wisconsin Department of Natural Resources

Jerry Young, Wisconsin Electric Power Company

KEEP Advisory Review Committee

Randy Champeau, Director, Wisconsin Center for Environmental Education

Anne Green, Outreach Coordinator, Wisconsin Center for Environmental Education

Daniel Sivek, Associate Professor, College of Natural Resources, University of Wisconsin-Stevens Point

Corky McReynolds, Director, Treehaven Environmental Center

Phyllis Peri, EE Resource/Network Coordinator, Wisconsin Center for Environmental Education

Dennis Yockers, Assistant Professor, College of Natural Resources, University of Wisconsin-Stevens Point

Acknowledgments

This document was developed by the Wisconsin K-12 Energy Education Program and published by the Energy Center of Wisconsin.
Portions of this document were adapted from *A Conceptual Framework for Energy Education*,

Concept Map by **Perry Cook,** Assistant Professor, Department of Education, University of Wisconsin-Stevens Point.

Conceptual Framework and Scope and Sequence Reviewed By

Ms. Carolyn Amegashie, Program and Planning Analyst, Wisconsin Department of Transportation, Madison
Mr. Tom Bobrofsky, Wisconsin Elementary Science Teachers Association, Loyal
Mr. Tom Bromley, Science Chairperson, Whitefish Bay High School, Whitefish Bay
Dr. Randy Champeau, Director, Wisconsin Center for Environmental Education, Stevens Point
Dr. Perry Cook, Assistant Professor, Department of Education, University of Wisconsin-Stevens Point
Mr. Frank Greb, Manager of Residential and Small Business Marketing Sales, Wisconsin Power and Light, Janesville
Ms. Anne Green, Outreach Coordinator, Wisconsin Center for Environmental Education, Stevens Point
Ms. Sally Ellingboe, K-12 Environmental Education Coordinator, Stevens Point School District, Stevens Point
Mr. Dave Engelson, Environmental Education Consultant, Sun Prairie
Dr. Mark Hanson, Executive Director, Energy Center of Wisconsin, Madison
Mr. Floyd Henschel, Past President, Wisconsin Society of Science Teachers, Beaver Dam
Mr. Al Hovey, Teacher, Longfellow Middle School, Wauwatosa
Mr. Jim Jenson, Community Education Coordinator, Madison Gas and Electric, Madison
Mr. Don Lutz, General Science Teacher, Marathon Middle School, Marathon City
Ms. Pat Marinac, Chairperson, Wisconsin Association for Environmental Education, Weyauwega
Ms. Libby McCann, Wisconsin Adopt a Lake/Project WET Coordinator, Stevens Point
Dr. Corky McReynolds, Director, Treehaven Environmental Center, Tomahawk
Mr. Chuck Mitchell, Alliance for Clean Energy Systems, Almond
Mr. Kurt, C.E.O., SOLutions, Cornucopia
Ms. Sharon Nelson, Past President, Wisconsin Society of Science Teachers, Waunakee
Ms. Cheryl Parrino, Chairman, Public Service Commission of Wisconsin, Madison
Dr. Tehri Parker, Co-Executive Director , Midwest Renewable Energy Association, Amherst
Ms. Hedda Patzke, Science Chairperson, 9th Grade Teacher, Bullen Junior High School, Kenosha
Ms. Phyllis Peri, EE Resource/Network Coordinator, Wisconsin Center for Environmental Education, Stevens Point
Mr. Ken Raneer, Public Service Commission of Wisconsin, Madison
Ms. Barbara Samuel, Public Information Coordinator, Wisconsin Energy Bureau, Department of Administration, Madison
Dr. Daniel Sivek, Associate Professor, College of Natural Resources, University of Wisconsin-Stevens Point
Ms. Susan Stein, Co-Executive Director, Midwest Renewable Energy Association, Amherst
Mr. Al Stenstrup, Education Specialist, Wisconsin Department of Natural Resources, Madison
Mr. Dennis Weibel, 2nd Grade Teacher, River Heights Elementary, Menomonie
Ms. Julie Willard, Environmental Education Specialist, Wisconsin Center for Environmental Education, Stevens Point
Dr. Dennis Yockers, Associate Professor, College of Natural Resources, University of Wisconsin-Stevens Point
Mr. Jerry Young, Community Relations Liaison, Wisconsin Electric Power Company, Milwaukee

Building An Energy Education Curriculum
Workshop Participants

Mr. Michael Anderson, Milwaukee Public Schools, Milwaukee
Mr. Joe Cabibbo, McFarland School District, McFarland
Ms. LeAnn Chase, Port Edwards Public School District, Port Edwards
Ms. Rochelle Cumming, School District of Phillips, Phillips
Mr. Jean Paul Dieme, George Williams College Educational Center, Williams Bay
Ms. Sally Ellingboe, Stevens Point Area School District, Stevens Point
Mr. Mark Elworthy, Eau Claire Area School District, Eau Claire
Mr. David Engelson, Retired, Wisconsin Department of Public Instruction, Sun Prairie
Ms. Kim Fabitz, Student Teacher, Madison Metropolitan School District, Madison
Ms. AnneMarie Flemming, Wisconsin Center for Environmental Education, Stevens Point
Ms. Mary Ford-Washington, Marshfield Schools, Marshfield
Ms. Marlene Furo, St. Vincent De Paul School, Wisconsin Rapids
Ms. Stephen Goding, McFarland School District, McFarland
Mr. Floyd Henschel, Past President, Wisconsin Society of Science Teachers, Beaver Dam
Ms. Jean Hoffmann, Retired Teacher, Whitefish Bay
Mr. Jeff Hyma, South Shore School District, Port Wing
Ms. Ruth Jaeger, School District of Beloit Turner, Beloit
Mr. John Kimmet, Wisconsin Rapids Public Schools, Wisconsin Rapids
Ms. Barb Kobs, School District of Iola-Scandinavia, Iola
Mr. James Korb, Richland School District, Richland Center
Ms. Patricia Krueger, Pittsville Public Schools, Pittsville
Mr. Don Lutz, School District of Marathon, Marathon
Mr. Max Machotka, Madison Metropolitan School District, Madison
Mr. Ken Maciaz, Shawano-Gresham School District, Shawano
Ms. Pat Marinac, Appleton School District, Appleton
Ms. Nola Michalskii, Park Falls School District, Park Falls
Ms. Rhonda Narus, School District of Iola-Scandinavia, Iola
Ms. Tammie Niffennegger, Port Washington-Saukville School District, Port Washington
Ms. Phyllis Peri, Wisconsin Center for Environmental Education, Stevens Point
Ms. Lynn Rinderle, Milwaukee Public Schools, Milwaukee
Mr. Dean Sauers, Retired Teacher, New London
Mr. David Seefeldt, Sheboygan Area School District, Sheboygan
Ms. Barbara Seiter, George Williams College Educational Center, Williams Bay
Mr. James Servais, Green Bay Area Public Schools, Green Bay
Ms. Judy Soles, School District of Platteville, Platteville
Ms. Susan Stein, Midwest Renewable Energy Association, Amherst
Ms. Lynn Swift, Greenfield School District, Greenfield
Mr. Ron Weber, Weyerhauser Schools, Weyerhauser
Ms. Debora Williams, Milwaukee Public Schools, Milwaukee
Ms. Fran Wong, Madison Metropolitan School District, Madison
Ms. Karen Yost, Our Lady of Sorrows School, Milwaukee

Contents

KEEP

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. With this initial funding secured, WCEE hired a coordinator of curriculum development, a coordinator of research, and a program assistant in the summer of 1995, and the Wisconsin K-12 Energy Education Program was born.

Mission Statement

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

Goals

Our goal is to improve and increase energy education in Wisconsin's K-12 schools by developing and disseminating this *Conceptual Guide to K-12 Energy Education in Wisconsin* and an energy education activity guide.

This project consists of three phases:

Phase I: Produce the *Conceptual Guide to K-12 Energy Education in Wisconsin* and an *Energy Education Activity Guide.*

Phase II: Develop and offer college-credit energy education courses for teachers.

Phase III: Continue the energy education initiatives beyond the project funding period.

We completed the first part of Phase I with the 1996 publication of the *Conceptual Guide* which helped direct the development of the *Energy Education Activity Guide.*

This updated *Conceptual Guide* reflects modifications to the framework that evolved during the completion of the *Activity Guide.*

A Rationale For Energy Education

Ask people to talk about energy, and what will they say? Some will describe how they use energy in their lives and at their work places. Some will talk about the cost of energy and mention the price of gasoline or the cost of heating their homes in winter. Others will point out that widespread use of fossil fuels leads to air pollution, acid rain, and global warming; they would say that the market place or the government should promote the use of environmentally-benign energy resources. Still others will recall the energy crisis of the 1970s, when the United States faced an oil embargo by the nations of the Middle East, and later, the subsequent sudden rise in the price of oil. They might add that our nation now imports half the oil it needs, that a disruption in its supply is still possible, and that development of domestic energy resources should be increased. While acknowledging these issues, nearly all of these people will agree that energy is necessary for maintaining their health, their well-being, their lifestyles, and their economy. Many will even say that they often take energy for granted.

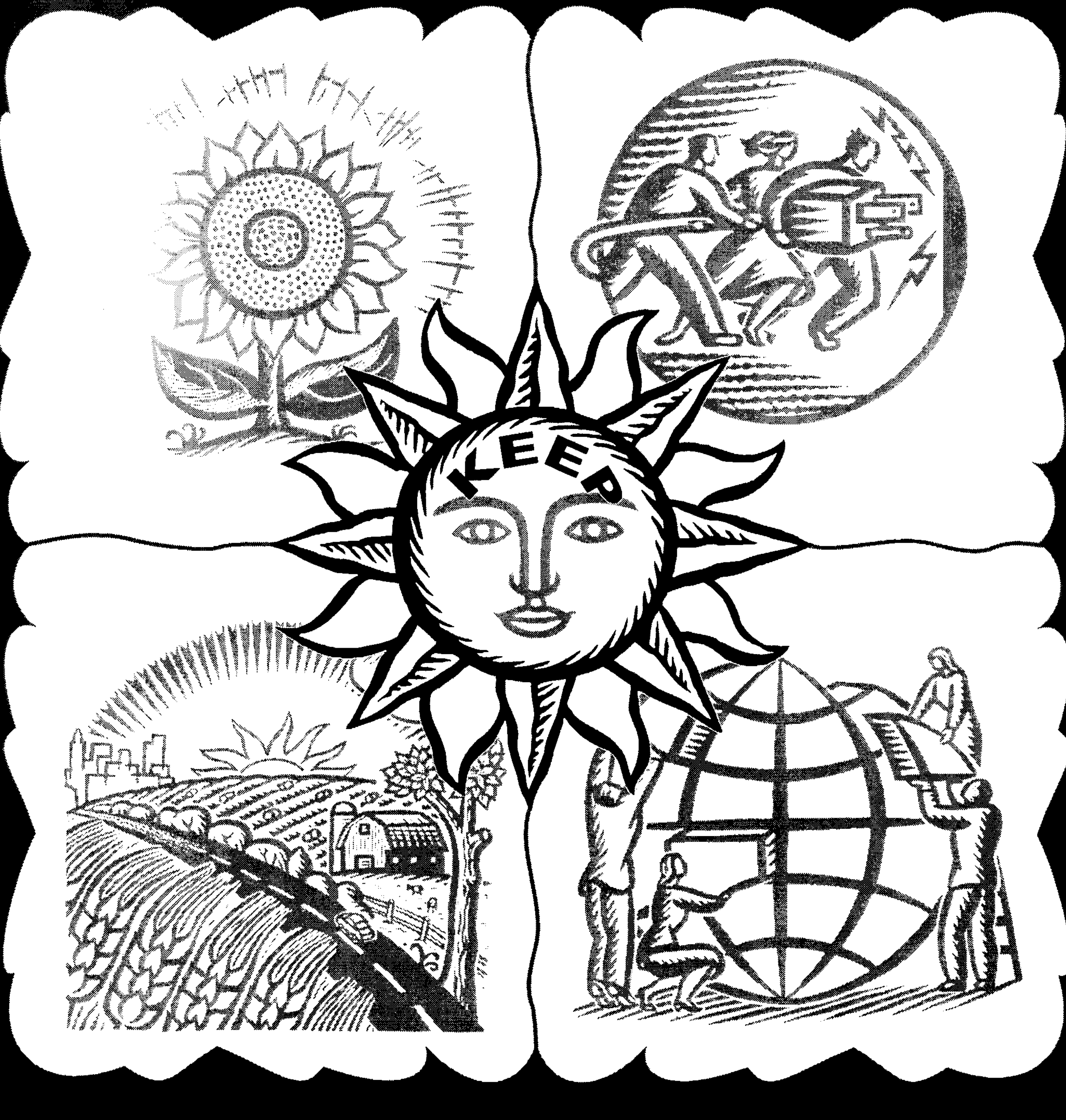
Energy is more than an individual economic, environmental, or sociopolitical issue or a passing concern. It is the agent of change for all processes on Earth and throughout the universe. Every interaction among living and nonliving things is accompanied by the transfer and conversion of energy. Energy is the underlying "currency" that is necessary for everything humans do with each other whether in the work place or in their personal lives. Understanding energy in this way enables people to see how issues are interconnected, and how a solution to one issue may even lead to the solution of another. For instance, the person who buys a fuel-efficient car saves money on gasoline, reduces air emissions, and decreases our nation's reliance on imported oil.

Since energy plays an essential role in people's lives, the study of energy and energy issues should be emphasized in education. Some curriculum developers and teachers in Wisconsin include energy-related activities in education curricula. However, many people believe more needs to be done if energy education is to be widely and consistently instituted throughout Wisconsin in a manner that effectively promotes life long learning and links students to the world around them. 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 the *Energy Education Activity Guide.*

ENERGY EDUCATION CONCEPTUAL FRAMEWORK



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. 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.

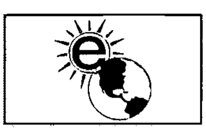
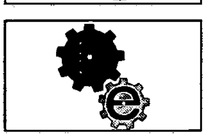
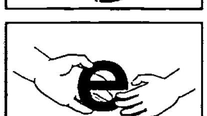
Framework Organization

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.

Themes	**Page**

The themes in the *Energy Educational Activity Guide* themes are identified with the following symbols:

	***We Need Energy***
	***Developing Energy Resources***
	***Effects of Energy Resource Development***
	***Managing Energy Resource Use***

We Need Energy

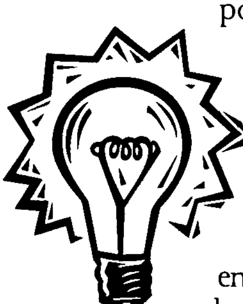
The concepts within this theme provide students with a fundamental knowledge about energy and help students appreciate the nature of energy in their everyday lives, providing them with an awareness of how energy is used to maintain, organize, and change systems that affect their lives. These concepts 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.

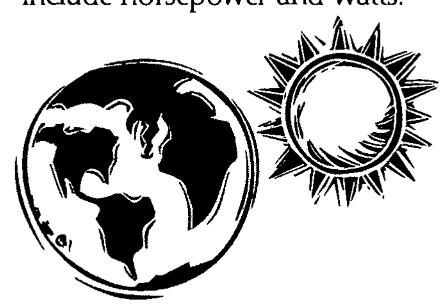
1. Energy is the ability to organize or change matter or "the ability to do work."

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 the 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:

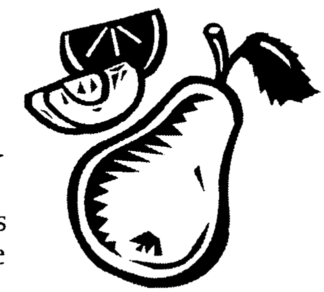
- Types and quantities of available energy sources, such as the chemical energy stored in plants.
- Types and characteristics of energy flows, such as food webs.
- Energy budgets, which are the amount of energy available with respect to the amount of energy used by an ecosystem. The total energy budget of an ecosystem determines its carrying capacity.
- An ability to use energy to maintain a balanced or steady state.

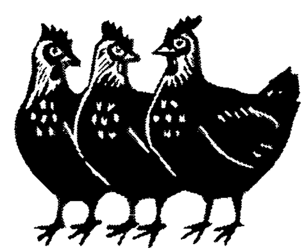
15. Wisconsin has five main biological communities: northern forests, southern forests, prairies, oak savanne and aquatic.

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 (Miller, 1988).

- 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.





- Nonindustrial 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.

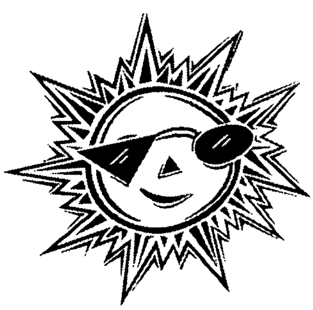
Development of energy resources

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.



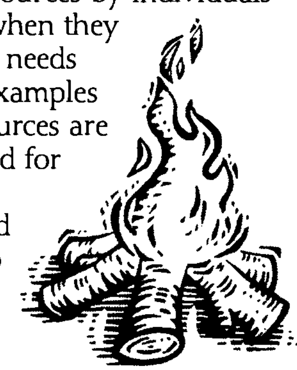
•The sun is a primary energy source and the principal source of Earth's energy. Energy from the sun is stored in other primary energy sources such as coal, oil, natural gas, and biomass (such as wood). Solar energy is also responsible for the energy in the wind and in the water cycle (the hydrologic 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, and 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 were 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. Certain energy resources are renewable because they can be replaced by natural processes quickly. 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. Other energy resources are nonrenewable because they 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.

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.

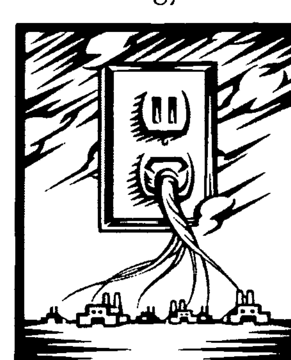
Consumption of energy resources

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, *What Are The 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 nonrenewable resources, such as fossil fuels.



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

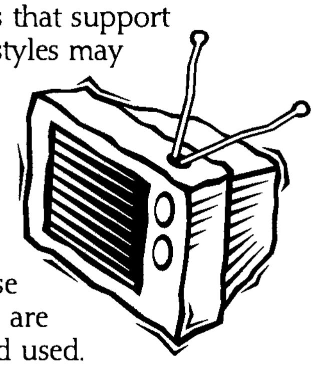
Understanding these concepts helps students analyze current energy-use practices and evaluate how they affect quality of life.

Lifestyles

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

➠ See concepts 44 - 47 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.



Health and safety

32. 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 48 for environmental risks to the health and well-being of human and nonhuman life.

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

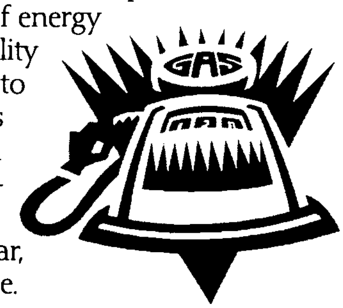
Economic

34. The availability and use of energy resources influence the economic growth and well-being of society.

35. Many occupations, businesses, and public services–such as utilities–result from the development and use of energy resources.

36. 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.

37. 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.



38. The rate of energy consumption is influenced by energy prices and externality costs.

39. The cost of energy is a factor in Wisconsin's economic development and affects the household budget of Wisconsin citizens.

Sociopolitical

40. 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.

41. The demand for energy resources influences relationships–alliances and conflicts–among states, regions, and nations.

42. 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.

43. Wisconsin's sociopolitical processes result in laws and regulations that govern energy development, availability, and use.

Cultural

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

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

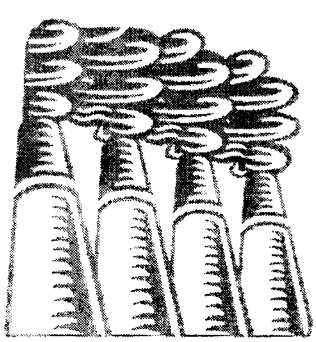
46. Because society's understanding of and relationship with energy changes over time, cultural expressions of energy use change over time as well. For example, ancient Egyptians worshiped the sun, while modern societies associate the sun with a positive mood, recreation, and nature.

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

Quality of the environment

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

48. 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.



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

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

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

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

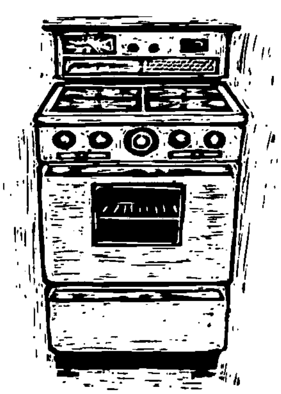
By mastering these concepts, students will recognize their ability to make decisions regarding which resources to use and how those decisions influence the future availability of resources. Students will also identify actions they can take based on these decisions.

52. The choice of energy resource and how it is used influences how energy resources are managed.

53. 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.

54. 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.

55. 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.



56. 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.

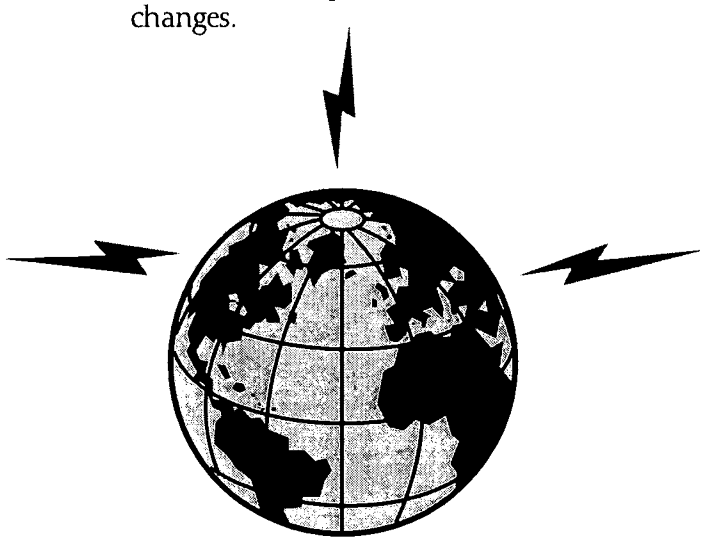
Future outlooks for the development and use of energy resources

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.

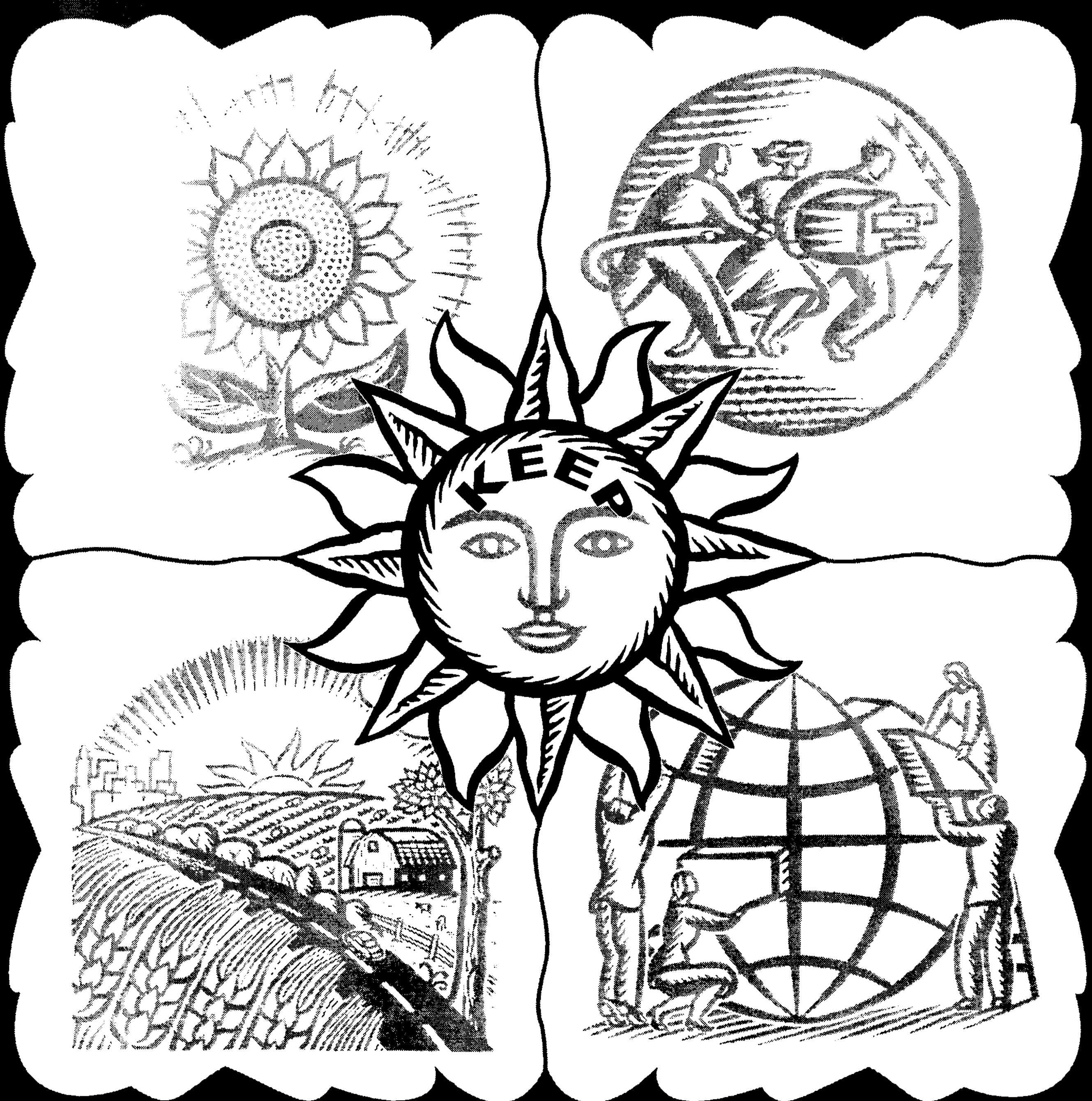
57. New energy resources, new ways of managing energy resources, and new energy technologies will be developed in the future.

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

59. 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.



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. 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 *Energy Education Activity Guide* will contains interdisciplinary energy-related activities that can be used by educators to bring energy concepts into their lessons.

Scope and Sequence Organization

This scope and sequence is based on the conceptual framework consisting of four main themes presented in the preceding section. The earlier themes in the framework involve lower level thinking skills such as knowledge and comprehension. These should be introduced in the early grades and mastered in middle school. The later themes involve higher level thinking skills such as synthesis and evaluation. These are best suited to middle and high school students.

Proficiency Levels

Each theme will move through three proficiency levels–*introduction, development,* and *mastery*–according to grade level.

- **Introduction**

  The *introduction* level presents basic information related to the concept. Learning usually occurs at the lower cognitive levels (knowledge and comprehension). The objective is to help students become aware of the facts related to the concept and how it is relevant to their lives.

- **Development**

  The *development* level builds on information learned in the introduction level. Students should gain enough knowledge and skills to apply the information to different settings. Analysis of information also begins at this level.

- **Mastery**

  The *mastery* level completes a thorough understanding of the concept. Learning usually occurs at the highest cognitive levels (synthesis and evaluation). The objective is for students to be able to use the information actively in their daily lives.

These proficiency levels are based on the taxonomy of thinking skills within the *cognitive domain* (Bloom, 1956) and on *environmental education subgoals* (Engleson and Yockers, 1994). See the appendix for more information on the cognitive thinking skills taxonomy and environmental education subgoals.

SUGGESTED SCOPE AND SEQUENCE

Overview of Suggested Scope and Sequence

The table below is an overview summarizing at what grade levels each theme should be introduced (I), developed (D), and mastered (M). This is a general overview that identifies where most–but not all–of the concepts within each theme should be incorporated. This overview also shows which taxonomic levels of the cognitive domain (CD) are emphasized and what environmental education subgoals (EE) are relevant for each theme. The next section, *Scoped and Sequenced Themes*, provides a more detailed look at each theme.

Theme and Comprehensive Performance Objective	Grade levels K-2	3-5	6-8	9-12
We need energy Students will be able to identify forms of energy and simulate or demonstrate how energy is used as it flows through systems (non-living, living, and ecosystems, including human). CD: Knowledge, Comprehension and Application EE: Perceptual Awareness, Knowledge and Environmental Ethic	I	D	M	
Developing Energy Resources Students will be able to identify energy resources and explain how they are developed and used. CD: Analysis EE: Environmental Ethic and Citizen Action Skills		I	D	M
Effects of Energy Rescource Development Students will be able to present and defend their views on how current energy-use practices have affected the quality of life and the quality of the environment. CD: Analysis EE: Knowledge, Environmental Ethic, and Citizen Action Skills		I	D	M
Managing Energy Resource Use Students will be able to make energy choice and use decisions and take action based on their analysis of available energy resources. Students will also demonstrate how use of these resources could affect the quality of life and the quality of the environment. CD: Synthesis and Evaluation EE: Environmental Ethic, Citizen Action Skills, and Citizen Action Experience		I	D	M

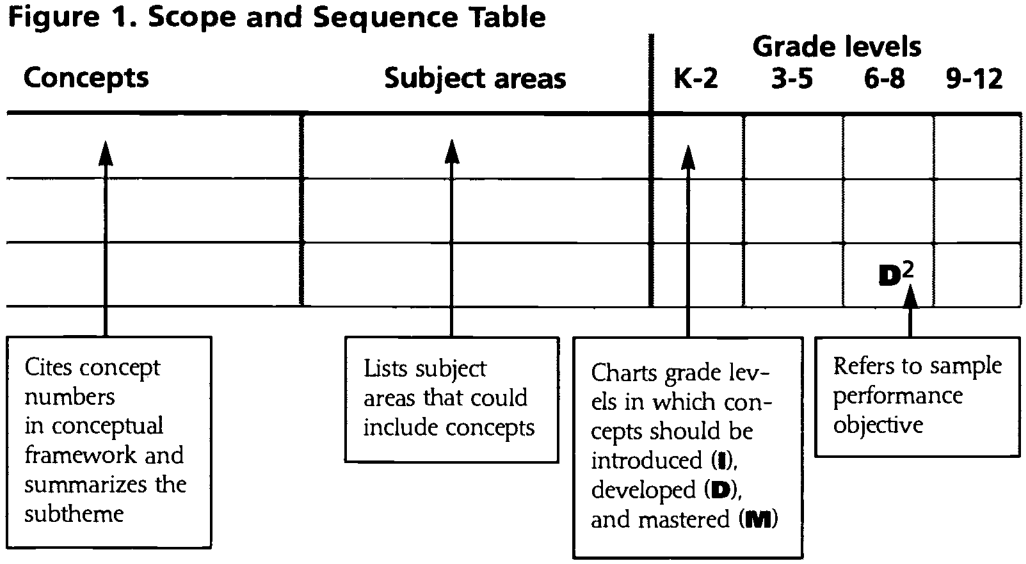
KEEP

Scoped and Sequenced Themes

For each of the four themes, we use a table to show at what grade level groups of concepts within that theme should be introduced, developed, and mastered (see Figure 1). Concept numbers refer to their locations within the conceptual framework. The tables also indicate the subject areas into which each group of concepts can be integrated.

Following each table are *sample performance objectives* that describe how students should be able to demonstrate they have learned a concept. We use action verbs that reflect the designated proficiency level for the concepts. We considered different learning styles of students, based on the Theory of Multiple Intelligences (see appendix). This theory identifies different ways people best express their knowledge and competencies. For example, some people are musically inclined while others are more analytical, so that instead of students simply stating energy safety rules, they might be encouraged to apply skills within the Musical-Rhythmic Intelligence category by writing and performing a song that communicates these rules. Considering both cognitive thinking skills and multiple intelligences increases the diversity and creativity of the performance objectives, making them more relevant to different subject areas. Superscript numbers within the tables show which subject areas and grade levels are associated with each performance objective.

Figure 1. Scope and Sequence Table



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, providing them 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.

These concepts should be incorporated early in students' learning experiences and and emphasized throughout students' learning experiences. These concepts are mastered when students can thoroughly explain how the natural laws that govern energy flow determine the form and function of ecosystems.

Concepts	Subject areas	Grade levels K-2	3-5	6-8	9-12
1-4: Definition of energy Energy is the ability to do work. There are many forms of energy. Power is the rate at which energy is used.	Fine arts[1] Language arts[2] Mathematics Physical education Physical science	I[1]	D[2]	M	M
5-7: Natural laws that govern energy Energy cannot be created or destroyed; it can only be converted from one form to another. With each conversion, some energy is always dispersed into a less useful form.	Mathematics Physical science[3] Technology education	I	I	D[3]	M
8-12: Energy flow in living systems Living systems' use of energy includes growth, movement, maintenance, and reproduction.	Health education Science[1]*	I	D[1]	D	M
13-18: Energy flow in ecosystems, including human societies Ecosystems are characterized by energy availability and patterns of flow. Wisconsin has four ecosystems. Human societies can be classified according to how they use energy.	Family and consumer education Geography[2] Global studies Mathematics Science* Social studies	I	D	M[2]	M

*Includes the Earth, life, and physical sciences

Sample Performance Objectives

1. Students will be able to demonstrate that certain actions produce sounds.
Multiple Intelligence: Musical-Rhythmic (introduction to sound energy)
Cognitive Domain: Knowledge
EE Subgoal: Perceptual Awareness, perceiving and discriminating among stimuli

Sample Performance Objectives *Continued*

2. Students will be able to write a story about a hanging drop of water that incorporates the concepts of potential and kinetic energy.
   Multiple Intelligence: Verbal-Linguistic
   Cognitive Domain: Comprehension
   EE Subgoal: Knowledge, translating and interpreting information

3. Students will be able to build a machine that uses the potential energy in water to lift an object.
   Multiple Intelligence: Visual-Spatial
   Cognitive Domain: Application
   EE Subgoals: Perceptual Awareness, processing, refining, and extending perceptions;
   Knowledge, knowledge of principles;
   Citizen Action Skills, application of principles

4. Students will be able to trace the energy flow of every item in their lunch back to the sun.
   Multiple Intelligence: Logical-Mathematical
   Cognitive Domain: Comprehension
   EE Subgoal: Knowledge, interpreting information

5. Students will be able to design a model village that illustrates how energy flows through a community.
   Multiple Intelligence: Visual-Spatial
   Cognitive Domain: Application
   EE Subgoal: Knowledge, application of principles;
   Citizen Action Skills, application of principles.

Developing Energy Resources

Concepts in this theme help students realize how they and other humans have become more and more dependent on the development and use of energy resources to satisfy their accustomed standard of living.

This theme involves students interpreting how humans, through technology, have developed energy resources. Higher-level thinking skills are involved as students analyze how these developments have influenced energy consumption patterns. These concepts may not be thoroughly mastered until students are in high school.

Concepts	Subject areas	Grade levels K-2	3-5	6-8	9-12
19-27: Development of energy resources Through technology, humans have been able to develop a variety of renewable and nonrenewable energy sources to meet societal needs. Wisconsin imports many of its energy resources.	Geography[1] Mathematics Social studies	I	I	D[1]	M
28-29: Consumption of energy resources Supply and demand influence energy resource development and use. Global demand for energy resources is increasing.	Fine arts[2] Global studies Physical science Social studies	I	I	D	M[2]

Sample Performance Objectives

1. Students will be able to design a chart that compares percentages of energy resources used in Wisconsin and that identifies which of these resources are imported.
Multiple Intelligences: Visual-Spatial and Logical-Mathematical
Cognitive Domain: Comprehension
EE Subgoal: Knowledge, interpreting information

2. Students will be able to write and perform a play that shows how the cost of a resource increases as its availability decreases.
Multiple Intelligence: Bodily-Kinesthetic
Cognitive Domain: Analysis
EE Subgoal: Environmental Ethic, valuing

Effects of Energy Resource Development

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

Awareness of how energy use positively and negatively affects quality of life and the environment can begin during the primary grades; however, because of the complexity of environmental issues they may be better introduced at a later stage (e.g., late elementary). In addition, students should develop skills necessary to investigate energy-related environmental issues. Students should master this theme during their high school years.

Concepts	Subject areas	Grade levels K-2	3-5	6-8	9-12
30-47: Quality of life Energy use has affected the quality of human life: life styles; health and safety; economic development; sociopolitical development; and cultural development. Wisconsin's quality of life has been affected by energy use.	Economics[3] Family and consumer education Health education[1] Language arts[2] Science* Social studies[4]	I	I[1]	D[2,3]	M[4]
48-51: Quality of the environment Energy use has affected the quality of the environment which in turn affects the health of organisms living in the environment. Wisconsin's environment has been affected by energy resource development and use.	Fine arts[5] Global studies Physical science Social studies	I	I	D	M[5]

*Includes the environmental, life, physical sciences

Sample Performance Objectives

1. Students will be able to perform a rap song that includes safety rules about electricity.
   Multiple Intelligence: Musical-Rhythmic
   Cognitive Domain: Knowledge
   EE Subgoal: Environmental Ethic, responding

2. Students will be able to analyze how energy use and availability have affected the lives of characters in a novel (e.g., *Little House on the Prairie*, by Laura Ingalls Wilder and *Brave New World* by Aldous Huxley).
   Multiple Intelligence: Interpersonal
   Cognitive Domain: Analysis
   EE Subgoal: Environmental ethic, valuing

3. Students will be able to interpret the results of an energy audit to determine how the costs of energy affect the family budget.
   Multiple Intelligence: Interpersonal
   Cognitive Domain: Analysis
   EE Subgoal: Citizen Action Skills, production of a plan or proposed set of options

4. Students will be able to role play a mock rate case hearing that illustrates how the Public Service Commission of Wisconsin regulates the state's electric and gas utilities.
   Multiple Intelligences: Bodily-Kinesthetic and Interpersonal
   Cognitive Domain: Analysis
   EE Subgoal: Environmental Ethic, valuing

5. Students will be able to write a journal article that analyzes the history of an energy-related environmental issue, and presents and interprets the values people affected by the issue hold.
   Multiple Intelligence: Interpersonal
   Cognitive Domain: Analysis
   EE Subgoal: Environmental Ethic, valuing

Managing Energy Resource Use

Concepts in this theme help students to identify ways in which they can help ensure that energy resources will be available for future users.

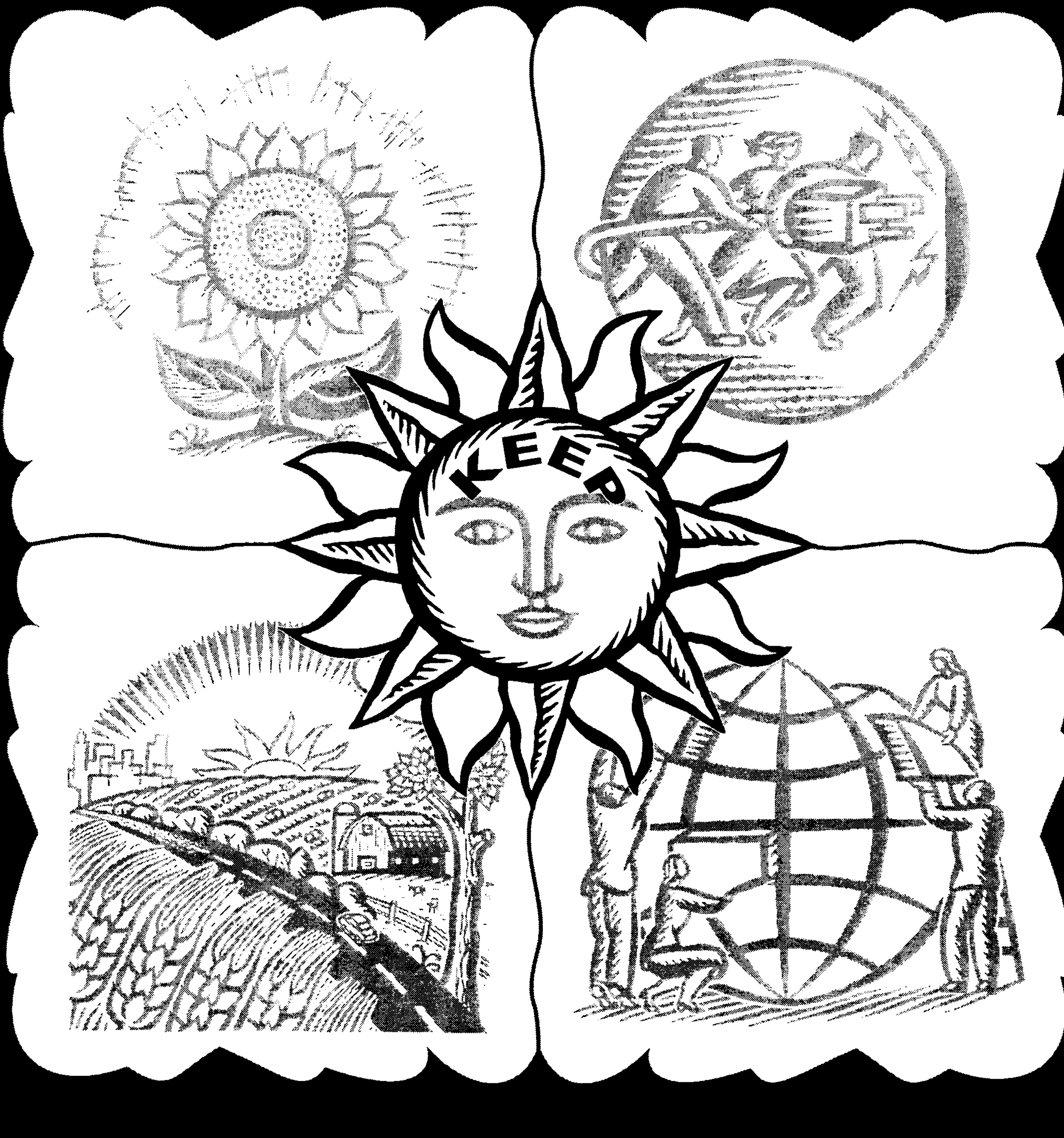
Young children can be taught how to use energy efficiently and why it's important to do so. As students increase their understanding of how energy-use practices affect the quality of life and the environment, they will begin to determine how they choose to use energy resources. By the time students graduate from high school, they should have mastered the skills and concepts that will enable them to make wise energy choice decisions and take actions that reflect their personal energy use ethic. In addition, they should be able to extrapolate how their actions today could affect the availability of energy resources tomorrow.

Concepts	Subject areas	Grade levels K-2	3-5	6-8	9-12
52-56: Management of energy resource use Energy resource management involves societies deciding which resources to use and determining how to use them efficiently. Wisconsin has a variety of programs available on energy conservation.	Language arts Environmental science[1] Social studies[3] Technology education[2]	**I**[1]	**I**[2]	**M**	**M**[3]
57-59: Future outlooks for the development and use of energy resources New energy resources, new ways of managing energy resources, and new technologies will be developed in the future. Energy resource management will affect the quality of life and the environment.	Language arts Environmental science Social studies	**I**	**I**	**D**	**M**

Sample Performance Objectives

1. Students will be able to distinguish between a household that is using energy efficiently and one that is not (such as a household that leaves lights on unnecessarily).
   Multiple Intelligence: Logical-Mathematical
   Cognitive Domain: Knowledge
   EE Subgoals: Knowledge, knowledge of terminology;
   Environmental Ethic, responding
2. After they have cooked a meal in a solar oven of their own design, students will be able to explain why they would or would not choose to use a solar oven.
   Multiple Intelligences: Intrapersonal and Visual-Spatial
   Cognitive Domains: Synthesis and Evaluation
   EE Subgoals: Environmental Ethic, organizing a value system;
   Citizen Action Skills, evaluation
3. Students will be able to evaluate the success of promoting and implementing an energy efficiency plan for their school.
   Multiple Intelligence: Intrapersonal
   Cognitive Domain: Evaluation
   EE Subgoals: Citizen Action Skills, analysis and synthesis;
   Citizen Action Experience, education and persuasion

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

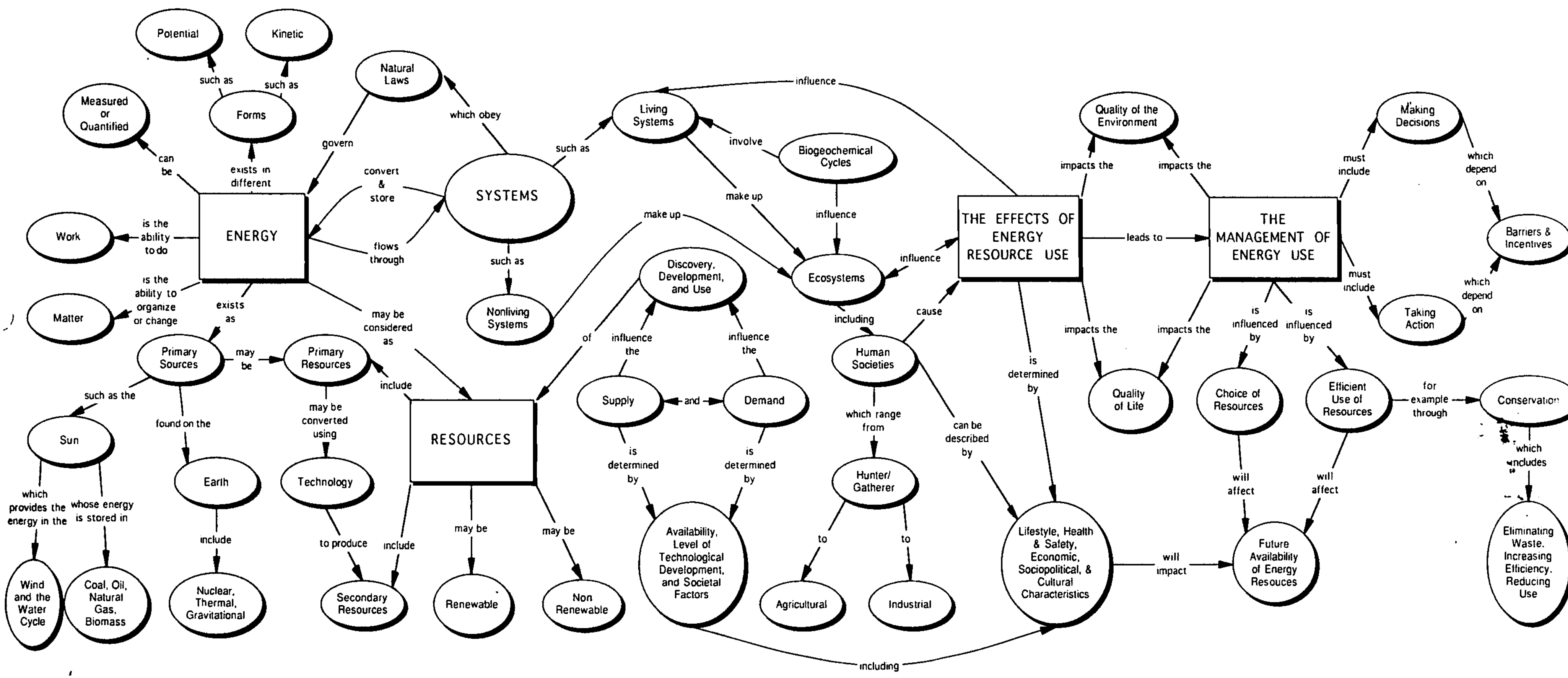
Our concept map visually represents the themes and selected concepts presented in the framework. It shows that the concepts are not isolated, fragmented ideas. Rather, they are integral components of the framework and are complementary, connected, and interrelated. As we develop the energy education activity guide, we will create more detailed concept maps for each theme.

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.

Lift flap to view concept map

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").



BEST COPY AVAILABLE

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.

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 energy 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 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.

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.

Heterotroph

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

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.

Photovoltaic cell

Device that converts solar energy directly into electricity. For example, photovoltaic cells provide electricity for hand-held calculators, watches, battery chargers, homes, and satellites.

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.

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.

Resources And References

Armstrong, T. 1994. *Multiple intelligences in the classroom.* Alexandria, Va.: Association for Supervision and Curriculum Development.

Bloom, B. S., ed. 1956. *Taxonomy of educational objectives: The classification of educational goals: Handbook I: Cognitive domain.* New York: David McKay Company, Inc.

Engleson, D. C., and Yockers, D. H. 1994. *A guide to curriculum planning in environmental education.* Madison, Wisc.: Wisconsin Department of Public Instruction.

Gronlund, N. E. 1991. *How to write and use instructional objectives, 4th edition.* New York: MacMillan Publishing Company.

Krathwohl, D. R., Bloom, B. S., and Masia, B. B. 1964. *Taxonomy of educational objectives: The classification of educational goals: Handbook II: Affective domain.* New York: David McKay Co., Inc.

Hungerford, H. R., Litherland, R., Peyton, R. B., Ramsey, J., Tomera, A., and Volk, T. 1992. *Investigating and evaluating environmental issues and actions: Skill development modules.* Champaign, Ill.: Stipes Publishing Company.

Miller, G. T. 1988. *Living in the environment: An introduction to environmental science.* Belmont, Calif.: Wadsworth Publishing Company.

National Energy Foundation. 1987. *Energy conceptual framework.* Salt Lake City: National Energy Foundation.

North American Association for Environmental Education. 1990. *Essential learnings in environmental education: A database for building activities and programs.* Troy, Ohio: North American Association for Environmental Education.

Novak, J. D., and Gowin, D. B. 1984. *Learning how to learn.* New York: Cambridge University Press.

Starr, M. L., and Krajcik, J.S. 1990. Concept maps as a heuristic for science curriculum development: Toward improvement in process and product. *Journal of Research in Science Teaching* 27: 987-1000.

University of North Iowa Energy Education Curriculum Project. n.d. *Goal statements and curriculum framework.* Duplicated.

Wandersee, J. H. 1990. Concept mapping and the cartography of cognition. *Journal of Research in Science Teaching* 27: 923-936.

Appendix

Taxonomy of Educational Objectives

These tables briefly describe the taxonomy of thinking skills within the cognitive and affective domain. In each table, the descriptions are arranged from lowest level of thinking skills to the highest or most complex.

Cognitive Domain and Selected Illustrative Verbs

Description of Categories Within the Cognitive Domain	Illustrative Verbs
Knowledge Remembering and recalling previously learned information.	define, identify, outline
Comprehension Understanding and interpreting learned information.	paraphrase, predict, rewrite, summarize
Application Demonstrating understanding by using learned information in new or different situations.	change, model, solve, prepare, manipulate
Analysis Identifying parts and components of learned information and investigating relationships among those components.	analyze, diagram, illustrate, relate, perform
Synthesis Arranging components of learned information to create a new product (e.g., a collection of ideas, an invention).	categorize, build, create, plan, organize
Evaluation Judging the value or worth of learned information and products created during synthesis.	evaluate, conclude, critique, justify

Based on Bloom, 1956.

Affective Domain and Selected Illustrative Verbs

Description of Categories Within the Affective Domain	Illustrative Verbs
Receiving Willingness to participate in an experience or new learning situation.	reply, name, follow, identify, recognize
Responding Reacting to and displaying interest in a new learning situation.	report, assist, request, read, seek
Valuing Forming or identifying attitudes and values toward a new learning situation.	complete, describe, explain, demonstrate
Organization Analyzing values related to a learning situation and organizing them into a value system.	modify, organize, prepare, determine
Characterization by a Value or Value Complex Demonstrating behaviors that indicate a value system has been incorporated into one's lifestyle.	illustrate, perform, solve, develop, exhibit

Based on Krathwohl, et al. 1964.

KEEP

Subgoals of Environmental Education

This table describes the subgoals of environmental education and identifies their associated learning domains.

Subgoal	Definition	Learning Domain
Perceptual Awareness	To help students develop the ability to perceive and discriminate among stimuli; to process, refine, and extend those perceptions; and to concurrently acquire an aesthetic sensitivity to both natural and built environments.	Affective (primarily receiving and responding)
Knowledge	To help students acquire a basic understanding of how the natural environment functions, how its functioning is affected by human activity, and how harmony between human activity and the natural environment can be achieved.	Cognitive
Environmental Ethic	To help students develop a universal ethic on which they may act to defend, improve, and sustain the quality of the environment.	Affective
Citizen Action Skills	To help students develop the skills needed to identify, investigate, and take action toward the prevention and resolution of environmental issues.	Cognitive
Citizen Action Experience	To help students gain experience in applying their acquired perceptual awareness, knowledge, environmental ethic, and citizen action skills in working toward the prevention and resolution of environmental issues at all levels, local through universal.	Cognitive, Affective

Based on Engleson and Yockers, 1994.

Summary of Multiple Intelligences

This table describes the seven types of intelligences.

Type of Intelligence	Definition
Verbal-Linguistic	Using language to express ideas and concepts.
Logical-Mathematical	Skillfully using numbers mathematically and reasoning out problems.
Visual-Spatial	Perceiving elements of the spatial world and representing those expressions efficaciously.
Bodily-Kinesthetic	Creatively using the whole body to illustrate ideas and concepts.
Musical-Rhythmic	Discriminating among musical components and using instruments or the voice to express understandings.
Interpersonal	Demonstrating empathy toward or appreciating the thoughts and feelings of others.
Intrapersonal	Analyzing one's own thoughts and motivations and expressing understandings of those thoughts and feelings through behavior.

Based on Armstrong, 1994.

Wisconsin K-12 Energy Education Program
(KEEP)

414 LRC
University of Wisconsin-Stevens Point
Stevens Point, WI 54481
PH (715) 346-4770
FAX (715) 346-3025
Email: energy@uwspmail.uwsp.edu

S8010889

ERIC®

U.S. Department of Education
Office of Educational Research and Improvement (OERI)
Educational Resources Information Center (ERIC)

REPRODUCTION RELEASE
(Specific Document)

I. DOCUMENT IDENTIFICATION:

Title: A Conceptual Guide to K-12 Energy Education in Wisconsin

Author(s): Wisconsin K-12 Energy Education Program

Corporate Source: Energy Center of Wisconsin and Wisconsin Center for Environmental Education

Publication Date: 1996, 1997

II. REPRODUCTION RELEASE:

In order to disseminate as widely as possible timely and significant materials of interest to the educational community, documents announced in the monthly abstract journal of the ERIC system, *Resources in Education* (RIE), are usually made available to users in microfiche, reproduced paper copy, and electronic/optical media, and sold through the ERIC Document Reproduction Service (EDRS) or other ERIC vendors. Credit is given to the source of each document, and, if reproduction release is granted, one of the following notices is affixed to the document.

If permission is granted to reproduce and disseminate the identified document, please CHECK ONE of the following two options and sign at the bottom of the page.

[X] Check here
For Level 1 Release:
Permitting reproduction in microfiche (4" x 6" film) or other ERIC archival media (e.g., electronic or optical) *and* paper copy.

The sample sticker shown below will be affixed to all **Level 1** documents

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL HAS BEEN GRANTED BY

Sample

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

Level 1

The sample sticker shown below will be affixed to all **Level 2** documents

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN OTHER THAN PAPER COPY HAS BEEN GRANTED BY

Sample

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

Level 2

[ ] Check here
For Level 2 Release:
Permitting reproduction in microfiche (4" x 6" film) or other ERIC archival media (e.g., electronic or optical), but *not* in paper copy.

Documents will be processed as indicated provided reproduction quality permits. If permission to reproduce is granted, but neither box is checked, documents will be processed at **Level 1**.

"I hereby grant to the Educational Resources Information Center (ERIC) nonexclusive permission to reproduce and disseminate this document as indicated above. Reproduction from the ERIC microfiche or electronic/optical media by persons other than ERIC employees and its system contractors requires permission from the copyright holder. Exception is made for non-profit reproduction by libraries and other service agencies to satisfy information needs of educators in response to discrete inquiries."

Sign here→ please

Signature: Jennie F. Lane

Printed Name/Position/Title: Jennie F. Lane, Education Coordinator

Organization/Address: WI K-12 Energy Education Program, WCEE, LRC, UWSP, Stevens Point, WI 54481

Telephone: (715) 346-4770

FAX: (715) 346-4698

E-Mail Address: energy@uwsp.edu

Date: 2/11/98

(over)

III. DOCUMENT AVAILABILITY INFORMATION (FROM NON-ERIC SOURCE):

If permission to reproduce is not granted to ERIC, *or*, if you wish ERIC to cite the availability of the document from another source, please provide the following information regarding the availability of the document. (ERIC will not announce a document unless it is publicly available, and a dependable source can be specified. Contributors should also be aware that ERIC selection criteria are significantly more stringent for documents that cannot be made available through EDRS.)

Publisher/Distributor:

Energy Center of Wisconsin (attn: Kathy Kuntz)

Address:

595 Science Drive
Madison, WI 53711-1060

Price:
N/A

IV. REFERRAL OF ERIC TO COPYRIGHT/REPRODUCTION RIGHTS HOLDER:

If the right to grant reproduction release is held by someone other than the addressee, please provide the appropriate name and address:

Name:
Please also contact:
Wisconsin Center for Environmental Education attn: Jennie Lane

Address:
110 CNR, UWSP
Stevens Point, WI 54481

V. WHERE TO SEND THIS FORM:

Send this form to the following ERIC Clearinghouse:

ERIC/CSMEE
1929 Kenny Road
Columbus, OH 43210-1080

However, if solicited by the ERIC Facility, or if making an unsolicited contribution to ERIC, return this form (and the document being contributed) to:

ERIC Processing and Reference Facility
1100 West Street, 2d Floor
Laurel, Maryland 20707-3598

Telephone: 301-497-4080
Toll Free: 800-799-3742
FAX: 301-953-0263
e-mail: ericfac@inet.ed.gov
WWW: http://ericfac.piccard.csc.com