THE DEVELOPMENT AND EVALUATION OF A BIOMASS ACTIVITY GUIDE FOR THE WISCONSIN K-12 ENERGY EDUCATION PROGRAM.

By

Carrie Bea Ziolkowski

A Thesis
Submitted in partial fulfillment of the
requirements of the degree

MASTERS OF SCIENCE
IN
NATURAL RESOURCES
(ENVIRONMENTAL EDUCATION)

College of Natural Resource

UNIVERSITY OF WISCONSIN
Stevens Point, Wisconsin

December 2007

APPROVED BY THE GRADUATE COMMITTEE OF:

Randy Champeau

Dr. Randy Champeau, Committee Chairperson
Director of Wisconsin Center for Environmental Education
Associate Dean, College of Natural Resources

Dennis H. Yockers

Dr. Dennis Yockers
Associate Professor of Environmental Education

Michael Demchik

Dr. Michael Demchik
Associate Professor of Forestry

Jennie Lane

Dr. Jennie Lane
Director, Wisconsin K-12 Energy Education Program

ABSTRACT

The purpose of this research was the development and evaluation of a curriculum on biomass energy education for the Wisconsin K-12 Energy Education Program (KEEP).

This research focuses on the process used to develop and evaluate a biomass energy activity guide and the steps that were taken to ensure its conceptual accuracy and relevance to the needs of Wisconsin K-12 teachers. First the biomass energy topics were identified. Then a list of the existing K-12 biomass classroom resources available was compiled. The activity guide was drafted, field-tested, and evaluated.

During the literature review six biomass energy topics were identified for the activity guide along with twenty-six existing K-12 biomass energy classroom resources that addressed the topics. Eleven K-12 teachers reviewed the existing classroom resources and five of those activities were adapted for the activity guide based on the teachers' recommendations and five additional activities were developed. In total, ten activities were developed and underwent a conceptual review. Following the conceptual review each activity was piloted by two to three teachers in their classroom. Those teachers then evaluated each activity for grade-level appropriateness, ease of accomplishment, and success in achieving the intended objectives. The final step of the process was the comprehensive review which examined the extent to which important biomass energy concepts were covered by the activities and assessed the guide's cohesiveness and level of organization.

The development and evaluation process ensured the curriculum will be functional for Wisconsin K-12 teachers. For future curriculum development projects, it is recommended that the drafted activities be tested in-house before the teacher pilot. Additional teacher pilots and participant observation of those pilots would also improve the research.

ACKNOWLEDGEMENTS

Because I have been working on obtaining my Master's for several years I have many people to thank. I would like to start by thanking my husband for supporting me through this project and for pushing me towards completing when it was difficult. I would also like to thank my mother, father and sister for their support and encouragement during these past four years. Thank you Craig, Mom, Dad, and Staci.

I would like to thank my graduate committee Jennie Lane, Randy Champeau, Dennis Yockers, and Michael Demchik for making sure my work was up to College of Natural Resources standards. The biggest thanks go to Jennie Lane for acting as my guide and "go to" person when I was panicked and unsure of myself. Thank you also to Randy for taking the time out of his schedule to ask me the difficult questions I did not want to hear. Thank you, Dennis, for acting as my Stevens Point father who always had words of support and encouragement when I was frustrated.

Thank you to the current and past KEEP and WCEE staff that has worked at the WCEE while I have working on this project. You have helped create a creative and fun work environment. I look forward to continuing to work with you and develop new and exciting ways to incorporate environmental education into K-12 schools.

TABLE OF CONTENTS

LIST OF FIGURES

Chapter One
Introduction

"There sleeps, on the land, a mighty Dragon, with power greater than all the energy contained in all of the oil and all of the coal and gas that we have used, and will use, for warmth and comfort and work.

The Dragon was the master of the fire from the dawn of time until the industrial age. Now it naps in confidence, knowing that the secret of its might is self-renewal. With care, it is immortal, and as the last fossil fuels are consumed, it will awake to serve again in all of its strength and energy.

The Dragon is called biomass and, while it naps, you are welcome to explore its lair to learn the secrets of its service and its importance to human kind. For it, along with the sun and wind and water, will again be one of our powerful protectors against the cold and darkness."

Taken from:
Lied Conference Center,
National Arbor Day Foundation,
Nebraska City Fuelwood Energy Plant
August 2006

The purpose of Chapter One is to provide an introduction to this study and describe the following:

I. Importance of Study

II. Statement of Purpose

III. Statement of Subproblems

IV. Hypothesis

V. Limitations

VI. Definition of Terms

VII. Assumptions

VIII. Acronyms

Importance of Study

There are organizations that have recognized the need to prepare for the future and have taken the initiative to increase energy and renewable energy education. The Wisconsin K-12 Energy Education Program (KEEP) has taken the lead in Wisconsin by empowering K-12 teachers to increase and improve energy education in Wisconsin schools. KEEP recognizes that energy education can be the tool to prepare for future energy challenges. As of June 2006 KEEP has reached over 3,000 teachers through their inservice courses and those teachers have reached thousands of Wisconsin students who are better prepared to tackle energy challenges of the future. KEEP does not just teach future energy issues but develops tools to help educators teach about current energy and renewable energy issues.

The development of a biomass energy curriculum is an example of how KEEP has been proactive in the development of a resource teachers can use to teach about a current issue. Lacking any deposits of coal or oil, Wisconsin needs to import all the fossil fuels we depend on to heat our home and to drive our cars. Wisconsin's Governor, Jim Doyle, recognizes this and has increased the development and use of Wisconsin's energy sources. One of the largest renewable energy resources Wisconsin has is biomass. To address the increased interest in this particular resource, KEEP is working with Wisconsin's Department of Administration's (DOA) Division of Energy (DOE) office and Focus on Energy to develop a biomass energy curriculum to supplement the existing *KEEP Activity Guide* and *Doable Renewables: Supplement to the KEEP Activity Guide*. The biomass energy curriculum will address biomass energy topics which will also help students become informed and aware citizens and will prepare them for the energy future of Wisconsin.

Statement of the Problem

This research proposes to identify biomass energy topics that can be integrated into the KEEP curriculum; to identify K-12 biomass energy classroom lessons available to educators on the identified topics; to develop a Wisconsin biomass energy curriculum; and to field-test and evaluate the biomass energy curriculum for the Wisconsin K-12 Energy Education Program.

Subproblems

1. The first subproblem is to identify biomass energy topics that can be integrated into the KEEP curriculum.
2. The second subproblem is to identify K-12 biomass classroom lessons available to educators on the identified topics.
3. The third subproblem is the development of a Wisconsin biomass energy curriculum.
4. The fourth subproblem is to evaluate the biomass energy curriculum.

Limitations

1. KEEP will work with selected biomass professionals to determine biomass energy concepts.
2. Rather than try to address each biomass energy topic, ten activities will be developed in this study. The activities will address some of the specific topics and others will provide an overview of biomass topics and their related issues.

3. The biomass energy curriculum will be used as a supplement to the KEEP *Activity Guide* and *Doable Renewables: A Supplement to the KEEP Activity Guide.* Before studying biomass energy resources, student should understand the energy basics which are addressed in the KEEP *Activity Guide* and renewable energy basics which are addressed in *Doable Renewables*.
4. The activities developed will be for specific grade levels. Extensions will be included for various grade levels but teachers will need to adapt activities to fit their needs.
5. Selected teachers will assist with the development of the curriculum.

Definition of Terms

Bioenergy	see biomass
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. (KEEP, 2005a)
Biomass Professional	Biomass professionals include staff of the Wisconsin Conservation Corporation, Focus on Energy, Midwest Renewable Energy Association, Department of Administration, and independent renewable energy consultants.
Formal Educator	Classroom teacher (K-12 public or private)

Nonrenewable Energy Resource	Energy resource that is either replenished very slowly or is 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 examples of nonrenewable energy resources. (KEEP, 2005a)
Renewable Energy	Energy resources that can be quickly replenished. Certain renewable resources will always be available no matter how they are used, while other renewable resources can be depleted when their rate of use exceeds their rate of replacement. (KEEP, 2005a)

Assumptions

1. Biomass education topics are of interest to Wisconsin K-12 educators.
2. Educators will be interested in working on the development of a biomass energy curriculum.
3. Educators will be willing to evaluate the curriculum.
4. The biomass energy curriculum will further complement the KEEP *Activity Guide* and *Doable Renewables*.
5. Educators will use a biomass curriculum.

Abbreviations

DOA = Department of Administration

DOE = Division of Energy (within the DOA)

EE = Environmental education

KEEP = Wisconsin K-12 Energy Education Program

MREA = Midwest Renewable Energy Association

UWSP = University of Wisconsin-Stevens Point

WCEE = Wisconsin Center for Environmental Education

WECC = Wisconsin Energy Conservation Corporation

Chapter Two
Review of the Related Literature

This literature review will address the following topics:

- Environmental Education
- Need for Energy Education
- Need for Renewable Energy Education
- Need for Biomass Energy Education
- Overview of KEEP and List of Achievement
- Concept Based Education
- Review of Current Biomass Energy Topics
- Existing Biomass Activities
- Development of Activities
- Formative Assessment
- Questionnaire
- Reliability and Validity
- Researcher as the Primary Research Tool
- Summary

Environmental Education

Teaching about the environment is not a new concept, it has been called nature education, conservation education and outdoor education over the years. Environmental education (EE) became more important after Rachel Carlson's book, *Silent Spring* spawned a national movement towards increasing EE in 1962. In 1969 and 1970 the National Environmental Education Act and the National Environmental Policy act were passed (Wilke, 1993). The Belgrade Charter, 1976, provided a goal for EE and the Tbilisi Declaration, 1978, stated broad objectives for EE (NAAEE, 2000). In 1990 the National Environmental Education Act was revised and Earth Day was established (Wilke, 1993).

In 1990 the Wisconsin legislature established the Wisconsin Center for Environmental Education (WCEE) and the Wisconsin Environmental Education Board (WEEB). These organizations were put in place in order to support and improve EE in Wisconsin (Champeau, 1997). In 1997 the WCEE published results of a study entitled *Environmental Education: Are we walking the talk?*, which was the basis for several of the programs the WCEE would establish. The WCEE went on to create, in 1992, an EE Master's program at the University of Wisconsin-Stevens Point in the College of Natural Resources. The WCEE also developed the K-12 Energy Education Program (KEEP), Forestry Education Program (LEAF), and the Global Environmental Teachings (GET) Program.

Need for Energy Education

In 2002 the National Environmental Education & Training Foundation conducted a poll on America's knowledge, attitude and behavior related to energy. The study found that Americans know little about energy and are not prepared to face coming energy issues. Only twelve percent, or one out of eight, of the participants passed the basic energy quiz. In fact "only one out of 100 adults received a grade of 'A' on the energy quiz" which required them to answer nine out of ten questions correctly (NEETF, 2002).

According to the poll there is a correlation between energy knowledge and energy issues. Because energy knowledge is low, important energy issues are neglected. Because Americans have little knowledge on energy issues we are not able to adequately discuss energy issues such as gas mileage, energy security, or global climate change (NEETF, 2002). Without this knowledge it seems that Americans may find themselves in an energy crisis without even knowing it.

The study also found that energy knowledge is directly related to energy saving activities. Americans who have a higher level of knowledge are more willing to participate in energy conservation practices; they are more likely to turn off the light when not in use or lower their heat in the cold winter months. This is a key example of why energy education is extremely important to raising informed and active adults for the future. The study states that we need to improve energy literacy and we need to start with the youth of America (NEETF, 2002).

In order to direct what is being taught to Wisconsin's youth educational guidelines, called the Wisconsin Model Academic Standards, were developed in 1998 by the Wisconsin Department of Public Instruction. The standards specify the information K-12 students should know and what they should be able to do. The standards are performance, content and proficiency based. Each subject area has a set of academic standards that need to be met at the K-4, 5-8, and 9-12 grade levels.

Because Wisconsin teachers must address the academic standards, KEEP has identified the academic standards that are related to KEEP's energy concepts. The *KEEP Conceptual Guide to K-12 Energy Education in Wisconsin* has identified specific standards in Environmental Education, Science, Social Studies, Technology Education, and Family and Consumer Education and correlated those standards to the KEEP energy concepts.

The Academic Standards identified are listed in Appendix A.

Need for Renewable Energy Education

Renewable energy will be an important part of the energy future. Because it is already known that people with knowledge about energy issues are more open to making changes to their energy use it is important that we begin to educate K-12 students so they will be prepared for the future they face. The rationale for renewable energy education from KEEP's *Doable Renewables Supplement* (2005) states that "given the importance of renewable energy in helping to resolve our current and future energy challenges, the study of renewable energy should be emphasized in education”.

Need for Biomass Energy Education

Understanding energy issues can help students prepare for the future in Wisconsin, the United States, and global communities in the future (KEEP, 2005b). Wisconsin does not contain oil, coal, or natural gas reserves and must purchase fuel from other states and nations for our energy needs. As the shift to renewable energy approaches, Wisconsin has to evaluate the renewable resources available. In 2004 the most utilized renewable energy resource in Wisconsin was wood burning in homes and industry.

The need for biomass energy education was also identified by the leaders in the field of energy. Maria Boardman, the program coordinator for the Wisconsin Alternative Fuels Task Force, stated that “the development of a curriculum to educate our youth is a step forward in including everyone in the effort to increase awareness on our state’s energy, economic, environment, public health, and transportation needs”. Boardman is specifically interested in the development of activities that increase student awareness about biodiesel and the ethanol fuel blend E85 (Boardman, 2005).

Don Wichert, the Director of the Focus on Energy Renewable Energy Program, said “it is important to educate students today about using this locally available resource” (Wichert, 2005). Wichert is the former Chief of the Energy Resources section of the Wisconsin

DOA, Division of Energy and is considered on of the foremost experts on renewable energy in Wisconsin.

The Wisconsin DOA, Division of Energy, worked with KEEP to apply for a United States Department of Energy grant relating specifically to biomass. KEEP and DOA proposed to develop a biomass energy curriculum, bookmark contest, and public service announcement contest with a theme of biomass. The grant was awarded to the DOA and KEEP.

Overview of KEEP

The Wisconsin K-12 Energy Education Program (KEEP) was formed in 1995 with the support of the Wisconsin Center for Environmental Education (WCEE), Energy Center of Wisconsin (ECW), and the Wisconsin Environmental Education Board (WEEB). The first years of KEEP were spent working with energy and education professionals to develop a comprehensive conceptual framework which has been the basis for all of the curriculum development done by KEEP. This framework was then further expanded to include more in depth renewable energy concepts. The framework is designed to address K-12 energy education in four themes.

- *We Need Energy* concepts address energy basics such as the definition of energy and the first and second laws of thermodynamics.
- *Developing Energy Resources* addresses the individual energy sources and how we use them in the past and today.

- *Effects of Energy Resource Development*, theme three, covers the how using energy resources affects us in a positive and negative way.
- *Managing Energy Resource Use*, addresses how we can resolve our energy issues that were identified in previous themes.

After the development of the *KEEP Conceptual Framework* KEEP staff worked with Wisconsin educators and energy professionals to develop a multitude of educational materials including:

- KEEP *Activity Guide,*
- *Doable Renewable: A Supplement to the KEEP Activity Guide,*
- *Know the Flow of Energy in Your School,*
- *Agriculture and Energy*, and
- *Energy Matters: A Web-based Exploration of Energy Today and Tomorrow*.

While KEEP was originally based on the Conceptual Framework and Activity Guides it offers more support materials for teachers to help them increase and improve energy education in the K-12 classroom. KEEP offers students involvement opportunities such as the *Bright Idea* Fundraiser, Energy Education Bookmark Contest, Students Built Homes Program, Electrathon, and the Energy Awards Ceremony. Because students learn in different ways KEEP has collected hands-on resources that teachers can borrow to help teach about energy. Some of theses resources include watt meters, hand crank generators, and energy cycles. KEEP also presents and attends conference to reach out to diverse teacher populations.

With the assistance of teachers and organizations like the WCEE, Focus on Energy, electrical utilities, and Department of Administrations Division of Energy office, KEEP is able to continue developing services and programs for K-12 teachers. This is important because as time passes KEEP needs to remain current on energy issues facing Wisconsin. As we face these issues additional educational materials will need to be developed in order to prepare teachers to instruct to their student.

Concept Based Education

Concept based education moves teachers and students away from routine memorization of facts and into broader ideas that can help students move towards thinking critically. Concepts are a great way to organize large amounts of information that are always growing (Erickson, 2001). Concepts are organized facts that have commonalities, organized into a single word or phrase and should be timeless, universal, and broad (Kemp, 1985) they should also grow more complex as students move into higher grade levels (Erickson, 1998). When KEEP developed the Renewable Energy Conceptual Framework professionals who work in the field of renewable energy and K-12 educators were surveyed using a Delphi Panel to validate the concepts (Kane, 2003). Once the concepts are developed and organized teachers can use them to build on what has and will be taught (Erickson, 2001).

Review of Current Teachable Biomass Topics

Research on biomass as a source of energy has been conducted for numerous years by many organizations and individuals; therefore, it is quite extensive. For the purposes of this study research was limited to Focus on Energy, National Renewable Energy Laboratory (NREL), and the United States Department of Energy (US DOE). The research was limited to these sources because there is a significant amount of information available on biomass energy. A K-12 activity guide on biomass energy should focus on biomass energy sources and practices that are mainstream to simplify the information for this audience. Focus on Energy is a Wisconsin based program that offers information about biomass energy on their Web site in the form of Fact Sheets. The US DOE has a biomass Web site and a Biomass Document Database located at www1.eere.energy.gov/biomass/document_database.html which houses a search tool that can query articles by title, keyword, author, or document number. NREL also has a web site dedicated specifically to biomass research that can be found at www.nrel.gov/biomass/. This site houses general information about biomass, biomass projects, staff, publications, awards, and energy analysis and tools.

For this research the biomass topics will be divided into the following categories; direct burning, co-firing, anaerobic digestion, bio-fuels, gasification, and pyrolysis.

Existing Biomass Energy Activities

The National Energy Education Development (NEED) Program has a biodiesel activity guide that includes fact sheets, short activities, and classroom worksheets such as word searches and crossword puzzles. NEED developed the activity guide because they had requests from teachers to connect biology to energy concepts as well as to have the "what's next" in energy. The content of the activity guide was reviewed by NEED's Advisory Board and then was sent to practicing teachers who further evaluated the guide. A final evaluation was completed by the granting organization, the United States Department of Agriculture (Spruill, 2005).

The National Energy Foundation (NEF) publication *Energy Technology and Society* has a chapter dedicated to biomass energy that seems well thought out and could be useful to Wisconsin Educators. The NEF activity guide was adapted from an existing Australian activity guide. Educators were able to have input in the design and written materials and were also involved in the evaluation of the materials as well (National Energy Foundation, 1990). The activities have a video to be used in cooperation with the activity guide. Activities in this chapter are What is Biomass, Food is Biomass, Using Wood for Energy, Biogas, and Alcohol Fuels. Problems with this chapter are that it is for only high school teachers and it is not correlated the academic standards.

Out of the biomass topics identified — direct burning, co-firing, anaerobic digestion, bio-fuels, gasification, and pyrolysis — there were only three that there is no existing K-12 activity for. Those topics were co-firing, pyrolysis, and gasification. The majority of the activities were on the topic of biofuels and anaerobic digestion.

Academic standards are one of the missing components of the existing activities. The only activities or guides that are correlated to academic standards were the KEEP and NEED materials. The NEED alternative fuels materials were only correlated to National Science Standards which can tied to state science standards in many cases but alternative fuels is a topic that can be applied in technology education and history classrooms as well. The KEEP activities could be made stronger by listing academic standards in each of the activities instead of a general list that is provided in the KEEP Conceptual Framework. The remaining activities contained no reference to either national or state academic standards.

Activities and activity guides identified are not complete activities if judged on what an activity should contain. The NEED activities contain background information but the activities themselves are worksheet. The worksheets provided crossword puzzles and graphing worksheets, are not hands on. The procedures are vague and do not contain a logical process for the teacher to follow. Besides poor procedures some activities are missing an evaluation component. The activity in the National Renewable Energy Laboratory contains good background information and procedure but do not contain an evaluation process for the teacher to follow once the activity is complete. The activity Waste Digester Design developed by the University of Florida Civil Engineering Department also contains background and procedure information but lacks an evaluation procedure. Other activities that are missing evaluation are *Farm Facts Lesson Plans – At the Pump*, all of the activities from NREL, *Photosynthesis and Biomass Growth*, *Biofuel Production*, and *Lessons for Teaching Sustainable Agriculture*.

Development of Biomass Activities

Getting Ready

When preparing to write a curriculum the first step is to identify the scope of the document. First the audience of the project is identified. Then the setting is identified. Is the learner in a formal classroom setting or a non-formal, nature center setting? What grade levels and subject areas that will be focused on? Are the activities to long to fit into a teacher's crowded schedule? Can the instructor afford to buy the materials for the activity (Sowell, 1996)? Other considerations for curriculum development are time, budget, and schedule (Jacobs, 1989).

Aims, Goals, and Objectives

After the big picture has been determined the developer can move onto setting the aims, goals, and objectives of the activities (Smilkstein, 2003). Aims are the broadest of the outcome statements and are sometimes called philosophical or general statements. Goals and objectives are more specific than the aim. Objectives are usually worded to reference what the student will know upon completion of the activity (Sowell, 1996).

Content

After the aim, goals, and objectives for the curriculum have been determined the curriculum developer should determine how the activity is going to get the teacher/students to meet the aim, goals, and objectives (Smilkstein, 2003). The content of the activity is based on how suitable it is for the intended objectives, is the content suitable and learnable for the audience, and is it true to real life situations. The various activities should use different teaching methods to hold student interest and address their different styles of learning. Possible methods include lecture, group work, discussion, research, and design (Jacobs, 1989). Activities should also build upon knowledge and awareness students already have from previous activities or experiences (Smilkstein, 2003).

Activities are supposed to help students understand the concepts and help them acquire skills (Smilkstein, 2003). In order to assure students will remember concepts long term the curriculum developer will relate the topics to the lives of the students or allow opportunities for the students to make their own connections to the concept (Christ, 1995). One way to accomplish this is to use an interdisciplinary approach that incorporates more than one subject into a classroom activity (Jacobs, 1989).

Evaluation

After the curriculum is designed it should be revised by a developmental group. After the developmental group has reviewed the curriculum the operational field test, implementation in a small number of classrooms, can be conducted (Sowell, 1996). This step is the final test to determine if the product is ready to be implemented. The field test should be done by a teacher, in a setting as close to the actual setting as possible, and the teacher should fill out a questionnaire upon completion of the activity that tells the researcher if the activity was successful or not (Borg and Gall, 1983). The success of the activities is based on the students successfully completing the activity (Jacobs, 1989).

Once the questionnaires have been completed and returned they should be compiled and the final suggestions should be implemented (Borg and Gall, 1983).

Formative Assessment

Assessment is a tool educators can use to prove what they are doing works and to ensure that the end product will meet the needs of the educators. This is essential because if the developer can prove that the product works they will have an easier time convincing others to implement the final product (Beyer, 1995).

Formative assessment is the assessment of a program while it is in the process of being developed and is therefore often used in curriculum development. It is important to have formative assessment done because it is often done by people outside of the development process and the developer is often too close to the project to complete an objective assessment (Beyer, 1995). There are four stages of formative assessment: design, prototype, pilot, and field-test. First is the design stage, the description of the project before it is developed. It states the goals, audience, and components of the project. The second stage, prototype, is the document in draft form where the evaluation done is a review completed by one or more people. The third stage is the pilot stage and contains the document in a useable form and is the stage in which others try it out and make suggestions for improvement. The last stage is field-testing. It is completed in the "real world" where it is used by a sample of expected users in the same environment that it will be used in (Beyer, 1995).

Questionnaires

It is important to write a good questionnaire not only to gather the correct information but to increase your chance of a high response rate, which will in turn increase accuracy (Salant and Dillman, 1994). A questionnaire should only ask questions that pertain to the information that is necessary (Peterson, 2000). In order to make the questionnaire easy for the respondent to complete and to gather the most reliable information ask clear questions and supply clear answers (Salant and Dillman, 1994). After the questionnaire has been developed and before it is sent to the respondents it must be evaluated. The evaluation of the questionnaire is called the pre-test and it is used to increase the validity of the data gathered (Jacobs, 1974).

Reliability and Validity

In order to ensure the assessment is effective validity and reliability must be assured (Borg, 1969). Validity ensures that the measurement tool is measuring what it is supposed to and reliability ensures the assessment is accurate (Leedy, 1993).

Researcher as the Primary Research Tool

Qualitative and quantitative research differs in the tools used for researching. Quantitative uses more statistical methods for reaching conclusions while qualitative research is about getting inside the situation to see it from the perspective of the participant and often uses the researcher as the main tool for conducting research (Flick, 2002).

In qualitative research the researcher takes on an observation role (Merriam, 1998). The observation can either be covert or overt and either non-participant or participant. The observation can also be done in a natural or artificial setting (Flick, 2002). Having the researcher act as the research tool has advantages. One of those advantages is that the researcher can adapt to situations and consider the whole of the research when they are making conclusion. Another advantage is that the researchers conducting observations may also take into consideration nonverbal cues that they observe (Merriam, 1998).

Because the researcher is in contact with the people being researched it is important for the researcher to have specific qualities. The researcher should be tolerant to ambiguity, a good communicator, and be sensitive to the context/data/personal bias. Researchers require a tolerance to ambiguity because there are not set procedures and it is left for the researcher to decide. Being a good communicator involves empathy, establishing rapport, asking quality questions, and being an attentive listener. The researcher must be sensitive to what is going on in the setting with the people and the nonverbal behavior in order to collect data (Merriam, 1998).

Many people may question the validity and reliability of the researcher as the research tool because the researcher is not disengaged from their subjects. This is why it is very important for the researcher to remain objective (Kirk and Miller, 1986). Just like in quantitative research there are ways to prevent bias when doing qualitative research. One way to prevent bias when conducting qualitative research is to talk through experiences with peers or to have an independent audit done. The independent audit is done by a person who is external to the research (Lincoln and Guba, 1985).

Summary

Wisconsin does not have fossil fuels occurring naturally in our state which means we depends on purchasing coal, oil, and natural gas from other states and countries. As the price of nonrenewable energy increases and the supplies decrease Wisconsin will find itself at a disadvantage in the struggle for supplying its citizens with the energy they expect. As this happens renewable energy is becoming a workable option for the state. While solar, wind, hydro, and geothermal power are important to incorporate into the state's energy portfolio, it is important to take advantage of our most bountiful resource. Wisconsin is rich in biomass in the form of agriculture, wooded land, and wood and paper industries. These forms of biomass can be used to provide energy and to support the economy. If Wisconsin develops biomass energy resources we add jobs to the state which adds to the general well being of the state.

There are currently no Wisconsin specific biomass energy activity guides available to Wisconsin teachers. KEEP has a long history of developing Wisconsin based energy curriculums and activity guides and is in a position to develop a biomass energy curriculum that will be available to Wisconsin teachers.

Chapter Three
Methods

<u>Overview</u>

The Wisconsin K-12 Energy Education Program was created in 1995 to increase and improve energy education in Wisconsin K-12 schools. KEEP is pursuing this goal by developing energy curriculums and support program which are provided to practicing Wisconsin K-12 educators. During the initial stages of KEEP a conceptual framework was developed which identified energy concepts that students should know as they move through their school careers. This framework was revised in 2003 to include renewable energy concepts. It was and still is the basis for KEEP's curriculum development.

While renewable energy has been used throughout history, our current society has adapted to use coal, natural gas, and oil as our main sources of energy. There is, however, a shift towards moving the United States towards increasing our renewable energy portfolio so we can rely less on fossil fuels. One of the renewable energy resources that are more prominently used is biomass because it can be used in a variety of ways. As the use of biomass resources for energy production increases it is important to ensure that citizens are aware of how bioenergy is utilized and how the use of it affects their lives. Because biomass energy use is increasing and Wisconsin citizens need awareness and knowledge about it, KEEP received funding in 2004 to develop a biomass energy curriculum, which will in turn increase biomass energy literacy. The funding was granted to KEEP by the United States Department of Energy and the Wisconsin Department of Administration: Division of Energy.

This chapter describes the methods utilized to develop, implement, and evaluate a biomass energy curriculum.

<u>Statement of the Problem</u>

This research proposes to identify biomass energy topics that can be integrated into the KEEP curriculum; to identify K-12 biomass energy classroom lessons available to educators on the identified topics; to develop a Wisconsin biomass energy curriculum; and to field-test and evaluate the biomass energy curriculum for the Wisconsin K-12 Energy Education Program.

<u>Subproblem One</u>

The first subproblem is to identify biomass energy topics that can be integrated into the KEEP curriculum.

<u>Subproblem Two</u>

The second subproblem is to identify K-12 biomass energy classroom lessons available to educators on the identified topics.

<u>Subproblem Three</u>

The third subproblem is the development of a Wisconsin biomass energy curriculum.

<u>Subproblem Four</u>

The fourth subproblem is to evaluate the biomass energy curriculum.

The Research Methodology

Procedures Related to Subproblem One

Subproblem One: Identify biomass energy topics that can be integrated into the KEEP curriculum.

The list of biomass energy topics was compiled from national programs such as the National Renewable Energy Laboratories, the United States Department of Energy, Wisconsin Department of Administration: Division of Energy, and Focus on Energy was compiled in the literature review. The information gathered was separated into different categories of sources of biomass such as gasification, and co-firing, alternative fuels. Three energy professionals will be asked to submit a list of biomass topics and their lists will be correlated to the list compiled in this research. Changes will be made after the review if there are discrepancies.

Procedures Related to Subproblem Two

Subproblem Two: The second subproblem is to identify K-12 biomass energy resource information available to educators on the identified topics.

In order to locate existing activity guides, curriculums, and individual activities on biomass energy topics a search was conducted in two steps. The first search was conducted in the Wisconsin Center for Environmental Education Resource Library which includes an extensive collection of curriculums and activity guides on a variety of environmental topics. The resource library was searched for activity guides and curriculums that focus on or include activities on biomass energy. The search started by using the UW-Stevens Point Library search engine then a manual search was done of the collection of activity guides. The second step of the search was to ask energy education professionals in the National Energy Education Development (NEED) and the National Energy Federation (NEF) if they know of existing biomass activity guides, curriculums, and stand alone activities. An Internet search was also done in order to locate online activity guides on biomass energy.

In order to organize the activity guides and activities as they we located a table was made that recorded the name of the activity guide/curriculum guide, the name of the activity, and the organization it was developed by. Each activity will be reviewed by a teacher or KEEP staff in order to determine if it should be used in whole or part in the Wisconsin biomass energy curriculum.

Procedures Related to Subproblem Three

Subproblem Three: The third subproblem is the development of a biomass curriculum.

The development of the Wisconsin biomass energy curriculum occurred in stages. Each stage will include an evaluation process to ensure that the curriculum successfully increases biomass energy literacy.

Several things must fall into place before a curriculum can be developed. First the identified biomass energy topics must be cross referenced to the concepts from the KEEP *Conceptual Framework* and the grade level and subject area the concept addresses must be identified. Then each existing biomass energy activity identified in subproblem two must be evaluated. One of the last steps before developing the activities is to determine the format the activities will follow.

Conceptual Review

A review of the existing KEEP Conceptual Framework will be completed to identify concepts that are biomass related. The concepts identified will then be used in the development of the curriculum. A formative review will be completed through email on the concepts using a likert scale rating process. Each evaluator will fill out the evaluation and return it to the researcher who will then compile the data. The panel will consist of biomass energy professionals and environmental education professionals. The framework will be revised and finalized based on the suggestions.

Scope and Sequence

A scope and sequence of KEEP concepts will be conducted with Wisconsin K-12 educators before the development of the *KEEP Activity Guide* and *Doable Renewables: Renewable Energy Supplement to the KEEP Guide.* This scope and sequence will be used as the model for the development of the biomass energy curriculum.

Grade Level and Subject Area

Teachers attending KEEP renewable energy courses identified Wisconsin Model Academic Standards in Science, Social Studies and English Language Arts. After this is completed the results will be combined with the scope and sequence previously prepared by KEEP staff. This will provide KEEP staff with guidelines on grade levels and subject areas that the biomass activities should address.

Review of Existing Activities

Teachers reviewed and evaluated existing biomass energy curriculums, activity guides, and single activities to identify potential activities to fit within the scope and sequence. Then KEEP staff will read and review the teacher evaluations. Then they will identify which, if any, of the reviewed activities should be used in whole or part in the biomass energy curriculum.

Activity Guide Format

The biomass energy curriculum format will be based on the KEEP *Activity Guide* as previously developed, reviewed, and evaluated. The KEEP *Activity Guide* and *Doable Renewables* are given out during KEEP courses and are evaluated during the courses.

Developing Activity Guide

Because there are some energy education resources, with individual biomass energy activities, already in existence, KEEP will obtain permission to adapt some activities from previously published materials. These activities will be selected based on reviews of existing biomass energy education resources conducted by Wisconsin K-12 teachers during the scope and sequence. When there is not an existing activity that fits into the KEEP model a new activity will be developed. KEEP staff will draft, review, and revise activities. Biomass energy professionals and environmental education professionals reviewed the drafted activities for conceptual accuracy and changes will be made based on comments. An introduction and appendix for the guide will also be developed.

Procedures Related to Subproblem Four

Subproblem Four: The fourth subproblem is to evaluate the biomass energy curriculum.

Field Test

Each activity was field tested by at least one practicing Wisconsin K-12 teacher. The teachers who conducted the field test filled out a questionnaire which was adapted from the questionnaire originally developed and used by Project WET when they developed their curriculum. This questionnaire was also used by KEEP during the development of the *KEEP Activity Guide* and *Doable Renewables*. It guides the teachers in assessing the activity for grade-level appropriateness, ease of accomplishment, and success in achieving intended objectives. KEEP staff will revise the activities based on the field testers' suggestions.

Comprehensive Review

Energy professional, environmental education professionals and K-12 teachers conducted a comprehensive review of the curriculum. The comprehensive reviewers will fill out a short questionnaire that was used by KEEP during the development of the KEEP *Activity Guide* and *Doable Renewables.* The purposes of this review were (1) to examine the extent to which important energy concepts are covered in the activities and (2) to assess the curriculum's cohesiveness and level of organization. Final revisions were made to the curriculum.

Chapter Four
Results

Overview

The purpose of this research is to identify biomass energy topics that can be integrated into the KEEP curriculum; to identify K-12 biomass energy classroom lessons available to educators on the identified topics; to develop a Wisconsin biomass energy curriculum; and to field-test and evaluate the curriculum for the Wisconsin K-12 Energy Education Program. This was accomplished with the four subproblems listed below:

1. Identify biomass energy topics that can be integrated into the KEEP curriculum.
2. Identify K-12 biomass classroom lessons available to educators on the identified topics.
3. Development of a Wisconsin biomass energy curriculum.
4. Evaluate the biomass energy curriculum.

This chapter will summarize the results obtained in the literature review, development, and field-testing of the biomass curriculum. The results will be presented for each subproblem listed above along with the corresponding research and development steps.

Subproblem One: Identify biomass energy topics that can be integrated into the KEEP curriculum.

Four sources of information were considered for this research; The National Renewable Energy Laboratory, United States Department of Energy, Wisconsin Department of Administration: Division of Energy, and Focus on Energy. These sources were chosen because there are numerous sources of information on biomass energy and not all of those sources are reliable. By limiting the places the information can be gathered from a manageable amount of data can be collected from dependable sources. After the review of the literature six topics were identified. They were as follows;

1. Direct burning,
2. Co-firing,
3. Anaerobic digestion,
4. Biofuels,
5. Gasification, and
6. Pyrolysis.

After this list was compiled three energy professionals were asked to submit a list of biomass energy topics to be cross referenced with the list generated from the literature review. Don Wichert, Focus on Energy, Director of Renewable Energy Program; Larry Krom, Focus on Energy; and Alex DePillis, Seventh Generation Energy provided a list of biomass topics (see figures 4.1 – 4.3). After receiving the lists from the energy professionals the lists were cross referenced to the list generated in the literature review.

While the terms used and the division of topics was diverse the topics generated in the literature review were listed in some form in the lists provided by Wichert, Krom, and DePillis. Some topics identified by the Wichert, Krom, and DePillis were too complicated for the K-12 audience and were not addressed in the curriculum. Some topics were not only biomass energy sources but can be considered a socioeconomic issue. While those issues are not in the listed topics they are related to KEEP concepts and the activities developed will deal with these issues.

Figure 4.1: Biomass Energy Topics Identified by Alex Depillis
Seventh Generation Energy, Madison, WI

"The way I like to think about "types" of biomass is:

Liquid
- ethanol
- biodiesel
- pyrolysis oils and other bio-oils

Solid
- densified wood, paper, or grasses
- wood chips
- whole trees
- grasses

Gas
- anaerobic digestion (AD) on farms
- AD in food-processing, paper, and other industries
- AD in municipal waste-water treatment plants
- Landfill gas
- gasification of solids"

Figure 4.2: Biomass Energy Topics Identified by Don Wichert
Focus on Energy, Renewable Energy Program
Transportation
- Ethanol
- Where does the feedstock come from?
- Corn surplus

Production facilities close to where the corn is grown
Biodiesel

Commercial
Governor's Forestry Council
Wood Chips for Rural Areas
Heating schools
Municipal buildings
Small Commercial Buildings
Wood Industry

Industrial
Food Industry – Anaerobic Digestion
Wood Industry – puts ash back where they got the wood

Utility
Waste Waster Treatment
Co-Firing (coal and wood products)
Bio-refinery
Cellulose – wood, corn stalks
Take products out of it
High value products – less harmful waste

Agriculture
Anaerobic digestors
Methane
Switchgrass
Growing crops
Poplars and willows
Legumes

Other ideas
Economic issues – it is less expensive for WI to grow their own fuel than to transport coal from other states

Figure 4.3 – Biomass Energy Topics Identified by Larry Krom
Focus on Energy, Madison, WI
Primary Energy Conversion
Heat, steam, and cooling
Producer gas
Bio-oil
Black liquors
Methane
Chemicals

Anaerobic digestion on farms
- Waste products
- Create heat, electrical, and value added products (soil amendment)
- WI- is a leader in anaerobic digestion

Gasification
- 6-25 MW (megawatt) currently the most practical size scale
- In most gasifiers, biomass is heated for four distinct processes; drying, pyrolysis, oxidation, and reduction
- The product gas consists principally of carbon monoxide, carbon dioxide, hydrogen, methane, water, and nitrogen
- Feedstock can be grown specifically for energy production: (oat hulls, corn, wood waster & residue, other)

Pyrolysis
- Pyrolysis oil – fuel or lubricant
- Pyrolysis involves heating biomass in the absence of air
- The products are pyrolysis gases and organic vapors which are condensed to form bio-oil. Charcoal is also produced

Gasification in Supercritical Water
- In the presence of superficial water at high temperature and pressure, biomass is converted, in the absence of oxidants, to fuel gases including oxygen

Biorefinery
- You can use biomass to make anything you could make out of a barrel of oil (cost is one factor & switching over has barriers).
- The key to a biorefinery is the production of liquid fuels and chemicals with a net excess energy left over for export (heat and/or electricity).
- A biorefinery can be constructed by combining some or all of chemical and/or biological processes → anaerobic digestion, gasification, distillation, pyrolysis, gasification in supercritical water, catalysis, etc.

Secondary Energy Conversion Equipment
- Microturbine, engine-generator set, steam engine, steam turbine, gas combustion turbine, fuel cell
- Heat exchangers

Fermentation
- Ethanol production

Distillation
- Methanol production

Combustion technologies
- Heating – see above

Boilers
- Heat, cooling, shaft power, and electrical power

Landfills
- Methane production
- Bioreactor in WI (in ground processing cells)

Wastewater treatment facilities
- Digesters produce methane
- Gas is the byproduct

Food Processing facilities
- Heating and electrical

Subproblem Two: The second subproblem is to identify K-12 biomass energy resource information available to educators on the identified topics.

The Wisconsin Center for Environmental Education has a large compilation of environmental education resource materials. A large section of the WCEE Resource Library is dedicated to curriculums and activity guides for K-12 teachers. A computer search was completed using the keywords biomass and biomass energy to identify curriculums or activity guides on biomass energy. The search produced zero items. In order to make sure guides were not missed a manual search was then completed on the resources in the WCEE Resource Library. There were no activity guides or curriculums in the library specifically on the subject of biomass energy. The next step of the search was to look for individual activities on the subject of biomass energy. A manual search was again completed in the library and several activities related to biomass energy were identified.

Because the Internet has become a resource for educators many organizations have listed K-12 activities on their Web site. An Internet search was conducted and was useful in locating activities that are available online.

For the complete list of the activities identified see Appendix B.

Subproblem Three: The third subproblem is the development of a biomass curriculum.

Conceptual Framework

Based on the *KEEP Conceptual Framework*, a review of the existing KEEP framework was completed by KEEP Staff to identify which concepts are biomass energy related. These concepts were then sent to three energy and education professions for a review. The review was done to ensure that major concepts were not missed.

After the review was completed the ranking of the concepts was compiled and assessed. The instructions that were given to the review panel are listed in Appendix C. The lowest ranked concept was number 15 (concept numbers are listed after the text in parenthesis) which received an average ranking of 2.6. The review panel was also given the opportunity to add concepts that they felt were missing from this document. There were no additional concepts added to the existing framework. See Appendix C for the Concept Review Form and Results.

Scope and Sequence and Academic Standards

Because no new concepts were added to the KEEP *Conceptual Framework* the Suggested Scope and Sequence in the framework applies to this curriculum. The scope and sequence divides each concept into grade level. See Appendix D for the Scope and Sequence of KEEP Concepts.

Teachers who had taken a NR 732 KEEP Doable Renewables course were assembled to review science, socials studies, and English language arts Wisconsin Model Academic Standards. The twelve teachers reviewed KEEP concepts and the academic standards to determine which standards the concepts address. Because the teachers reviewed only the concepts and not actual activities they noted that additional academic standards can be identified for the individual activities after they are developed.

Review of Existing Activities

Each of the activities that were identified were reviewed by a K-12 teacher who had been through a KEEP renewable energy course. The teachers identified the grade level and subject areas that each activity addresses. They were also responsible for rating each activity on the following criteria;

- The activity is relevant to biomass energy in Wisconsin.
- The activity objectives clearly state what students are to learn.
- The activity includes a complete list of needed materials that are easily obtained and affordable by the average teachers.
- Background information is provided and will help the teachers prepare for the activity.
- The activity procedure steps are easy to follow and it appears could be accomplished successfully.
- Participatory teaching strategies (e.g., hands on, cooperative learning, inquiry) are used.

- The assessment strategies will help determine if the objectives of the activity were achieved.

The final question asked of the teacher is if they would recommend the activity be considered for the biomass energy curriculum. See Appendix E for the review form and Appendix F for the compiled results of the review.

When the review of the existing activities was completed there were some activities that could be used and/or adapted for the biomass energy curriculum. Activity one, *Which Grass Produces More Biomass*, was adapted by KEEP Staff as a new activity entitled *Grasses for the Masses*. Activities 14, 16, 18, and 24 are about anaerobic digesters so activity 24 was used as inspiration for a new activity on anaerobic digestion entitled *Roadside Renewables*. The activity *Corn in Your Car* was used, in whole, in the biomass energy curriculum. Activities nine and twenty-five dealt with photosynthesis. Neither of those activities was good but KEEP has an existing activity *Photosynthesis Promenade* that was pulled from the Elementary Supplement to be used in the biomass energy curriculum. The activity *So You Want to Heat Your Home* from the KEEP *Activity Guide* was not used but could be listed as an additional activity. The rest of the activities will be listed on the KEEP Web site as additional activities for teachers to reference.

Activity Format

The biomass energy curriculum format was based on the KEEP *Activity Guide* and *Doable Renewables* as previously developed, reviewed and evaluated. The guides have been evaluated by the teachers that use them after taking a KEEP graduate credit course through the University of Wisconsin-Stevens Point.

Each activity contains the following information:

- Summary,
- Objectives and Rationale,
- Grade Level,
- Subject Area,
- Setting,
- Time,
- Vocabulary,
- Major Concept Area,
- Getting Ready: directions for preparing for the activity,
- Resources: for teachers and students,
- Related KEEP Activities,
- Materials,
- Background,
- Procedure,
- Assessment, and
- Extensions.

Developing the Biomass Energy Activities

The data gathered during the existing activities review was used to determine which activities should be considered for the biomass energy curriculum. As stated previously, some activities had the potential to be adapted to fit into the KEEP activity format while others had a procedure that was good but were lacking background material and/or assessment strategies. When part of or a whole activity was used, permission was asked of the organization that originally developed the activity. The permissions were listed in the activity when it was published. See Appendix G for an example of a letter requesting permission to use an activity in the biomass energy curriculum.

When permission was granted to use an existing activity parts or the whole activity could be used in the writing process. KEEP Staff used existing biomass energy activities, existing KEEP activities, and brainstormed new ideas for biomass energy activities based on the concepts from the KEEP *Conceptual Framework* and biomass energy topics identified. Once the activities were written they were reviewed by the Director of KEEP and her edits and suggestions were incorporated into the next draft.

Figure 4.4 - List of Biomass Energy Activities Developed

Grade	Activity Name	Activity Summary
K-4	Photosynthesis Promenade	Students simulate the process of photosynthesis through a whole body demonstration.
K-4	Would You Heat With Wood?	Students write and illustrate a story about burning wood to demonstrate how energy comes from wood.
5-8	Advertising Biodiesel	Students evaluate and categorize advertisements that promote the development and consumption of energy and then design their own advertisement for biodiesel.
5-8	Community Design – It's a Gas	Students identify current energy use practices and incorporate the use of energy from methane into community design.
5-8	Don't Waste	Students "harvest" celery to demonstrate waste

	Waste	accumulation from timber practices and brainstorm uses for the waste products.
5-8	Grasses for the Masses	Students will learn that different types of grasses produce varying amounts of biomass by planting varieties of grasses and measuring their growth rate and leafy content.
5-8	Roadside Renewables	Students build a model landfill, observe the decomposition process, and collect the gas that is emitted from the model.
9-12	BioFuel Beliefs	Students use research skills to investigate various viewpoints surrounding the issue of ethanol as a fuel.
9-12	Biomass Gazette	Students will act as reporters assembling a newspaper on biomass energy.
9-12	Corn in Your Car	Through mapping and research, students measure the availability of ethanol-blended fuels in their community, and the environmental benefits of using these fuels.

Content Review

The second draft was sent to a professional (see Appendix O) for the list of content reviewers) in the energy field that has an expertise in the area the activity addresses. For example the activity dealing with ethanol was sent to a Department of Transportation staff member who deals with alternative fuels in Wisconsin. The content reviewers were given a form to fill out when evaluating the activity. They were encouraged to write directly on the activity that was sent to them. See Appendix H for the cover letter for the content reviewer and Appendix I for the content review form.

When the content review was completed and returned to KEEP the information was reviewed by the staff. The new information gathered was input into each activity to ensure it was conceptually accurate.

Subproblem Four: The fourth subproblem is to evaluate the biomass energy curriculum.

Piloting/Teacher Review

Each activity was given to a teacher who had successfully completed a KEEP renewable energy course to review. Each activity was reviewed at least once by two to three teachers in the subject area and grade level indicated by the activity whenever possible. The activities were reviewed for grade-level appropriateness, ease of accomplishment, and success in achieving intended objectives. KEEP's pilot testing tool is based on the instrument used by University of Michigan for the national field testing the Project WET curriculum and activity guide; Lane (2007) adapted the tool for KEEP in 1996. She reported that after using the results of UM's study to revise the Project WET guide, she became familiar with the items that were most useful and relevant for activity assessment and those which were extraneous. The pilot instrument used for KEEP, therefore, included only these useful items. Lane indicated she found the revised version of the instrument effectively helped the KEEP writing teams to pilot drafted activities. This current study will help confirm the effectiveness of the instrument as a pilot testing tool. See Appendix J for the Piloting Cover Letter, Appendix K for the Piloting Instructions and Appendix L for the Activity Pilot Form.

How the Piloting Instrument was Utilized

Questions 1 - 8 of the piloting instrument were used as background material. They covered what grade level and subject area the teacher covers as well as how many times they conducted the activity. Question 2 determined if the activity is appropriate for the grade level it was piloted at. Results from this question lead to changes in the suggested grade level to use the activity at or changes to the activity content that made it appropriate for the grade level originally suggested. Questions 5 - 7 were used to determine if the preparation time and activity time in the piloted activity were accurate. If they were not correct changes were made to the time section of the activity. Question 8 determined if there were resources that should have been referenced in the activity.

Question 9 determined what changes, if any, the teacher made to the activity when they used it. If the teacher made adaptations to the activity the pilot instrument asks them to record those changes. The changes were then made in the activity if they were determined necessary for the improvement of the activity.

Questions 10 through 13 were basic questions that acted as red flags for the researcher. If the teacher was uncomfortable with the activity it could have meant that there was not enough background material or the procedure was not clear. It also asked if the students showed interest and activity participated in the activity. If the teacher indicated that the students did not like the activity or were not actively engaged in it changes were made to make the activity more engaging for the students.

Questions 14 - 16 evaluated the effectiveness of the activity. This section used a likert scale rating format. The goal was to have an average of 4 or above for the appropriate grade level. If a teacher piloted an activity at a lower level than it is intended changes may not be made to the activity because it was intended for a higher grade level.

Extensions could be added to activities to give teachers at the lower or higher grade levels advice on how to conduct the activity for their students.

Question 17 was an opportunity for teachers to provide feedback they did not get a chance to share in questions 1 - 16. Following question 17 were six optional questions which acted as red flags for the evaluator. If any of these questions were indicated as no, a review needed to be conducted to see how the problem could be fixed.

Criteria for Assessing Teacher Pilots

An attempt was made to have each activity field-tested by three teachers. The activities *Photosynthesis Promenade*, *Grasses for the Masses*, and *Advertising Biodiesel* were reviewed by only two teachers because the third teacher did not complete the pilot. Criteria for accepting or rejecting the changes recommended in the pilots were established before the pilots were reviewed. The criteria included:

1. If two or more teachers made the same or similar suggestion the change will be accepted.
2. If two or more teachers had different times for the "getting ready" and "activity time" a time range will be given or the time will be changed to reflect a time in the middle of their suggestions.
3. If a teacher makes a suggestion for an addition to the activity that was missing and should have been included in the activity before it was sent to pilot (example: missing vocabulary or missing objective) that change will be accepted.

4. If a teacher recommends a resource which is easily obtained like a book or online source that change will be accepted. NOTE: If the recommended Web site requires the teachers to become a member of their organization, that suggestion will be rejected. Resources that are not related to the activity subject will also be rejected.
5. Spelling/grammar changes will be accepted.
6. If any of the pilot teachers suggest a change or mention an adaptation that could be made to improve the content and/or make the activity easier for the teacher/students the suggestion will be accepted.
7. If a teacher disagrees or answers a question no without an explanation an attempt will be made to solve the problem but because there was not a suggestion it can neither be accepted or rejected.
8. If a teacher from a higher or lower grade level than what the activity suggests pilots the activity and makes suggestions for how to improve the activity for their grade level those suggestions were rejected but may be added as an extension.
9. The teacher made a change to the activity to make it fit into a unit they care working on the suggestion will be rejected. The biomass energy activities are all designed to fit into energy, renewable energy, or biomass energy unit. KEEP understands and accepts that most all teachers will adapt each activity to fit their unique situation.

Piloting/Teacher Assessment Results

Changes were made to each of the activities after they went through the teacher pilot. The comments from the pilots were compiled and changes were made based on the suggestions of the teachers criteria determined above. A summary of the changes made to each activity are listed below. See Appendix M for the complete Piloting Review Results.

Don't Waste Waste

1. The font size was increased from 12 to 14 on the student worksheet and made the table larger to provide students with more room to record answers.
2. The spelling and grammar corrections were made.
3. After the preparation time a note was added that says first time users should allow up to an hour to prepare for the activity.
4. Based on Teacher C's suggestions the Orientation of the procedure was changed to make the alternative the only option the teachers has. Doing it this way follows the flow of the student worksheet and will be easier for the teacher and student to follow.
5. Two teachers mentioned using the celery as a snack so this suggestion was added at the activity.
6. The procedure was rewritten to follow along with the recording page.
7. The time for the activity was changed to one to two 50 minute class periods.
8. In the extension section a note was made about using visuals instead of percentages for younger students.
9. The background was reworded to remove some of the technical jargon.

Roadside Renewables

1. All of the teachers agreed that the activity is suitable for the intended grade level.
2. The preparation time for the activity was changed to 90 minutes because each teacher took a different amount of time to get ready. The times were 30 minutes, 90 minutes and 120 minutes. Ninety minutes was the middle time and therefore it was used for the activity.
3. In the materials list it was noted that natural materials and food waste work best for the activity.
4. In the materials list milk jugs were changed to large glass or plastic jars with tight covers.
5. The procedure was changed to reference the student sheets correctly.
6. Revised the student worksheet based on teacher C's edits and comments.
7. The activity runs for a short period of time. In the activity it is noted that it may take more than one week to observe the build up of gas. In the materials list it has also been noted to use a lightweight plastic bag to collect the gas.
8. Added a drawing of what the model should look like to the bottom of the How to Build a Model Landfill student page.
9. Changed glass tube to plastic tube in the materials chart.

Advertising Biodiesel

1. Changed grade level to grades 6-8 and entered grades 9-12 as an option as well.
2. Class time changed to four – 50 minute periods because an additional step was added to the activity.

3. Teachers will define diesel and biodiesel for the students in step 2.
4. Teacher B comments on the amount of background material and would like all of the material removed with the exception of the chart on biodiesel/diesel and the text on biodiesel. This change was not made because although the activity is about biodiesel it is also about advertising and if the information was not included other teachers may not use the activity or if they do they may need to do additional research on advertising in order to conduct the activity.
5. The background material was reviewed and reworded.
6. Teacher B changed the assignment to designing a poster which would make the advertising information not as relevant to her. This change was not made.
7. In the procedure it was noted that the students can work in groups.
8. A step was inserted between the existing steps 2 and 3. The new step has students researching biodiesel and developing their own fact sheets.
9. Deleted the table Types and Sources of Advertisements Related to Energy because after reviewing the activity the chart did not seem relevant.

Would You Heat With Wood?

1. The preparation time was left at 50 minutes because the three teachers had a wide range of preparation times and 50 minutes is in the mid range of teacher times. All three teachers indicated that the next time they do the activity the time needed to prepare will be less.
2. An ecosystem or poster of a forest was added to the materials list.
3. Added outside to the setting.

4. Added descriptive labels to the pictures.
5. Added a section in the opening of the activity where the teacher reviews the activities with the students.
6. Wood pellets and log were added as optional items in the materials list.
7. Added a Related KEEP Activities section to the activity and listed the activities *Energy Divide* and *Renewable Candy Resources*.
8. The words, energy, efficiency, and renewables were added to the vocabulary list.
9. A second step was added to the procedure in which students will have to identify which wood burning process is the most efficient and a worksheet for the students will be provided.

Community Design It's a Gas

1. Added computer lab and library to the setting.
2. Changed preparation time to one hour.
3. The link to the streaming video mentioned by Teacher C was not added because the United Streaming Web site requires membership and password.
4. Because this activity is complex it would be best used as a final lesson in a unit on biomass energy or renewable energy.   This was added to the summary of the activity.
5. The steps of the procedure were reviewed to asses the ease of use. Teacher B did not think the steps were easy to follow but not indicate how they could be improved or what steps were hard to follow. Upon review the following changes were made to the procedure.

A. Step 4: Second bullet: The lines – What would the upfront cost be for such a system? Were deleted.

B. Step 4: A third bullet was added. Which options seem the most cost effective?

C. Step 5: The sentence – "tell them to include all potential costs for development and have them estimate how much they will make (by selling plots or by building homes on the lots and selling them)" – was deleted.

Biomass Gazette

1. Changed the grade level from 9-12 (5-8) to 9-12 (7-8) because two teachers indicated it was too difficult for fifth and sixth graders.
2. Changed the preparation time to one hour. It was formerly 15 minutes but one teacher took 45 minutes and the other took 1-2 hours to prepare for it. They did both indicate that the next time they do the activity it will take less time.
3. The time required to complete the activity was changed from one week to one to two weeks because all three teachers indicated different times that ranged between one to two weeks.
4. As mentioned above two teachers noted that the activity was too difficult for grades 5 and 6 so the recommended grade level was changed top 9-12 (7-8).
5. Developed student handout to guide student work.
6. Put an * next to the topics that are more difficult.
7. An objective was added. "Students will be able to describe how a news article is different than an essay."

Bioenergy Beliefs

1. Added Social Studies to the list of subject areas.
2. Reworded Getting Ready section.
3. Added the recommended book to the resources section of the activity.
4. Added computer lab to setting.
5. Changed repetitive wording in the summary.
6. In the closure a note was added that an alternative to a class discussion would be a class debate and the students could work in groups.
7. Teacher C rewrote the activity to fit into an ecology lesson while the other two did not. This is why he made some of the changes. The changes that made the steps of the procedure easier to follow were added to the activity.

Grasses for the Masses

1. Changed the time required to prepare for the activity to two hours.
2. Noted that teachers can use a dehydrator or oven to dry out the plants.
3. Added large ice cream pails to the materials list.

Corn in Your Car

1. The preparation time was increased to 1.5 hours.
2. The activity time was changed to one to two weeks.
3. Added two Web sites on ethanol to the resources section.

4. Although each of the teachers left the mapping section of the activity out it is noted that they are all from small communities where mapping is not necessary. The mapping section is left in for larger communities. A note was added to the step in the procedure where this part of the activity is conducted.
5. One of the objectives was revised from "Students will be able to explain the environmental benefits of ethanol fuels" to "Students will be able to explain the pros and cons of ethanol fuels."

Photosynthesis Promenade

1. Extended the preparation time for the activity to one to two hours from 50 minutes.
2. Added the resources recommended two *Magic School Bus* books on plants and seeds and an additional book on how plants grow. A link to an activity on the Newton's Apple Web site was added as well from a teacher recommendation.
3. A suggestion to use nametags instead of colored shirts was added to the activity.
4. The steps of the Photosynthesis Promenade were spelled out more clearly.
5. Photosynthesis diagram for the students was made.
6. The resources that were added from the comments made in questions 8 will supply the teacher with additional background material.

<u>Descriptive Summary</u>

The pilot instrument proved to be an effective tool in determining how the activities worked in the classroom. Using the first eight questions as the overview to get an idea of the teacher's classroom situation proved very helpful when determining what changes should be made. The rest of the document provided teachers with the opportunity to demonstrate the changes they made and what they think needs to be improved. The main difficulty stemmed from the teachers who would disagree or reply no to a question and then not follow up with an explanation or solution that would address the problem. This made it difficult to assess where the problem occurred and how to fix it.

Each activity had diverse corrections and some were easier to remedy than others. The most difficult activity to correct was *Would You Heat with Wood*. This activity needed many corrections and an addition student worksheet. *Advertising Biodiesel* was also difficult to fix because one teacher liked the activity and the other did not like the activity at all. With only two reviews completed on this activity that made assessing what changes to implement more difficult. Great care was taken to improve the background and procedure of the activity. On the other hand *Photosynthesis Promenade*, *Grasses for the Masses* and *Corn in Your Car* had fewer corrections to be made and received high marks from the teachers. The remaining five activities, *Biomass Gazette*, *Community Design – It's a Gas*, *Biofuel Beliefs*, *Roadside Renewables,* and *Don't Waste Waste* had a significant amount of small corrections that needed to be made.

<u>Comprehensive Review</u>

The comprehensive review is the final step in the curriculum development. The purpose of the comprehensive review is to provide KEEP staff with an overall idea about the entire guide (all of the activities, the introductory matter, and the appendices). The reviewers consist of one KEEP Adjunct Faculty who is a retired high school teacher, Director of the WCEE, and Director of Focus on Energy's Renewable Energy Program.

To conduct the comprehensive review a cover letter and list of questions were sent to the reviewers. The questions were from the review form KEEP had used when developing both the KEEP *Activity Guide* and the Doable *Renewables Supplement to the KEEP Activity Guide*. The reviewers were given two weeks to provide the KEEP Staff with feedback.

The Comprehensive Review Cover Letter and Review Form are available in Appendix N and O.

<u>Criteria for Assessing Comprehensive Review Results</u>

Criteria for accepting or rejecting the changes recommended in the comprehensive review were established before the review was completed. Some of the criteria included:

1. If two or more reviewers made the same or similar suggestion the change will be accepted.
2. If a reviewer makes a suggestion for an addition to the biomass energy curriculum that was missing and should have been included in the guide before it was sent to comprehensive review (example: missing vocabulary or missing objective) that change will be accepted.
3. If a reviewer makes a correction to the factual content it will be accepted.

4. If a reviewer recommends a resource which is easily obtained like a book or online source that change will be accepted. NOTE: If the recommended Web site requires the teachers to become a member that suggestion will be rejected. Resources that are not related to the activity subject will also be rejected.
5. Even though the comprehensive review is not supposed to review spelling and/or grammar any spelling/grammar changes will be accepted.
6. If any of the reviewers suggest a change or mention an adaptation that could be made to improve the content and/or make an activity easier for the teacher/students the suggestion will be accepted.
7. If a reviewer disagrees or answers a question no without an explanation an attempt will be made to solve the problem but because there was not a suggestion it can neither be accepted or rejected.
8. If the reviewer suggests a change to the guide to make it fit into a unit they are working on the suggestion will be rejected. The biomass energy activities are all designed to fit into energy, renewable energy, or biomass energy unit. KEEP understands and accepts that most all teachers will adapt each activity to fit their unique situation.

Comprehensive Review Results

The comprehensive review was completed by all three reviewers with various levels of feedback. The KEEP Adjunct Faculty who is a retired teacher spent his time reviewing the curriculum and answering the questions asked in the review form. Don Wichert from Focus on Energy's Renewable Energy Program spent his time reviewing the document for conceptual accuracy. After inquiring about the questions on the form he sent in his responses to the questions. Randy Champeau, the Director of the WCEE, reviewed the document for the comprehensiveness of the document as a whole. See Appendix P for the feedback gathered from the comprehensive review.

Each section is listed below with comments regarding the comprehensive review feedback and any changes that were or were not made to the curriculum.

Introduction

- A suggestion was made to include the KEEP *Conceptual Framework* in the front of the biomass energy curriculum. The decision to exclude the framework was made while the introductory materials were being developed. It was excluded because the majority of people who will access the curriculum will be doing so online and they will be able to link to the framework because it is already online.
- An addition to the text about ethanol was made on page vi.
- A spelling error was corrected on page iv.

Photosynthesis Promenade

- A note was added to the activity to reference a page number to help clarify the location of the materials to assist the teacher with the activity.
- Unnecessary text was deleted on page 6.

Would You Heat With Wood?

- Text was added to the activity on page 11.

Advertising Biodiesel

- Text was added to the *Strategies in Advertising* sidebar on page 19.
- Text was deleted and added to page 20.

Community Design: It's a Gas!

- The definition for methanol was added to the activity.
- Conceptual changes were made on page 22 and 23.

Don't Waste Waste

- A recommendation was made to insert graphics of a forest before and after it has been cut to illustrate the amount of material lying on the forest floor. This will be added to the KEEP Web site.

Grasses for the Masses

- In the materials list the word grow was put before the fluorescent light to clarify the type of fixture the teachers would need for the activity.
- Content changes were made to page 29.

Roadside Renewables

- A note was added to the activity that encouraged teachers to take the students on a fieldtrip to a landfill.
- Content changes were made to page 34, 35, and 36.

Biofuel Beliefs

- An investor was added to the list of possible rolls students could play while doing the roll play at the end of the activity.
- A suggestion to take students on a field trip was also added in the orientation section of the procedure.
- In the background a note about where to obtain the articles for the activity was added.

Biomass Gazette

- No corrections

Corn in Your Car

- Content changes were made to page 50.

Appendix

- Corrections were made to the glossary.
- A correction was made to Subject Area Chart on page 58.

Summary

The biomass energy curriculum was created using a process that KEEP has used on at least two occasions to develop curriculum. This process utilizes the combined knowledge of the KEEP Staff, Adjunct Faculty, K-12 teachers, WCEE Staff, and KEEP stakeholders. The ten activities along with the introduction and appendix combined create a comprehensive biomass energy curriculum.

Chapter Five
Conclusions

Summary

The purpose of this study was to develop and evaluate a biomass energy curriculum. The researcher along with KEEP Staff, KEEP Adjunct Faculty, K-12 teachers, and members of the graduate committee worked for three years on the development of the curriculum. The end product, a comprehensive biomass energy curriculum, resulted from an extensive development process

The development process began with of a review of the KEEP concepts that are biomass energy related by environmental and energy professionals. Then K-12 teachers reviewed the identified existing activities by teachers and made recommendations on their inclusion in the new curriculum. After compiling the results KEEP Staff asked for and received permission to adapt some of the existing activities that were recommended by the teachers in the previous step and wrote new activities to come up with a total of ten biomass energy activities. When the activities were developed and proofread each activity underwent a content review. The reviews were completed by an energy professional with experience in the topic covered by the activity. Changes were made to the activities based on the results of the content review and then the format for the curriculum was determined. The curriculum was developed in full, including the introduction and appendix, and went through a comprehensive review of the whole document. The comprehensive review was completed by two teachers, the Director of the WCEE, the Director of KEEP, and the Director of the Focus on Energy Renewable

Energy Program. Those results were compiled and the final changes were made to the biomass energy curriculum before it was printed.

Conclusions Related to Subproblem One

Subproblem One: Identify biomass energy topics that can be integrated into the KEEP curriculum.

Biomass energy was a complex concept to break apart into individual topics that fit into the KEEP curriculum. Because there is extensive research and design being done all over the world it was difficult to separate the technology that was relevant and the technology that was still a work in progress. For the purpose of this curriculum, only the biomass energy technologies that have proven to work were included.

During this research there were several biomass energy topic areas identified. Of those topics, gasification and pyrolysis were very complex and while they were included within activities, there were not activities developed that dealt specifically with them because the audience is not advanced enough for the topics. The teachers that would use those activities on gasification and pyrolysis would be advanced physics and chemistry teachers. During the activity “Biomass Gazette” teachers noted that there were topic areas that were more difficult than others and therefore a note was made in the activity that said the topics pyrolysis and gasification are more challenging. Because there was a limit to the number of activities developed it seemed more worthwhile to develop activities that appeal to a more general audience and allow the more advanced teachers to incorporate gasification and pyrolysis into these lessons if teachers feel it is appropriate.

It is recommended that when identifying topics for a complex subject such as biomass energy, the search be narrowed to reliable organizations. This will result in topics that are current and not in the research and design stages. It is also recommended that advanced topics be included only as a reference, adaptation, or extension for advanced classes.

<u>Conclusions Related to Subproblem Two</u>

Subproblem Two: The second subproblem is to identify K-12 biomass energy resource information available to educators on the identified topics.

Identifying existing biomass energy resource information available to educators is an extensive process. Doing searches for resources through library searches yielded very few documents which led me to believe there are very few full activity guides solely on biomass energy. In order to find individual activities on biomass energy a physical search was conducted. This was the most effective method to identify existing resources in printed texts. The online search was also more effective than a library computer search. Word of mouth also resulted in the location of resources although some of the resources identified were already located online. The WCEE Resource Library proved to be a valuable resource when it came to searching for existing materials.

It is recommended that if another organization is making a list of existing resources they do not limit their search to sitting at a library computer to find full documents but instead rely more on manual searches, word-of-mouth, and internet searches. It is also recommended that if a manual search is going to be done that the researcher search at a place like the WCEE Resource Library that has a large collection of environmental education resources.

Conclusions Related to Subproblem Three

Subproblem Three: The third subproblem is the development of a biomass curriculum.

Conceptual Framework

The review of the concepts in the KEEP *Conceptual Framework* was an important step in the development of the biomass energy curriculum. **If someone were to repeat this process it would be recommended that all of the existing concepts be reviewed and ranked by the panel. This could pull out some additional concepts that were missed but that are relevant to the subject material.**

Scope and Sequence and Academic Standards

Because there were no new concepts added to the Conceptual Framework for the biomass energy curriculum a new Scope and Sequence did not need to be conducted. **If new concepts were added it would be recommended that the researcher gather a group of 15 to 20 teachers of various grade levels and subject areas to conduct a Scope and Sequence.** To do this the teachers should be sorted into three groups, K-4, 5-8, and 9-12.

Each group of teachers would be given the concepts on slips of paper and a chart divided by grade level (same as division of groups). The teachers would then be asked to review each concept and tape it to the chart in the appropriate grade level. Then the groups have a chance to review the work of the other groups and any discrepancies between the groups are discussed until a conclusion can be reached. The results are put into a chart like the one in Appendix D. The last step is a final review by KEEP staff.

The correlation of KEEP concepts to academic standards was not a necessary step because KEEP had already determined that the concepts are related to numerous Wisconsin Model Academic Standards. Instead of correlating the standards to KEEP concepts **it is recommended that in future curriculums the academic standards be correlated to each individual activity.** This information would be more useful for the K-12 teacher than the correlation of standards to concepts.

Review of Existing Activities

This step is helpful to the extent that the researcher can pull out any activities that the teachers said they would not recommend to be used for the new curriculum. The teachers were not critical enough of the activities but it is unknown how to make them be more critical so it was the job of the researcher to look at the teacher comments to pull out the activities that received the highest rankings and see how they could fit into a new curriculum. **Although this step does not eliminate enough of the activities it is a valuable step in the development process and it is recommended to anyone**

developing curriculum or activity guides. It is also recommend that a questionnaire, just like, or similar to the tool used in this research be used.

Activity Format

The format used in the KEEP *Activity Guide* and *Doable Renewables* were and continue to be evaluated and those results are compiled and reported at the end of the fiscal year. The format includes many different sections and is designed to provide the teachers with as much information as possible to complete the activity. Besides going to the recommended resources the teachers should be able to complete the activity successfully with the information provided in the curriculum. **It is recommended that other organizations developing curriculums or activity guides follow a format with all or many of the components of KEEP's activity format.**

Development of Biomass Energy Activities

Without the work completed in the initial stages the development of the activities would be a challenge. The activity reviews completed by the teachers assisted in identifying the five activities that were eventually adapted and used in the biomass energy curriculum. Some of the images from existing activities were used as well even if the activity was not useful. **If part or a whole activity is used or even adapted it is recommended that permission is asked of the organization that originally developed the activity.**

Content Review

There are many misconceptions that people have about renewable energy and that was why the content review process was critical to the development process. The KEEP Staff are not experts in biomass energy so to be sure teachers and students have accurate information each activity was reviewed by a professional who works in the field of the activity they reviewed. Without this step the biomass energy curriculum would not have reliable information and would be spreading inaccurate information throughout K-12 schools. **This step is essential to the development and evaluation process and is highly recommended. The content review tool has been used by KEEP for the development of two curriculums and now for the development of the biomass energy curriculum. It proved to be a useful tool and its use would also be recommended.**

Conclusions Related to Subproblem Four

Subproblem Four: The fourth subproblem is to evaluate the biomass energy curriculum.

Piloting/Teacher Review

Piloting the activities is another one of the essential steps of developing activities and is highly recommended. In this research at least two teachers piloted each activity one or more times. The maximum number of teachers that piloted an activity was limited to three because that was all the funding allowed. If more funding was available additional reviews would have improved the final document. **It is recommended that at least two teachers review each activity but if funding and time allow up to six teachers would be beneficial.**

If funding and time would allow it would also be beneficial to have the researcher or another participant observer sit in on the teacher pilots to gain additional perspective. This would help the researcher determine how the activity was used in the classroom and also determine if there are things the teacher missed that should be more prominent within the activity.

Comprehensive Review

The comprehensive review was completed by three individuals with diverse professions and therefore different ideas of what their role is during the comprehensive review. Each of the reviewers went through the whole document. Two of the three reviewers filled out and completed the review form and two out of three made comments on the draft of the curriculum that was sent to them. All of the reviews were helpful but the comments made in the document were the most helpful**. It is recommended that additional comprehensive reviews should be conducted if funding and time allow. It is also advised that reviewers be encouraged to write in the document.**

Recommendations for Future Research

Besides the bolded recommendations in the rest of this chapter it would also be recommended to study the development process of a curriculum from a more qualitative approach. The researcher would be able to record their own reflections throughout the process. Participant observation should be used for the activity pilots as well.

Follow up research could be completed on the biomass energy curriculum. The study could address how effective the biomass energy activities are at teaching students energy concepts. A pre- and post-test for each activity could be administered to determine the knowledge gained by the students. If the research is conducted over five years after the biomass energy curriculum is published an additional review could be completed on how up-to-date the biomass energy topics are. It is possible with scientific advances that new technologies could become more mainstream.

Final Note

This research was needed because of the lack of biomass energy educational resources available for K-12 educators. While this curriculum was in the development process KEEP frequently received inquiries from teachers and other organizations all around the United States about the availability of the curriculum. KEEP anticipates that once the biomass energy curriculum is put online in PDF form it will be used frequently by educators of all kinds.

See Appendix Q for the completed biomass energy curriculum entitled *BioFutures*.

References

Barry, Dana M. (July 2001). "The Environmental Risks of Using Combustion as a Source of Energy". Presented at the CONFCHEM Online Conference, 6-31.

Beyer, Barry K. (1995). How to Conduct a Formative Evaluation. Alexandria: Association for Supervision and Curriculum Development.

Boardman, Maria. (2005). Letter of Support.

Borg, Walter R., and Meredith D. Gall. (1983). Educational Research: An Introduction. New York: Longman.

Brower, Michael, M. Tennis, E. Denzler and M. Kaplan. (1993) Powering the Midwest Renewable Electricity for the Economy and the Environment. Union of Concerned Scientists.

Champeau, Randy and et al.. (1997). Environmental Education in Wisconsin: Are we walking the talk? Stevens Point: Wisconsin Center for Environmental Education.

Christ, George. M.. "Curriculum with Real World Connections." Educational Leadership. May 1995: 32-35.

Erickson, H. Lynn. (1998). Concept-Based Curriculum and Instruction: Teaching Beyond the Facts. Thousand Oaks: Corwin Press.

Erickson, H. Lynn. (2001). Stirring the Heart and Soul: Redefining Curriculum and Instruction. Thousand Oaks: Corwin Press.

Flick, U. (2002). An Introduction to Qualitative Research (2nd Ed.). Thousand Oaks: Sage.

Gibson, Bob and et al.. (1998). "Schools Going Solar: A Guide to Schools Enjoying the Power of Solar Energy". Department of Energy.

Grady, S.M. and Lee, S.A.. (1998) *Wisconsin's Model Academic Standards for Science*. Madison: Wisconsin Department of Public Instruction.

Grady, S.M., Lee, S.A., and Marinac, P.A. (1998) *Wisconsin's Model Academic Standards for Environmental Education*. Madison: Wisconsin Department of Public Instruction.

Grady, S.M., Miller, K.D., and Starkman K.J.. (1998) *Wisconsin's Model Academic Standards for Technology Education*. Madison: Wisconsin Department of Public Instruction.

Grady, S.M. and Prickette K.R.. (1998) *Wisconsin's Model Academic Standards for Social Studies*. Madison: Wisconsin Department of Public Instruction.

Grady, S.M. and Stefonek, T. (1998) *Wisconsin's Model Academic Standards for Family and Consumer Education*. Madison: Wisconsin Department of Public Instruction.

Herzog, Antonia V, et al. "Renewable Energy a Viable Choice." Environment. Dec. 2001: 8-20.

Jacobs, Heidi (Ed.). (1989). Interdisciplinary Curriculum: Design and Implementation. Alexandria: Association for Supervision and Curriculum Development.

Kane, Stephanie. (2003). The Development, Evaluation, and Application of a Conceptual Framework for K-12 Renewable Energy Education. Stevens Point: WCEE.

Kemp, Jerrold E. (1985). The Instructional Design Process. New York: Harper & Row.

Kirk, Jerome and Marc Miller. (1986). Reliability and Validity in Qualitative Research. Beverly Hills: Sage.

Lane, Jennie. (December, 10 2007). Wisconsin K-12 Energy Education Program. Personal Communication.

Leedy, Paul D. (1993). Practical Research: Planning and Design (5th Ed). New York: Macmillan.

Lincoln, Y and E. Guba. (1985). Naturalistic Inquiry. Beverly Hills: Sage.

Marcinkowski, Thomas. (2001). Assessment in Environmental Education. In Hungerford, Harold R, Bluhm, William J., Volk, Trudi L., and Ramsey, John M. (Eds.). Essential Readings in Environmental Education (2nd Edition) (pp. 179-216). Champaign: Stipes.

Merriam, S. (1998). Qualitative Research and Case Study Applications in Education (2nd Ed.). San Francisco: Jossely-Bass.

National Energy Foundation. (1999). Energy technology and Society: A Teaching Resource Package for Grades 9-12. Salt Lake City: National Energy Foundation.

National Environmental Education and Training Foundation (NEETF). (October 2002). Americans' Low "Energy IQ:" A Risk to Our Energy Future, Why America Needs a Refresher Course on Energy (10th Edition).

National Renewable Energy Laboratory. (2006a). Biofuels. Retrieved February 24, 2006 from http://www.nreal.gov/learning/re_biopower.html

National Renewable Energy Laboratory. (2006b). Biopower. Retrieved February 24, 2006 from http://www.nreal.gov/learning/re_biopower.html

National Renewable Energy Laboratory. (2006c). Bioproducts. Retrieved February 24, 2006 from http://www.nreal.gov/learning/re_bioproducts.html.

North American Association for Environmental Education (NAAEE). (2000). Environmental Education Materials: Guidelines for Excellence Workbook; Bridging Theory & Practice.

Peterson, Robert A. (2000). Constructing Effective Questionnaires. Thousand Oaks: Sage.

Salant, Priscella and Don Dillman. (1994). How to Conduct Your Own Survey. New York: John Wiley & Sons.

Smilkstein, Rita. (2003). We're Born to Learn:Using the Brain's Natural Learning Process to Create Today's Curriculum. Thousand Oaks: Corwin Press.

Smith, Jeremy. (2003). "Oil & Security." The Ecologist. Jan. 2003: 28-33.

Sowell, Evelyn J. (1996). Curriculum: An Integrative Introduction. Columbus: Prentice Hall.

Spruill, Mary. Personal communication. November 14, 2005.

United States Department of Energy. (2005). EERE: Biomass Program Home Page. Retrieved September 25, 2005 from, http://www1.eere.gov/biomass.

Vine, Edward, Drury Crawley, and Paul Centolella. (1991). Energy Efficiency and the Environment: Foraging the Link. American Council for an Energy Efficient Economy.

Wichert, Don. (2005). Letter of Support.

Wilke, Richard J. ed., (1993). Environmental Education: Practical Guide for K-12 Environmental Education. Millwood: Kraus.

Wisconsin Department of Administration (DOA). (2005). Wisconsin Energy Statistics: 2004. Wisconsin Department of Administration: Wisconsin.

Wisconsin Focus on Energy. (2002a). Farm Energy from Manure. Retrieved January 22, 2007, from http://www.focusonenergy.com/data/common/dmsFiles/W_RB_MKFS_Farm%20energy%20from%20manure.pdf.

Wisconsin Focus on Energy. (2002b). Turning Wastewater into Energy. Retrieved January 22, 2007, from http://www.focusonenergy.com/data/common/dmsFiles/W_RB_MKFS_Turning%20wastewater%20to%20energy%20fact%20sheet.pdf.

Wisconsin K-12 Energy Education Program (KEEP) (2005a). KEEP Activity Guide. Focus on Energy and Wisconsin Center for Environmental Education: Wisconsin.

Wisconsin K-12 Energy Education Program (KEEP) (2005b). Doable Renewables: A Supplement to the KEEP Activity Guide. Focus on Energy and Wisconsin Center for Environmental Education: Wisconsin.

United States Department of Energy (US DOE). (2000). Biofuels for the Economy.

United States Department of Energy (US DOE). (2006). Electrical Power Generation. Retrieved February 24, 2006 from http://www1.eere.energy.gov/biomass/electrical_power.html.

.

Appendix A
Wisconsin Model Academic 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 now3

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 Studies

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.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 their 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. Identify several contributions the family makes in meeting family members needs for food, clothing, shelter, and economic resources; encouraging 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 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

- describe what it means to be reflective
- explain the importance of using reflection; such as family member use of reflection to identify and evaluate attitudes, beliefs, and patterns of thinking and acting that affect accomplishment of goals
- identify situations that call for reflection in daily life

D.1. Give examples of individual, family, and community action

D.2. Describe a specific family-related concern in the classroom, school, or neighborhood

- set clear and realistic goals that address this concern
- describe actions that might be taken to reach goals
- predict the potential impact these actions might have on the people who will be affected

Appendix B
List of Existing Biomass Energy Activities

#	Organization	Name of Activity Guide	Name of Activity/Activities
1	National Renewable Energy Laboratory	R.E.A.C.T. Renewable Energy Activities - Choices for Tomorrow Teacher's Activity Guide for Grades 6-8	Activity 9: Which Grass Produces More Biomass?
2	National Energy Foundation	Energy Technology & Society Kit	Unit 3 Biomass: Section 1 What is Biomass?, Section 2 Food is Biomass, Section 3 Using Wood for Energy, Section 4 Biogas, Section 5 Alcohol Fuels
3	Re-energy.ca		Build Your Own Biogas Generator
4	National Science Teachers Association	Wind, Water, Fire, and Earth: Energy Lessons for the Physical Sciences	Lesson 5: Biomass Conversion Process
5	Wisconsin Rural Development Center	Lessons for Teaching Sustainable Agriculture: Interdisciplinary lessons for hands-on instruction of sustainable agricultural concepts.	Grow Your Own Fuel
6	KEEP	Doable Renewables: A Supplement to the KEEP Activity Guide	Corn in Your Car
7	United States Dept. of Energy, Energy Efficiency and renewable energy	Biofuel Production	1. What can be controlled to increase the efficiency of ethanol production?, 2. What kinds of biomass have the most heat energy in a given quantity?, 3. What type of biomass will produce the greatest quantity of biogases by heating?, 4. What conditions provide the maximum yield of charcoal from biomass?, 5. What conditions will produce the most efficient breakdown of paper into sugars?, 6.What conditions and/or biomass are best for producing methane? 7. What conditions would produce the most efficient conversion of algae to a useful fuel? 8. What is the most efficient way to produce biodiesel?
8	KEEP	KEEP Activity Guide	So you Want to Heat Your Home
9	United States Dept. of Energy, Energy Efficiency and renewable energy	Photosynthesis and Biomass growth	1. How do modern farming techniques affect the growth of biomass?, 2. Is natural sunlight, imitation sunlight, fluorescent light or incandescent right best for plants?, 3. How does varying CO2 levels affect the rate of plant growth in plants?, 4. What are the true colors of leaves?, 5.How do aquatic plants survive underwater? Do they still need light to make oxygen?, 6. What happens when plants are

			crowded?, 7. can a cascade of wetlands be a pollution solution?
10	American Farm Bureau Foundation for Agriculture	Farm Fact Lesson Plans - grades 4-6	At the Pump (ethanol)
11	National Renewable Energy Laboratory	Research Projects in Renewable Energy for High School Students.	1. What is the efficiency of ethanol production from various sources?, 2. What kind of biomass is best for producing methane?, 3. What kinds of plants have the most heat energy in a given quantity of biomass?, 4. How much energy can be obtained from alcohol fuels?, 5. What factors affect biomass growth?
12	National Energy Education Development	NEED Science Fair Project for Kids	Sprouting Seeds
13	National Energy Education Development	Alternative Fuels: Biodiesel	Whole document is about Biodiesel
14	University of Florida Civil Engineering		Waste Digester Design
15	National Energy Foundation	This is poster	Fueling the Future
16	National Energy Education Development	NEED Science Fair Project for Kids	Decaying Food
17	Renewable Energy: The infinite Power of Texas	Unit of Study No. 15	Biomass: Nature's Most Flexible Energy Resource
18	Renewable Energy: The infinite Power of Texas	Unit of Study No. 20	Clean Energy from Texas Landfills
19	NEED	Energy Exchange, March 2006, Page 5	Primary Activity: Biogas
20	Wisconsin Energy Corporation	Choose to Renew: Teacher’s Guide for grades 6-8 on Renewable Energy (p 18-21)	Biomass Energy
21	National Renewable Energy Laboratory	R.E.A.C.T. Renewable Energy Activities - Choices for Tomorrow Teacher's Activity Guide for Grades 6-8	Activity 8: Which has more heat?
22	Wisconsin Rural Development Center	Lessons for Teaching Sustainable Agriculture: Interdisciplinary lessons for hands-on instruction of sustainable agricultural concepts.	Alternative Crops as Energy Sources
23	Wisconsin Rural Development Center	Lessons for Teaching Sustainable Agriculture: Interdisciplinary lessons for hands-on instruction of sustainable agricultural concepts.	Design a Future with Renewable Energy

24	National Energy Education Development	NEED Science Fair Project for Kids	Energy From Garbage
25	National Energy Education Development	NEED Science Fair Project for Kids	Seeds and Needs

Appendix C
Concept Review Form and Results

Instructions

- Rank each of the concepts on their relevance to bioenergy. (1 = not very relevant, 5 = very relevant)
- Please feel free to comment on your response
- If you feel that there are important concepts missing please review the KEEP *Conceptual* Framework to see if it already exists. If it does add the concept number in the extra space provided below. If it does not exist please draft a concept in the space provided at the end of the document.

Concept	1-5 Rank	Comment
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 covert 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. (11)	4, 3, 3 (3.3)	
Wisconsin has five main biological communities: northern forest, southern forests, prairies, oak savanne and aquatic. (15)	4, 1, 4 (2.6)	- How is this changing due to human influences, including climate change? Will it be true in 20 years? Are some biological communities now only maintained through human intervention (burning regimes)? - I know this is already in the framework, but it's a specific fact, not a general idea.
Primary energy sources are those that are either found or stored in nature. • 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).	4, 2, 4 (3.3)	

• 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. (19)		
Each renewable energy resource has inherent qualities that make it more suitable for some applications than others. (25.5) • Each biomass resource contains a different amount of energy. This must be considered when making the decision as to what resource to use.	5, 4, 5 (4.6)	
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. (25.15)	4, 5, 4 (4.3)	The release can occur without people.
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. (25.16)	4, 5, 4 (4.3)	Transportation fuel?
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. (27) • Wisconsin has numerous biomass resources because of its rich agriculture traditions.	4, 5, 5 (4.6)	
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. (35)	4, 3, 4 (3.6)	
Using renewable energy will reduce some personal and community health risks since it generally releases fewer pollutants into the environment than fossil fuels. (37)	5, 4, 4 (4.3)	
When comparing the cost of renewable energy to non-renewable energy,	4, 4, 4 (4)	

externality costs associated with non-renewable energy should be considered. (47) • When making the decision to use a resource for energy one must consider not only the energy issues but also the economic and social issues that surround the use of the resource.		
Many occupations, businesses, and public services (such as utilities) result from the development and use of renewable energy resources. (48)	5, 3, 5 (4.3)	
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. (49) • Some renewable resources are also considered to be waste products which can then be used to create energy. Example: Wood waste from logging may be burned to heat a building.	4, 2, 4 (3.3)	- Again, I know the concept wording is a done deal, but "most"? Wind and solar certainly, but if there is a demand and people will pay, it won't be free. (in Central Wisconsin wood waste from residential tree removal is free. In larger cities it is often sold for firewood or woodchips are bagged for mulch and sold.
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. (70)	4, 5, 4 (4.3)	
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. (73)	4, 5, 3 (4)	

Appendix D
Scope and Sequence of KEEP Concepts

Scope and Sequence

The shaded areas are where the concept should be emphasized. Emphasized concepts in grades K-4 and/or 5-8 should be built upon as the student(s) progresses through the K-12 system.

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.

Concepts	Grade K-4	Grade 5-8	Grade 9-12
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. (11)	**Language Arts** A.4.1, A.4.2, A.4.3, A.4.4 C.4.1, C.4.2, C.4.3 D.4.1 E.4.1, E.4.5 F.4.1 **Science** A.4.1 – A.4.5 B.4.1 – B.4.3 C.4.1 – C.4.4, C.4.7, C.4.8 D (all)	**Language Arts** A.8.4 **Science** A.8.6, A.8.8 C.8.2 D.8.8, D.8.9 E.8.4, E.8.6 F.8.2, F.8.6, F.8.8 **Social Studies** A.8.10, A.8.11	**Language Arts** A.12.1, A.12.2, A.12.3, A.12.4 C.12.1, C.12.2, C.12.3 **Science** D.12.3-D.12.6, D.12.9, D.12.11, D.12.12 E.12.1, E.12.3 F.12.1 G.12.3, G.12.4 H.12.1 **Social Studies** A.12.2, A.12.4

Wisconsin has five main biological communities: northern forest, southern forests, prairies, oak savanne and aquatic. (15)	**Language Arts** A.4.1, A.4.3, A.4.4 B.4.1 C.4.1, C.4.2 D.4.1, D.4.2 E.4.1, E.4.5 F.4.1 **Science** E.4.1 – E.4.3, E.4.5, E.4.8 **Social Studies** A.4.2	**Language Arts** A.8.4 **Science** C.8.8 F.8.8 **Social Studies** A.8.1, A.8.3 – A.8.5	**Language Arts** A.12.3, A.12.4 C.12.2, C.12.3 **Science** E.12.1 **Social Studies** A.12.1 – A.12.3, A.12.12

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 a system is necessary to appreciate how humans have come to value and treat energy as a resource.

Concepts	K-4	5-8	9-12
Primary energy sources are those that are either found or stored in nature. • 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). • 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. (19)	**Language Arts** A.4.1, A.4.3, A.4.4 C.4.1, C.4.2, C.4.3 D.4.1 E.4.1 (use computers) F.4.1 **Science** B.4.3 D.4.3, D.4.8 D.4.1 – D.4.8 E.4.7, E.4.8 **Social Studies** B.4.8	**Language Arts** F.8.1 **Science** B.8.1, B.8.3, B.8.6 D.8.8 – D.8.10 E.8.2, E.8.5, E.8.6 G.8.6 H.8.1, H.8.2 **Social Studies** A.8.1, A.8.4 – A.8.6	**Language Arts** A.12.1, A.12.2, A.12.4 B.12.1 C.12.1, C.12.2 **Science** D.12.1 – D.12.3, D.12.8 – D.12.12 E.12.1, E.12.5 H.12.1, H.12.6 E.12.1, E.12.2 **Social Studies** A.12.4, A.12.6, A.12.12
Each renewable energy resource has inherent qualities that make it more suitable for some applications	**Language Arts** A.4.1, A.4.3, A.4.4 C.4.1, C.4.2, C.4.3 D.4.1 E.4.2	**Language Arts** F.8.1 **Science** D.8.4 E.8.6	**Language Arts** A.12.4 **Science** A.12.4, A.12.5 C.12.3

than others. (25.5) • Each biomass resource contains a different amount of energy. This must be considered when making the decision as to what resource to use.	F.4.1 **Science** D.4.6 E.4.7 F.4.4 **Social Studies** B.4.1	G.8.1, G.8.3 H.8.1, H.8.2 **Social Studies** A.8.4, A.8.10 D.8.7	D.12.3, D.12.10 – D.12.12 E.12.1, E.12.2 G.12.3, G.12.4 **Social Studies** A.12.4 – A.12.6, A.12.8 C.12.8
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. (25.15)	**Language Arts** A.4.1, A.4.3, A.4.4 C.4.1, C.4.2, C.4.3 D.4.1 F.4.1 **Science** D.4.6, D.4.8 E.4.7	**Language Arts** A.8.4 **Science** D.8.1, D.8.3, D.8.4 E.8.6 **Social Studies** A.8.7	**Language Arts** A.12.4 **Science** A.12.5, A.12.6 B.12.1 D.12.3, D.12.6, D.12.10 – D.12.12 E.12.1, E.12.2 F.12.4, F.12.9
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. (25.16)	**Language Arts** A.4.1, A.4.3, A.4.4 C.4.1, C.4.2, C.4.3 F.4.1 **Science** D.4.8 **Social Studies** D.4.4	**Language Arts** A.8.4 F.8.1 (research and summarize) **Science** D.8.4 G.8.3 H.8.1, H.8.2 **Social Studies** A.8.7	**Language Arts** A.12.4 C.12.1 **Science** A.12.5 B.12.3 D.12.3, D.12.4, D.12.6, D.12.10 – D.12.12 E.12.1, E.12.2, E.12.4 F.12.9 **Social Studies** B.12.9 C.12.8
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	**Language Arts** A.4.1, A.4.3, A.4.4 C.4.1, C.4.2, C.4.3 D.4.1 F.4.1 **Science** A.4.1 – A.4.5 **Social Studies**	**Language Arts** B.8.2 **Science** E.8.2 H.8.1, H.8.2 **Social Studies** D.8.7 E.8.4, E.8.5, E.8.7	**Language Arts** A.12.4 **Science** A.12.1 B.12.3 C.12.1 E.12.1, E.12.2, E.12.4

include biomass, hydropower, solar energy, and wind, all of which are renewable and can be found within the state. (27) • Wisconsin has numerous biomass resources because of its rich agriculture traditions.	D.4.4		H.12.1, H.12.6, H.12.7 **Social Studies** A.12.1, A.12.2, A.12.5, A.12.6, A.12.11, A.12.12

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.

Standards	Grade K-4	Grade 5-8	Grade 9-12
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. (35)	**Language Arts** A.4.1, A.4.3, A.4.4 C.4.1, C.4.2, C.4.3 D.4.1 F.4.1 **Science** F.4.1 – F.4.5 **Social Studies** D.4.7	**Language Arts** A.8.2 C.8.1 (debate) **Science** G.8.5 H.8.1 – H.8.3 **Social Studies** B.8.2, B.8.8, B.8.9 C.8.3, C.8.6, C.8.7 E.8.3	**Language Arts** A.12.4 B.12.1 C.12.1, C.12.2 F.12.1 **Science** A.12.1, A.12.2, A.12.5 B.12.1 C.12.1 D.12.11, D.12.12 G.12.1, G.12.4 H.12.1 – H.12.3, H.12.5, H.12.7 **Social Studies** A.12.4, A.12.12 B.12.1, B.12.9 C.12.8
Using renewable energy will reduce some personal and community health risks since it generally releases fewer pollutants into the environment than fossil fuels. (37)	**Language Arts** A.4.1, A.4.3, A.4.4 C.4.1, C.4.2, C.4.3 E.4.2 F.4.1 **Science** F.4.1 – F.4.5 H.4.1 – H.4.4 **Social Studies** D.4.7	**Language Arts** B.8.1 (persuasive writing) **Science** F.8.8 G.8.5 H.8.1 – H.8.3 **Social Studies** B.8.8 C.8.8 D.8.1, D.8.2	**Language Arts** A.12.4 B.12.1 C.12.1 **Science** A.12.1, A.12.2, A.12.5 B.12.1 C.12.1 D.12.3, D.12.6, D.12.11, D.12.12 E.12.1 G.12.1, G.12.3 H.12.6 **Social Studies** A.12.4, A.12.12 C.12.8
When comparing the cost of renewable energy to non-renewable energy,	**Language Arts** A.4.1, A.4.3, A.4.4 C.4.1, C.4.2, C.4.3 E.4.2	**Language Arts** F.8.1 (multiple sources) **Science**	**Language Arts** A.12.4 B.12.1, B.12.2 F.12.1

externality costs associated with non-renewable energy should be considered. (47) • When making the decision to use a resource for energy one must consider not only the energy issues but also the economic and social issues that surround the use of the resource.	F.4.1 **Science** H.4.1 – H.4.4 **Social Studies** D.4.7	B.8.6 F.8.8 H.8.1 – H.8.3 **Social Studies** A.8.10 D.8.5, D.8.8, D.8.11 E.8.3, E.8.8	D.12.2 E.12.1 **Science** A.12.1, A.12.2, D.12.5 B.12.1 C.12.1 D.12.3, D.12.11, D.12.12 E.12.4 G.12.1 H.12.1, H.12.5 **Social Studies** A.12.2, A.12.4 – A.12.6, A.12.11, A.12.12 B.12.9 C.12.8 D.12.2
Many occupations, businesses, and public services (such as utilities) result from the development and use of renewable energy resources. (48)	**Language Arts** A.4.1, A.4.3, A.4.4 C.4.1, C.4.2, C.4.3 F.4.1 **Science** G.4.1 – G.4.5 **Social Studies** C.4.3 D.4.3, D.4.4	**Language Arts** C.8.3 (discussion) **Science** G.8.1 – G.8.3 **Social Studies** A.8.11 B.8.7, B.8.9 C.8.8 D.8.7, D.8.8 E.8.7, E.8.10	**Language Arts** A.12.4 B.12.1 **Science** A.12.1, A.12.3, A.12.5 B.12.1 – B.12.5 H.12.1 **Social Studies** A.12.4, A.12.12 B.12.9 C.12.8 D.12.2
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	**Language Arts** A.4.1, A.4.3, A.4.4 C.4.1, C.4.2, C.4.3 F.4.1 **Science** G.4.1 – G.4.5 H.4.1 – H.4.4 **Social Studies** D.4.1, D.4.4, D.4.7	**Language Arts** F.8.1 (research) E.8.1, E.8.4 **Science** F.8.8, F.8.9 H.8.1 – H.8.3 **Social Studies** B.8.8 C.8.8 D.8.1, D.8.2, D.8.7, D.8.8	**Language Arts** A.12.4 B.12.1 **Science** A.12.1, A.12.3, A.12.5 B.12.1 – B.12.5 G.12.3 H.12.1 **Social Studies** A.12.4, A.12.5 C.12.8 D.12.2

resource is located. (49) • Some renewable resources are also considered to be waste products which can then be used to create energy. Example: Wood waste from logging may be burned to heat a building.			
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. (70)	**Language Arts** A.4.1, A.4.3, A.4.4 C.4.1, C.4.2, C.4.3 D.4.1 E.4.2 F.4.1 **Science** G.4.1 – G.4.4 **Social Studies** A.4.8 D.4.4	**Language Arts** B.8.3 F.8.1 (evaluate) **Science** F.8.9 H.8.1, H.8.2 **Social Studies** C.8.6 – C.8.8 D.8.4, D.8.5	**Language Arts** A.12.4 B.12.1 F.12.1 **Science** A (all) B.12.1 C.12.1 D.12.3, BD.12.11, D.12.12 H.12.1, H.12.5 **Social Studies** A.12.2, A.12.4, A.12.5, A.12.11, A.12.12 B.12.9 C.12.8

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 resources 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	Grade K-4	Grade 5-8	Grade 9-12
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. (73)	**Language Arts** A.4.1, A.4.3, A.4.4 C.4.1, C.4.2, C.4.3 D.4.2 E.4.2 F.4.1 **Science** G.4.1 – G.4.5 H.4.1 – H.4.4 **Social Studies** B.4.3, B.4.4 C.4.3 D.4.7	**Language Arts** D.8.2 **Science** H.8.1 – H.8.3 **Social Studies** B.8.2 C.8.1, C.8.3, C.8.6 – C.8.8 D.8.5 E.8.1	**Language Arts** A.12.4 B.12.1 C.12.1, C.12.2, C.12.3 E.12.1, E.12.2 **Science** A (all) B (all) C.12.1 D.12.11, D.12.12 G.12.1 H.12.1, H.12.2, H.12.5, H.5.7 **Social Studies** A.12.4, A.12.11, A.12.12 C.12.8, C.12.11 E.12.9

Teaching Ideas

Language Arts

K-4

All of these concepts could be addressed with written expression or oral activities, or reading activities. The teachers could adapt all the concepts to any type of activity the teacher wanted.

I had no problem identifying the reading standards that matched your concepts. A.4.1, A.4.3, and A.4.4 matched most of your concepts. A.4.2 could work depending upon the activities you develop. The writing standards were more difficult to match up. I think they could be incorporated depending on the activities used.

Musical activities can be tied to reading ideas. Write a song about a particular subject. Sing your song [it can be done in a speaking/singing way like opera (recitation or solte volce)). Research folk songs that include subject matter about chopping wood or sitting around the campfire.

Notes: Standards for media and technology – E.4.1 could be used for each one if students use computers for research. E.4.3 and E.4.5 – would be used if students are creating word documents or PowerPoint presentation for their activity. E.4.4 could be used in all if students are trying to be persuasive or adjusted for different audiences.

9-12

Individual assignment can take on long-term and comprehensive levels that will address any of these standards. Oral presentations, PowerPoint shows, research papers and journalism applications will address all of these standards dependent upon construction of the individual assignments.

Science

K-4

I see too many connections of standards – everything is related – I did try to narrow down – but it was difficult.

9-12

Standard “C” could be accomplished easily in any group as long as activities were focused on applying knowledge to questioning, experimenting and relating to students’ lives.

Standard “B” could be met if concepts are applied to different cultures.

Appendix E
Activity Review Form

ACTIVITY REVIEW FORM

Reviewer Name: ____

Activity Title:____
Resource Title:____
Author/publisher: ____
Page numbers:____
Grade levels to which activity applies (circle one): K-4 5-8 9-12
Concept number(s) to which activity applies: ________________________________
Subject area(s) to which the activity applies (circle all that apply):

all subject areas	mathematics	sciences	family and consumer education
environmental education	social sciences	what field? ____________	other: ________
language arts	technology education	special education	

Please provide a brief summary of the activity:

Review the activity and evaluate the quality of the activity based on the following criteria:

Criteria	Grade				
The activity is **relevant to biomass energy** in Wisconsin	A	B	C	D	F
The activity **objectives** clearly state what students are to learn	A	B	C	D	F
The activity includes a complete list of needed **materials** that are easily obtained and affordable by the average teacher.	A	B	C	D	F
Background information is provided and will help the teacher prepare for the activity.	A	B	C	D	F
The activity **procedure** steps are easy to follow and it appears could be accomplished successfully.	A	B	C	D	F
Participatory teaching strategies (e.g., hands on, cooperative learning, inquiry) are used.	A	B	C	D	F
The **assessment** strategies will help determine if the objectives of the activity were achieved.	A	B	C	D	F

Should this activity be considered for the *Biomass Activity Guide*?

YES **NO** **MAYBE**

Use the back to provide suggestions for improving this activity.

Appendix F
Activity Review Results

Summary of Teacher Reviews of Existing Biomass activities
(Activities listed by reference number in Appendix ___)

1. *Choices for Tomorrow Teacher's Activity Guide for Grades 6-8*
Teacher review
Grade level: K-12
Subject areas: not indicated
Concepts: none indicated
Teacher comments:
"I liked this activity and it would provide a great supplement. It could provide more detail for teachers that aren't or don't have a science background".
Teacher recommendation to include in the KEEP biomass curriculum: yes

Grades:

Criteria	Grade				
The activity is **relevant to biomass energy** in Wisconsin	**A**	B	C	D	F
The activity **objectives** clearly state what students are to learn	**A**	B	C	D	F
The activity includes a complete list of needed **materials** that are easily obtained and affordable by the average teacher.	**A**	B	C	D	F
Background information is provided and will help the teacher prepare for the activity.	**A**	B	C	D	F
The activity **procedure** steps are easy to follow and it appears could be accomplished successfully.	**A**	B	C	D	F
Participatory teaching strategies (e.g., hands on, cooperative learning, inquiry) are used.	**A**	B	C	D	F
The **assessment** strategies will help determine if the objectives of the activity were achieved.	**A**	B	C	D	F

Researcher observations:
This is a fun activity that could be developed for middle school student with extensions for both high school and elementary school students. It is an easy demonstration and ties biomass to concepts most students already understand or can relate to (i.e. growing plants). Although the activity was given an "A" for each category it will need to be adapted for use. I recommend KEEP use this activity and ask for permission to use it from NREL.

2. *Energy Technology & Society Kit*
Teacher review
Grade level: 9-12
Subject areas: Technology Education, EE, Science
Concepts: not identified
Teacher comments: none
Teacher recommendation to include in the KEEP biomass curriculum: no

Grades:

Criteria	Grade				
The activity is **relevant to biomass energy** in Wisconsin	**A**	B	C	D	F
The activity **objectives** clearly state what students are to learn	**A**	B	C	D	F
The activity includes a complete list of needed **materials** that are easily obtained and affordable by the average teacher.	**A**	B	C	D	F
Background information is provided and will help the teacher prepare for the activity.	A	B	C	**D**	F
The activity **procedure** steps are easy to follow and it appears could be accomplished successfully.	**A**	B	C	D	F
Participatory teaching strategies (e.g., hands on, cooperative learning, inquiry) are used.	A	**B**	C	D	F
The **assessment** strategies will help determine if the objectives of the activity were achieved.	A	B	**C**	D	F

Researcher observations:
These activities are already part of a comprehensive Activity Guide. There is little background material and assessment strategies but it will be a good source to list as a resource for educators to go to for more biomass activities.

3. *Build Your Own Biogas Generator*
Teacher review
Grade level: 5-8
Subject areas: EE and Science
Concepts: 19, 25.5, 25.15, 35, 70
Teacher comments:
“The objectives and assessment need to be more specific.
This would be great to do. Unfortunately our middle school doesn’t have this equipment and it would have to be purchased.
I think students would love to do this once they got over the “Ew” factor! I could see them wanting to do this at home and since many live on farms, I could see this causing some problems due to the access to manure. “Safety” and do not try this at home would have to be stressed”.
Teacher recommendation to include in the KEEP biomass curriculum: yes

Grades:

Criteria	Grade				
The activity is **relevant to biomass energy** in Wisconsin	**A**	B	C	D	F
The activity **objectives** clearly state what students are to learn	A	B	C	**D**	F
The activity includes a complete list of needed **materials** that are easily obtained and affordable by the average teacher.	**A**	B	C	D	F
Background information is provided and will help the teacher prepare for the activity.	**A**	B	C	D	F
The activity **procedure** steps are easy to follow and it appears could be accomplished successfully.	**A**	B	C	D	F
Participatory teaching strategies (e.g., hands on, cooperative learning, inquiry) are used.	**A**	B	C	D	F
The **assessment** strategies will help determine if the objectives of the activity were achieved.	A	B	**C**	D	F

Researcher observations:
This activity would be fun to do although it does involve a long list of equipment. Maybe this could be linked to the activity as an extension for high school students since they may have access to the equipment needed. This activity would work very well in an agriculture classroom. It would be fun to develop this activity more. It sounds like both the teachers and students would enjoy it.

4. *Wind, Water, Fire and Earth: Energy Lessons for the physical Science (Lesson 5: Biomass Conversion Process)*
Teacher review
Grade level: 9-12
Subject areas: environmental education, language arts, social studies, technology education, science, and family and consumer education
Concepts: 19, 25.5, 25.15, 25.16, 37, 48, 49, 70
Teacher comments:
<u>Pros</u>
Addresses many of the concepts
Intriguing teacher demos
High degree of applicability, engaging
<u>Cons</u>
Article written at a high level
Demos/activities involve a lot of teachers prep outside of class
Background knowledge in advanced chemical concepts is required.
Seems like students may be fairly removed from the actual activity.
<u>Other</u>
- I think these would be excellent for teaching/training teachers."
Teacher recommendation to include in the KEEP biomass curriculum: no

Grades:

Criteria	Grade				
The activity is **relevant to biomass energy** in Wisconsin	**A**	B	C	D	F
The activity **objectives** clearly state what students are to learn	**A**	B	C	D	F
The activity includes a complete list of needed **materials** that are easily obtained and affordable by the average teacher.	A	B	**C**	D	F
Background information is provided and will help the teacher prepare for the activity.	A	B	C	**D**	F
The activity **procedure** steps are easy to follow and it appears could be accomplished successfully.	A	B	C	**D**	F
Participatory teaching strategies (e.g., hands on, cooperative learning, inquiry) are used.	A	**B**	C	D	F
The **assessment** strategies will help determine if the objectives of the activity were achieved.	A	**B**	C	D	F

Researcher observations:
The activity has a long list of equipment and will be very time intensive. The activity level is far beyond what a typical high school student would be able to do.

5. ***Lessons for Teaching Sustainable Agriculture (Grow Your Own Fuel)***
Teacher review
Grade level: 9-12
Subject areas: EE, Science, Agriculture
Concepts: 19, 25.5, 25.15, 25.16, 47
Teacher comments: none
Teacher recommendation to include in the KEEP biomass curriculum: yes

Grades:

Criteria	Grade				
The activity is **relevant to biomass energy** in Wisconsin	**A**	B	C	D	F
The activity **objectives** clearly state what students are to learn	**A**	B	C	D	F
The activity includes a complete list of needed **materials** that are easily obtained and affordable by the average teacher.	A	**B**	C	D	F
Background information is provided and will help the teacher prepare for the activity.	A	B	**C**	D	F
The activity **procedure** steps are easy to follow and it appears could be accomplished successfully.	A	B	C	**D**	F

Participatory teaching strategies (e.g., hands on, cooperative learning, inquiry) are used.	**A**	B	C	D	F
The **assessment** strategies will help determine if the objectives of the activity were achieved.	A	B	C	**D**	F

Researcher observations:
There was another activity like this one that was better. Maybe we could combine the two of them.

6. *Doable Renewables (Corn in Your Car)*
Teacher review
(Teacher 1)
Grade level: 9-12
Subject areas: environmental education, technology education, sciences, and agriculture classes
Concepts: not identified
Teacher comments:
"I'm not sure that this activity would/should take 2 weeks to complete. I would include this as a part of a unit, where we would move on to other activities in class and students work on this project outside of class with occasional class time to work on this".
Teacher recommendation to include in the KEEP biomass curriculum: yes

Grades:

Criteria	**Grade**				
The activity is **relevant to biomass energy** in Wisconsin	A	**B**	C	D	F
The activity **objectives** clearly state what students are to learn	**A**	B	C	D	F
The activity includes a complete list of needed **materials** that are easily obtained and affordable by the average teacher.	A	**B**	C	D	F
Background information is provided and will help the teacher prepare for the activity.	**A**	B	C	D	F
The activity **procedure** steps are easy to follow and it appears could be accomplished successfully.	**A**	B	C	D	F
Participatory teaching strategies (e.g., hands on, cooperative learning, inquiry) are used.	**A**	B	C	D	F
The **assessment** strategies will help determine if the objectives of the activity were achieved.	A	**B**	C	D	F

(Teacher 2)
Grade level: 9-12
Subject areas: all
Concepts: none indicated
Teacher comments: none
Teacher recommendation to include in the KEEP biomass curriculum: yes

Grades:

Criteria	Grade				
The activity is **relevant to biomass energy** in Wisconsin	**A**	B	C	D	F
The activity **objectives** clearly state what students are to learn	**A**	B	C	D	F
The activity includes a complete list of needed **materials** that are easily obtained and affordable by the average teacher.	**A**	B	C	D	F
Background information is provided and will help the teacher prepare for the activity.	**A**	B	C	D	F
The activity **procedure** steps are easy to follow and it appears could be accomplished successfully.	**A**	B	C	D	F
Participatory teaching strategies (e.g., hands on, cooperative learning, inquiry) are used.	**A**	B	C	D	F
The **assessment** strategies will help determine if the objectives of the activity were achieved.	**A**	B	C	D	F

Researcher observations:
This activity has already been developed by KEEP and would be an easy inclusion for the curriculum. There could be some possible extensions developed from other fuel-related activities reviewed.

7. *Biofuel Production*
Teacher Review
Grade level: 6-12
Subject areas: not indicated
Concepts: 19, 25.5, 25.15, 25.16
Teacher comments: none
Teacher recommendation to include in the KEEP biomass curriculum: no

Grades:

Criteria	Grade				
The activity is **relevant to biomass energy** in Wisconsin	A	**B**	C	D	F
The activity **objectives** clearly state what students are to learn	A	B	C	**D**	F
The activity includes a complete list of needed **materials** that are easily obtained and affordable by the average teacher.	A	B	C	D	**F**
Background information is provided and will help the teacher prepare for the activity.	A	B	**C**	D	F
The activity **procedure** steps are easy to follow and it appears could be accomplished successfully.	A	B	C	D	**F**

Participatory teaching strategies (e.g., hands on, cooperative learning, inquiry) are used.	A	B	C	D	**F**
The **assessment** strategies will help determine if the objectives of the activity were achieved.	A	B	C	D	**F**

Researcher observations:
The activities are each very short and are not very well developed. KEEP will not be using them for the development of the biomass curriculum.

8. *KEEP Activity Guide (So You Want to Heat Your Home)*
Teacher Reviews
(Teacher 1)
Grade level: 6-12
Subject areas: language arts, mathematics, and science classes
Concepts: 47, 70
Teacher comments:
"Have ready to copy transparencies for teachers to use, possible examples/key, more advanced grade levels, and good table … clear to read."
Teacher recommendation to include in the KEEP biomass curriculum: yes

Grades:

Criteria	**Grade**				
The activity is **relevant to biomass energy** in Wisconsin	**A**	B	C	D	F
The activity **objectives** clearly state what students are to learn	**A**	B	C	D	F
The activity includes a complete list of needed **materials** that are easily obtained and affordable by the average teacher.	**A**	B	C	D	F
Background information is provided and will help the teacher prepare for the activity.	A	**B**	C	D	F
The activity **procedure** steps are easy to follow and it appears could be accomplished successfully.	**A**	B	C	D	F
Participatory teaching strategies (e.g., hands on, cooperative learning, inquiry) are used.	**A**	B	C	D	F
The **assessment** strategies will help determine if the objectives of the activity were achieved.	**A**	B	C	D	F

(Teacher 2)
Grade level: not indicated
Subject areas: math, technology education, and science
Concepts: 41
Teacher comments:
"Should be more hands on".

Teacher recommendation to include in the KEEP biomass curriculum: yes

Grades:

Criteria	Grade				
The activity is **relevant to biomass energy** in Wisconsin	A	**B**	C	D	F
The activity **objectives** clearly state what students are to learn	**A**	B	C	D	F
The activity includes a complete list of needed **materials** that are easily obtained and affordable by the average teacher.	A	**B**	C	D	F
Background information is provided and will help the teacher prepare for the activity.	A	**B**	C	D	F
The activity **procedure** steps are easy to follow and it appears could be accomplished successfully.	A	**B**	C	D	F
Participatory teaching strategies (e.g., hands on, cooperative learning, inquiry) are used.	A	B	**C**	D	F
The **assessment** strategies will help determine if the objectives of the activity were achieved.	A	**B**	C	D	F

Researcher observations:
This is a good activity but I think it should remain in the KEEP Activity Guide. It can be reference in the Biomass Guide or on the Biomass Web site that will be developed.

9. ***Photosynthesis and Biomass Growth***
Teacher review
Grade level: 5-12
Subject areas: EE, Science (Biology/Chemistry)
Concepts: 19
Teacher comments: none
Teacher recommendation to include in the KEEP biomass curriculum: no

Grades:

Criteria	Grade				
The activity is **relevant to biomass energy** in Wisconsin	A	B	**C**	D	F
The activity **objectives** clearly state what students are to learn	A	B	C	**D**	F
The activity includes a complete list of needed **materials** that are easily obtained and affordable by the average teacher.	**A**	B	C	D	F
Background information is provided and will help the teacher prepare for the activity.	A	B	**C**	D	F

The activity **procedure** steps are easy to follow and it appears could be accomplished successfully.	A	B	**C**	D	F
Participatory teaching strategies (e.g., hands on, cooperative learning, inquiry) are used.	**A**	B	C	D	F
The **assessment** strategies will help determine if the objectives of the activity were achieved.	A	B	**C**	D	F

Researcher observations:
The activities are very brief outlines of what teachers can do. In order to fit into biomass curriculum there would need to be improvement to the while thing. Not all of the activities are relevant to bioenergy. For the purpose of the biomass curriculum KEEP needs students to understand the basics of photosynthesis.

10. ***Farm Fact Lesson Plans (At the Pump)***
Teacher review
Grade level: 4-6
Subject areas: language arts and social studies
Concepts: 47, 73
Teacher comments:
"Assessment Activity. Instead of verbally asking students why shouldn't the U.S. have to rely on foreign countries for oil, this would become a writing assignment. I would contact local gas stations (in step 5) prior to the activity. The students wouldn't be able to use school phones for activity – having them cal would waste class time. Background information may be needed depending on teacher's familiarity on subject matter".
Teacher recommendation to include in the KEEP biomass curriculum: yes

Grades:

Criteria	**Grade**				
The activity is **relevant to biomass energy** in Wisconsin	**A**	B	C	D	F
The activity **objectives** clearly state what students are to learn	A	**B**	**C**	D	F
The activity includes a complete list of needed **materials** that are easily obtained and affordable by the average teacher.	**A**	B	C	D	F
Background information is provided and will help the teacher prepare for the activity.	A	B	**C**	D	F
The activity **procedure** steps are easy to follow and it appears could be accomplished successfully.	A	**B**	C	D	F
Participatory teaching strategies (e.g., hands on, cooperative learning, inquiry) are used.	A	**B**	C	D	F
The **assessment** strategies will help determine if the objectives of the activity were achieved.	A	**B**	C	D	F

Researcher observations:
This activity is wonderful because it covers the topic of agriculture which is an important sector of the bioenergy industry. I don't think having the student's research a country is appropriate for the objectives of the activity. Since the curriculum is based on Wisconsin it would be more relevant to point out Wisconsin does not have the non renewable resources needed for transportation but it does have renewable fuel options in the form of biofuels. This idea could be adapted into a new activity which would have the students making a map of their community and the availability of biofuels.

11. *Research Projects in Renewable Energy for High School Students*
Teacher review
Grade level: 9-12
Subject areas: biology
Concepts: not noted
Teacher comments: none
Teacher recommendation to include in the KEEP biomass curriculum: yes

Grades:

Criteria	**Grade**				
The activity is **relevant to biomass energy** in Wisconsin	**A**	B	C	D	F
The activity **objectives** clearly state what students are to learn	A	**B**	C	D	F
The activity includes a complete list of needed **materials** that are easily obtained and affordable by the average teacher.	**A**	B	C	D	F
Background information is provided and will help the teacher prepare for the activity.	A	**B**	C	D	F
The activity **procedure** steps are easy to follow and it appears could be accomplished successfully.	A	**B**	C	D	F
Participatory teaching strategies (e.g., hands on, cooperative learning, inquiry) are used.	A	**B**	C	D	F
The **assessment** strategies will help determine if the objectives of the activity were achieved.	A	**B**	C	D	F

Researcher observations:
These activities use materials that are dangerous and KEEP has been unwilling in the past to write activities that have students doing dangerous projects. They are also for a very specific subject area (biology or chemistry) and would not be applicable to other subject areas. KEEP tries to develop science activities but to also develop activities that could be used in language arts, math, and social studies classes as well. The fifth activity that measures how much energy is in a plant would work well for all grade levels with some variations and could be adapted into a stand alone activity as well as a unit.

12. ***NEED Science Fair Projects for Kids (Sprouting Seeds)***
Teacher Review
Grade level: K-4
Subject areas: environmental education and science
Concepts: not indicated
Teacher comments: none
Teacher recommendation to include in the KEEP biomass curriculum: yes

Grades:

Criteria	Grade				
The activity is **relevant to biomass energy** in Wisconsin	**A**	B	C	D	F
The activity **objectives** clearly state what students are to learn	**A**	B	C	D	F
The activity includes a complete list of needed **materials** that are easily obtained and affordable by the average teacher.	**A**	B	C	D	F
Background information is provided and will help the teacher prepare for the activity.	**A**	B	C	D	F
The activity **procedure** steps are easy to follow and it appears could be accomplished successfully.	**A**	B	C	D	F
Participatory teaching strategies (e.g., hands on, cooperative learning, inquiry) are used.	**A**	B	C	D	F
The **assessment** strategies will help determine if the objectives of the activity were achieved.	**A**	B	C	D	F

Researcher observations:
It is unclear why this activity received high marks. It does not contain a background but yet received an "A" in that category. While it is not well thought out it could be used in combination with some of the other activities that addressed how plants grow and how much energy they contain.

13. ***Alternative Fuels: Biodiesel***
Teacher review
Grade level: 4-12
Subject areas: language arts, mathematics, social studies, and science
Concepts: 25.15, 25.16
Teacher comments:
Teacher recommendation to include in the KEEP biomass curriculum: maybe

Grades:

Criteria	Grade				
The activity is **relevant to biomass energy** in Wisconsin	**A**	B	C	D	F

The activity **objectives** clearly state what students are to learn	A	**B**	C	D	F
The activity includes a complete list of needed **materials** that are easily obtained and affordable by the average teacher.	**A**	B	C	D	F
Background information is provided and will help the teacher prepare for the activity.	**A**	B	C	D	F
The activity **procedure** steps are easy to follow and it appears could be accomplished successfully.	A	**B**	C	D	F
Participatory teaching strategies (e.g., hands on, cooperative learning, inquiry) are used.	A	B	**C**	D	F
The **assessment** strategies will help determine if the objectives of the activity were achieved.	A	B	C	D	**F**

Researcher observations:
Parts of the Activity Guide could be used in an activity. The best use of this activity Guide would be to link it from the Web site where the biomass curriculum will be and allow teachers to use parts of it if they would like.

14. *Waste Digester Design*
Teacher review
Grade level: 9-12 listed in the activity but it is for a higher level
Subject areas: environmental, technology education and science
Concepts: 25.5, 25.11, 24
Teacher comments: none
Teacher recommendation to include in the KEEP biomass curriculum: yes

Grades:

Criteria	**Grade**				
The activity is **relevant to biomass energy** in Wisconsin	**A**	B	C	D	F
The activity **objectives** clearly state what students are to learn	A	**B**	C	D	F
The activity includes a complete list of needed **materials** that are easily obtained and affordable by the average teacher.	A	B	**C**	D	F
Background information is provided and will help the teacher prepare for the activity.	A	B	**C**	D	F
The activity **procedure** steps are easy to follow and it appears could be accomplished successfully.	A	**B**	C	D	F
Participatory teaching strategies (e.g., hands on, cooperative learning, inquiry) are used.	A	**B**	C	D	F
The **assessment** strategies will help determine if the objectives of the activity were achieved.	A	**B**	C	D	F

Researcher observations:
This activity is based on the generation of bioenergy from human waste at a waste water treatment facility. This is a great tool to help students understand not only energy issues but to also help students make the connection to where our waste goes. It would also be a great opportunity to take a field trip to the local waste water treatment facility. Part of the activity will involve students testing for methane with fire but it can be done under the supervision of the teacher. The activity is not well organized and would need to be rewritten in order to make it easy to use for teachers. The activity is very time intensive.

15. *Fueling the Future* (poster)
Teacher Review
Grade level: 5-8
Subject areas: environmental education and science
Concepts: 35, 37, 47, 49, 70
Teacher comments:
"Air quality – Petroleum jelly activity. I liked it 5th grade and higher / simple. Will you really see something under the scope?
Transparencies
IQ quiz – use questions in a Jeopardy format
Student Activity ideas
#2 I had a class representatives go to the car dealership, videotape an interview and then play for all students.
#3 – 6 Good but add materials, procedure, instructions
#7 (no)
#8 need to see it
#9 (no) they are to busy to have my 150 students calling randomly. Ask one class representative to do this."
Teacher recommendation to include in the KEEP biomass curriculum: yes

Grades:

Criteria	**Grade**				
The activity is **relevant to biomass energy** in Wisconsin	A	**B**	C	D	F
The activity **objectives** clearly state what students are to learn	A	B	C	D	**F**
The activity includes a complete list of needed **materials** that are easily obtained and affordable by the average teacher.	A	B	C	D	**F**
Background information is provided and will help the teacher prepare for the activity.	**A**	B	C	D	F
The activity **procedure** steps are easy to follow and it appears could be accomplished successfully.	A	B	C	D	**F**
Participatory teaching strategies (e.g., hands on, cooperative learning, inquiry) are used.	A	B	C	D	**F**

The **assessment** strategies will help determine if the objectives of the activity were achieved.	A	B	C	D	**F**

Researcher observations:
Parts of this activity could be used to write a new one. Since the background material was graded high it may be a good place to start for background information for an alternative fuels activity. KEEP would need to ask for permission if we were to use this information.

16. ***NEED Science Fair Project for Kids (Decaying Food)***
Teacher Reviews
(Teacher 1)
Grade level: K-3
Subject areas: Science
Concepts: 11
Teacher comments: none
Teacher recommendation to include in the KEEP biomass curriculum: maybe

Grades:

Criteria	Grade				
The activity is **relevant to biomass energy** in Wisconsin	A	B	**C**	D	F
The activity **objectives** clearly state what students are to learn	**A**	B	C	D	F
The activity includes a complete list of needed **materials** that are easily obtained and affordable by the average teacher.	**A**	B	C	D	F
Background information is provided and will help the teacher prepare for the activity.	**A**	B	C	**D**	F
The activity **procedure** steps are easy to follow and it appears could be accomplished successfully.	**A**	B	C	D	F
Participatory teaching strategies (e.g., hands on, cooperative learning, inquiry) are used.	**A**	B	C	D	F
The **assessment** strategies will help determine if the objectives of the activity were achieved.	**A**	B	C	**D**	F

(Teacher 2)
Grade level: K-4
Subject areas: Environmental Education and science
Concepts: not identified
Teacher comments: none
Teacher recommendation to include in the KEEP biomass curriculum: yes

Grades:

Criteria	Grade

The activity is **relevant to biomass energy** in Wisconsin	A	**B**	C	D	F
The activity **objectives** clearly state what students are to learn	**A**	B	C	D	F
The activity includes a complete list of needed **materials** that are easily obtained and affordable by the average teacher.	**A**	B	C	D	F
Background information is provided and will help the teacher prepare for the activity.	A	B	**C**	D	F
The activity **procedure** steps are easy to follow and it appears could be accomplished successfully.	**A**	B	C	D	F
Participatory teaching strategies (e.g., hands on, cooperative learning, inquiry) are used.	**A**	B	C	D	F
The **assessment** strategies will help determine if the objectives of the activity were achieved.	A	**B**	C	D	F

Researcher observations:
The activity is not well developed. It would be possible to use part of this activity in conjunction with another biogas from landfill activity as an extension.

17. ***Unit of Study No. 15 (Biomass, Nature's Most Flexible Energy Resource)***
Teacher review
Grade level: 6-7 according to the activity but the teacher suggested that it be taught in grades 8-12
Subject areas: environmental education, mathematics, social studies, and family and consumer education
Concepts: not identified
Teacher comments:
"I would combine the first two activities for the introduction and I assume that the instructor could or would modify the lesson for their own class. I would use this and students would enjoy. I would take it a step further and make gas (fuel)".
Teacher recommendation to include in the KEEP biomass curriculum: yes

Grades:

Criteria	Grade				
The activity is **relevant to biomass energy** in Wisconsin	A	B	C	D	F
The activity **objectives** clearly state what students are to learn	A	B	C	D	F
The activity includes a complete list of needed **materials** that are easily obtained and affordable by the average teacher.	A	B	C	D	F
Background information is provided and will help the teacher prepare for the activity.	A	B	C	D	F

The activity **procedure** steps are easy to follow and it appears could be accomplished successfully.	A	B	C	D	F
Participatory teaching strategies (e.g., hands on, cooperative learning, inquiry) are used.	A	B	C	D	F
The **assessment** strategies will help determine if the objectives of the activity were achieved.	A	B	C	D	F

Researcher observations:
The activity is well developed and formatted. There is no reason to adapt this activity. It should be linked to the KEEP web site with permission from the organization that developed it.

18. ***Unit of Study No. 15 (Clean Energy from Texas Landfills)***
Teacher review
Grade level: 9-12
Subject areas: environmental education, mathematics, social studies, science, and family and consumer education
Concepts: 19, 47, 37, 25.15
Teacher comments: none
Teacher recommendation to include in the KEEP biomass curriculum: yes

Grades:

Criteria	Grade				
The activity is **relevant to biomass energy** in Wisconsin	**A**	B	C	D	F
The activity **objectives** clearly state what students are to learn	**A**	B	C	D	F
The activity includes a complete list of needed **materials** that are easily obtained and affordable by the average teacher.	**A**	B	C	D	F
Background information is provided and will help the teacher prepare for the activity.	**A**	B	C	D	F
The activity **procedure** steps are easy to follow and it appears could be accomplished successfully.	A	**B**	C	D	F
Participatory teaching strategies (e.g., hands on, cooperative learning, inquiry) are used.	**A**	B	C	D	F
The **assessment** strategies will help determine if the objectives of the activity were achieved.	A	**B**	C	D	F

Researcher observations:
The activity is laid out well although the objectives are not listed in the beginning of the activity. The list of materials is very long and not all of the materials will be easy to come by. The idea of methane generation could be covered by this activity or an activity on manure or waster water treatment facilities (see #14). Page 13 has an activity on how to build your own Landfill and collect the gas. This could be made into a stand alone activity.

19. ***Energy Exchange, March 2006 (Primary Activity: Biogas)***
Teacher review
Grade level: K-4
Subject areas: environmental education, social studies, and science
Concepts: 25.5, 25.16
Teacher comments: none
Teacher recommendation to include in the KEEP biomass curriculum: yes

Grades:

Criteria	Grade				
The activity is **relevant to biomass energy** in Wisconsin	**A**	B	C	D	F
The activity **objectives** clearly state what students are to learn	A	B	**C**	D	F
The activity includes a complete list of needed **materials** that are easily obtained and affordable by the average teacher.	**A**	B	C	D	F
Background information is provided and will help the teacher prepare for the activity.	A	B	C	**D**	F
The activity **procedure** steps are easy to follow and it appears could be accomplished successfully.	**A**	B	C	D	F
Participatory teaching strategies (e.g., hands on, cooperative learning, inquiry) are used.	**A**	B	C	D	F
The **assessment** strategies will help determine if the objectives of the activity were achieved.	**A**	B	C	D	F

Researcher observations:
The activity is very simple. This would be suitable for a K-4 extension to a biogas activity.

20. ***Choose to Renew: Teacher's Guide for grades 6-8 on Renewable Energy (Biomass Energy)***
Teacher review
Grade level: 5-8
Subject areas: mathematics, science
Concepts: 25.5, 25.15, 48
Teacher comments:
"This would be a great activity to use and a lot of math can be incorporated into it although you could eliminate the math without effecting the experiment. Step 3 is a little confusing because it is unclear of the purpose of the liner and if it is put between each layer or just used as an overall liner. The teacher background pages on biomass energy are very clear and easy to understand".
Teacher recommendation to include in the KEEP biomass curriculum: yes

Grades:

Criteria	Grade				
The activity is **relevant to biomass energy** in Wisconsin	**A**	B	C	D	F

The activity **objectives** clearly state what students are to learn	**A**	B	C	D	F
The activity includes a complete list of needed **materials** that are easily obtained and affordable by the average teacher.	**A**	B	C	D	F
Background information is provided and will help the teacher prepare for the activity.	**A**	B	C	D	F
The activity **procedure** steps are easy to follow and it appears could be accomplished successfully.	A	**B**	C	D	F
Participatory teaching strategies (e.g., hands on, cooperative learning, inquiry) are used.	**A**	B	C	D	F
The **assessment** strategies will help determine if the objectives of the activity were achieved.	**A**	B	C	D	F

Researcher observations:
This activity seems to stand alone and does not need much improvement. KEEP should reference it an additional resource on the web site.

21. ***Choices for Tomorrow Teacher's Activity Guide for Grades 6-8 (Activity 8: Which has more heat?)***
Teacher review
Grade level: 5-8
Subject areas: environmental education, science
Concepts: not indicated
Teacher comments:
"You could add to this by having students calculate cost of both types of oil".
Teacher recommendation to include in the KEEP biomass curriculum: yes

Grades:

Criteria	Grade				
The activity is **relevant to biomass energy** in Wisconsin	A	**B**	C	D	F
The activity **objectives** clearly state what students are to learn	A	**B**	C	D	F
The activity includes a complete list of needed **materials** that are easily obtained and affordable by the average teacher.	**A**	B	C	D	F
Background information is provided and will help the teacher prepare for the activity.	**A**	B	C	D	F
The activity **procedure** steps are easy to follow and it appears could be accomplished successfully.	A	**B**	C	D	F
Participatory teaching strategies (e.g., hands on, cooperative learning, inquiry) are used.	**A**	B	C	D	F

The **assessment** strategies will help determine if the objectives of the activity were achieved.	A	B	**C**	D	F

Researcher observations:
This is a good activity and could be included in the curriculum if there is room.

22. ***Lessons for Teaching Sustainable Agriculture (Alternative Crops as Energy Sources)***
Teacher review
Grade level: 9-12
Subject areas: EE, Science
Concepts: 25.15
Teacher comments:
"The activity needs charts to record data".
Teacher recommendation to include in the KEEP biomass curriculum: no

Grades:

Criteria	**Grade**				
The activity is **relevant to biomass energy** in Wisconsin	**A**	B	C	D	F
The activity **objectives** clearly state what students are to learn	**A**	B	C	D	F
The activity includes a complete list of needed **materials** that are easily obtained and affordable by the average teacher.	**A**	B	C	D	F
Background information is provided and will help the teacher prepare for the activity.	A	B	**C**	D	F
The activity **procedure** steps are easy to follow and it appears could be accomplished successfully.	A	B	C	**D**	F
Participatory teaching strategies (e.g., hands on, cooperative learning, inquiry) are used.	A	B	**C**	D	F
The **assessment** strategies will help determine if the objectives of the activity were achieved.	A	B	C	**D**	F

Researcher observations:
There is an existing KEEP activity that covers this topic using a multi-curricular method. These activities may be dangerous and would only be used in a science class.

23. ***Lessons for Teaching Sustainable Energy (Design a Future with Renewable Energy)***
Teacher review
Grade level: 9-12
Subject areas: EE, Language Arts, Science
Concepts: none indicated
Teacher comments: none
Teacher recommendation to include in the KEEP biomass curriculum: maybe

Grades:

Criteria	Grade				
The activity is **relevant to biomass energy** in Wisconsin	**A**	B	C	D	F
The activity **objectives** clearly state what students are to learn	**A**	B	C	D	F
The activity includes a complete list of needed **materials** that are easily obtained and affordable by the average teacher.	**A**	B	C	D	F
Background information is provided and will help the teacher prepare for the activity.	A	B	**C**	D	F
The activity **procedure** steps are easy to follow and it appears could be accomplished successfully.	A	B	**C**	D	F
Participatory teaching strategies (e.g., hands on, cooperative learning, inquiry) are used.	A	B	C	**D**	F
The **assessment** strategies will help determine if the objectives of the activity were achieved.	A	B	**C**	D	F

Researcher observations:
The idea of including a debate in an activity is good because it addresses the language arts concepts.

24. ***NEED Science Fair Projects for Kids (Energy from Garbage)***
Teacher review
(Teacher 1)
Grade level: 3-5
Subject areas: environmental education and science subjects
Concepts: 25.15, 25.16
Teacher comments:
"Very easy experiment but not a lot of background knowledge for the teacher. I would make charts for observations and charting amount of gas produced".
Teacher recommendation to include in the KEEP biomass curriculum: yes

Grades:

Criteria	Grade				
The activity is **relevant to biomass energy** in Wisconsin	**A**	B	C	D	F
The activity **objectives** clearly state what students are to learn	**A**	B	C	D	F
The activity includes a complete list of needed **materials** that are easily obtained and affordable by the average teacher.	**A**	B	C	D	F
Background information is provided and will help the teacher prepare for the activity.	A	B	**C**	D	F

The activity **procedure** steps are easy to follow and it appears could be accomplished successfully.	**A**	B	C	D	F
Participatory teaching strategies (e.g., hands on, cooperative learning, inquiry) are used.	**A**	B	C	D	F
The **assessment** strategies will help determine if the objectives of the activity were achieved.	A	**B**	C	D	F

(Teacher 2)
Grade level: 4-6
Subject areas: mathematics (tables) and science
Concepts: 25.15, 25.16
Teacher comments:
"Assessment: What will the end products look like at the end of the experiment? I would include a chart to fill out
More resources or background information as to what to expect – energy information we use.
I might include a graphing portion to this activity."
Teacher recommendation to include in the KEEP biomass curriculum: yes

Grades:

Criteria	**Grade**				
The activity is **relevant to biomass energy** in Wisconsin	**A**	B	C	D	F
The activity **objectives** clearly state what students are to learn	**A**	B	C	D	F
The activity includes a complete list of needed **materials** that are easily obtained and affordable by the average teacher.	**A**	B	C	D	F
Background information is provided and will help the teacher prepare for the activity.	A	B	**C**	**D**	F
The activity **procedure** steps are easy to follow and it appears could be accomplished successfully.	**A**	B	C	D	F
Participatory teaching strategies (e.g., hands on, cooperative learning, inquiry) are used.	**A**	B	C	D	F
The **assessment** strategies will help determine if the objectives of the activity were achieved.	A	**B**	C	D	F

Researcher observations:
This activity could be combined with others to make a more comprehensive activity on the subject. KEEP will need to combine them, add background information, and make some tables for the students. KEEP will need to ask NEED for permission to adapt the activity.

25. ***NEED Science Fair Projects for Kids (Seeds and Needs)***
Teacher Reviews
(Teacher 1)

Teacher review
Grade level: K-6 but it could be adapted for lowed or higher grade levels
Subject areas: language arts and science classes
Concepts: 11, 19
Teacher comments:
" - some background info or introduction to the activity (this would be something I could easily add into my science unit about sunlight)

- for younger grades: suggested reading material to enhance
- - for assessment: could make a chart/graph
  * students could draw what they see daily or every other day
  * younger grades… :) or : (for growth"

Teacher recommendation to include in the KEEP biomass curriculum: maybe

Grades:

Criteria	Grade				
The activity is **relevant to biomass energy** in Wisconsin	**A**	B	C	D	F
The activity **objectives** clearly state what students are to learn	A	B	**C**	D	F
The activity includes a complete list of needed **materials** that are easily obtained and affordable by the average teacher.	**A**	B	C	D	F
Background information is provided and will help the teacher prepare for the activity.	A	**B**	C	D	F
The activity **procedure** steps are easy to follow and it appears could be accomplished successfully.	**A**	B	C	D	F
Participatory teaching strategies (e.g., hands on, cooperative learning, inquiry) are used.	**A**	B	C	D	F
The **assessment** strategies will help determine if the objectives of the activity were achieved.	A	**B**	C	D	F

(Teacher 2)
Grade level: K-6
Subject areas: science
Concepts: 11
Teacher comments: none
Teacher recommendation to include in the KEEP biomass curriculum: yes

Grades:

Criteria	Grade				
The activity is **relevant to biomass energy** in Wisconsin	**A**	B	C	D	F

The activity **objectives** clearly state what students are to learn	A	**B**	C	D	F
The activity includes a complete list of needed **materials** that are easily obtained and affordable by the average teacher.	**A**	B	C	D	F
Background information is provided and will help the teacher prepare for the activity.	A	B	C	**D**	F
The activity **procedure** steps are easy to follow and it appears could be accomplished successfully.	**A**	B	C	D	F
Participatory teaching strategies (e.g., hands on, cooperative learning, inquiry) are used.	**A**	B	C	D	F
The **assessment** strategies will help determine if the objectives of the activity were achieved.	A	B	**C**	D	F

Researcher observations:
This activity is similar to other activities that were reviewed and were recommended to consider for this curriculum. It may be possible to combine those ideas into one activity with extensions for other grade levels. The KEEP activity Photosynthesis Promenade may address these topics and we would not need to obtain permission to use it.

Appendix G
Permissions Cover Letter

Wisconsin K-12 Energy Education Program
Wisconsin Center for Environmental Education
Learning Resources Center, UW – Stevens Point
Stevens Point, WI 54481
715.346.4770; energy@uwsp.edu; www.uwsp.edu/keep

September 30, 2005

Linda Lung
National Renewable Energy Laboratory

Dear Ms. Lung:

We would like permission to adapt Activity 9: Which Grass Produces More Biomass from the *Renewable Energy Activities – Choices for Tomorrow: Teacher's Activity Guide for Middle Level Grades 6-8* for a teacher lesson in the Wisconsin K-12 Energy Education Program BioFutures Bioenergy Activity Guide. The BioFutures Bioenergy Activity Guide will be available on the KEEP Web site at www.uwsp.edu/keep. Teachers and students would know that the article is adapted from its original form. We will note that the activity was adapted from the Activity Guide referenced above and that NREL granted us permission to use the activity. Because this is an online curriculum we will also post a link to your Web site.

The Wisconsin K-12 Energy Education Program (KEEP) was created in 1995 by the Wisconsin Center for Environmental Education to promote energy education in Wisconsin. KEEP is the product of an innovative public private partnership between educators and energy professionals. KEEP receives its primary funding through the Focus on Energy Residential, Business, and Renewable Energy Programs. Focus on Energy is 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.

We look forward to hearing from you in the next week or so about this permission and what you would like see in the credit line. Normally, we put "the name of the permission provider. Used with permission. All rights reserved." Please let us know if any alternations are necessary.

We hope you will lend your support for energy education in Wisconsin, by providing written permission to use an adapted version of the activity.

Thank you for your prompt consideration of this request.

Sincerely,
Carrie Bea Ziolkowski
Wisconsin K12 Energy Education Program
Program Specialist
Learning Resource Center, Room 403
Stevens Point, WI 54481
715.346.4651, cziolkow@uwsp.edu

Appendix H
Content Review Cover Letter

Wisconsin K-12 Energy Education Program
Wisconsin Center for Environmental Education
Learning Resources Center, UW – Stevens Point
Stevens Point, WI 54481
715.346.4770; energy@uwsp.edu; www.uwsp.edu/keep

November 7, 2005

T.J. Marth
Marth Wood Sahvings
6752 State Hwy 107 N.
Marathon, WI 54448

Dear T.J.:

Thank you for agreeing to review the classroom activity title *Would You Heat with Wood* for the Wisconsin K-12 Energy Education Program (KEEP). Enclosed is an activity review form consisting of questions that assess the content of this activity.

Please complete the review within two weeks. Return the review form and the activity in the pre-addressed stamped envelope when finished. Because we know your time is valuable we are offering a $50 stipend to our content reviewers. If you would like to receive this payment please fill out the invoice enclosed and return it with the review form.

Your comments will help ensure that the concepts and related content covered by this activity are accurate and consistent. If you have questions regarding this review or KEEP in general, please call me. Again I think you for your assistance.

Sincerely,

Carrie Bea Ziolkowski
Wisconsin K-12 Energy Education Program
University of Wisconsin-Stevens Point
Wisconsin Center for Environmental Education
Stevens Point, WI 54481
cziolkow@uwsp.edu
715.346.4651

Appendix I
Content Review Form

Wisconsin K-12 Energy Education Program

Review of Activity Content

Activity Title ____

Instructions

Carefully read through the attached activity keeping on this review form in mind. Please write your comments on this form, especially if you answer “no” to any of the questions. Use additional sheets if necessary. You are welcome to make notes on the activity itself, but please make sure you address the questions on this form as well. NOTE: This activity is in first draft form; we will send it to a graphic designer after the review.

Background section (also applies to sidebars and supplemental information if included)

Are the concepts and related content in the background section of this activity accurate and thorough?

Does the background provide a fair and unbiased presentation of the issue?

Activity procedure

Are the concepts and related content in the activity procedures accurate and thorough?

Will the procedure encourage students to examine the myriad viewpoints related to bioenergy?

Goals and objectives

Do the concepts and related content accomplish the intended goals and objectives of the activity?

Wisconsin K-12 Energy Education Program

Review of Activity Content - continued

Overall Review

Are the concepts and related content represented consistently throughout the activity as a whole?

Graphics (answer if graphics are included)

Do the graphics (charts, illustrations, graphs, etc.) accurately and thoroughly support the activity?

Please suggest any additional graphics that could be used in this activity.

Resources

Do the resources listed accurately and appropriately support the activity?

Please suggest any additional resources that could be used by teachers to support their understanding of concepts in this activity.

Thank you for reviewing this activity. Please return this form in the envelope provided.

Appendix J
Piloting Cover Letter

January 3, 2007

Jeremie Johnson
Denmark High School
450 N. Wall St.
Denmark, WI 54208

Dear Jeremie,

Thank you for agreeing to review an activity for the Wisconsin K-12 Energy Education Program's (KEEP) forthcoming *Biomass Energy Activity Guide*. Classroom teachers are an integral part of this guide's development. Your review of this activity for age appropriateness and ease of use will be invaluable as we revise the activity and prepare it for publication. Please note, this activity has already been reviewed for conceptual accuracy and thoroughness. After your review, it will be edited, proofread, and graphically designed in an easy-to-follow format.

In appreciation of your contribution, you will receive the following:

- A stipend of $100 for each activity you review,
- Credit for your assistance will be given in the *Biomass Energy Activity Guide*

What we expect from you:

- Completion and return of the *Activity Pilot Form* (green sheet) by __________________
- Candid comments about the activity, including ideas about how to better orient it toward the middle school grades (in particular we'd like to know about teaching strategies and approaches—such as paired reading, debates, small group discussion, recommended trade books—that work well with children of this age that we could add to the activity.)
- Fill out the invoice form and include your SS# in order for us to pay you.
- Fill out the expense report form if you purchased supplies (up to $25). If you need to purchase more than $25 in supplies please contact KEEP before purchasing for approval.

Enclosed please find the following:

- KEEP brochure
- A copy of the activity we'd like you to review (white sheets). NOTE: This activity is in draft form. We've made every effort to make it as complete as possible. We will inform you if some item or component is not included.
- *Activity Pilot Form* (green sheet)
- A prepaid return envelope

If any of these items are missing, please contact me at 715.346.4651 or cziolkow@uwsp.edu. Please don't hesitate to call if you have any questions. I look forward to your response.

Sincerely,
Carrie Ziolkowski
KEEP, Program Coordinator
LRC, WCEE
Stevens Point, WI 54481

Appendix K

Piloting Instructions

INSTRUCTION FORM

For piloting activities for the KEEP *Biomass Energy Activity Guide*

1. Review the activity and the *Activity Pilot Form* thoroughly.

2. Do the activity with your students, keeping in mind the feedback we are requesting. We want to know what works and what doesn't work in your classroom. If you make changes in the activity, please describe on the *Activity Pilot Form*. If you are unable to do all of the activity, please be sure to note that.

3. If your students have any comments or suggestions, we'd like to hear them as well.

4. When you have completed the activity, fill in the *Activity Pilot Form* and return it and any other papers upon which you made comments in the envelope no later than the date states on the cover letter.

CONTACT SOMEONE AT THE KEEP OFFICE IF YOU ARE UNABLE TO MEET THE DEADLINE ON THE COVER LETTER!!

Appendix L
Activity Pilot Form

Activity Pilot Form for

____

(title of activity)

____

Name ________________________________

Date _________________________________

Thank you for taking the time to review this activity. Your comments and suggestions will contribute to the effectiveness of KEEP's *Biomass Energy Curriculum*.

INSTRUCTIONS: After you have completed the activity, respond to ALL items on this form. Whenever possible, provide written explanation for your responses, using the back of the page or attaching additional pages if necessary. If you make comments directly on the activity, include the activity with the completed form.

Questions 1 though 8 are designed to provide an overview about your use of the activity.

1. With what grade(s) did you use this activity?________________________

2. Was this activity appropriate for the grade level with which you used it?
   (circle one) YES NO
   If no, for what grade levels would it be more appropriate or how would you revise the activity to make it more appropriate for this grade level?

3. In what subject areas would this activity be appropriate (check all that apply)

   _ Life Sciences
   _ Health
   _ Ecology
   _ Environmental Science
   _ Physical Sciences
   _ Earth Science
   _ Social Studies
   _ Geography
   _ History/ Anthropology
   _ Mathematics
   _ Language Arts
   _ Fine Arts
   _ Tech Ed
   _ Other

4. How many times did you conduct this activity?______________________

5a. How much preparation time (acquiring materials, background review, preparing handouts, cutting cards, designing charts, etc.) was required for this activity?

b. Will preparation time be less next time activity is conducted?
(circle one) YES NO
If yes, predict how long future preparation times will take (provide explanation if desired).

6a. How much class time was required to complete the activity? ___________

b. Did you do the activity in one session/period? (circle one) YES NO
If no, how many sessions/periods? ____________

7. Was the suggested setting appropriate for your teaching situation?
(circle one) YES NO
If no, identify which setting would be better ________________________

8. Please list any trade books, video, poster and musical titles you recommend be added to the **Resources**. (Use back of page if necessary).

Use the following question to provide information about activity omissions and alterations.

9. Did you do the activity as written? (circle one) YES NO
If no, please describe major changes or omissions below and provide reasons why.

Major Changes or Omissions Made	Why

For questions 10 through 13, indicate if you agree or disagree with the statement by circling the response that best fits your opinion. If you disagree, describe how you would revise the activity to address the problem.

10.	I felt comfortable using this activity.	Agree	Disagree
11.	Students actively participated in the activity.	Agree	Disagree
12.	It appeared my students enjoyed this activity.	Agree	Disagree

13. I would do this activity again. Agree Disagree

Use questions 14 through 17 to provide overall comments regarding effectiveness of the activity.

14. On a scale of 1 to 5, (1=low level of learning and 5=high level of learning) estimate to what extent the objectives of the activity were completed (circle one)

    1 2 3 4 5

    Please explain your rating below. Give examples of student behaviors or other indicators of student learning.

15. On a scale of 1 to 5, (1=low level of learning and 5=high level of learning) estimate to what extent learning beyond the objectives was completed (circle one)

    1 2 3 4 5

    Please explain your rating below. Give examples of student behaviors or other indicators of student learning.

16. Describe how this activity did or did not contribute to developing energy concepts in the unit you developed.

17. Write your overall opinions of and suggestions for this activity (steps that should be added/deleted, teaching strategies that should be incorporated, alternative materials, etc.). You may find it helpful to refer to the questions below.

Optional: Use the questions below to provide your opinion about the effectiveness of specific activity components. For any item to which you respond "no," please provide suggestions on how to make improvements.

	YES	NO
The objectives clearly state what students are to learn.	❒	❒
The materials for the activity are easily obtained by the average teacher.	❒	❒

The background is clearly written.	❒	❒
The background helped me prepare for the activity.	❒	❒
The steps of the procedure were easy to follow.	❒	❒
The procedure can be conducted safely. Ample warnings were given as needed.	❒	❒

Appendix M
Pilot Review Results

Activity - Don't Waste Waste

Questions 1 through 8 are designed to provide an overview about your use of the activity.

Question	Teacher A	Teacher B	Teacher C
1. With what grade(s) did you use this activity?	7, 8 (English Learning Students)	3	5
2. Was this activity appropriate for the grade level with which you used it? (circle one) YES NO If no, for what grade levels would it be more appropriate or how would you revise the activity to make it more appropriate for this grade level?	Yes	Yes	Yes, but… Make the worksheet larger print Larger chart/larger space to record data.
3. In What subject areas would this activity be appropriate (check all that apply)	Ecology, Environmental, Mathematics, Language Arts	Environmental, Mathematics	Health, Environmental, Geography, mathematics
4. How many times did you conduct this activity?	1	1	1
5a. How much preparation time (acquiring materials, background review, preparing handouts, cutting cards, designing charts, etc.) was required for this activity?	90 minutes	30 minutes	Most of my time was spent locating appropriate scales to measure total, waste, and products. First time was about 45 minutes.
5b. Will preparation time be less next time activity is conducted? (circle one) YES NO If yes, predict how long future preparation times will take (provide explanation if desired).	Yes, 30 minutes (gathering scales, weights, making copies)	Yes 15	A half hour is a good number for time. Once you read the lesson, get scale, purchase celery … it is around that time.
6a. How much class time was required to complete the activity?	60 minutes	45 minutes	At least 1 hour, or turn into 2 lessons
6b. Did you do the activity in one	Yes	Yes	No

session/period? (circle one) YES NO 60 If no, how many sessions/periods?			1- 40 minutes 1- 20 minutes
7. Was the suggested setting appropriate for your teaching situation? (circle one) YES NO If no, identify which setting would be better.	Yes	Yes	Yes
8. Please list any trade books, video, poster and musical titles you recommend be added to the **Resources**.	*An Inconvenient Truth* video, www.ethanol.org, Discover Wisconsin video E85/Flex Fuel		

Results

1. The font size was increased from 12 to 14 on the student worksheet and made the table larger to provide students with more room to record answers.
2. The spelling and grammar corrections noted on the copy of the activity that was sent back to KEEP were made.
3. After the preparation time a note was added that says first time users should allow up to an hour to prepare for the activity.

Use the following question to provide information about activity omissions and alterations.

9. Did you do the activity as written? (circle one) YES NO
If no, please describe major changes or omissions below and provide reasons why.

Teacher A - No

Major Changes or Omissions Made	Why

Added an anticipation guide	Get kids thinking about topic
Viewed video on Ethanol Discover Wisconsin	Showed due to biomass

Teacher B - Yes

Major Changes or Omissions Made	Why

Teacher C - No

Major Changes or Omissions Made	Why
Did the alternative	Had groups come to front table to measure total then waste and usable; had to use 2 different scales and most had never used them before.
Each group had a group name to add some creativity.	Kids like to "design" their own titles.
Did worksheet together	Students would record their specific information at the front table with me supervising. Then as a whole class we did the worksheet together.
Gave each group a bunch of celery	Students divide into parts and cut together and double checked

Results

1. The anticipation guide is a process that Teacher A uses in her classroom. While it is suitable for her class the suggestion is

rejected because it is specific to her classroom.

2. The suggestion to use the Discover Wisconsin video on ethanol was rejected because the activity is on woody biomass not ethanol.
3. The suggestion to use the video *An Inconvenient Truth* on global warming was rejected because the activity is on woody biomass not global warming. This video may apply depending on what other activity the teacher does with the class but does not fit with this activity alone.
4. Based on Teacher C's suggestions the Orientation of the procedure was changed to make the alternative the only option the teachers has. Doing it this way follows the flow of the student worksheet and will be easier for the teacher and student to follow.
5. Teacher C recommended allowing the groups to name their groups. This is not essential to the activity and is something the teacher can easily do without directions so the suggestion was rejected.

For questions 10 through 13, indicate if you agree or disagree with the statement by circling the response that best fits your opinion. If you disagree, describe how you would revise the activity to address the problem.

Question	Teacher A	Teacher B	Teacher C
10. I felt comfortable using this activity.	Agree	Agree	Agree
11. Students actively participated in the activity.	Agree	Agree	Agree
12. It appeared my students enjoyed this activity.	Agree	Agree	Agree

13. I would do this activity again.	Agree	Agree	Agree

Results – No changes

Use questions 14 through 17 to provide overall comments regarding effectiveness of the activity.

Question	Teacher A	Teacher B	Teacher C
14. On a scale of 1 to 5, (1=low level of learning and 5=high level of learning) estimate to what extent the objectives of the activity were Please explain your rating below. Give examples of student behaviors or other indicators of student learning.	4 This was the 1st time many of my students had used a balance and weights. That was the challenge in itself, but fun! The students had a visual of waste that occurs in harvesting trees.	3 The term biomass was a new term – the students will need a few more lessons on the topic to truly understand and remember it.	4 Students learned a new term – biomass. Parts of the tree were reviewed, and students made a list of wood products.
15. On a scale of 1 to 5, (1=low level of learning and 5=high level of learning) estimate to what extent learning beyond the objectives was completed (circle one) Please explain your rating below. Give examples of student behaviors or other indicators of student learning.	4 Using scales and weights was learned. Teamwork/partnership was learned.	3 Students learned/reviewed measurement using inches and grams.	4 Most students could explain what biomass and conservation were after the activity. Students related lights overhead to this.
16. Describe how this activity did or did not contribute to developing energy concepts in the unit you developed.	This activity complemented a unit on energy, transferring energy, and energy conservation that I was in the midst of teaching when this arrived in the mail.	Students discussed where energy comes from – there are other sources; not just fossil fuels.	This lesson was great with working on my ideas I am using from the Building Efficiency class I took. It helped enhance the concept of conserving energy in school, at home, and in the community.

17. Write your overall opinions of and suggestions for this activity (steps that should be added/deleted, teaching strategies that should be incorporated, alternative materials, etc.). You may find it helpful to refer to the questions below.	See previous comments and resources. The lesson was easily adapted to meet the needs of beginning English language learner students.	The students enjoyed the activity. They were surprised to learn about biomass. The closure didn't mention what to do with the 3" celery pieces or the waste piles. We washed the 3" pieces and had them as a snack. The waste was put in the compost pile! The recording page was not used – it seemed a bit confusing. We reworded the data on the board (% is too advanced at this time!)	I enjoyed letting the students work together in groups and making "teams." At the end students are the celery with peanut butter I supplied for a "healthy" snack. I had the students find the weight of the celery… at times we had to estimate because our scales for the larger amounts went by 25 increments. I wonder if broccoli would work too? I did use a lot of teacher directed training to guide students with measurements and recording information/date. I would normally do this in 2- 40 minute segments so we can gather data on 1st day. 2nd day would be math and eating ☺

Results

1. Two teachers mentioned using the celery as a snack so this suggestion was added to the activity.

2. The procedure was reordered to follow along with the recording page so the comments made by Teacher B should be

remedied.

3. The time for the activity was changed to one to two 50 minute class periods.

4. In the extension section a note was made about using visuals instead of percentages for younger students.

Optional: Use the questions below to provide your opinion about the effectiveness of specific activity components. For any item to which you respond "no," please provide suggestions on how to make improvements.

Question	Teacher A	Teacher B	Teacher C
The objectives clearly state what students are to learn.	Yes	Yes	Yes
The materials for the activity are easily obtained by the average teacher.	Yes	Yes	No
			Depends on school equipment… @ elementary we struggle for workable and available items like scales.
The background is clearly written.	Yes	Yes	Yes
The background helped me prepare for the activity.	Yes	Yes	Yes
	Rewording of biomass in less technical terms would be nice.		
The steps of the procedure were easy to follow.	Yes	Yes	Yes
The procedure can be conducted safely. Ample warnings were given as needed.	Yes	Yes	Yes

Results

1. The background was reworded to remove some of the technical jargon.

Activity: Roadside Renewables

Questions 1 through 8 are designed to provide an overview about your use of the activity.

Question	Teacher A	Teacher B	Teacher C
1. With what grade(s) did you use this activity?	5	7	None – I did not have the right opportunity or time to properly complete this activity. I did not do this with the class but tried to construct the model on my own. Thus my suggestions are based strictly o n my experience and observations with building the model and not with a classroom setting. Sorry!
2. Was this activity appropriate for the grade level with which you used it? (circle one) YES NO If no, for what grade levels would it be more appropriate or how would you revise the activity to make it more appropriate for this grade level?	Yes	Yes	No, middle school (6-8) would be best.
3. In What subject areas would this activity be appropriate (check all that apply)	Ecology, Environmental, Physical Science, Earth science,	Life sciences, Ecology, Environmental Science, Physical Science, Earth science, Chemistry	Environmental Science, Earth Science, Other (Consumer Ed)
4. How many times did you conduct this activity?	5	3	One time by myself
5a. How much preparation time (acquiring	11/2 hours with trip to H.S.	2 hours (includes picking	30 minutes

materials, background review, preparing handouts, cutting cards, designing charts, etc.) was required for this activity?	for glass tubing. Additional 1 hour for getting alt. containers and clay.	up supplies)	
5b. Will preparation time be less next time activity is conducted? (circle one) YES NO If yes, predict how long future preparation times will take (provide explanation if desired).	Yes, using existing glass tubing and containers	Yes, 1 hour tops – including getting supplies	No maybe a little less because I know what I am doing.
6a. How much class time was required to complete the activity?	1-1hour session 1-3/4 hour session 2-15 minute sessions 1-30 minute session	1 Full 80 minute block + half day discussion	I would guess about 45 minutes (1 period)
6b. Did you do the activity in one session/period? (circle one) YES NO If no, how many sessions/periods?	No, 5	No, 6	No
7. Was the suggested setting appropriate for your teaching situation? (circle one) YES NO If no, identify which setting would be better.	yes	yes	No, middle School
8. Please list any trade books, video, poster and musical titles you recommend be added to the **Resources**.		Good time to discuss NIMBY (not in my backyard) too In KEEP book, there's a lab on building a landfill. I couldn't find it so I improvised from info – but it would go perfectly. I also do the SEPUP model fruitvale – talks about groundwater – I will tie	None needed – your resources were fine.

		this in	

Results

1. All of the teachers agreed that the activity is suitable for the intended grade level.

2. The preparation time for the activity was changed to 90 minutes because each teacher took a different amount of time to get ready. The times were 30 minutes, 90 minutes and 120 minutes. Ninety minutes was the middle time and therefore it was used for the activity.

Use the following question to provide information about activity omissions and alterations.

9. Did you do the activity as written? (circle one) YES NO
If no, please describe major changes or omissions below and provide reasons why.

Teacher A – Yes for 3 models, no for 2 models

Major Changes or Omissions Made	Why
Changed milk jug to: - 2-2 liter soda bottles cut into parts to make a column - Mayo container (also used for relish, pickles, etc) make of plastic and tight fitting lid. Changed modeling clay to ceramic clay in slip form	Milk jugs did not provide for a tight seal, even when using tape, handles were in the way. The mayo container worked very well, had a tight seal and placed 1 glass tube below clay and one above.

	There was no way modeling clay could be pressed onto the garbage to make a tight seal. Ceramic clay, in slip form, could be poured over the garbage to seal.

Teacher B - no

Major Changes or Omissions Made	Why
Procedure	Little confusing – couldn't find what to put in landfill – in how to build section – so I asked students to bring it in.

Teacher C - no

Major Changes or Omissions Made	Why
I did review the activity and constructed the model. I made changes on the activity sheet. The biggest change is the instructions on "How to build the model landfill."	

Results

1. In the materials list it was noted that natural materials and food waste work best for the activity.
2. In the materials list milk jugs were changed to large glass or plastic jars with tight covers.
3. The procedure was changed to reference the student sheets correctly.
4. Revised the student worksheet based on teacher C's edits and comments.

For questions 10 through 13, indicate if you agree or disagree with the statement by circling the response that best fits your opinion. If you disagree, describe how you would revise the activity to address the problem.

Question	Teacher A	Teacher B	Teacher C
10. I felt comfortable using this activity.	Agree	Agree and Disagree	Agree
11. Students actively participated in the activity.	Agree	Agree	N/A
12. It appeared my students enjoyed this activity.	Agree	Agree	N/A
13. I would do this activity again.	Disagree, at this time little to no gas was produced making the model of little use.	Agree	Agree

Results

1. The activity runs for a short period of time. In the activity it is noted that it may take more than one week to observe the build up of gas. In the materials list it has also been noted to use a lightweight plastic bag to collect the gas.

Use questions 14 through 17 to provide overall comments regarding effectiveness of the activity.

Question	Teacher A	Teacher B	Teacher C
14. On a scale of 1 to 5, (1=low level of learning and 5=high level of learning) estimate to what extent the objectives of the activity were Please explain your rating below. Give examples of student behaviors or other indicators of student learning.	2	5	N/A
		Worked in lab – we're able to complete it	I think the objective would have been met

15. On a scale of 1 to 5, (1=low level of learning and 5=high level of learning) estimate to what extent learning beyond the objectives was completed (circle one) Please explain your rating below. Give examples of student behaviors or other indicators of student learning.	3	5 It helps them to evaluate their own patterns of garbage disposal.	N/A Again, I think learning beyond the objectives would have been accomplished
16. Describe how this activity did or did not contribute to developing energy concepts in the unit you developed.	At the time of setting up the model, grass was not available to add to the garbage (in January). However, if it was I would have hesitated to add it because we teach recycling concepts (and state regulations also) which would make putting recyclable organic materials into a landfill model opposite of what we teach.	We did this activity independent of our unit right now. I will tie information in when we study environment in may.	N/A
17. Write your overall opinions of and suggestions for this activity (steps that should be added/deleted, teaching strategies that should be incorporated, alternative materials, etc.). You may find it helpful to refer to the questions below.	The activity guide suggest that methane gas would be produced over the "next few weeks." However after 3 weeks there is no evidence that gas has been produced. Even the alternative models we made, that had a much tighter seal, did not have plastic bags that fully	Have a suggestion to teachers to look for waste a couple of days ahead of time – just to put in preplanning. Not good in winter b/c harder to find yard waste (show) We didn't collect much gas (some condensation!) I wonder if we also put	See Activity Sheet w/suggestions/modifications I made [to the How to Build a Model Landfill]

	extended. One problem with the bag is finding one that is made of a material that is light enough to allow for expansion.	newspaper in as a carbon source it that would help. We may just not have had a tight seal. In one of my classes I said to use newspaper to help compost.	

Results

1. See results of question 9.

Optional: Use the questions below to provide your opinion about the effectiveness of specific activity components. For any item to which you respond "no," please provide suggestions on how to make improvements.

Question	Teacher A	Teacher B	Teacher C
The objectives clearly state what students are to learn.	yes	yes	yes
The materials for the activity are easily obtained by the average teacher.	no	Yes and no	yes
	Glass tube less available to elementary teachers unless they have a H.S. source	Could be	
The background is clearly written.	yes	yes	yes
The background helped me prepare for the activity.	yes	yes	yes
The steps of the procedure were easy to follow.	no	yes	yes
	Very difficult to understand: modeling clay application, placement of glass tubes, wrapping and sealing with plastic.		Except the "How to Build a Model Landfill"

The procedure can be conducted safely. Ample warnings were given as needed.	yes	yes	yes
		Make sure to put warning about releasing gas in bold too.	Eliminate the razors and scissors.

Results

1. Added a drawing of what the model should look like to the bottom of the How to Build a Model Landfill student page.
2. Changed glass tube to plastic tube in the materials chart.
3. See previous results sections that address these comments.

Activity - Advertising Biodiesel

Questions 1 through 8 are designed to provide an overview about your use of the activity.

Question	Teacher A	Teacher B	Teacher C
1. With what grade(s) did you use this activity?	6	5	
2. Was this activity appropriate for the grade level with which you used it? (circle one) YES NO If no, for what grade levels would it be more appropriate or how would you revise the activity to make it more appropriate for this grade level?	yes	No – not as written See outline attached.	
3. In What subject areas would this activity be appropriate (check all that apply)	Ecology, Environmental, Language Arts, Art	Environmental, Language arts, Fine arts	
4. How many times did you conduct this activity?	1	1	
5a. How much preparation time (acquiring	About two weeks	Collecting pictures for the	

materials, background review, preparing handouts, cutting cards, designing charts, etc.) was required for this activity?		whole class would be unnecessary. Group students – give each group one energy ad. Only need 6-8.	
5b. Will preparation time be less next time activity is conducted? (circle one) YES NO If yes, predict how long future preparation times will take (provide explanation if desired).	Yes, The same ads can be used again. It won't be necessary to gather ads.	Yes would have ads. reuse	
6a. How much class time was required to complete the activity?	5 – 43 class periods	I did 2, 45 minute sessions	
6b. Did you do the activity in one session/period? (circle one) YES NO If no, how many sessions/periods?	No, 5	No, 2	
7. Was the suggested setting appropriate for your teaching situation? (circle one) YES NO If no, identify which setting would be better.	Yes	Yes	
8. Please list any trade books, video, poster and musical titles you recommend be added to the **Resources**.		At this grade level, for this lesson I would not use any other resources	

Results

1. Changed grade level to grades 6-8 and entered grades 9-12 as an option as well.

Use the following question to provide information about activity omissions and alterations.

9. Did you do the activity as written? (circle one) YES NO

If no, please describe major changes or omissions below and provide reasons why.

Teacher A - No

Major Changes or Omissions Made	Why
I had students define diesel and biodiesel between steps 2 & 3	I wanted them to understand the words
I had students research biodiesel and list facts	I felt this helped deepen their understanding of biodiesel and design a more effective add.

Teacher B - no

Major Changes or Omissions Made	Why
The lesson I conducted focused on these objectives only, no necessarily the ones originally listed in the lesson. Explain what biodiesel is, give examples of how biodiesel can be used, explain why alternative fuels are necessary, identify at least two reasons why biodiesel is a good fuel choice, design a poster that will teach others about biodiesel and promote its use.	I thought the original lesson was all over the place and not focused enough for my fifth-grades. (Maybe the original would work better at the middle school level?)
Grouped students in 3-4 per group in the procedure. Have students look at energy ads one per group Discuss the purposes of the ads, as listed in the original lesson – background – paragraph 2.	Does the first paragraph on the third page of the original document even make sense???? I would get rid of the whole page except for the chart on emissions and associated side bar information. Kind of getting to the point on the top of page 4-keep some of this (but again – some incoherent sentences and needs to be rewritten.)

I would also keep the chart on page two and the first paragraph after the chart on page two and get rid of the rest of the page. This is then where I would define biodiesel and talk about how it can be used instead of gas or diesel and why it's a better choice. 1. Poser should define/explain what biodiesel is. 2. Poster must identify biodiesel as a good alternative fuel because: it promotes the use of renewable energy – it is better for the environment because it reduces emissions.	Evaluation – for me it was different than what was printed in the original lesson.

Teacher C

Major Changes or Omissions Made	Why

Results

1. Class time changed to four – 50 minute periods because an additional step was added to the activity.
2. Teachers will define diesel and biodiesel for the students in step 2.
3. Teacher B comments on the amount of background material and would like all of the material removed with the exception of the chart on biodiesel/diesel and the text on biodiesel. This change was not made because although the activity is about biodiesel it is also about advertising and if the information was not included other teachers may not use the activity or if they

do they may need to do additional research on advertising in order to conduct the activity.

4. The background material was reviewed and reworded.
5. Teacher B changed the assignment to designing a poster which would make the advertising information not as relevant to her. This change was not made.
6. In the procedure it was noted that the students can work in groups.
7. A step was inserted between the existing steps 2 and 3. The new step has students researching biodiesel and developing their own fact sheets.
8. Deleted the table Types and Sources of Advertisements Related to Energy because after reviewing the activity the chart did not seem relevant.

For questions 10 through 13, indicate if you agree or disagree with the statement by circling the response that best fits your opinion. If you disagree, describe how you would revise the activity to address the problem.

Question	Teacher A	Teacher B	Teacher C
10. I felt comfortable using this activity.	Agree	Disagree – not as written	
11. Students actively participated in the activity.	Agree	Agree	
12. It appeared my students enjoyed this activity.	Agree	Agree	
13. I would do this activity again.	Agree	Agree if it is revised	

Results

1. No changes

Use questions 14 through 17 to provide overall comments regarding effectiveness of the activity.

Question	Teacher A	Teacher B	Teacher C
14. On a scale of 1 to 5, (1=low level of learning and 5=high level of learning) estimate to what extent the objectives of the activity were	5	2	
Please explain your rating below. Give examples of student behaviors or other indicators of student learning.	Some of the ads designed by the students demonstrated successful understanding of the objectives	I reduced/changed objectives – okay then – see question 9 results	
15. On a scale of 1 to 5, (1=low level of learning and 5=high level of learning) estimate to what extent learning beyond the objectives was completed (circle one)	3	1	
Please explain your rating below. Give examples of student behaviors or other indicators of student learning.	Students' ads indicated an understanding of using biodiesel	We stuck to the point	
16. Describe how this activity did or did not contribute to developing energy concepts in the unit you developed.	Students became aware of what biodiesel is, how it is used and some benefits to using it.	Importance of promoting and educating the pubic on new forms of energy is the way to make it become mainstream. It would do a good job of teaching students about biodiesel and their posters would spread the word.	
17. Write your overall opinions of and suggestions for this activity (steps that should be added/deleted, teaching strategies that should be incorporated, alternative	I provided students with a list of websites. I included the following website. www.biodiesel.org.au/biod	See results from question 9	

materials, etc.). You may find it helpful to refer to the questions below.	ieselfacts.htm overall I though this was a good activity. The students learned a lot and some of the ads were well done. I didn't feel it fit as well into our 6th grade language arts curriculum as I would have like it to. I think it might fit better into a FACE or art curriculum. While students were researching facts on biodiesel, I had them list the facts in their notebook. I feel this helped them better understand biodiesel and enabled them to design a more effective ad.		

Results

1. The objectives were revised.

Optional: Use the questions below to provide your opinion about the effectiveness of specific activity components. For any item to which you respond "no," please provide suggestions on how to make improvements.

Question	Teacher A	Teacher B	Teacher C
The objectives clearly state what students are to learn.	Yes		
		Didn't like and wouldn't	

		teach the objectives as listed	
The materials for the activity are easily obtained by the average teacher.	Yes		
		All you need is about 6-8 ads relating to energy and paper/poster board	
The background is clearly written.	Yes		
		I felt it was all over the place and needs to be trimmed down.	
The background helped me prepare for the activity.	Yes		
		No, not really, see question 9	
The steps of the procedure were easy to follow.	Yes	Didn't like or use lesson as written. Some of the steps were okay	
The procedure can be conducted safely. Ample warnings were given as needed.	Yes	Not a problem for this activity	

Results

1. See previous results.

Activity - Would You Heat With Wood

Questions 1 through 8 are designed to provide an overview about your use of the activity.

Question	Teacher A	Teacher B	Teacher C
1. With what grade(s) did you use this activity?	7	3	4

2. Was this activity appropriate for the grade level with which you used it? (circle one) YES NO If no, for what grade levels would it be more appropriate or how would you revise the activity to make it more appropriate for this grade level?	Yes with some modifications	Yes	Yes
3. In What subject areas would this activity be appropriate (check all that apply)	Health, Environmental science, Physical Science, Language arts	Ecology, Environmental science, Physical science, language arts, Fine arts	Life science, Environmental Science, language arts
4. How many times did you conduct this activity?	1	1	1
5a. How much preparation time (acquiring materials, background review, preparing handouts, cutting cards, designing charts, etc.) was required for this activity?	5-10 minutes	30 minutes	1.5 hours
5b. Will preparation time be less next time activity is conducted? (circle one) YES NO If yes, predict how long future preparation times will take (provide explanation if desired).	no	Yes, 15 minutes, reviewing material next time will be less because I am already familiar with it.	Yes, ½ hour
6a. How much class time was required to complete the activity?	135 minutes	60 minutes	2 hours
6b. Did you do the activity in one session/period? (circle one) YES NO If no, how many sessions/periods?	No, 3	Yes	No, 2
7. Was the suggested setting appropriate for your teaching situation? (circle one) YES NO If no, identify which setting would be better.	Yes because it incorporates writing	Yes	Yes and no – classroom and outside
8. Please list any trade books, video, poster			Ecosystem Poster/forest

and musical titles you recommend be added to the **Resources**.			

Results

1. The preparation time was left at 50 minutes because the three teachers had a wide range of preparation times and 50 minutes is in the mid range of teacher times. All three teachers indicated that the next time they do the activity the time needed to prepare will be less.
2. An ecosystem or poster of a forest was added to the materials list.
3. Added outside to the setting.

Use the following question to provide information about activity omissions and alterations.

9. Did you do the activity as written? (circle one) YES NO
If no, please describe major changes or omissions below and provide reasons why.

Teacher A - no

Major Changes or Omissions Made	Why
1. I introduced the lesson using the background section 2. We stopped and defined several words	1. vocabulary reasons 2. to aid understanding

Teacher B - No

Major Changes or Omissions Made	Why
Concept of resources (renewable vs. nonrenewable)	This was difficult for 3rd graders to understand. We first had to identify what resources are and the difference between renewable and nonrenewable, another somewhat difficult subject.
Photos of wood burners	When photos arrived, they were not labeled and I had to do some research. It would be helpful to have them clearly labeled.
Safety	We read *Safety Around Fire* after our discussion about wood burners. This added additional background knowledge for the story writing activity.

Teacher C - No

Major Changes or Omissions Made	Why
I added: Wood pellets, corn cob, oil, corn kernels, pellet stove, log of wood RAFTS = helped students to focus on objective and have a purpose to write.	8"x10" pictures weren't enough resources for me to teach this lesson with. I needed more! Luckily, our hardware store was willing to bring a pellet stove to school, and it added a lot to this activity. Kids needed to touch and feel pellets, corn, log and heat exhausted from pellet stove. Large ecosystem poster helped also.

Results

1. Added labels to the pictures.

2. Added a section in the opening of the activity where the teacher reviews the activities with the students.

3. Wood pellets and log were added as optional items in the materials list.

4. Added a Related KEEP Activities section to the activity and listed the activities Energy Divide and Renewable Candy Resources.

For questions 10 through 13, indicate if you agree or disagree with the statement by circling the response that best fits your opinion. If you disagree, describe how you would revise the activity to address the problem.

Question	**Teacher A**	**Teacher B**	**Teacher C**
10. I felt comfortable using this activity.	Agree	Agree	Agree
11. Students actively participated in the activity.	Agree	Agree	Agree
12. It appeared my students enjoyed this activity.	Agree	Agree	Agree
13. I would do this activity again.	Agree	Agree	Agree

Results

1. No changes

Use questions 14 through 17 to provide overall comments regarding effectiveness of the activity.

Question	Teacher A	Teacher B	Teacher C
14. On a scale of 1 to 5, (1=low level of learning and 5=high level of learning) estimate to what extent the objectives of the	2	5	5
	I don't think there is enough depth regarding	The concept of renewable resource was an "a-ha"	

activity were Please explain your rating below. Give examples of student behaviors or other indicators of student learning.	how fires make us of fuel and oxygen.	moment for the students. They were able to use reasoning skills to figure it out.	
15. On a scale of 1 to 5, (1=low level of learning and 5=high level of learning) estimate to what extent learning beyond the objectives was completed (circle one) Please explain your rating below. Give examples of student behaviors or other indicators of student learning.	3 We did some story sharing and writing, also we defined several words (harvesting, efficiency, apparatus, ambience, aesthetically pleasing, renewable).	4 The discussion of fire prompted student discussion about how their home could be fire-safe.	3 Visuals – poster The students saw a pellet stove in use – had wood pellets, corn to feel
16. Describe how this activity did or did not contribute to developing energy concepts in the unit you developed.	This was taught as a supplement to science curriculum – it introduced ideas of efficiency, fuel and oxygen as necessary components of a fire.	It seems like this lesson was better connected to types of wood burners renewable resources and fire safety rather than a direct connection to energy use related to wood burners. That seems to need more stress in the procedure.	I used this activity with my ecosystem unit/living and nonliving/decomposers. Renewable energy was the focus = wood & corn fuels. By having the pellet stove at school, the students could see how environmentally friendly is was. Worked well.
17. Write your overall opinions of and suggestions for this activity (steps that should be added/deleted, teaching strategies that should be incorporated, alternative materials, etc.). You may find it helpful to refer to the questions below.	-stones around fire may promote safety better - more attention needed to the way fire burns. - Could label images so we know which kind of stove is which - make vocabulary list that includes other words (see	See below	Day One – I felt this activity was lacking meat! I supplemented the wood pellets, corn cob, ecosystem poster, corn kernals, log of wood and guest speaker to tell about the pellet stove. I was pleased with the

	#15) - align this lesson to state standards, if not for science, then for writing.		flow of the activity, the delivery of information gained by students with the additions I added. Day 2 = We did RAFTS writing assignment. I made a handout & example of a RAFTS letter as a guide. I added: cavemen were the first to use fire for heat and light energy.

Results

1. Teacher A said the activity does not have enough depth but because the activity is for grades 3-5 and Teacher A teaches grade 7. If the activity was grade 7 it would have more depth but teacher B and C did not have the same problem so the suggestion to add more depth was rejected.
2. The activities are not currently correlated to academic standards. The KEEP concepts in the Conceptual Framework are correlated to academic standards. In the final draft of the activity each activity will have a list of which concepts are address so the teacher can cross reference which academic standards the activity addresses.
3. The words, energy, efficiency, and renewables were added to the vocabulary list.
4. A second step was added to the procedure in which students will have to identify which wood burning process is the most efficient and a worksheet for the students will be provided.

Optional: Use the questions below to provide your opinion about the effectiveness of specific activity components. For any item to which you respond "no," please provide suggestions on how to make improvements.

Question	Teacher A	Teacher B	Teacher C
The objectives clearly state what students are to learn.	Yes	No	Yes
		There seems to be a lack of connection b/n use of energy in wood burners stated in procedure. It should be stated up front.	
The materials for the activity are easily obtained by the average teacher.	No	Yes	Yes
	The books were not available		(as is)
The background is clearly written.	Yes	Yes	Yes
The background helped me prepare for the activity.	Yes	Yes	Yes
		Please label photos	
The steps of the procedure were easy to follow.	Yes	Yes	Yes
The procedure can be conducted safely. Ample warnings were given as needed.	Yes	Yes	Yes

Results

1. No changes

Activity - Community Design – It's a Gas

Questions 1 through 8 are designed to provide an overview about your use of the activity.

Question	Teacher A	Teacher B	Teacher C
1. With what grade(s) did you use this activity?	10-12	8	7
2. Was this activity appropriate for the grade level with which you used it? (circle one) YES NO If no, for what grade levels would it be more appropriate or how would you revise the activity to make it more appropriate for this grade level?	Yes, my high school students had a hard time with this. I had to do a lot of coaching to help students think about the community's energy needs and how more alternatives could be added.	Yes	yes
3. In What subject areas would this activity be appropriate (check all that apply)	Environmental Science, Earth Science	Physical science	Ecology, Environmental science
4. How many times did you conduct this activity?	2	6	1
5a. How much preparation time (acquiring materials, background review, preparing handouts, cutting cards, designing charts, etc.) was required for this activity?	Minimal	5 hours 2 hours map 3 hours readings	2 hours
5b. Will preparation time be less next time activity is conducted? (circle one) YES NO If yes, predict how long future preparation times will take (provide explanation if desired).	Yes, I would go over the terms with the students. I would also provide examples of businesses in our community and describe energy use of these.	No time – I've laminated the maps and cards and they will be used again and again.	Yes, 1 hour, I won't have to take the time to order maps from our city hall and pick them up because now I have a classroom set.
6a. How much class time was required to complete the activity?	4-50 minute class periods	50 minutes	4, 50 minute class periods
6b. Did you do the activity in one session/period? (circle one) YES NO If no, how many sessions/periods?	No, 4	yes	yes
7. Was the suggested setting appropriate for your teaching situation? (circle one) YES	No, we used the computer room and school library.	yes	Yes

NO If no, identify which setting would be better.			
8. Please list any trade books, video, poster and musical titles you recommend be added to the **Resources**.			I used the video from United Streaming on-line called "The Garbage Story" before the activity – it gives a good explanation on methane.

Results

1. Added computer lab and library to the setting.
2. Changed preparation time to one hour and added in parenthesis - If you have not done this activity before preparation can take up to two hours.
3. The link to the streaming video mentioned by Teacher C was not added because the United Streaming Web site requires membership and password.

Use the following question to provide information about activity omissions and alterations.

9. Did you do the activity as written? (circle one) YES NO
If no, please describe major changes or omissions below and provide reasons why.

Teacher A - Yes

Major Changes or Omissions Made	Why

Teacher B – Yes, once – No, 5 times

Major Changes or Omissions Made	Why
(Included handouts that were included)	

Teacher C - Yes

Major Changes or Omissions Made	Why

Results

1. No changes.

For questions 10 through 13, indicate if you agree or disagree with the statement by circling the response that best fits your opinion. If you disagree, describe how you would revise the activity to address the problem.

Question	Teacher A	Teacher B	Teacher C
10. I felt comfortable using this activity.	Agree	Disagree	Agree
11. Students actively participated in the activity.	Agree	Disagree	Agree
12. It appeared my students enjoyed this activity.	Disagree, They struggled with understanding assignment.	Agree and Disagree	Agree
13. I would do this activity again.	Agree	Agree with my adaptations	Agree

Results – see next session.

Use questions 14 through 17 to provide overall comments regarding effectiveness of the activity.

Question	Teacher A	Teacher B	Teacher C
14. On a scale of 1 to 5, (1=low level of learning and 5=high level of learning) estimate to what extent the objectives of the activity were Please explain your rating below. Give examples of student behaviors or other indicators of student learning.	4	5	4
	Students did well with the benefits of using the activity but struggles with the limitations. They had a hard time applying this to community example.	Students learned (through this activity) that methane is a source of energy for their communities that are sometimes overlooked.	My students were very interested in seeing places in their own community that used to be landfills and could be used for methane. High interest level.
15. On a scale of 1 to 5, (1=low level of learning and 5=high level of learning) estimate to what extent learning beyond the objectives was completed (circle one) Please explain your rating below. Give examples of student behaviors or other indicators of student learning.	4	5	3
	Students researched more than methane as a biofuels. Some branched out and included biodiesel into their community plan.	Besides methane, students learned about other alternative energy sources. I observed this through their written work and large group discussion.	I gave this a 3 because we definitely covered the objectives, but the students also learned about human impact on the environment in general.
16. Describe how this activity did or did not contribute to developing energy concepts in the unit you developed.	This unit helped students understand the differences between renewable and non renewable resources. Its design caused students to start thinking about applying alternative energy into the community and the feasibility of using these.	NA	It was a great start to my alternative energy sources that I begin at the end of my ecology unit and the beginning of my energy unit. It was a great transition.

	Students had a hard time finding information about the community and its use of biofuels. I found this activity challenged my high school students (grades 10-12) and would be difficult for middle school students. This would be a good activity to invite a community member or business in to share use of biofuels in their business.	See additions (maps and info sheets)	My opinion is that this activity is an outstanding example of the types of lessons my district is looking for – we call it high quality Intellectual Work where students are having a lot of substantive conversations beyond the classroom. I think in science you could delete some of the research or cost effectiveness if you had lass time to work with.

Results

1. Because this activity is complex it would be best used as a final lesson in a unit on biomass energy or renewable energy.

   This was added to the summary of the activity.

2. One teacher allowed students to use other forms of biomass. This was already in the activity as an extension.

Optional: Use the questions below to provide your opinion about the effectiveness of specific activity components. For any item to which you respond "no," please provide suggestions on how to make improvements.

Question	**Teacher A**	**Teacher B**	**Teacher C**
The objectives clearly state what students are to learn.	Yes	Yes	Yes
The materials for the activity are easily obtained by the average teacher.	Yes	Yes	Yes

The background is clearly written.	Yes	Yes	Yes
The background helped me prepare for the activity.	Yes	Yes	Yes
The steps of the procedure were easy to follow.	Yes	No	Yes
The procedure can be conducted safely. Ample warnings were given as needed.	Yes	Yes	Yes

Results

1. The steps of the procedure were reviewed to asses the ease of use. Teacher B did not think the steps were easy to follow but not indicate how they could be improved or what steps were hard to follow. Upon review the following changes were made to the procedure.
    A. Step 4: Second bullet: The lines – What would the upfront cost be for such a system? Were deleted.
    B. Step 4: A third bullet was added. Which options seem the most cost effective?
    C. Step 5: The sentence – "tell them to include all potential costs for development and have them estimate how much they will make (by selling plots or by building homes on the lots and selling them)" – was deleted.

Activity - Biomass Gazette

Questions 1 through 8 are designed to provide an overview about your use of the activity.

Question	Teacher A	Teacher B	Teacher C

1. With what grade(s) did you use this activity?	6	9	6
2. Was this activity appropriate for the grade level with which you used it? (circle one) YES NO If no, for what grade levels would it be more appropriate or how would you revise the activity to make it more appropriate for this grade level?	No, I think it would be more appropriate for grades 9-12. Perhaps 7-8 grades could do it too but I would not recommend it for 5-6.	Yes	Yes
3. In What subject areas would this activity be appropriate (check all that apply)	Ecology, Environmental Science, Earth Science, Social Studies, Language Arts	Ecology, Environmental Science, Physical Science, Language Arts	Life Sciences, Ecology, Environmental Science, Earth Science, Language Arts
4. How many times did you conduct this activity?	Once	2	1, 1 week 45 min sessions
5a. How much preparation time (acquiring materials, background review, preparing handouts, cutting cards, designing charts, etc.) was required for this activity?	About 1-2 hours. – checking out websites	About 45 minutes	
5b. Will preparation time be less next time activity is conducted? (circle one) YES NO If yes, predict how long future preparation times will take (provide explanation if desired).	Yes, 15 minutes	Yes, 10 minutes – since I now have the student handout prepared I only have to run copies next time.	30 min.
6a. How much class time was required to complete the activity?	2 weeks	1 week	5 hours (approx.)
6b. Did you do the activity in one session/period? (circle one) YES NO If no, how many sessions/periods?	No, 10	No, 5	5/45 min sessions
7. Was the suggested setting appropriate for your teaching situation? (circle one) YES	yes	yes	Yes

NO If no, identify which setting would be better.			
8. Please list any trade books, video, poster and musical titles you recommend be added to the **Resources**.			

Results

1. Changed the grade level from 9-12 (5-8) to 9-12 (7-8) because two teachers indicated it was too difficult for fifth and sixth graders.
2. Changed the preparation time to one hour. It was formerly 15 minutes but one teacher took 45 minutes and the other took 1-2 hours to prepare for it. They did both indicate that the next time they do the activity it will take less time.
3. The time required to complete the activity was changed from one week to one to two weeks because all three teachers indicated different times that ranged between one to two weeks.

Use the following question to provide information about activity omissions and alterations.

9. Did you do the activity as written? (circle one) YES NO
If no, please describe major changes or omissions below and provide reasons why.

Teacher A - No

Major Changes or Omissions Made	Why
I had <u>all</u> the students research a topic and report on it and then had them work with a partner to put together one newspaper.	I was concerned with how students would spend class time when they were not actively involved. The research was challenging for 6^{th} graders. I didn't feel the different tasks required the same amount of time and effort. The students did enjoy working with a partner though. I also felt they each

	learned more by each researching a topic.

Teacher B - Yes

Major Changes or Omissions Made	Why
Took portions of the information included and put it into a handout for the students. They were also given a grading rubric at the beginning.	Students needed something to look at and follow to make sure they had all the information required.

Teacher C - no

Major Changes or Omissions Made	Why
Students were assigned a vocabulary term. They then defined the term and provided examples of each in a PowerPoint presentation. Their examples were supposed to be specific to Wisconsin.	To complex for 6^{th} grade (too much at once)

Results

1. As mentioned above two teachers noted that the activity was too difficult for grades 5 and 6 so the recommended grade level was changed top 9-12 (7-8).
2. Developed student handout to guide student work.
3. Put an * next to the possible topics that are more difficult.

For questions 10 through 13, indicate if you agree or disagree with the statement by circling the response that best fits your opinion. If you disagree, describe how you would revise the activity to address the problem.

Question	Teacher A	Teacher B	Teacher C
10. I felt comfortable using this activity.	Agree	Agree	Agree
11. Students actively participated in the activity.	Agree	Agree	Agree
12. It appeared my students enjoyed this activity.	½ did and ½ didn't	Agree	Agree
13. I would do this activity again.	Disagree	Agree	Agree

Results

1. The teacher that indicated she would not do the activity again was one of the teachers who thought the activity was too difficult for her sixth graders. No changes made.

Use questions 14 through 17 to provide overall comments regarding effectiveness of the activity.

Question	Teacher A	Teacher B	Teacher C
14. On a scale of 1 to 5, (1=low level of learning and 5=high level of learning) estimate to what extent the objectives of the activity were Please explain your rating below. Give examples of student behaviors or other indicators of student learning.	4	4	5
	Students' newspaper articles provided examples of biomass energy use in WI. Some of the topics were difficult to research.	Although some students achieved a high level of learning by doing excellent researching/reporting, most students did only what was necessary or even below that.	Students defined terms that they had no prior knowledge of. They then provided examples proving they understood the lesson.
15. On a scale of 1 to 5, (1=low level of learning and 5=high level of learning) estimate to what extent learning beyond the objectives was completed (circle one) Please explain your rating below. Give	5	4	5
	Basic researching skills and notetaking were also part of the learning process. Our students have not had much (if any)	Again, some students went beyond what was expected and did interviews while most didn't put any extra effort into it.	Students learned how to present and develop a PowerPoint presentation.

examples of student behaviors or other indicators of student learning.	experience with researching at this point.		
16. Describe how this activity did or did not contribute to developing energy concepts in the unit you developed.	This activity did contribute to developing energy concepts. The students researched energy topics they did not have a lot of background information on.	This activity helped students understand that even though some biomass fuels are the products of some complex process there are other fuels that are being used right now in their own homes that are renewable – many students have outdoor wood furnaces, pellet stoves and corn stoves and some know people who are making biodiesel.	Students shared their findings with classmates through an oral presentation. At the end students knowledge of energy concepts were broadened.
17. Write your overall opinions of and suggestions for this activity (steps that should be added/deleted, teaching strategies that should be incorporated, alternative materials, etc.). You may find it helpful to refer to the questions below.	I think the activity is fine and would probably work better with the target audience (9-12). I feel it is too difficult and frustrating for 5-6 graders. It should be done with students who have done research topics in the past and are familiar with how to research! More time should be allowed for researching. Students felt they needed more time to research their topics.	I wasn't sure how the students finished paper would look but I was really surprised at how well they put their articles together and made it look like a newspaper. They had some trouble understanding gasification and pyrolysis and I wasn't much help. Next time I will be better prepared by researching them myself first so I can better help my students. Next time I would like to do this project along with the	Specific to 6th grade, this activity started out too complex! However after some modifications students seemed to get a lot out of the activity. They enjoyed presenting in the PowerPoint format. In the future students could take the next step and become reporters by conducting research projects and writing news articles. It would be helpful to integrate classes. I.e. language/science

		English teacher so that they can also learn more about article writing at the same time. I have included the handout I prepared for the students along with the grading rubric I developed.	(language teacher could focus on the newspaper portion) (science could do research)

Results

1. An objective was added. "Students will be able to describe how a news article is different than an essay."

Optional: Use the questions below to provide your opinion about the effectiveness of specific activity components. For any item to which you respond "no," please provide suggestions on how to make improvements.

Question	Teacher A	Teacher B	Teacher C
The objectives clearly state what students are to learn.	No	Yes	Yes
	I think objectives relating to researching, note taking, journalism writing could be included.		
The materials for the activity are easily obtained by the average teacher.	Yes	Yes	Yes
		All you need it computers w/ internet for students and some magazines are helpful but not necessary.	
The background is clearly written.	Yes	Yes	Yes
The background helped me prepare for the activity.	Yes	Yes	Yes

The steps of the procedure were easy to follow.	Yes	Yes	Yes
The procedure can be conducted safely. Ample warnings were given as needed.	Yes	NA	Yes
		No warnings needed	

Results

1. No changes from this section

Activity - Bioenergy Beliefs

Questions 1 through 8 are designed to provide an overview about your use of the activity.

Question	Teacher A	Teacher B	Teacher C
1. With what grade(s) did you use this activity?	11-12 Advanced Genetics	10-12	9
2. Was this activity appropriate for the grade level with which you used it? (circle one) YES NO If no, for what grade levels would it be more appropriate or how would you revise the activity to make it more appropriate for this grade level?	Yes, Any 9-12 could use this activity.	Yes	yes
3. In What subject areas would this activity be appropriate (check all that apply)	Life Science, Environmental Science, Physical Science, Social Studies	Environmental Science, Social Studies	Life Science, Ecology, Environmental Science, Earth Science, Social Studies, Other (energy)
4. How many times did you conduct this activity?	1 time	2 separate class periods	Once with three of my top kids
5a. How much preparation time (acquiring materials, background review, preparing handouts, cutting cards, designing charts,	½ hour	3 hours – reading, materials and creating a power point to provide	@ 30 minutes for reviewing material

etc.) was required for this activity?		students with background knowledge.	
5b. Will preparation time be less next time activity is conducted? (circle one) YES NO If yes, predict how long future preparation times will take (provide explanation if desired).	Yes, 15 minutes	Yes, I would like to use the program inspiration in the future for this activity. Inspiration is a flow chart program based on the computer.	No – because I know what I'm doing now
6a. How much class time was required to complete the activity?	1. 30 minute introduction 2. 1 week research 3. 1 70+ minute debate	2 ½ periods – 50 minutes (24 students each period)	270 minutes
6b. Did you do the activity in one session/period? (circle one) YES NO If no, how many sessions/periods?	Yes, 70+ minute debate	No, 3-50 minute periods I had the students so the research portion during 1 class period.	No, 3 blocks (90 minutes) 45 instruction, 45 research time, 90 computer time, 90 for presentations
7. Was the suggested setting appropriate for your teaching situation? (circle one) YES NO If no, identify which setting would be better.	yes	yes	Yes – but energy is the best
8. Please list any trade books, video, poster and musical titles you recommend be added to the **Resources**.		Alternative Energy; Neil Schlager and Jayne Weisblatl, editors Publisher – Thomas Gale, the Thomson Corporation	

Results

1. Added Social Studies to the list of subject areas.
2. Reworded Getting Ready to read "It may be helpful to involve the school librarian with research".
3. Added the recommended book to the resources section of the activity.

4. Added computer lab to setting.

5. Changed repetitive wording in the summary.

Use the following question to provide information about activity omissions and alterations.

9. Did you do the activity as written? (circle one) YES NO
If no, please describe major changes or omissions below and provide reasons why.

Teacher A – Yes - however

Major Changes or Omissions Made	Why
	I put students in teams of 4, each assigned a different viewpoint. Debate day – put like viewpoints together for 15 minute – debate after that. Debate last 1 ½ class periods (90 min).

Teacher B - No

Major Changes or Omissions Made	Why
1. Change of one week to gather information	I had the students research in the library and the lab the information regarding the six sources
2. I specified a minimum of 2 of each source type	Each group needed 6 sources. 2 were from the newspaper, 2 were from books, and 2 were from web sites.
3. Ethanol view point form.	I've drafted this and made students fill this in for each source. I then had them pick one pro and con choice to present from the group. Redraft enclosed.

Teacher C - No

Major Changes or Omissions Made	Why
See attachment sent on e-mail and with this mailing	- part of why I did things differently was because where I was at in my curriculum and trying to fit it in. - The other reason I made some big changes is to provide another way to help the student present the material (i.e. PowerPoint presentation)

Results

1. Even though the teachers made some changes I didn't feel they were essential to meeting the objectives of the activity. Teacher B added strict guidelines to the resources used and later wrote that he/she wished the students would have had a wider variety or resources for information.
2. In the closure section of the activity I did note that an alternative to a class discussion would be a class debate and that the students should work in groups.

For questions 10 through 13, indicate if you agree or disagree with the statement by circling the response that best fits your opinion. If you disagree, describe how you would revise the activity to address the problem.

Question	Teacher A	Teacher B	Teacher C
10. I felt comfortable using this activity.	Agree	Agree	Agree
11. Students actively participated in the activity.	Agree	Agree	Agree
12. It appeared my students enjoyed this activity.	Agree, outstanding debate	Agree	Agree
13. I would do this activity again.	Agree	Agree	Agree

Results

No changes based on the comments.

Use questions 14 through 17 to provide overall comments regarding effectiveness of the activity.

Question	Teacher A	Teacher B	Teacher C
14. On a scale of 1 to 5, (1=low level of learning and 5=high level of learning) estimate to what extent the objectives of the activity were Please explain your rating below. Give examples of student behaviors or other indicators of student learning.	5	4	4
	Students learned about ethanol production through their research. More importantly, they learned that all EE issues have many viewpoints and that one must look at all viewpoints before they draw an educated conclusion!	Many of my students all used the same books/news articles so our view points were not all that varied – it would be better to have them search on own in future.	If I were to do this again. I would give my class more instruction/resources on NEV. They didn't talk about this as much as I would have liked.
15. On a scale of 1 to 5, (1=low level of learning and 5=high level of learning) estimate to what extent learning beyond the objectives was completed (circle one) Please explain your rating below. Give examples of student behaviors or other indicators of student learning.	5	5	2
	Debate led to many other issues such as global climate change, global warming, world hunger, gas, tax, and fossil fuel farming!	Students discussed uses of alternative energy in and around Merrill, WI. They applied the uses and advantages of these.	These guys did not do much beyond because I gave them some pretty stringent guidelines (see rubric) you could allow for this though.
16. Describe how this activity did or did not contribute to developing energy concepts in the unit you developed.	I incorporated this activity during my intro. To biotechnology unit. The debate brought out genetically modified organisms (algae) to produce "vegetable oils" for biodiesel etc. This was	This unit helped my students begin the process of understanding, renewable and nonrenewable energy types, and the differences between these. Many students farm so for them	We were talking about ecology, so it fit in O.K., but when I do it again, I will more it to our energy unit. This would be a better fit because we talk about renewable and nonrenewable energy.

	an outstanding infusion of "energy" into the unit.	there was the interest of using manure for a biofuels (methane).	
17. Write your overall opinions of and suggestions for this activity (steps that should be added/deleted, teaching strategies that should be incorporated, alternative materials, etc.). You may find it helpful to refer to the questions below.	Outstanding activity overall; however, this activity is dependent on the efforts of the student "research" and maturity of the class to debate properly. With my college bound 11-12 grade students, the debate was outstanding. Younger students (9-10) may need more guidance.	I thought this was a good introductory activity to explaining a biofuels. I liked the fact that it focuses on the pro's and cons of alternative fuels. I would like to push students to search more for a greater variety of sources. I would also like students to analyze the material a little more in depth.	I revised the activity (see attached) to better fir my class environment (which my teacher will do anyhow). All the stuff I changed is in light green. Overall I was satisfied with the activity, but there were some confusing steps which I edited and made a better fit for me.

Results

1. The teacher that gave the activity a "2" on question 15 also wrote that they did not go beyond learning about the objectives because he gave them strict guidelines. No changes based on teacher comments.

Optional: Use the questions below to provide your opinion about the effectiveness of specific activity components. For any item to which you respond "no," please provide suggestions on how to make improvements.

Question	**Teacher A**	**Teacher B**	**Teacher C**
The objectives clearly state what students are to learn.	Yes	Yes	No
			I rewrote them to try and make more clear.
The materials for the activity are easily obtained by the average teacher.	Yes	Yes	Yes

The background is clearly written.	Yes	Yes	Yes
The background helped me prepare for the activity.	Yes	Yes	Yes
The steps of the procedure were easy to follow.	Yes	Yes	No
			I made improvements on the sheet
The procedure can be conducted safely. Ample warnings were given as needed.	Yes	Yes	Yes

Results 1. Teacher C rewrote the activity to fit into an ecology lesson while the other two did not. This is why he made some of the changes. The changes that made the steps of the procedure easier to follow were added to the activity.

Activity - Grasses for the Masses

Questions 1 through 8 are designed to provide an overview about your use of the activity.

Question	**Teacher A**	**Teacher B**	**Teacher C**
1. With what grade(s) did you use this activity?	7	8	
2. Was this activity appropriate for the grade level with which you used it? (circle one) YES NO If no, for what grade levels would it be more appropriate or how would you revise the activity to make it more appropriate for this grade level?	Yes – Very It was perfect!	Yes	
3. In What subject areas would this activity be appropriate (check all that apply)	Life Sciences	Life sciences, Ecology, Environmental Science	
4. How many times did you conduct this	3	6	

activity?			
5a. How much preparation time (acquiring materials, background review, preparing handouts, cutting cards, designing charts, etc.) was required for this activity?	A couple of hours – not including getting materials	Getting seeds 1 hr. Planting 1 hr, water each day – 10 minutes, charts/preparing 2 hours	
5b. Will preparation time be less next time activity is conducted? (circle one) YES NO If yes, predict how long future preparation times will take (provide explanation if desired).	Yes – ½ - 1 hour – not including travel time supplies	2 hours	
6a. How much class time was required to complete the activity?	3 full blocks and extra time for checking plants	Each day measure – 5 min, final day – 47 minutes	
6b. Did you do the activity in one session/period? (circle one) YES NO If no, how many sessions/periods?	Yes, 3+	No, 3	
7. Was the suggested setting appropriate for your teaching situation? (circle one) YES NO If no, identify which setting would be better.	Yes, very	Yes	
8. Please list any trade books, video, poster and musical titles you recommend be added to the **Resources**.			

Results

1. Changed the time required to prepare for the activity to two hours.
2. Noted that teachers can use a dehydrator or oven to dry out the plants.

Use the following question to provide information about activity omissions and alterations.

9. Did you do the activity as written? (circle one) YES NO
If no, please describe major changes or omissions below and provide reasons why.

Teacher A - no

Major Changes or Omissions Made	Why
Worksheet created Intro lesson	Just more appropriate for my class

Teacher B - yes

Major Changes or Omissions Made	Why

Teacher C

Major Changes or Omissions Made	Why

Results

No changes made based on the results.

For questions 10 through 13, indicate if you agree or disagree with the statement by circling the response that best fits your opinion. If you disagree, describe how you would revise the activity to address the problem.

Question	Teacher A	Teacher B	Teacher C
10. I felt comfortable using this activity.	Agree	Agree	
11. Students actively participated in the activity.	Agree	Agree	
12. It appeared my students enjoyed this activity.	Agree	Agree	
13. I would do this activity again.	Agree	Agree	

Results No changes made based on the results.

Use questions 14 through 17 to provide overall comments regarding effectiveness of the activity.

Question	Teacher A	Teacher B	Teacher C
14. On a scale of 1 to 5, (1=low level of learning and 5=high level of learning) estimate to what extent the objectives of the activity were Please explain your rating below. Give examples of student behaviors or other indicators of student learning.	4 We did not go outside to look for grasses.	5 They can explain biomass, understand how it was produced, what makes good biomass.	
15. On a scale of 1 to 5, (1=low level of learning and 5=high level of learning) estimate to what extent learning beyond the objectives was completed (circle one) Please explain your rating below. Give examples of student behaviors or other indicators of student learning.	4+ Discussing on how to make fuels how to save energy.	5 They discussed how fast/slow certain crops grew. They enjoyed seeing the roots. They expressed interest in the mass difference from wet/dry weight.	
16. Describe how this activity did or did not	- Did have the students	We talked about using	

contribute to developing energy concepts in the unit you developed.	examine behavior on how we use energy Can't "sec" how grasses can make fuel or gas.	biomass as a source of fuel today and in the future. It fit in with our study of using wood as fuel; corn (Stanley WI) and the ethanol plant; sugarcane in Brazil, Peat (Ireland).	
17. Write your overall opinions of and suggestions for this activity (steps that should be added/deleted, teaching strategies that should be incorporated, alternative materials, etc.). You may find it helpful to refer to the questions below.	Going to playground – we only have a park next door – no natural grasses – when I take my students camping in May we discuss this more.	We used larger ice cream pails and one class measured plants. Other classes observed each day. Each group measured the grasses masses. The enjoyed using the triple beam balance. I put the grasses in the oven to dry. Students remeasured the mass.	

Results

1. Added large ice cream pails to the materials list.

Optional: Use the questions below to provide your opinion about the effectiveness of specific activity components. For any item to which you respond "no," please provide suggestions on how to make improvements.

Question	Teacher A	Teacher B	Teacher C
The objectives clearly state what students are to learn.	Yes	Yes	
The materials for the activity are easily obtained by the average teacher.	Yes	Yes	

The background is clearly written.	Yes	Yes	
The background helped me prepare for the activity.	Yes	Yes	
The steps of the procedure were easy to follow.	Yes	Yes	
The procedure can be conducted safely. Ample warnings were given as needed.	Yes	Yes	

Results

No changes based on the comments.

Activity - Corn in Your Car

Questions 1 through 8 are designed to provide an overview about your use of the activity.

Question	Teacher A	Teacher B	Teacher C
1. With what grade(s) did you use this activity?	9	9	10&11
2. Was this activity appropriate for the grade level with which you used it? (circle one) YES NO If no, for what grade levels would it be more appropriate or how would you revise the activity to make it more appropriate for this grade level?	yes	yes	yes
3. In What subject areas would this activity be appropriate (check all that apply)	Life Science, Environmental Science, Physical Science, Earth Science, Social Studies,	Environmental Science, Physical science	Tech Ed

	Language Arts		
4. How many times did you conduct this activity?	1	2	10 days
5a. How much preparation time (acquiring materials, background review, preparing handouts, cutting cards, designing charts, etc.) was required for this activity?	4	About 1 ½ hours – most of this time was used for the experiment preparation	About 1 ½ hours
5b. Will preparation time be less next time activity is conducted? (circle one) YES NO If yes, predict how long future preparation times will take (provide explanation if desired).	Yes, the majority of the prep time came from having to research ethanol. I wouldn't need to do as much next time so I'd say about 1 or 2 hours with the experiment.	Yes, could possibly cut it down to an hour since I already know what I need and where it is.	No- finding current articles review current status of ethanol.
6a. How much class time was required to complete the activity?	5 days	1 week of 45 minute classes	10 periods
6b. Did you do the activity in one session/period? (circle one) YES NO If no, how many sessions/periods?	No, 5	No, 1 week	No, 10 days
7. Was the suggested setting appropriate for your teaching situation? (circle one) YES NO If no, identify which setting would be better.	Yes, although this would be very difficult in a smaller community.	yes	yes
8. Please list any trade books, video, poster and musical titles you recommend be added to the **Resources**.	The resources list I was provided was unreadable! There were three articles in our local paper and in the Milwaukee Journal, and the State of the Union Address to use as resources though.	Students found some useful information on the website howstuffworks.com and then searched E85 fuel.	

Results

1. The preparation time was increased to 1.5 hours.

2. The activity time was changed to one to two weeks.

3. Added two Web sites on ethanol to the resources section.

Use the following question to provide information about activity omissions and alterations.

9. Did you do the activity as written? (circle one) YES NO
If no, please describe major changes or omissions below and provide reasons why.

Teacher A - no

Major Changes or Omissions Made	Why
Did not transfer gas station info to a class map.	All of the gas stations in Antigo are on the same street and only 2 had E10, none had E85.

Teacher B - no

Major Changes or Omissions Made	Why
Used one week to do the project instead of two weeks listed Also did not do a community map because there are only 2 gas stations here and neither has E85 fuel – Instead I had them locate the nearest 5 stations with E85 fuel and find out the cost of it.	If given too much time to do a project students will get off task and will wait until the last minute anyway. I did the fermentation experiment with them on the 1st day and they started the research part with the remaining class time. The 2nd day they did the observations then had the rest of the time on the computers. The last three days they had the entire class time to do research and work on the fact sheet/flyer.

Teacher C - no

Major Changes or Omissions Made	Why
Step 4 – create map from research information	Students did a good job of researching stations. Since the 3 towns we surveyed are small (Wild Rose, Wautoma, Waupaca) I didn't think it would serve any purpose to map out stations (the class time could be spent better on something else). A metropolitan area (Madison, Milwaukee) would be okay to map out to see if certain areas do not have ethanol available.

Results

1. Although each of the teachers left the mapping section of the activity out it is noted that they are all from small communities where mapping is not necessary. The mapping section is left in for larger communities. A note was added to the step in the procedure where this part of the activity is conducted.

For questions 10 through 13, indicate if you agree or disagree with the statement by circling the response that best fits your opinion. If you disagree, describe how you would revise the activity to address the problem.

Question	**Teacher A**	**Teacher B**	**Teacher C**
10. I felt comfortable using this activity.	Agree	Agree	Agree
11. Students actively participated in the activity.	Agree	Agree	Agree
12. It appeared my students enjoyed this activity.	Agree	Agree	Agree
13. I would do this activity again.	Agree	Agree	Agree

Results
No changes based on these results.

Use questions 14 through 17 to provide overall comments regarding effectiveness of the activity.

Question	Teacher A	Teacher B	Teacher C
14. On a scale of 1 to 5, (1=low level of learning and 5=high level of learning) estimate to what extent the objectives of the activity were Please explain your rating below. Give examples of student behaviors or other indicators of student learning.	4.5 Students held a graded discussion on the pros and cons of increased ethanol fuel consumption. All of them had an opinion substantiated with evidence from their research.	5 Students remained on task throughout the week, they asked very good questions, they also looked up flex-fuel engine vehicles and their cost as well as comparing the cost per mile of E85 vs. E10.	5 Students were motivated. Some students were special needs [these students were very positive and interested in this activity].
15. On a scale of 1 to 5, (1=low level of learning and 5=high level of learning) estimate to what extent learning beyond the objectives was completed (circle one) Please explain your rating below. Give examples of student behaviors or other indicators of student learning.	4.5 Arguments went beyond environmental factors and into economic and societal factors as well.	4 Many students researched information not required and learned a lot about other ethanol production facilities that use sugar cane instead of corn.	4 Students identified and were very willing to share detailed information concerning the objectives.
16. Describe how this activity did or did not contribute to developing energy concepts in the unit you developed.	We were able to integrate information on the energy changes from the sun to the corn to the ethanol to the car as well as how ethanol fuel may reduce the use of fossil fuels. This was an excellent activity for	I think the students learned a lot about alternative to petroleum and how ethanol is better for the environment and the local economy even though the gas mileage isn't as good for E85. This is a farming	This unit contributed by showing students energy issues are being addressed, right now, and in central WI. Students became aware of problems/issues relating to ethanol; that ethanol is

	helping students realize how important energy usage, production, and sources are to the environment and the economy.	community and I think the kids from farms were surprised at how much corn in WI is currently being used for ethanol production. Since many of the freshmen will be driving soon they also were interested in the flex-fuel vehicles available.	not a magic secret cure all.
17. Write your overall opinions of and suggestions for this activity (steps that should be added/deleted, teaching strategies that should be incorporated, alternative materials, etc.). You may find it helpful to refer to the questions below.	I used this activity in 9th grade physical science. I received the activity and had to do it at a point in our year where it didn't really fit. Despite that, it was well received by the students, parents, and many in the community. I began the activity be doing the "Experimentation in Fermentation" and then discussing ethanol production. I then let the students spend a day on the computers compiling their fact sheets. After that they were assigned a gas station in the Antigo area and told to go to the station to find out as much about their fuel as possible. After 3 days, we listed the stations	I really liked this activity and I learned a lot as well! I used to do a debate on petroleum – pros/cons – is it running out? But there are no longer any pros about it! I have included the handouts I gave to the students – the background information into that we read through together, the experiment data sheet and the requirements for the fact sheet/flyer. Again I would suggest the activity be done in a week – my students had plenty of time to finish during class periods alone. I had my students use Microsoft Publisher for the flyer and many did not know how to use it so a quick lesson on	The activity should address the negative aspects of ethanol in addition to the positive, especially from corn (title of activity). There is only so much corn that can be produced. Students were concerned; about farmland being planted that really shouldn't be planted (marginal land/Wildlife habitat). Less ground in other crops the effect of that (soybeans). Corn burning furnaces. How much fossil energy it takes to make ethanol – should we be going to closed loop systems (methane from ___lots to fuel ethanol plants. Corn

	on the board w/ as much info. As we knew about them. The students used the information from their ethanol fact sheets and from their gas station interviews to hold a graded class discussion on the pros and cons of ethanol-blended fuels. Then they took the ideas they gained from the graded discussion and worked in groups with similar viewpoints to create public address advertisements for the gas stations that sold fuels which fit with their substantiated beliefs. I think this project was very successful in getting my students to think about many of the costs and benefits associated with ethanol-blended fuels, as well as dispelling some myths that they had heard. If I were to do it again I would do it in a unit on energy, and I would skip or replace the "Experimentation in Fermentation." I would	it would be beneficial. I have enclosed copies of student work.	that will not be shipped to starving 3rd world people – gas mileage is less with ethanol, corn feed beef/cattle – will the price go up?, corn can not do everything Overall this is a great activity. I thought so and so did the students all indicated they learned something without my prompting students became very concerned about making ethanol only from corn. They also had many concerns about the overall efficiency of ethanol – production and use in a vehicle. All students recommended the unit be taught to future students! Students were eager to DISCUSS ETHANOL – very eager.

	also alert the gas stations in advance so that they could be prepared to answer students' questions. I would not recommend the gas station part of this activity for small communities because many do not have enough gas stations to really get a meaningful sample of data. A suggestion would be to find the nearest ethanol blended fuel station in that case.		

Results

1. The time for the activity was changed from two weeks to one to two weeks.
2. One teacher commented that the activity should have students address the pros and cons of utilizing ethanol. The closure of the activity includes a section for the students to discuss the pros and cons.

Optional: Use the questions below to provide your opinion about the effectiveness of specific activity components. For any item to which you respond "no," please provide suggestions on how to make improvements.

Question	Teacher A	Teacher B	Teacher C
The objectives clearly state what students are to learn.	Yes	Yes	Yes
	I think an objective stating the economic benefits should be included as well.		

The materials for the activity are easily obtained by the average teacher.	Yes	Yes	Yes
		At first I was worried that they would have a hard time finding info on the internet but this was not a problem at all!	
The background is clearly written.	Yes	Yes	Yes
	But I needed to do a lot more research on my own before being comfortable w/all of the concepts.		
The background helped me prepare for the activity.	Yes	Yes	Yes
	But… see above comment.		
The steps of the procedure were easy to follow.	Yes	Yes	Yes
	Could be a little more organized/scheduled w/ time frames, etc. but I liked the flexibility to do things as I saw fit.		
The procedure can be conducted safely. Ample warnings were given as needed.	Yes	Yes	Yes
		I do very few activities with my freshman classes because they don't understand the concept of dangerous chemicals so I really liked the fermentation experiment because it is safe to do.	

Results

1. One of the objectives was revised from "Students will be able to explain the environmental benefits of ethanol fuels" to "Students

will be able to explain the pros and cons of ethanol fuels."

Activity - Photosynthesis Promenade

Questions 1 through 8 are designed to provide an overview about your use of the activity.

Question	Teacher A	Teacher B	Teacher C
1. With what grade(s) did you use this activity?	4	2	
2. Was this activity appropriate for the grade level with which you used it? (circle one) YES NO If no, for what grade levels would it be more appropriate or how would you revise the activity to make it more appropriate for this grade level?	yes	Yes, we did not spend great time on vocabulary as it is not developmentally appropriate for 2nd grade.	
3. In What subject areas would this activity be appropriate (check all that apply)	Life science, Ecology, Environmental Science	Life science, Ecology, Environmental Science	
4. How many times did you conduct this activity?	Once	1	
5a. How much preparation time (acquiring materials, background review, preparing handouts, cutting cards, designing charts, etc.) was required for this activity?	2-3 hours – time depends on activities conducted	1 hour	
5b. Will preparation time be less next time activity is conducted? (circle one) YES NO If yes, predict how long future preparation times will take (provide explanation if desired).	no	Yes, 45 minutes – less time needed for background review	
6a. How much class time was required to complete the activity?	2 ½ hours	1 hr 45 minutes	

6b. Did you do the activity in one session/period? (circle one) YES NO If no, how many sessions/periods?	No, 4	No, 3	
7. Was the suggested setting appropriate for your teaching situation? (circle one) YES NO If no, identify which setting would be better.	yes	yes	
8. Please list any trade books, video, poster and musical titles you recommend be added to the **Resources**.	There are a number of *Magic School Bus* DVDs that would be appropriate	See web page copy I included *How A Plant Grow*s by Bobbie D. Kalman	

Results

1. Extended the preparation time for the activity to one to two hours from 50 minutes.

2. I added the resources recommended two *Magic School Bus* books on plants and seeds and an additional book on how plants grow.

A link to an activity on the Newton's Apple Web site was added as well from a teacher recommendation.

Use the following question to provide information about activity omissions and alterations.

9. Did you do the activity as written? (circle one) YES NO
If no, please describe major changes or omissions below and provide reasons why.

Teacher A - no

Major Changes or Omissions Made	Why
Step 8	Did not have water plant/elodea available

Teacher B – no for the most part

Major Changes or Omissions Made	Why
We did photosynthesis promenade in our class even though it was suggested for older students. Instead of wearing the color I made nametags the kids wore on a string around their necks to say which component they were I made a big leaf on the floor that served as our stage. I did not do the sun test with the plants in the dark, but we did discuss what happens to plants w/out sun, air, water. We will do this in the spring in our plant unit.	

Teacher C

Major Changes or Omissions Made	Why

Results

1. A suggestion to use nametags instead of colored shirts was added to the activity.

For questions 10 through 13, indicate if you agree or disagree with the statement by circling the response that best fits your opinion. If you disagree, describe how you would revise the activity to address the problem.

Question	Teacher A	Teacher B	Teacher C
10. I felt comfortable using this activity.	Agree	Agree	

11. Students actively participated in the activity.	Agree	Agree	
12. It appeared my students enjoyed this activity.	Agree	Agree	
13. I would do this activity again.	Agree	Agree	

Results
No changes were made from these comments.

Use questions 14 through 17 to provide overall comments regarding effectiveness of the activity.

Question	Teacher A	Teacher B	Teacher C
14. On a scale of 1 to 5, (1=low level of learning and 5=high level of learning) estimate to what extent the objectives of the activity were Please explain your rating below. Give examples of student behaviors or other indicators of student learning.	5 Students were able to explain, demonstrate, and draw out photosynthesis.	5 Kids really understood photosynthesis after we did promenade activity.	
15. On a scale of 1 to 5, (1=low level of learning and 5=high level of learning) estimate to what extent learning beyond the objectives was completed (circle one) Please explain your rating below. Give examples of student behaviors or other indicators of student learning.	5 Students were engaged and enthused about all of the activities	4 Also learned about food chain	
16. Describe how this activity did or did not contribute to developing energy concepts in the unit you developed.	This activity was a great introduction to my plant unit.	The students really understood the concepts of photosynthesis. I did not	

		incorporate it with other energy concepts at this time. I would include this activity in our plant until I normally teach in the spring.	
17. Write your overall opinions of and suggestions for this activity (steps that should be added/deleted, teaching strategies that should be incorporated, alternative materials, etc.). You may find it helpful to refer to the questions below.	This is a great activity. The steps to the promenade need to be spelled out more clearly. I also think you need more reference information for students and teachers alike. Perhaps this will already be in another section. One activity that I did was let the children create their own poem, dance, skit, etc., explaining photosynthesis. They worked cooperatively in groups and did a great job	I taught my students this riddle… "Oxygen comes from plants everyday, while carbon dioxide is taken away". They loved it!! A great activity, there is a lot to it. I didn't even do the whole thing (sun test). They loved the cookie demonstration this reinforced the concept of needing thermal energy-plant needing sunshine.	

Results 1. The steps of the Photosynthesis Promenade were spelled out more clearly.

Optional: Use the questions below to provide your opinion about the effectiveness of specific activity components. For any item to which you respond "no," please provide suggestions on how to make improvements.

Question	**Teacher A**	**Teacher B**	**Teacher C**
The objectives clearly state what students	Yes	Yes	

are to learn.			
The materials for the activity are easily obtained by the average teacher.	Yes	Yes	
The background is clearly written.	Yes	Yes	
The background helped me prepare for the activity.	no	Yes	
	I think there could be more background information about photosynthesis. A handout for the students would also be helpful.		
The steps of the procedure were easy to follow.	No	Yes	
	The Photosynthesis Promenade really needs to be spelled out. Is this to be like a square dance? Perhaps music.		
The procedure can be conducted safely. Ample warnings were given as needed.	Yes	Yes	

Results

1. Photosynthesis diagram for the students was made.
2. The resources that were added from the comments made in questions 8 will supply the teacher with additional background material.

Appendix N
Comprehensive Review Cover Letter

June 28, 2007

Randy Champeau
CNR
Stevens Point, WI 54481

Dear Randy:

You have just received the most recent draft of KEEP's forthcoming publication, *BioFutures*. We request that you conduct a comprehensive review so we can prepare the guide for publication. We would appreciate if you would complete your review by July 12 and return it in the envelope provided. If you make any marks, suggestions, or comments in any part of the guide, please mail the entire guide to us and we will reimburse postage.

The purpose of this review is for you to provide us with your overall comments about the entire guide (all the activities, the introductory matter, and the appendices). See the enclosed Comprehensive Review Form for guiding questions. Content experts and classroom teachers have already reviewed the activities. All the materials that will be in the published guide are included in this draft. This guide will also be available online and additional reference materials and fact sheets will be provided online.

The activities in this draft have gone through proofreading and will go through a second proofread. Please spend your time reviewing the overall content instead of proofreading to save yourself some time.

Thank you very much for your prompt and thoughtful attention to this review. Your comments will help us improve the quality of the guide. If you have any questions, please contact me (715.346.4651; cziolkow@uwsp.edu).

Sincerely,

Carrie Ziolkowski
KEEP, Program Coordinator

Appendix O
Comprehensive Review Form

Comprehensive Review for KEEP's *BioFutures*
Feedback Form

On the back of this form or on a different page, please provide your overall comments about the guide (include strengths, limitations, how it compares to similar educational materials, etc.).

Below are listed several items to consider in your review. You may answer these questions within your overall review or answer each question individually.

- ➞ Before beginning, consider what you expect this guide to contain, especially considering specific concepts or themes that you think are critical to biomass energy education. After completing your review, were your expectations met?

- ➞ Will this guide—including the introductory materials, activities, and appendices—help educators select and organize lessons to address biomass energy-related themes and concepts?

- ➞ Will the guide help teachers address Department of Public Instruction Academic Standards?

- ➞ Please provide comments on the guide size, organization, and content. Consider the following:
  - Is the organization of the activities the most useful arrangement for educators? If not, how would you prefer the activities to be organized?
  - What are your opinions about the guide's length?
  - What are your perceptions of the cohesiveness of the entire guide? Is there a logical flow between and among the front, middle, and back materials?

- ➞ Would you use this guide in the context of your work? If so, how? If not, why not?

- ➞ Although this is a comprehensive review, please take a few minutes to examine the glossary and resources. If you can think of any corrections or additions to these sections, please let us know.

Appendix P
Feedback from the Comprehensive Review

Question	Floyd Henschel	Don Wichert	Randy Champeau
Before beginning, consider what you expect this guide to contain, especially considering specific concepts or themes that you think are critical to biomass energy education. After completing your review, were your expectations met?	Ethanol is a huge issues and your publication had good emphasis on the topic. I've included a picture to help students understand the process in an ethanol plant – may be helpful as well (attached).		Yes Some definitions vague. Seem to include expected information.
Will this guide—including the introductory materials, activities, and appendices—help educators select and organize lessons to address biomass energy-related themes and concepts?	I think so – it is a good start for those teachers looking for meaningful biomass energy activities & materials with good references.		Yes
Will the guide help teachers address Department of Public Instruction Academic Standards?	Yes – they are listed and should be familiar with DPI Academic Standards in their area of expertise.		Yes
Please provide comments on the guide size, organization, and content. Consider the following: • Is the organization of the activities the most useful arrangement for educators? If not, how would you prefer the activities to be organized? • What are your opinions	OK – my only suggestion was to move the concepts to be compatible with KEEP's Activity Guide for NR 730. Nice and compact and to the point. Yes – again except		Yes, ok Ok Yes but the theme should be addressed in each activity. I am not sure Activity One Photo. Syn. Prom. – makes an obvious connection to your theme of biofuels?? Even if it is for K-4.

about the guide's length? • What are your perceptions of the cohesiveness of the entire guide? Is there a logical flow between and among the front, middle, and back materials?	for the conceptual framework section.		
Would you use this guide in the context of your work? If so, how? If not, why not?	Yes – I already introduce ethanol in my NR 730 course. I would make teachers aware of KEEP's new publication coming out on BioFutures in future courses.		Yes
Although this is a comprehensive review, please take a few minutes to examine the glossary and resources. If you can think of any corrections or additions to these sections, please let us know.	See glossary for my suggestions.		OK – you may want to put vocabulary words in bold. Biofuel Beliefs – you need to tell people where to find the articles! E.g. "History of Ethanol Production"
Other comments	Celery activity is very god as well as Corn in Your Car. – Ethanol plant waste can be used as cattle feed!! Wood heat is an informative activity. Excellent photos. Landfill activity will have more meaning with a fieldtrip or slide presentation. Students must be aware of what we all throw away and where it ends up.	Various comments made within the document. Corrects were made to biomass information in the actual activities.	

Appendix Q
BioFutures

(NOTE: The document, *BioFutures*, has been reduced in size to accommodate the required margins of this thesis.

BioFutures

A Biomass Energy Education Supplement to the KEEP Activity Guide

focus on energy
The power is within you.

BioFutures

A Biomass Energy Education Supplement to the KEEP Activity Guide

focus on energy
The power is within you.

BioFutures

A Biomass Energy Education Supplement to the KEEP Activity Guide

BioFutures is a supplement to the KEEP *Activity Guide* and *Doable Renewables*. The supplement can be used as a stand-alone unit, but will be enriched if used in conjunction with the KEEP *Activity Guide* and *Doable Renewables*. References to the guide and suggested complementary activities are provided throughout this supplement. If you are interested in participating in a KEEP inservice, please contact the KEEP office at **WCEE, LRC, UWSP, Stevens Point, WI 54481** or call **715.346.4770** or **Email: energy@uwsp.edu** for more information.

Wisconsin K-12 Energy Education Program (KEEP)
Wisconsin Center for Environmental Education
University of Wisconsin-Stevens Point
Stevens Point, WI 54481
Phone: 715.346.4770
Fax: 715.346.4698
Email: energy@uwsp.edu
www.uwsp.edu/keep

KEEP Staff

Jennie Lane Director
Melissa Rickert Outreach Specialist
Carrie Bea Ziolkowski Program Coordinator
Sara Windjue Energy Education Specialist
Jamie Hiler Program Assistant

Renewable Energy Education Production Team

Production Manager: Carrie Bea Ziolkowski
Production Advisors: Randy Champeau, Jennie Lane, Dennis Yockers, Michael Demchek
Writers: Sara Windjue, Carrie Bea Ziolkowski
Proofreaders:
Graphic Design: Carrie Bea Ziolkowski
Printing:

KEEP Advisory Committee Members

Randy Champeau (chair) Director, Wisconsin Center for Environmental Education
Peter Hewson Professor of Curriculum and Instruction, UW-Madison
Jim Jenson Community Education Coordinator, Madison Gas & Electric
Kathy Kuntz Director of Energy Programs, Wisconsin Energy Conservation Corporation
Shelley Lee Science Education Consultant, Department of Public Instruction
Pat Marinac Teacher Induction and Staff Development, Appleton Area School District
Andrea Minniear Education Outreach Services, Energy Center of Wisconsin
Tehri Parker Executive Director, Midwest Renewable Energy Association
Jacquelyn Peck Education Outreach, We Energies
Charlie Schneider Sector Manager, CESA 10 and Focus Schools & Government Program
Chris Schultz-Buechner Director of Corporate Communications, Focus on Energy
Dan Sivek Professor of Environmental Education, UW-Stevens Point
Kelly Zagrzebski Public Affairs, Wisconsin Public Service Corporation

BioFutures Sponsorship

Focus on Energy
Wisconsin Center for Environmental Education
Wisconsin Department of Administration
United States Department of Energy

KEEP Adjunct Faculty

Pat Arndt High School Teacher, Berlin
Janie Besharse Lecturer, UW-Milwaukee
Terrie Cooper Land Program Director, Door County Land Trust
Cynthia Edlund High School Teacher, Crandon
Jack Finger Retired Teacher, Waukesha School District
Jeanine Gelhaus Middle School Teacher, Medford
Floyd Henschel Retired Teacher, Beaver Dam School District
Jenny Hermans Energy Analyst, GDS Associates
Michelle Gransee-Bowman Energy Educator
Jim Jenson Community Education Coordinator, Madison Gas & Electric
Stephen Knudsen High School Teacher, Wausau
Bobbi Kubish CNR International Programs Coordinator, UW-Stevens Point
Scott Liddicoat High School Teacher, Green Bay
Pat Marinac Teacher Induction and Staff Development, Appleton Area School District
Ted May Academic Dean, Wisconsin Indianhead Technical College
Tehri Parker Executive Director, Midwest Renewable Energy Association
Charlie Schneider Sector Manager, CESA 10 and Focus Schools & Government Program
Alexandria Setter Gifted and Talented Teacher, Pewaukee
Dennis Weibel Retired Teacher, Menomonie School District
Dan York Senior Research Associate, American Council for an Energy Efficient Economy
Kelly Zagrzebski Public Affairs, Wisconsin Public Service Corporation

Acknowledgments

Conceptual Framework Reviewers

Sarah Gilbert Wisconsin Center for Environmental Education, Stevens Point
Jennie Lane Wisconsin K-12 Energy Education Program, Stevens Point
Clay Sterling Midwest Renewable Energy Association, Custer
Don Wichert Focus on Energy, Madison

Scope and Sequence Contributing Educators:

Rebecca Bestul Eau Claire North High School, Eau Claire
Lisa Braun Cumberland High School, Cumberland
Myron Buchholz Memorial High School, Eau Claire
Lewis Gunderson Cadott Elementary, Cadott
Darla Kruschke Valley Christian School, St. Croix Falls
Mary Luhman Sherman Elementary School, Eau Claire
David Misner Menomonie Middle School, Menomonie
Gregory Niemuth Memorial High School, Eau Claire
Karen Possley Stanley-Boyd High School, Stanley
Ryan Schneider School District of Cadott, Cadott
Maureen Skroski Sherman Elementary School, Eau Claire
Jean Van Houten Longfellow Elementary School, Eau Claire

Activity Pilot & Pedagogical Reviewers

Pat Arndt Berlin High School, Berlin
Jill Bell Trinity Lutheran, Mequon
Laura Beyer Holy Rosary School, Medford
Michelle Carpenter Abbotsford High School, Abbotsford
Rochelle Cummings Phillips Elementary, Phillips
Deb Dicks Roosevelt Middle School, Appleton
Ned Dorff Nicolet Elementary School, Green Bay
Lori Eisch Abbotsford Elementary School, Abbotsford
Eric Elmhorst Edgar High School, Edgar
Jennifer Elmhorst Abbotsford Elementary School, Abbotsford
Jeanine Gelhaus Medford Middle School, Medford
Will Gomez School District of Abbstoford, Abbotsford
Dean Hoegger Sawyer Elementary School, Sturgeon Bay
Jeremie Johnson Denmark High School, Denmark
Lisa Kirker Colby Middle School, Colby
Jeff Kujawa Almond-Bancroft School, Almond
Sally Lew Abbotsford Elementary School, Abbotsford
James Limmex Edgar High School, Edgar
Jody Mader Medford Elementary, Medford
Daniel Moreno Antigo High School, Antigo
Mary Nelson Athens High School, Athens
Cathy Ordemann Merrill High School, Merrill
Cindy Reetz Thomas Jefferson Middle School, Port Washington
Jennifer Steinhaus Wilson Junior High School, Manitowoc
Lisa Thompson Abbotsford Elementary School, Abbotsford
Laurie Voelker Fritsche Middle School, Milwaukee
Joan Wahlquist Wausau School District, Wausau

Content Reviewers

Alex DePillis Seventh Generation Energy Systems, Madison
Paul Fix Indian Trail Academy, Kenosha
Anna Haines University of Wisconsin–Stevens Point
Nick Hylla University of Wisconsin–Stevens Point
Larry Krom Focus on Energy, Renewable Program (L&S Technical Associates, Inc.), Spring Green
Shelly Laffin Focus on Energy, Renewable Program (L&S Technical Associates, Inc.), Spring Green
Angela Lemar Wisconsin Center for Environmental Education, Stevens Point
Tony "T.J." Morice Marsh Wood Supply, Marathon
Maria Redmond Wisconsin Department of Agriculture, Madison
Josh Stolzenberg Seventh Generation Energy Systems, Madison

Comprehensive Reviewers

Randy Champeau Wisconsin Center for Environmental Education, Stevens Point
Don Wichert Focus on Energy, Madison

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 is administered through the Wisconsin Center for Environmental Education and funded through Focus on Energy. This guide, in part, is the property of the State of Wisconsin, Department of Administration, Division of Energy, and was funded through the Focus on Energy Program. Focus on Energy works with eligible Wisconsin residents and businesses to install cost effective energy efficiency and renewable energy projects. Focus on Energy information, resources, and financial incentives help to implement projects that otherwise would not get completed, or to complete projects sooner than scheduled. Its efforts help Wisconsin residents and businesses manage rising energy costs, promote in-state economic development, protect our environment, and control the state's growing demand for electricity and natural gas. For more information call 800.762.7077 or visit focusonenergy.com.

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 Courses 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 courses increase teachers' energy literacy and increases the likelihood that they will implement KEEP materials in their classrooms.

Web-based Energy Literacy Courses: Energy education and renewable energy education via the Internet; the content of these interactive courses are available at no charge to teachers year-round via the KEEP Web site and are offered for credit during the year.

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

Statewide Network of Energy Educators: KEEP provides continued support for teachers through updates (print and online newsletters, Web site, 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 Biomass Energy Education

For over ten years, the Wisconsin K-12 Energy Education Program (KEEP) has been working with teachers, administrators, and energy resource managers to increase and improve energy education in Wisconsin schools. The KEEP *Activity Guide* and other services and support materials provide Wisconsin students of every grade level the opportunity to receive a logically sequenced, comprehensive education about energy.

Energy education can help students of today handle many of the energy resource issues and opportunities our nation faces. We have challenging energy decisions ahead of us, and the solutions will include a mix of energy efficiency measures, new technologies, and renewable resources. These decisions will need to be made by educated individuals who have a solid understanding of energy basics, including the pros and cons of both renewable and nonrenewable resources.

Understanding energy issues can help students prepare for the future in Wisconsin, the United States, and global communities. Wisconsin does not contain oil, coal, or natural gas reserves and is at the mercy of other states and nations for our energy needs. As the shift to renewable energy approaches, Wisconsin has to take stock of the renewable resources that are available. The most utilized renewable energy resource was wood burning in homes and industry.

Wisconsin is rich in biomass resources including; closed landfills, animal manure, crops such as corn and soybeans, and forested land. Biogas is currently being produced at waste water treatment facilities, closed landfills, and large dairy farms. The use of ethanol, an alternative fuel made from corn, is increasing due to the increased cost of gasoline and pollution regulations placed on six southeastern counties in Wisconsin. Biodiesel is being made in large facilities and by motivated individuals throughout the state for their own use. The uses of more biomass energy forms are likely to increase as time passes.

Maria Boardman, the program coordinator for the Wisconsin Alternative Fuels Task Force, stated that, "the development of a curriculum to educate our youth is a step forward in including everyone in the effort to increase awareness on our state's energy, economic, environment, public health, and transportation needs". Boardman is specifically interested in the development of activities that increase student awareness about biodiesel and the ethanol fuel blend E85.

Don Wichert, the Director of the Focus on Energy Renewable Energy Program, said, "it is important to educate students today about using this locally available resource." Before working with Focus on Energy, Wichert was the Chief of the Energy Resources section of the Wisconsin Division of Energy and is considered one of the foremost experts on renewable energy in Wisconsin.

The Wisconsin Department of Administration (DOA), Division of Energy worked with KEEP to apply for a United States Department of Energy grant relating specifically to biomass. KEEP and the DOA proposed to develop a biomass activity guide along with a bookmark contest and public service announcement contest with a biomass theme. The grant was awarded to the DOA and KEEP.

Development of BioFutures

A Biomass Energy Education Supplement to the KEEP *Activity Guide*

In 1997, KEEP developed a conceptual framework for energy education. This framework identified key concepts in energy education that students should learn and understand to become energy literate. They were divided into four themes, with the first theme focusing on fundamental concepts and subsequent themes building on the first and each other toward effective energy resource management practices. For more information about the conceptual framework and its development, visit the KEEP Web site and select *Resources*.

In 2002, KEEP decided additional concepts addressing renewable energy were needed. Focus groups consisting of teachers and energy resource managers determined that while the first theme adequately covered concepts needed for renewable energy literacy, additional concepts were needed for the remaining three themes.

Using the Delphi process, energy resource managers from around the state helped identify and validate concepts for the revised conceptual framework. The process involved participants reviewing and ranking the proposed list of additional concepts. Their responses were used to prioritize and revise the concepts. The experts then reviewed the list again and agreed that the revised framework effectively addressed the needs of renewable energy education literacy.

The KEEP framework includes renewable energy education concepts in Themes II, III, and IV. This framework directed the development of *BioFutures*. To develop the supplement, teachers participated in a scope and sequence workshop and identified activities that addressed renewable energy concepts in the framework (for Themes II, III, and IV). Given the grade level emphasis appropriate for each of the themes (see below), the activity selection process resulted in activities geared mainly for middle and high school students. Understanding the details of biomass energy development, consumption, and management involves higher level skills more appropriate for older students. Therefore, while there are activities included for elementary students in the supplement, most of the activities are for secondary education teachers.

It is very important, however, that students experience activities related to concepts in Theme I to understand renewable energy and biomass energy concepts. Moreover, it is crucial that students gain an appreciation for renewable energy resources at an early age. This early awareness will support their further explorations of biomass energy resource development and use. *BioFutures* includes several activities that will support awareness of biomass energy resources. Finally, the KEEP *Activity Guide* contains a number of Theme I activities. Teachers can contact the KEEP office to learn how to obtain this guide if they would like a copy.

Following is further explanation of the development of *BioFutures*.

The development of *BioFutures* occurred in six stages. Each of these stages included an evaluation process to ensure that the supplement successfully promotes renewable energy education.

Stage 1: Conceptual Framework. A review of the KEEP *Conceptual Framework* was conducted to assess if additional concepts were needed for the development of a biomass energy curriculum. The environmental educators and energy resource managers that reviewed the document determined that the existing framework had the necessary concepts for the development of a biomass energy curriculum.

Stage 2: Scope and Sequence. KEEP conducted a Biomass Energy Scope & Sequence Workshop, involving K-12 teachers. These educators expanded the conceptual framework into a scope and sequence, identifying the grade levels and subject areas in which the concepts should be introduced, developed, and mastered. These teachers also reviewed existing energy curriculum and activity guides to identify potential activities to fit within the scope and sequence.

Stage 3: Activity Format. The activity format for *BioFutures* is based on the KEEP *Activity Guide* and *Doable Renewables* format that was previously developed, reviewed, and evaluated.

Stage 4: **Activities.** *BioFutures* activities were selected based on reviews of published energy education resources. The reviews were conducted by Wisconsin K-12 teachers. KEEP staff drafted, reviewed, and revised activities.
Evaluation Process: Content Review. After activities were drafted, they were reviewed for content accuracy. An expert in a field relevant to the concepts in the activity evaluated its Background and Procedure for content thoroughness and accuracy. Activities were revised based on these professionals' recommendations.
Piloting and Teacher Review. Each activity was given to two or three classroom teachers to pilot in a classroom. Teachers were given a review form that guided them in assessing the activity for grade-level appropriateness, ease of accomplishment, and success in achieving intended objectives. KEEP staff once again revised the activities based on the reviewers' suggestions.

Stage 5: **Supplement Design.** After the activities were revised, they were put in table of contents order. The KEEP staff then drafted the front and back matter for the supplement (Introduction and Appendix).
Evaluation Process. Biomass energy and educational professionals conducted a comprehensive review of the supplement. The purpose of this review was (1) to examine the extent to which important energy concepts were covered in the activities and (2) to assess the supplement's cohesiveness and level of organization. KEEP staff then made final revisions to the supplement.

Stage 6: **Pilot and Revise.** The first publication of *BioFutures* was piloted by K-12 teachers throughout Wisconsin.
Evaluation Process: *BioFutures* was piloted with Wisconsin K-12 educators to assess the effectiveness.

Dissemination of BioFutures

BioFutures is being disseminated through KEEP's Web site: www.uwsp.edu/keep. Select *Resources* for the link to *BioFutures*.

Contents

Introduction

BioFutures, the KEEP biomass energy supplement provides K-12 teachers in a variety of subject areas with easy-to-use, hands-on, minds-on activities designed to promote energy literacy in Wisconsin students. The Wisconsin Department of Public Instruction's Academic Content and Performance Standards were referenced during the development of this supplement.

Grade Levels and Theme Emphasis

Concepts within all the themes from the KEEP *Conceptual Framework* are relevant to teachers at any grade level and in a variety of subject areas (see Cross-Reference Charts: Grade Levels and Subject Areas in Appendix). However, when building a K-12 renewable energy education program, certain themes can be stressed at different grade levels. For more information about the KEEP *Conceptual Framework*, visit the KEEP Web site and select *Resources.*

Participating in activities from **Theme I: We Need Energy** provides students with a fundamental knowledge about energy. The concepts within this theme are the foundation upon which concepts in the other three themes are built. Therefore, We Need Energy should be emphasized in grades K-5. The KEEP *Activity Guide* as well as KEEP's Renewable Energy Web site offer a variety of lessons and ideas for supporting student learning of Theme I energy concepts.

Activities and teaching ideas from **Theme II: Developing Energy Resources** have students identify and look at different sources of energy. These concepts are appropriate for the elementary grades, especially grades 3-5. However, other concepts within this theme require higher level thinking skills because students must interpret and examine the process of energy resource development. Therefore, many of the activities from this theme pertain to students in middle school.

Awareness of how renewable energy use positively and negatively affects quality of life, economic activity, and the environment can begin during the primary grades; however, because of the complexity of many issues, these concepts may be better introduced at a later stage. The majority of the activities within **Theme III: Effects of Energy Resource Development** are appropriate for the middle school years. High school students can take what they have learned earlier and use the knowledge and skills to conduct special projects (see Appendix). Educators can teach younger students the importance of renewable energy use. However, younger students may not comprehend the reasoning behind these efforts until they learn to think more abstractly.

The higher level thinking skills (such as linking economic activity and energy flows, linking environmental impacts and energy flows, and extrapolating how today's actions could affect the availability of energy resources tomorrow) are best suited for more mature students. Consequently, most of the activities from **Theme IV: Managing Energy Resource Use** are designed for middle and high school students. By the time students graduate from high school, they should have mastered the concepts and learned lessons from the world around them. These competencies will enable them to make wise decisions regarding energy choice, to understand the workplace and career opportunities and associated school-to-career elements, and to take actions that reflect their personal ethic and knowledge of energy.

Types of Activities

Activities in *BioFutures* are fully developed activities that provide educators with background information, explicit objectives, a detailed procedure, and assessment strategies. They are designed to be self-contained lessons. Background information is usually found within the activity; occasionally other sections of the guide may be referenced. Most activities require some preparation time to locate and set up materials; however, this time should decrease with successive uses. For the most part, the materials for the activity should be available in local stores or within the school.

Introduction

Integrating Energy Concepts

Concepts in *BioFutures* are applicable to teachers of Science, Mathematics (Math), Social Studies (SS), English/Language Arts (ELA), Technology Education (TE), Environmental Education (EE), and Family and Consumer Education (FCE), or to anyone who wants to promote energy as part of their curriculum. Educators can use KEEP Cross Reference Charts to identify activities relevant to a variety of their teaching needs, such as Subject Areas and Grade Level. KEEP activities can be used to address the Academic Content and Performance Standards developed by the Wisconsin Department of Public Instruction. These standards identify what students should understand and how they should demonstrate achieved learning. For more information about state standards, contact the Wisconsin Department of Public Instruction, P.O. Box 7841, Madison, WI 53707-7841, www.doa.state.wi.us.

In addition to the various Cross Reference Charts, educators and curriculum developers can refer to the Suggested Scope and Sequence in the Appendix that provides guidelines showing when and to what extent energy concepts could be integrated into school curricula. For example, teachers can use the Scope and Sequence to identify the concepts appropriate for their subject and grade level. The next step for educators is to determine which of these concepts are already included in and which are lacking from their curricula. Activities found within *BioFutures* provide teachers with opportunities to bring these energy concepts into their curricula.

Assessing Student Learning

BioFutures provides several approaches for assessing student learning. It is helpful to assess students' current understandings and misconceptions about energy. Orientation of each activity procedure provides suggestions for ascertaining what students know about the upcoming lesson. Formative and Summative Assessment ideas are located within each theme activity. Formative Assessment points out times during the activity when educators can check their students' achievement of the objectives. Summative Assessment takes place near the end of the activity or after the activity's completion. The aim of Summative Assessment is to determine if students can take what they have learned and apply it to a different experience.

Activity Format

Summary: Briefly describes student learning and activity procedure.

Grade Level: Suggested grade levels: K-4, 5-8, 9-12

Subject Areas:
Relevant subject areas.

Setting:
Recommended location.

Time:
Preparation: Approximate time needed to review background information and set up materials.
Activity: Average class time needed to conduct the activity.

Vocabulary:
Key terms introduced or used in the activity.

Major Concept Areas:
Lists the major concepts covered in this activity.

Getting Ready:
Directions for preparing materials or setting up demonstrations prior to conducting the activity with students.

Academic Standards:
A list of standards that can be tied to the activity.

Resources:
A list of books or Web sites that relate to the activity.

Related KEEP Activities:
Theme activities that can precede, supplement, or follow this activity.

Objectives
Knowledge and skills students will acquire as a result of doing the activity.

Materials
Items needed for the activity. Any necessary preparation of materials is described in Getting Ready.

Background
Description of energy topics and concepts addressed in the Procedure.

Procedure
Orientation
Discussion topics that can be used to relate forthcoming concepts to students' lives and to assess what students currently know about the concepts in the activity.

Steps
Suggested strategy for completing the activity. Written instructions and materials for students are found on separate Student Activity Sheets directly following the activity.

Closure
Discussion topics that can be used to conclude the activity and to assess what students have gained from participating in the activity.

Assessment
Formative
Questions about student actions that occurred during the activity.

Summative
Suggested activities that have students applying learned information or skills to new situations.

Extensions
Variations and additions to the activity.

Activities

Summary: Students simulate the process of photosynthesis through a whole-body demonstration.

Photosynthesis Promenade

Grade Level: (K-2) 3-4

Subject Areas:
Science, Dance, Environmental Education

Setting: Classroom

Time:
Preparation: One - two hours
Activity: three 50-minute periods

Vocabulary: Carbohydrate, Carbon dioxide, Chemical potential energy, Chlorophyll, Glucose Greenhouse, Heat, Light, Light energy, Molecule, Oxygen, Photosynthesis, Solar energy, Sun, Synthesis, Thermal energy

Major Concept Area:
Theme I
• Energy Flow in Living Systems

Related KEEP Activities:
Use "Photosynthesis Promenade" to enhance the KEEP activities "Food Chain Game" and "Energy from Food" (KEEP *Activity Guide*) and to help students have a better understanding of how energy is stored in food and is transferred to humans when we eat.

Academic Standards:
Science: D.4.4, F.4.1, F.4.2
EE: B.4.1

Objective

Students will be able to illustrate how plants use the sun's energy to make food.

Materials:

- Picture or drawing of an animal such as a rabbit (optional)
- Growing plants that have turned their leaves toward the light (optional)
- Fruits and vegetables
- Journals and writing implements,
- Photographs of magnified leaf cells showing chlorophyll (optional)
- Props and materials for Photosynthesis Promenade (optional)
- Ingredients and equipment for making chocolate cookies (optional)

Background

Photosynthesis is the process by which green plants use sunlight to produce carbohydrates such as glucose, other nutrients, and oxygen from simple compounds such as water and carbon dioxide. In energy terms, photosynthesis converts solar energy into chemical potential energy that is stored in carbohydrates.

Photosynthesis occurs when water is absorbed by the roots of the plant and is then carried to the leaves. Carbon dioxide then enters the plant through the leaves and goes into the plant cells that contain chlorophyll. Chlorophyll is the green pigment found in the chloroplasts of plants that are essential for producing carbohydrates by photosynthesis.

Photosynthesis gives off oxygen and takes in carbon dioxide while people take in oxygen and give off carbon dioxide. This makes photosynthesis a great example of how people and plants depend on each other.

Procedure

1. Put a picture of a rabbit on the board (or write the word) and ask students to complete a food chain around the rabbit. For example, they might show the rabbit eating a carrot that gets its energy from the sun and list a predator, such as a hawk, that eats the rabbit.

2. Have students explain what is happening between the links of the food chain, starting between the predator and the prey. They will probably be able to describe how the hawk eats the rabbit and the rabbit eats carrots, but how do they explain the connection between the sun and the carrot (or any plant)?

3. Ask students how they know plants need sunlight. Have students share their observations and thoughts about plants needing the sun. For example, students may have noticed how some plants turn their leaves toward the light. You might want to involve students in an investigation in which they prove plants need sunlight to survive. See **Suggested Sun Test Procedure** (see page 7) for ideas.

4. Students might know that plants need sunlight, but do they know how plants use the light? Have students provide explanations for how they think plants use sunlight. List their responses on the board.

5. Explain to students that sunlight helps the plant take air particles (carbon dioxide) and water and recombine them to build sugar particles (or molecules). Oxygen that we breathe is also created in the process.

6. Introduce the term photosynthesis. Students should recognize the root word "photo." Ask what they think it means. Help them understand that it means light. Students might also have heard the word synthesis or a related term, such as synthetic. Explain that to synthesize means to create or to make. See if students can use these explanations to develop a definition for photosynthesis. Make sure water, air, sun, sugar, and oxygen are included in the definition.

7. Have samples of fruit and vegetables handy that students can eat to taste the sweetness. Show students some plants and explain that plants use the sugar they create and other minerals from the soil to build their body structures (roots, stems, leaves, and fruit).

8. Explain that most plants are green because they contain a chemical called chlorophyll. This chemical helps the plant use the sun's light to make sugar out of water and air. If one is available, show students a picture of a magnified leaf cell with chlorophyll, or ask a biology teacher to let students look through a microscope at a leaf. You'll need to use a thin leaf such as one from a water plant or an elodea.

9. Involve students in simulating how water and air particles are recombined into sugar. Younger students can gain insight into the process of how materials are recombined to create something new through the **Chocolate Chip Demonstration**. Older students can participate in the **Photosynthesis Promenade**. For the promenade, students might be interested in adapting the simulation into a dance or play with costumes and props. For example, students representing chlorophyll can be dressed in green (or use colored nametags) and those representing the sun can be dressed in yellow and carry flashlights. A simple stage can be created to represent the leaf. Make sure students understand that this is a simple demonstration and does not represent the actual chemical process, which is very complex. If you do the simulation as a dance, consider playing music.

Assessment

- Have students revisit the food chain they created at the beginning of the lesson. Ask them to explain what is happening between each link, especially between the sun and the plant. Listen to see if they use the term photosynthesis.
- Ask students to define and describe photosynthesis.
- Have students draw a picture or write a simple story about the role of the sun on the life stages of a plant. Check to see if students describe how the sun helps the plants make food out of carbon dioxide and water.

Suggested Sun Test Procedure

Ask students how they can prove that a plant will die without sunlight. If they suggest shutting a plant in a dark closet, what other things might the plant not get that could contribute to the plant's death? Help them to understand that if the plant is not watered or if it does not get air, it will also die. Students need to make sure they are testing for only one item or variable. Encourage students to develop their own test to show that plants need sunlight. Below is one procedure they might follow. Plant seeds (bean or pea plants are recommended) and grow them to a few inches in height. Then allow one plant (the control) access to sunlight, water, and air. Have another plant get air and water, but no sunlight (put the plant in a dark closet). Let the third plant get sunlight and water, but no air (cover the plant with a plastic bag). Provide the fourth plant with sunlight and air, but no water. Make careful observations in a journal of what happens to each plant.

Chocolate Chip Demonstration:

To help students appreciate how air and water are recombined to create sugar, show students a chocolate chip cookie and ask them how they think it is made. Describe how a cookie is prepared from scratch (or involve students in baking cookies). Explain (or show) that the different ingredients such as butter, flour, chips, sugar, water, etc. are combined, but that they do not actually become cookies until thermal energy (heat) is added. This process is much like a plant using sunlight to recombine carbon dioxide and water to make sugar.

Resources:

Books

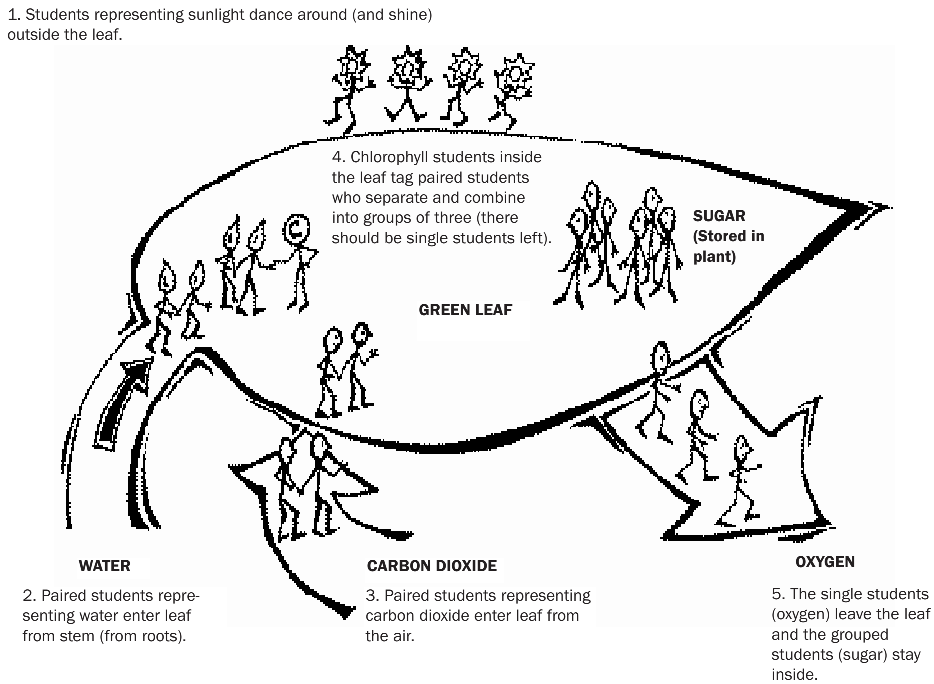
- The Magic School Bus Plants Seeds: A Book About How Living Things Grow, Joanna Cole (Created by Bruce Degen and Patricia Relf)
- The Magic School Bus Gets Planted: A Book About Photosynthesis, Joanna Cole (Created by Bruce Degen)
- How a Plant Grows, Bobbie D. Kalman

Web sites

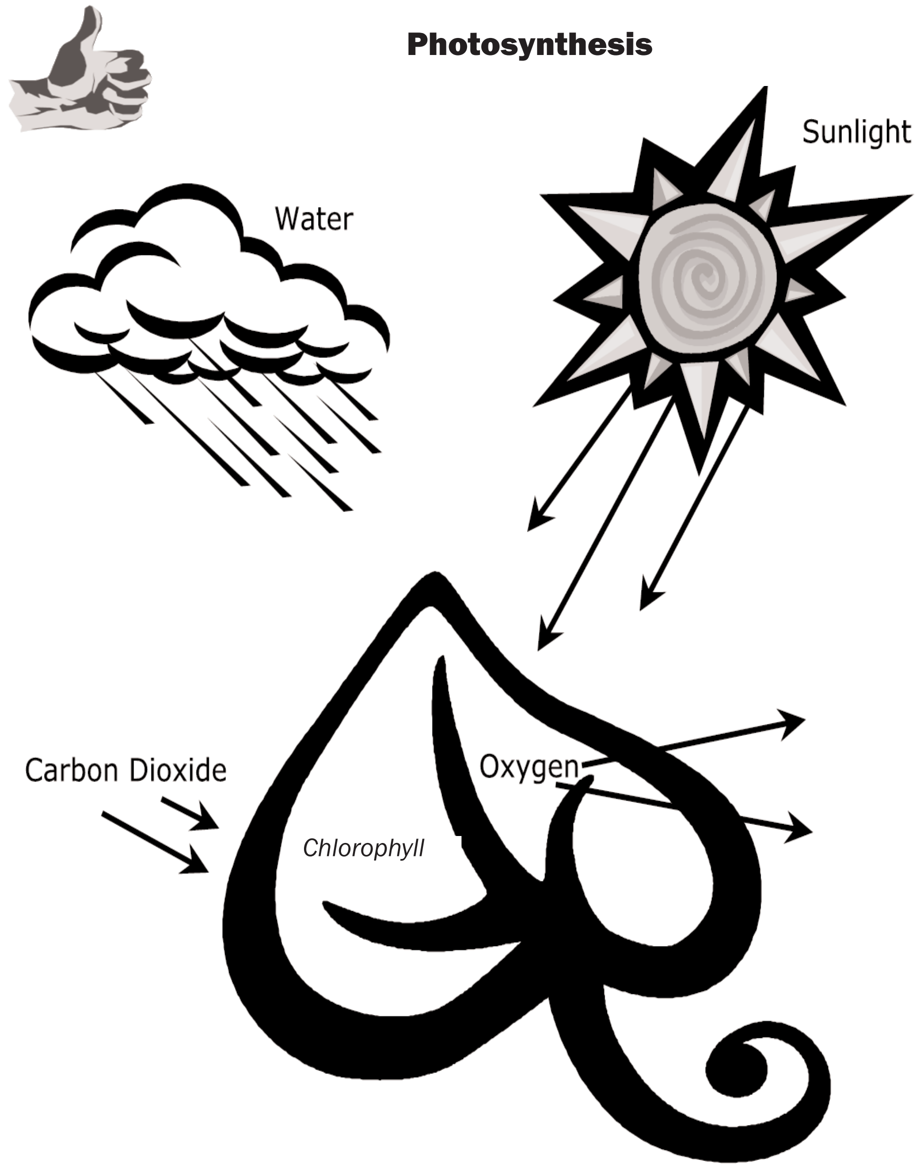
- Newton's Apple Web site, www.newtonsapple.tv/TeacherGuide.php?id=915

How to do the Photosynthesis Promenade

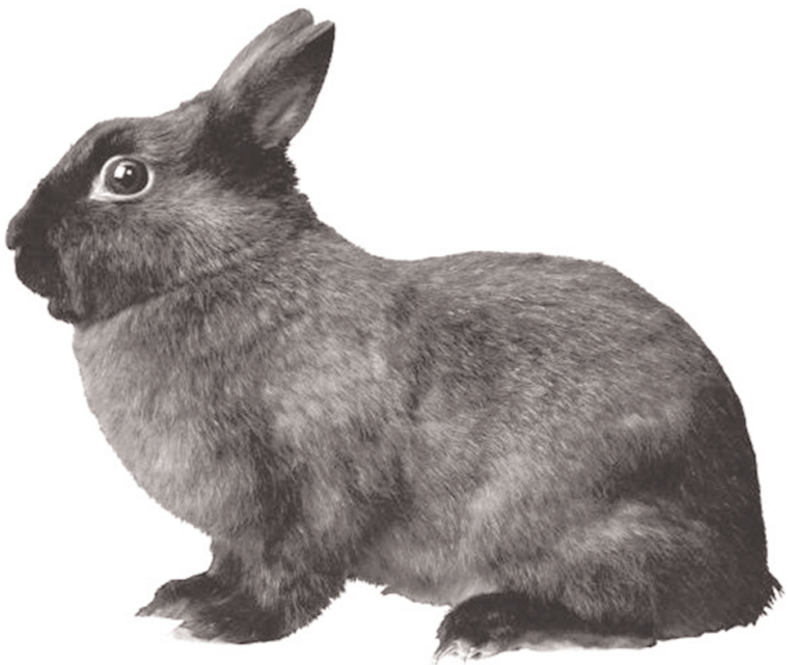
- Designate one section of the room as the leaf of the plant.
- Divide the class in half and have each half stand on either side of the leaf. Instruct students to stand in pairs. Pull out a few extra students to play the sunlight and chlorophyll. Direct the chlorophyll student(s) to stand inside the leaf area.
- Tell half the students they are air particles and the other half they are water that is coming to the leaves from the roots (drawn up from the plants stem). It might be helpful to give them signs labeling them as water or air molecules (particles).
- Instruct students to file as pairs into the leaf area.
- Provide the students representing sunlight with a flashlight and tell them to stand outside the leaf and shine the light on the students who are chlorophyll. Students should shine the light during the whole next step; they might want to dance about to music while shining the light.
- The chlorophyll students gently tag the air and water pairs once they enter the leaf. When paired students are tagged, they separate. If signs are being used, the chlorophyll students should take these away. When all the students are milling about into singles, instruct the chlorophyll students to recombine students into groups of three; there should be some single students left over.
- Direct the single students to leave the leaf.
- Ask students to suggest what the recombined group and single students are. The groups are sugar molecules and the single students represent the oxygen molecule (which is actually composed as two oxygen atoms). New signs can be distributed to these two groups.



Photosynthesis



Rabbit Image for Activity



Would You Heat With Wood?

Summary: Part One: Students write and illustrate a story about burning wood to demonstrate how energy comes from wood. Part Two: Students review the efficiency of different wood-burning apparatuses.

Objective
Students will be able to write and illustrate a story about burning wood for energy.

Materials
- Pictures of fireplace, bonfire, wood burner, pellet stove
- Ecosystem poster
- Log (optional)
- Wood pellets (optional)

Background
Burning Wood
Almost everyone has used wood to provide heat and light, whether it was a bonfire, a wood burning stove, or a fireplace in their home. While we often use fire because it is aesthetically pleasing, it also provides us with energy in the form of heat and light.

The uses of fire are varied depending on what apparatus the fire is burned in. When we use a bonfire, it is often for light when it is dark, to keep us warm, and to cook food to provide us with energy. Fireplaces are used to provide heat and to add a “glow” for ambiance. Wood burners and pellet stoves are two other examples of apparatuses that burn wood. A wood burner is often seen in residential homes, cabins, or hunting shacks. These can be used for heat and to cook on. Before homes had central heating systems, wood stoves were the primary place for heat for warmth and cooking. A pellet stove uses compressed pieces of leftover wood and paper products that are automatically fed into the apparatus.

Not only are the uses of the apparatuses different, but they also have different levels of efficiency. A campfire is the most inefficient method of burning wood because there is little control of the amount of air the fire receives. A fireplace can be controlled more, but can still be inefficient due to the air that comes in from the chimney into the open room. Wood stoves are more efficient than fireplaces because they are closed systems and the amount of air that gets into the system can be controlled by the operator. A pellet stove is the most efficient of the apparatuses mentioned for several reasons. Putting the fuel (wood pellets) into the stove does not require opening the door. (It can be manually or automatically fed so there is not energy lost from opening the door.) Like the wood burner, the operator has control over the amount of oxygen the pellet stove receives. Most of the energy from a fire comes from burning, and the pellet stove takes advantage of this far more than the other apparatuses.

For more information, see *Heating your Home with Wood Pellets Fact Sheet* and *Heating your Home with Wood Fact Sheet* (see *Resources*).

NOTE: Many manufacturers or companies that use wood products also use the wood by-products, such as sawdust and scraps, to provide heat and electrical energy for their facilities.

Safety
When operating any type of wood burning system, it is important to understand how to use the system safely. Children should never start fires unless it is a controlled area (fire ring, fireplace, wood burner) with an adult helping them. Fires are hot and should not be touched. All those near a fire should remain a safe distance from the flame. If you live in a home with a fireplace or a wood burning stove, it is important to clean the system, which includes the chimney and stovepipe, and also to set up your system safely, which involves proper floor and wall protection and proper clearance.

Procedure
Part One - Steps (Classroom or outside)
1. Show students a picture of a tree. Ask students what the picture is of. Show students a picture of a piece of wood. Ask them what the picture is of. After they have identified both, ask the students what the difference is

Grade Level: 3-5

Subject Areas:
Art, Language Arts, Science, Environmental Education

Setting: Classroom (possibly outside)

Time:
Preparation: 50 minutes
Activity: Two 50-minute periods

Vocabulary: Efficiency, Energy, Fuel, Harvest, Heat, Light, Light energy, Pellet stove, Renewable, Thermal energy, Wood, Wood burner

Major Concept Areas:
Theme I
- Energy Flow in Systems
- Definition of Energy

Getting Ready:
Tell students that they are going to be learning about energy that is made from a renewable resource – wood. Explain to students that renewable energy is energy that can be quickly replenished. Review the vocabulary words with the students and post them in the classroom.

Academic Standards:
Science: C.4.2, C.4.7, D.4.4, H.4.2
ELA: B.4.1, B.4.2, B.4.3
EE: A.4.2, B.4.2, B.4.10

Resources:

Web sites

- www.woodheat.org
- www.pelletheat.org
- http://hearth.com/clear/clearing.htm
- Heating Your Home with Wood Pellets www.focusonenergy.com/data/common/dmsFiles/W_RB_MKFS_Wood%20pellets%20fact%20sheet.pdf
- Heating Your Home with Wood www.focusonenergy.com/data/common/dmsFiles/W_RB_MKFS_Heating%20your%20home%20with%20wood%20fact%20sheet.pdf

Related KEEP Activities:

"Energy Divide" – KEEP *Activity Guide*

"Renewable Candy Resources" – *Doable Renewables*

between the two. Students should identify that one is alive and the other has been cut down or harvested.

2. Ask students why we harvest wood. If they have trouble identifying things made from wood, ask them to look around the classroom.

3. If they did not identify burning the wood as a reason for harvesting trees, show them a picture of a wood burner and/or a fireplace and ask the students if any of them have wood burners and/or fireplaces in their homes or cabins.

4. Ask students to raise their hands if they have ever sat by a fire before. Ask students if their families have rules for when they have a fire. If so, what are they? **NOTE**: See *Background* for more information on fire safety.

5. Hold up the picture of the bonfire and ask students what the picture is of. Tell them what that kind of fire is used for (see Background) and what the pros and cons are for this system.

6. Repeat step 5 for fireplaces, wood stoves, and pellet stoves.

7. Tell students that they are going to write a story about burning wood.

8. Provide students with paper and art supplies so they can write and draw the pictures for their story. (Students who are too young to write the story may draw pictures of how they have used fire.)

9. When the stories are finished, let the class share their stories with each other.

Part Two – Steps

1. Explain to students what the definition of energy is and discuss energy efficiency. Efficiency is accomplishing a task with a minimum of effort and waste. The different kinds of fires the class discussed in part one all have different levels of efficiency.

2. Explain to students that when a fire is efficient, there is not a lot of ash or smoke. Ash and smoke are waste products that show that all of the energy in the wood or wood pellet was used up.

3. Work with the students to identify how much ash and smoke are produced by a bonfire, fireplace, wood burner, and pellet stove. Draw on student experiences and insert any missing information.

4. Provide each student with the efficiency worksheet. Students should draw a face in the circle next to the picture to show whether it is efficient (smile) or not efficient (frown).

5. Review the answers with the students. KEY: Most efficient to least efficient – pellet stove, wood burner, fireplace, bonfire.

Closure

Read one of the following books or a book of your choice to the students.

1. *Central Heating: Poems About Fire and Warmth*
Marilyn Singer, Meilo So (Illustrator)

2. *Safety Around Fire*
Lucia Raatma

3. *Nature and Science of Fire*
Jane Burton, Kim Taylor

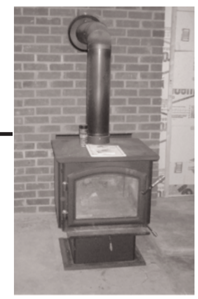
4. *Science of Fire*
Rennay Craats

Assessment

- Did students' stories and pictures show evidence of energy, i.e. heat and light?
- Were students able to match the pictures?

Efficiency Worksheet

Instructions: You are going to draw a face in the circle next to the picture to show whether it is efficient (smile) or not efficient (frown). Each face should be different based on how efficient the item in the picture is.



Wood Burner

Pellet Stove

Fireplace

Bonfire

Pellet Stove

Fireplace

Bonfire

Wood Burner

Summary: Students evaluate and categorize advertisements that promote the development and consumption of energy and then design their own advertisement for biodiesel.

Advertising Biodiesel

Grade Level: 6-8, (9-12)

Subject Areas:
Family and Consumer Education, Art, Language Arts, Environmental Education

Setting: Classroom, Computer lab

Time:
Preparation: Up to two weeks
Activity: Four 50-minute periods

Vocabulary: Advertising, Alternative fuels, Biodiesel, Diesel, Methane, Nonrenewable resource, Renewable resource

Major Concept Areas:
Themes II & III
- Consumption of Energy Resources
- Quality of Life

Getting Ready:
Try to obtain energy-related advertisements. (Make sure to obtain advertisements on transportation or for products that are transported from different parts of the world.) It may take a couple of weeks to collect advertisements. This can also be a student assignment (see *Orientation*).

Next time the activity is conducted preparation time should be less because these same ads can be used again. You may want to store the ads in folders or a three-ring binder, filing similar ads together. For example, advertisements related to transportation can be photocopied on the same colored paper or placed in the same folder. Ads can be laminated or stored within clear plastic protectors.

Objectives
Students will be able to:
- analyze the effectiveness of energy related ads;
- explain what biodiesel is;
- explain why alternative fuels are necessary; and
- design an advertisement that encourages the use of biodiesel.

Materials
- Advertisements from newspapers or magazines (not-energy related)
- Energy-related advertisements
- Art supplies or graphic designing software

Background
Advertising

You see them in newspapers and magazines, hear them on the radio, watch them on television, and nowadays, 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 energy use.

Advertising has a purpose. This purpose can entail any one, or any combination, of the following:
- To increase awareness of a product or its benefit;
- To enhance comprehension of some aspect of the product;
- To promote conviction or desire so that consumers will be eager to purchase the product; and/or
- To ensure action, resulting in the customer purchasing and using the product.

With energy, the “product” is often a source (oil, natural gas, batteries, solar panels, propane), a service (retrofitting your home, bringing natural gas to your home, installing solar panels), or a device that uses energy (furnace, automobile, stove). All of 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.

The types of advertisements that involve energy usually fall into three categories. The first includes “type of energy source” ads that aim to convince people one source of energy is better than another (for example, advertisements promoting use of natural gas over electricity, or renewable energy resources over the use of fossil fuels). The second category, which is the most common, is the “customer product” ad (for example, an oil company persuading drivers to buy its brand of gasoline, a utility-sponsored trade organization promoting the use of electricity, a battery manufacturer claiming that its batteries last longer than those made by the competition). The final category is the “public relations” ad.

The main emphasis of the public relations ad is to increase awareness and comprehension of the product. Energy companies frequently use public relations ads to highlight their contributions to the well-being and prosperity of the community. Sometimes they merely want to produce “good feelings” about the company, without any specific reference to a product or service. These ads also help to communicate a positive position on issues or incidents that might otherwise bring a company unfavorable attention. Advertisements in this category may describe a company’s efforts to protect the environment; support the arts, education, or the community; or promote technological advances which may eventually benefit its customers. The ads may also be used to defend a controversial position, such as the use of nuclear power, or to respond to an event or incident the company may have been involved in, such as a power outage, an oil spill, or a discrimination suit.

Different advertising strategies are used in each category. Rarely does an advertisement simply say, "buy this brand of fuel," "install these energy-efficient light bulbs," or "drive this kind of car." Instead, more subtle approaches are used to get and keep people's attention. Advertisers use these various strategies as well as creative artwork, imagery, and graphic design to be noticed (see **Strategies in Advertising**). Artwork pertains to visual as well as auditory techniques (for example, music in television and radio commercials). Advertisers use a variety of strategies and creative designs because they know there is no such thing as a mass audience. While some people like humor, others prefer tenderness.

People in the United States, including Wisconsinites, are becoming more interested in alternative fuels. This interest is mainly because the prices of gasoline and diesel fuel are increasing and more people are learning about the environmental impact of using diesel and gasoline. Therefore, many fuel companies and services are making and advertising fuel blends that increase the ratio of alternative fuels to gasoline or diesel.

Advertising which appeals to people's emotions and desires may not provide enough information about a service or product. It may also obscure critical issues, such as energy resource depletion, environmental effects, social justice, or long-term economic security, that may be related to the use of a product or service. Some advertisements deliberately omit or mislead people on these issues, while some make an effort to address them. Citizens, including students, need to develop a critical sense of how advertising is used to promote products and energy services. They can do so by learning how advertisements are designed to influence desires and emotions, and by getting additional information about services or products from independent sources. Doing so will help citizens make choices that will benefit not only them, but also their community and the environment.

Diesel

Transportation is a very important part of our lives. Not very many communities in Wisconsin have widely used mass transit systems such as buses or subways, which makes individual transportation even more necessary.

We depend on transportation to bring us goods from other areas. For example, where does a cotton shirt come from? If you start at the beginning, the cotton had to be grown on a farm, which means that tractors were used to plant, apply fertilizers/herbicides/pesticides, and harvest the cotton. Then the raw cotton was shipped to where it was made into thread and fabric. After the fabric was made it was shipped to the shirt manufacturer where it was made into a shirt. The shirt was then shipped to a store near you. You traveled to and from the store with the shirt.

All of the transportation of the goods is done in diesel trucks. Diesel is used in trucking, agriculture and irrigation, construction, and railroads.

Effects of Using Diesel

The exhaust from gasoline and diesel vehicles adds to the growing problem of air pollution which can be an environmental and health problem. According to the National Resource Defense Council, California, diesel exhaust causes cancer (http://www.nrdc.org/air/transportation/ebd/intro.asp). While this is widely debated, the exhaust is known to have toxins in it, which can cause health problems. Diesel

Strategies in Advertising

- Claims superiority without comparison to competition
- Claims superiority with comparison to competition (no brand name mentioned)
- Positions product or service directly against the competition (cites other brand name)
- Appeals to a common culture (i.e. nostalgia, the wild west, the computer age)
- Focuses on cost-saving qualities and economic improvement
- Emphasizes emotion (i.e. love, fear, sadness, joy)
- Promotes feelings of comfort and well-being
- Appeals to certain values, such as environmental concerns or health and safety concerns
- Utilizes humor, fun, or both
- Connects to people

Academic Standards:
FCE: A2, B3, C2
ELA: B.8.1, E.8.1-5
EE: A.8.6, C.8.4

Resources:
Web sites
- Biodiesel from Seeds - www.canren.gc.ca/tech_appl/index.asp?CaId=2&PgId=115
- National Biodiesel Board - www.biodiesel.org
- Make Your Own Biodiesel - http://journeytoforever.org/biodiesel_make.html
- Veggie Van - www.veggievan.org
- Biodiesel Now - www.biodieselnow.com

Books
Title: From the Fryer to the Fuel Tank: The Complete Guide to Using Vegetable Oil as an Alternative Fuel
Author: Joshua Tickell
Publisher: New Orleans, LA: Joshua Tickell Media Productions, 2003.

Title: Biodiesel: Growing a New Energy Economy
Author: Greg Pahl
Publisher: White River Junction, VT: Chelsea Green Publications, 2005.

Image Source: National Energy Education Development Project. *Transportation Fuels; Biodiesel.* Manasses, VA: The NEED Project. 2004.

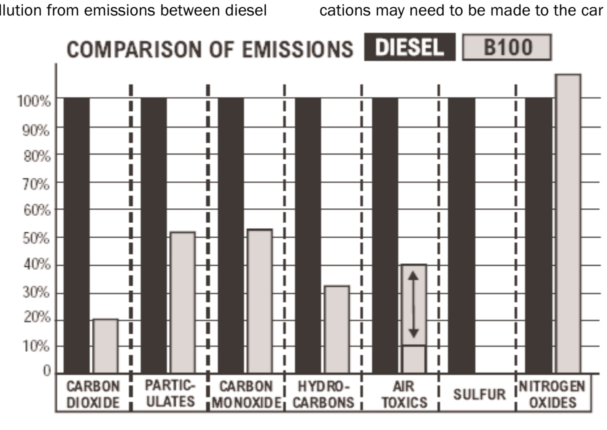
exhaust contains carbon (soot), nitrogen, water, carbon monoxide, aldehydes, nitrogen dioxide, sulphur dioxide, and polycyclic aromatic hydrocarbons (PAHs) (www.whsc.on.ca/Publications/hazardbulletins/fall2001/diesel.htm). Pollution from diesel vehicles can be seen easily in large cities. There have been many rules and regulations put in place to reduce the amount of harmful emissions from burning diesel fuel.

In larger cities, this pollution is thick and can be seen as smog. The consequences of using nonrenewable resources can be experienced throughout the world. Global climate change has become a hot topic in the news and politics. Global climate change is an interconnected chain of climactic events brought about by an increase in trapped heat in the atmosphere. The trapped heat alters atmospheric processes and their interaction with the oceans and the land. The climate—the product of that interaction—changes as well, causing altered weather patterns that bring unexpected rain or dry spells, sudden severe storms, and temperature changes.

The graph below shows the difference in the pollution from emissions between diesel and biodiesel (B100 = 100% biodiesel). All of the levels are lower with the exception of nitrogen oxides (NOx).

Other Issues to Consider
- Foreign policy – how does the use of diesel/petroleum affect the United States foreign policy?
- Car culture (consumerism, convenience, debt accumulation, and poverty)
- Petroleum use in pesticides, plastics, pharmaceuticals
- Consequences of resource depletion

Biodiesel
The supply of diesel fuel is limited because it is a nonrenewable resource. There are alternative fuel options that can be used as a substitute for diesel fuel, which will prolong the life of diesel resources. Biodiesel is a cleaner-burning alternative to diesel that comes from vegetable oils, animal fats, and recycled restaurant grease. Currently, there are only a few large-scale producers of biodiesel, but there are many small-scale producers. Many of these people make biodiesel for their own use in their diesel automobiles. Biodiesel can be mixed with diesel fuel or used on its own. Depending on how the biodiesel is made, some modifications may need to be made to the car in



order to use biodiesel. In most cases, the vehicle should not need to be altered. Biodiesel users should always consult with the OEM and engine warranty statement before using biodiesel.

Procedure

Orientation

Show students sample advertisements that are not necessarily related to energy. Ask them to identify what is being sold. Have the class create a list of the advertising strategies used (see Background). Review the purpose of advertising and discuss reasons for advertising and its importance. Do students think energy resources need to be advertised? Have students suggest reasons for advertising energy. **NOTE**: Students may work in groups in this activity.

Steps

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. Ask students if they know what diesel is. Have they heard of biodiesel? What do they think it is? Provide students with a definition for diesel and biodiesel. Write these definitions on the board or have students write them in their notes for future reference. **NOTE**: See Glossary for definition of biodiesel.

3. Have students research biodiesel and create a list of facts from their research. As a class, review the facts that were gathered and create a class fact sheet that can be used in step 6.

4. Ask students to list the types of vehicles that use diesel fuel (they should list semi trucks, buses, heavy machinery, some automobiles). Ask students if diesel fuel is something they use. If students answer no, ask them if they grow all of their own food. If they don't, remind them that most of the goods we buy are shipped to us and transportation, many times, uses diesel.

5. Explain that gasoline and diesel cause pollution and are nonrenewable resources. Biodiesel, on the other hand, is a renewable resource that causes less pollution than diesel. Diesel fuel now comes with a mixture of biodiesel in it to extend the remaining diesel available and to reduce pollution.

6. Have students work individually or in groups to design their own advertisement for biodiesel. Make sure students refer to the purposes of advertising as well as advertising strategies. Provide each student or group with the fact sheet developed by the class in step 3 to assist them with their ads.

7. Students may use the computer to design or draw their ad. All ads should be in color and fit on an 8 ½" by 11" piece of paper.

Closure

When the ads are turned in, place them on a bulletin board. As a class, discuss what ads stand out. What was the purpose of the ad? Did it achieve its purpose?

Assessment

Formative

- Can students explain the purpose of advertising?
- Were students able to identify strategies used to sell energy products?
- To what extent did students thoughtfully complete their own ads?

Extension

Have students focus their advertisements on current energy innovations in the transportation sector. This does not need to be limited to diesel/biodiesel but can be expanded into any energy efficiency or alternative fuel technology.

Summary: Students identify current energy use practices and incorporate the use of energy from methane into community design. NOTE: This activity is best used as a conclusion to additional renewable energy or biomass energy lessons.

Community Design - It's a Gas

Grade Level: 5-8 (9-12)

Subject Areas:
Science, Social Studies, Environmental Education

Setting: Classroom, Computer lab, Library

Time:
Preparation: One - two hours
Activity: One week

Vocabulary: Anaerobic digestion, Biogas, Biomass, Methane

Major Concept Areas:
Theme III & IV
- Quality of Life
- Management of Energy Resource Use

Getting Ready:
In the days before you introduce this activity, make sure you are familiar with your community resources. Does your community have a landfill? Where is the wastewater treatment facility? How many large farms are in the area?

Academic Standards:
Science: A.8.3, B.8.6, E.8.5, G.8.5
SS: A.8.1, D.8.4, D.8.11
EE: D.8.1, D.8.4

Objectives
Students will be able to
- identify possible sources of methane gas;
- discuss the benefits of using methane; and
- discuss the limitations of incorporating the use of methane into their community as it currently exists.

Materials
- Tag board or a map of the city
- Drawing utensils or 3-D models of trees, hills, roads, homes, etc.

Background
Community Planning

In the not-so-distant past, humans developed buildings and communities with renewable energy in mind. The availability of sources of fuel was included in the decision-making process. In modern society, these considerations have often dropped. In a time of growth, community planners are faced with the task of balancing multiple objectives, including economic feasibility, governmental regulations, social and cultural conditions, professional ethics, and environmental and architectural principles. The added planning and up-front costs that are incurred when using renewable energy in the design can often hinder its use.

Some planners recognize the environmental and economic benefits of including renewable energy as a consideration. They address wind patterns, solar access, the availability of unobstructed, direct sunlight, and energy efficiency. By designing a community with renewable energy in mind, residents can save money while reducing energy costs and living in a naturally comfortable home environment.

This activity will focus on methane (CH_4), a form a biomass energy that is generated from multiple sources. Methane can be used in much the same way as natural gas, but makes use of resources that are renewable. Methane can be made from cow, pig, or poultry waste, wastewater treatment facilities, and/or closed landfills. Many Wisconsin communities have agriculture, treatment facilities, and landfills near them. The production of biogas happens in an anaerobic system, or a system without oxygen. This happens in natural areas such as swamps, large bodies of water, and even in the stomach of large animals.

Methane from Animal Waste

Farms that have large herds of cows (over 500 head), pigs, or poultry can economically convert the manure into methane gas. Currently farms with small herds are not able to take advantage of this technology unless they work together and combine their resources. Research is being conducted to make this process work on smaller farms as well as large farms.

The animal waste is collected and dumped into the digester, which can be above or below ground. There are two types of digesters—batch and continuous. A batch digester is loaded with the waste, left to digest, and is then emptied and the process starts over again. A continuous digester is continuously fed with waste.

Useful by-products of this process are biogas (methane) and a solid material that can be used as fertilizer or bedding for animals. One of the added benefits of using a digester is that the smell of the animal waste is greatly reduced, which improves air quality for homes near the farm.

Methane from Wastewater Treatment Facilities

Wastewater treatment facilities treat the water that "goes down the drain." This wastewater includes our showers, sinks, and toilets. The treatment facilities are responsible for removing organic matter from the water, removing odor, and restoring the water to a higher quality than when it came in. As our communities grow, the demands on these facilities grow. One way the treatment facility can take advantage of the growing amount of wastewater is to use that waste to generate energy. The energy that is generated is sometimes used to power the wastewater treatment facilities. This can lower their energy bill, and since the residents of the community pay for the energy bill with tax money, it benefits not only the facility but the community as well. Some of the other benefits are the reduction of odors and the reduced production of solid waste. The solid waste that is produced can be used as a soil amendment after being processed.

Methane from Landfills

Most communities have a landfill nearby. When a landfill is filled up, it is then sealed off. Once the landfill is sealed, an anaerobic situation is created. The waste in the landfill breaks down in the absence of oxygen and gives off gases which are harmful to people and the environment. In order to prevent the release of the gases into the atmosphere the landfill gas is collected and flared. If you drive by a landfill at night, you can sometimes see the flares burning. One of the gases released is methane. Instead of burning the gas and not using it for the useful purpose, the gas can be burned to create electricity or used as fuel for heating.

See the activity *Roadside Renewables* for additional background information.

Procedure

Orientation

Talk about the principles and issues involved in community planning. Ask students what considerations they should address in designing the home plots and open spaces for a small community. Have them share ideas with the class. Encourage them to reflect on what comes into a community (electricity, water, fuel) and what leaves a community (waste, trash, heat). Consider other community needs such as transportation, recreation, privacy, etc.

Challenge students to identify which of the community activities are energy-related. Discuss which energy resources are currently used by most communities and how they enter and leave the community. Review costs and benefits of current energy use practices.

Introduce the topic of energy from alternative sources such as biomass. Can they name sources of biomass? Explain that there are many different ways biomass can be used to generate heat or electricity. Explain what methane is and how it can be made and used.

NOTE: This activity addresses one renewable resource—biomass from methane—which can be utilized in the development of a
sustainable community. Reference the activity "Sustainable Communities" in *Doable Renewables: A Renewable Energy Education Supplement to the KEEP Activity Guide* for an activity that includes all renewable energy resources.

Steps

1. Explain that the mayor of town X has requested information about biogas energy systems and is interested in developing more energy resources for his/her community. **NOTE**: Town X can be a fictional town or students can select an actual community such as their own. Other options include providing a map of a city for students or providing them tag board with pre-marked physical features such as rivers; wooded, plain, and wetland areas; topographical features; and existing structures (farms, homes, landfills, wastewater treatment facilities, power lines, etc.).

2. Inform the class that the goal is to assess a city for the potential of utilizing biogas energy technologies.

3. Establish teams of three or four students. If you are having students assess their own city, give them a few days to document the significant environmental and physical features, etc.

4. Explain that biogas energy technologies are often left out of the design of a city. Use the following questions to pose ideas for incorporating biogas into the students' site design:

- What nonrenewable resources are currently heavily used?
- Is there a renewable energy source being utilized for heat or electricity?
- Are there options for incorporating biogas energy sources into active systems?
- Which options seem the most cost effective?

5. Assign student groups the task of incorporating biogas energy technologies into their city. Give students a week to establish their design.

Closure

Have students present their findings to the entire class and lead a discussion on how they decided to lay out their city. The discussion should include benefits and drawbacks to developing methane systems in the community. Have other students critically analyze each subdivision, making recommendations for improvement. Have students redesign their subdivision after student presentations and critiques. How do the designs change over time?

Assessment

Formative

- Were students able to identify the many ways a community can utilize bioenergy in the form of methane?
- Were students able to show the benefits and drawbacks to developing a community utilizing renewable energy?

Summative

Take students on a tour of a landfill or wastewater treatment facility. Have each student prepare a question to ask their guide.

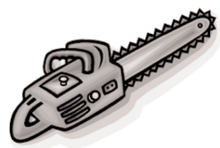
Extension

K-4

Explain to students what biomass is and ask students to list some sources of biomass energy. Take them on a tour of a wastewater treatment facility or a farm. Explain to students what happens with animal and human waste and what could be done in the future.

9-12

Have students do the same activity and try to incorporate additional biomass energy technologies (alternative fuels, using wood as a source of fuel, industries that use wood products can burn their wood waste to generate heat and/or steam) into the design of the city. See the other activities and fact sheets to get more ideas.



Don't Waste Waste

Summary: **Students "harvest" celery to demonstrate waste accumulation from timber practices and brainstorm uses for the waste products.**

Objectives
Students will be able to
- describe the parts of a tree;
- define biomass;
- identify alternative uses of the wood that is left behind after harvesting; and
- explain how biomass can be used to create energy.

Materials
- Scale (see Getting Ready)
- Each group of students will need the following:
  - o A bunch of celery
  - o Two or three plastic knives
  - o A ruler
  - o Two large trays
  - o Calculators
- Copies of **Don't Waste Waste – Recording Page** (optional)

Background
Biomass is defined as any plant-derived organic matter available on a renewable basis, including dedicated energy crops and trees, agricultural food and feed crops, agricultural crop wastes and residues, wood wastes and residues, aquatic plants, animal wastes, municipal wastes, and other waste materials. Biomass can provide energy in the form of electricity, heat, steam, and fuels. Bioenergy is the energy which can be generated from the use of biomass. Because biomass uses crops that are available on a renewable basis, it is considered a renewable energy source like sun, wind, water, and the heat from the earth (geothermal energy). According to the United States Department of Energy, biomass has been the largest source of renewable energy every year since 2000. Agricultural crops can be grown solely for bioenergy production, or the agricultural by-products can be used to create bioenergy.

According to the Department of Tourism, Wisconsin's history is tied closely with the history of its forests. Before Wisconsin was admitted into the Union in 1848, approximately 63-86 percent of Wisconsin was covered with forests. Between 1859 and 1930, more than half of Wisconsin's forests were cut down. It is during this time that Wisconsin became a world leader in logging. Since then, many of our forests have been restored, but Wisconsin still generates income from logging and the use of its forests. Forests are used by industry and individuals for various purposes including profit and recreation.

Wisconsin's industrial sector is already using bioenergy from wood wastes and residues. Companies are able to use wood to produce heat (thermal energy) and electricity. According to the United States Department of Energy, the forest products industry uses 85% of the wood waste available to generate heat energy and electricity. Due to technological improvements, the amount of wood wasted when converting a log into a product has greatly improved. Some companies generated over half of their energy from biomass. Industrial wood residue or wood waste is any part of the tree that is not used for the primary product such as paper or timber. This can include leaves, branches, stumps, or any other part of the tree that is determined unusable by the company. Sawdust and woodchips can also be utilized to generate bioenergy. The wood residue can be used to heat a substance such as water or air. This heated water or air can then be used for example, to maintain the temperature of an on-site kiln used for drying the wood products. Wood residue can also be burned to create steam, which then turns a turbine and creates energy.

NOTE: This activity calls the wood left after logging "waste." That "waste" is actually a very important part of the ecosystem. The organic materials such as leaves, branches, and twigs that remain after a harvest act as shelter for some animals. This material also decomposes as it lies on the forest floor and nutrients are released into the soil, making it better suited for the current trees and the trees to come in future years.

Grade Level: 5-8 (K-4)

Subject Areas:
Science, Math, Environmental Education

Setting: Classroom

Time:
Preparation: 30 - 60 minutes
Activity: One week

Vocabulary: Bioenergy, Biomass, Industrial wood residue

Major Concept Areas:
Themes II & III
- Development of Energy Resources
- Quality of Life
- Quality of the Environment

Getting Ready:
Before the lesson, clean and weigh each bunch of celery and calculate the total. Determine the weight of each tray or zero out the scale.

Academic Standards:
Science: C.4.5, C.4.2, C.8.4, C.8.6, C.8.10, C.8.11
Math: A.8.1, A.8.6, B.8.5, D.8.3, E.8.2, E.8.4
EE: A.8.3, A.8.4

Resources:

Web sites

- TFF Eco-Links www.forestinfo.org/products/eco-links/Index.htm
- Wood Utilization www.forestinfo.org/products/eco-links/Tech-Mill-lo.PDF
- Biomass www.forestinfo.org/products/eco-links/Biomass.pdf

Books

- Klass, Donald. Biomass Renewable Energy, Fuels, and Chemicals. Academic Press, 1998.
- Brown, Robert. Biorenewable Resources: Engineering New Products from Agriculture. Iowa State Press, 2003.
- Fulford, David. Running a Biomass Programme: A Handbook. ITDG Publishing, 1998.
- Graham, Ian. Geothermal and Bio-Energy. Austin, TX: Raintree Steck-Vaughn, 1999.
- Hayhurst, Chris. Biofuel of the Future: New Ways of Turning Organic Matter into Energy. New York: Rosen Publishing, 2003.

Related KEEP Activities:

"Roasted Peanuts" – KEEP *Activity Guide*
"So You Want to Heat Your Home" – KEEP *Activity Guide*
"Photosynthesis Promenade" – *BioFutures*
"Corn in Your Car" – *BioFutures*

Procedure

Orientation

Ask students to think of things that they throw away, but that could be used. Paper that has been printed on one side can be used for scratch paper. An aluminum can can be used to store things on a desk. A plastic bottle can be used as a water bottle. Tell students that there are other things that are considered waste that can be used for a second purpose.

Divide the class into groups of two to four students each. Ask students to list the parts of a tree and use a stalk of celery to show those parts. Draw the tree on the board as the students name the parts of the tree. Tell the groups that their assignment is to harvest trees. Celery will represent the trees. Hand out bunches of celery to each group of students along with a ruler, plastic knives, trays, and calculators.

Provide each group with a copy of the **Don't Waste Waste – Recording Page**. Have each group weigh their celery bunch and record date before they begin cutting. Students should predict the weight of celery they will be able to harvest before cutting and record their estimates. Students should then cut straight pieces of celery that are three inches (7.6 cm) long. Walk around the room making sure the pieces are straight and accurately measured. Instruct the groups to put their cut pieces on one tray and the leftovers on another. Stop working on the data sheet and go to step one below.

Steps

1. Inform the class that the celery-cutting exercise simulated a forestry project where trees were harvested and cut for lumber.

2. Point out that the groups successfully produced lumber, but what about the leftovers?

3. Use the **Don't Waste Waste – Recording Page** to record their findings and comments for step two. Ask groups to weigh their accumulated waste (subtracting the weight of the tray from the total if you did not zero out the scale). Provide the class with the weight of the celery before it was "harvested." Instruct the class to calculate what percentage of their harvest was "waste" (divide the weight of the leftover celery by the weight of the pre-cut celery). Discuss the results.

4. Explain that when trees are harvested, there is waste material as well. Have the class list the parts of a tree that might be leftover as a result of timber production. (leaves, branches, bark)

5. Explain that the waste from industrial use of timber is called industrial wood residue and is a form of biomass. Ask the class what they think biomass is and help them develop a definition (see Background).

6. Ask the class to list what they think happens or should happen to this waste material. List student ideas on the board, noting if they mention using the biomass as an energy source. Introduce the term bioenergy and explain its role in industrial energy production (see Glossary).

7. Have students explore the Internet and other sources to learn more about the use of industrial timber waste for bioenergy. Ask students to list benefits and drawbacks of using timber waste for energy.

Closure

Draw a picture of a tree on the board and have students list the many ways humans use it as a resource. Make sure they include energy.

Clean the celery and use it as a healthy snack for the class.

Assessment

Formative

- Were students able to do the math to figure out how much of the celery was actually wasted?

- Were students able to draw a connection between using the waste and creating energy as a biomass source?

Summative

Throughout the activity, we have been referring to the wood not used by the timber company as “waste.” This wood is not really wasted, even if it is left on the forest floor. As it decomposes, it adds valuable nutrients that are important to the ecosystem. Ask students if they can think of a new term for this wood. Examples include: secondary materials, wood residue, co-products.

Take students on a field trip to a local company who utilizes wood products (paper company, timber company) and uses biomass energy or invite a representative from that company to come to the classroom to discuss how they use biomass as an energy source.

Extensions

Have the class participate in a role play about the fate of a clear cut forest, debating the pros and cons of using the industrial waste for bioenergy.

Research the idea of a zero-waste product—a product that has no waste from the production aspect. Are there companies that do this? If so, how do they do it? (Example: some utilities use cogeneration – combined heat and power.)

For younger students, you can simplify the lesson by just looking at the piles of waste and seeing how much there is instead of calculating actual percentages.

Don’t Waste Waste Recording Page

1. What is the total weight of the timber (celery) harvest? ___________ grams (the whole class)

2. Estimate how much of the “forest” is useable and how much is waste.
   Useable ___________% (useable weight / total weight)
   Waste _____________% (leftover weight / total weight)

3. Cut the celery into straight “logs” that are three inches (7.6 cm) long. Then weigh the logs and the leftover (waste) material. Record your data in the first row of the table below.

Group	**Useable**	**Waste**	**Total**
Your Groups Harvest	(g)	(g)	(g)
Harvest total from other groups:			
1.	(g)	(g)	(g)
2.	(g)	(g)	(g)
3.	(g)	(g)	(g)
4.	(g)	(g)	(g)
5.	(g)	(g)	(g)
6.	(g)	(g)	(g)
7.	(g)	(g)	(g)
8.	(g)	(g)	(g)
Total (g)	**(g)**	**(g)**	

4. Gather the findings of the other groups’ harvest and fill in the table.

5. In the table above, add the class total of useable and waste timber.
   Useable __________ grams
   Waste ___________ grams

6. Find the average useable timber percentage (total useable divided by the weight in question 1. Remember to move the decimal point to get the percentage).
   _________________________%

7. Find the average waste timber (total waste divided by the weight in question 1. Remember to move the decimal point to get the percentage).
   _________________________%

Grasses for the Masses

Summary: Students will learn that different types of grass produce varying amounts of biomass by planting varieties of grasses and measuring their growth rate and leafy content.

Grade Level: 5-8

Subject Areas:
Science, Agriculture, Environmental Education

Setting: Classroom or laboratory

Time:
Preparation: About two weeks to grow plants
Activity: Two hours

Vocabulary: Biomass, Btu, Dry weight, Energy input, Energy output, Fresh weight, Light energy, Native and non-native species, Photosynthesis

Major Concept Area:
Theme II
- Development of Energy Resources

Resources:
Heating Your Home With Wood Pellets
www.focusonenergy.com/data/common/dmsFiles/W_RB_MKFS_Wood%20pellets%20fact%20sheet.pdf

Academic Standards:
Science: B.8.6, C.8.6, C.8.10, C.8.11, G.8.5, H.8.2
AG: B.8.2, D.8.3, D.8.4, D.8.7, E.8.6, F.8.1, F.8.2
EE: A.8.2-5

Objectives

Students will be able to

- describe what biomass is;
- explain how biomass is produced;
- understand what makes a good biomass fuel; and
- consider which biomass fuels to use for optimum energy output.

Materials

- Seeds: wheat or rye seed, corn seed, and oat seeds (whole seeds only, not milled)
- Potting soil
- Scale (balance or kitchen)
- 3 half-gallon milk cartons (large ice cream cartons work well also)
- Fluorescent grow lamp (optional) or window for plants to be near
- Dehydrator or oven

Background

The term bioenergy, or biomass energy, means any plant-derived organic matter available on a renewable basis, including dedicated energy crops and trees, agricultural food and feed crops, agricultural crop wastes and residues, wood wastes and residues, aquatic plants, animal wastes, municipal wastes, and other waste materials. These sources can provide energy in the form of electricity, heat, steam, and fuels. (See the activity *Biomass Gazette* for more background information on biomass.)

Biomass is a renewable resource – it can be replaced fairly quickly without permanently depleting Earth's natural resources. By comparison, fossil fuels, such as petroleum and coal, require millions of years of natural processes to be produced. Drilling for petroleum is considered a nonrenewable process because it depletes Earth's resources for thousands of generations.

There is more to consider than just energy input and output (the balance of energy put into growing and making a product compared to the amount of energy the fuel provides when used) when deciding which biomass fuel to use. Non-native plants may be an attractive biomass fuel to consider, however, the impact on the surrounding environment, on native animals, and other plants could be devastating and not worth the risk. Introducing non-native species always has a negative impact on ecosystems.

Current land use should also be considered. What exists on the land now and how would planting biomass fuels change the landscape or value of the land?

Compare wood as a biomass fuel to fossil fuels. One ton of green wood (fresh weight) produces about the same amount of Btus as 65 gallons of fuel oil. A ton of dry wood (dry weight) produces about the same amount of Btus as 120 gallons of fuel oil. Wood pellets are another alternative fuel composed of wood residues (sawdust) from sawmills and wood products manufacturing and construction. See the fact sheet on Heating Your Home with Wood Pellets (see Resources) for more information.

Grasses are another option for biomass fuels. Switchgrass is a sod-forming warm season grass. It was an important part of the native tall-grass prairies that once covered a large portion of the United States. Switchgrass is preferred over other biomass species due to the fact that it is native to all parts of the Midwest. Additionally it burns well, it is easily managed, it attains reasonable yields without high rates of fertilizers, and it provides good habitat for wildlife.

<u>Economics Versus Sustainability</u>

The use of biomass energy can lessen our dependence on fossil fuels. Nearly every source of energy, including renewable, comes with some kind of trade off. The main debate surrounding the use of bioenergy is the economic advantages versus the environmental/sustainability disadvantages. For example, ethanol, an alternative fuel, is

Getting Ready:

Explain the term biomass to your students and ask if any of them have a fireplace, woodstove, or pellet stove in their home. Discuss the fuels that are burned in fireplaces and distinguish between wood and wood pellets. There may be other fuels that students' families burn as well. Brainstorm why different fuels exist and what the differences may be between one fuel source and another. Discuss why some people may choose one fuel over another. Possibilities include size, mass, ease of use, availability, amount of heat produced, cost, etc.

Cut the milk cartons in half and fill them with potting soil. Plant the same number of seeds in each milk carton and keep the soil moist. Plant different varieties of seeds in separate milk cartons. Plants will take approximately two weeks to grow (leave an extra week to be sure that the plants have plenty of time to grow). Keep track of growth rates in the **Plant Growth and Development Chart**. If one of the days falls on a weekend, feel free to change the measuring schedule. Make sure to measure each species of plant on the same day.

Credits:

Adapted with permission from the Department of Energy's National Renewable Energy Laboratory. "Activity 9: Which Grass Produces More Biomass" p. 61 in Renewable Energy Activities – Choices for Tomorrow: Teacher's Activity Guide for Middle Level Grades 6-8. Golden, CO. Used with permission.

being made from corn in Wisconsin. The advantage to this is that the use of ethanol means that we use less foreign oil. This can strengthen national security. By increasing the supply of fuel for transportation, we also increase supply, which, in turn can steady the rises and slumps in fuel prices. The supply and demand would also help farmers get a better price for the corn they are harvesting.

On the other hand, the corn that is currently grown in Wisconsin is energy intensive and, depending on cultivation practices, there can be a number of environmental concerns. There can be run-off, which carries topsoil into waterways where the water becomes turbid (muddy) and this can threaten fish populations. The more corn we need for fuel, the more corn we will grow. This can create a monoculture of corn. A monoculture reduces diversity and can become a threat to the security of the crop. If a pest or disease becomes resilient to protective measures, a whole crop can be lost, which would mean the loss of not only a source of fuel but a source of food as well.

Procedure

Orientation

Assign each student a photo of a different species of plant or go outside in the schoolyard and have each student find a different species of plant. Have them describe their species or let them draw their plant, making sure they pay close attention to details such as parts of the plants that may not be visible above ground. Have students pick an individual plant, making sure that the root is pulled from the ground. If the plant breaks, it is all right to use the broken pieces in this activity, in order to avoid pulling too many plants. Use the balance or scale to weigh each plant, making sure that there isn't any dirt left on the plant.

Ask the students to define photosynthesis and see if this helps them determine whether there is energy in the plants.

Photosynthesis can be described as the process in green plants and certain other organisms by which carbohydrates are synthesized from carbon dioxide and water using the sun's light as an energy source. Most forms of photosynthesis release oxygen as a by-product and most plants use the process of photosynthesis to grow and produce flowers, seeds, bulbs, etc.

Once students have determined that plants do indeed contain energy, ask them if they think plants could replace fossil fuels such as oil, natural gas, or coal. What plants do the students think contain the most energy? The larger, most dense plants probably have the most energy due to their mass. Now ask the students how humans can get the energy from the plants. Some possibilities include eating the plants and burning the plants, which are both correct answers.

Steps

1. After the plants have grown for the same amount of time (14 days or longer), pull them out of the soil by the roots.

2. Wash off all of the dirt on the plants and dry them with a paper towel.

3. Weigh the plants and record the data in the **Weight Chart**.

4. Place the grasses on separate pieces of paper and let them dry out. You can use a dehydrator or an oven to speed up the process.

5. Weigh the dry plants and record the data in the **Weight Chart**.

6. Ask the students which plant has the most mass and discuss why it has the most mass.

7. Ask students if they think the mass of the plant directly correlates with the amount of energy that the plant contains.

Closure
This section can be done as a discussion or a short research topic.

Discuss what is done with most of the corn and wheat grown in this country. What happens to the waste products that come from crops such as corn and wheat? Do you think corn husks and other waste materials could be a reliable source of biomass for energy?

Assessment

Formative
- How well did the students conduct their experiments?
- Did the students use the scale and fill out their charts correctly?
- Can they make a conclusion as to what plant would work best for a biomass fuel and explain why?

Summative
Have students research what biomass fuels are suitable to be grown in Wisconsin and whether they are native. Give them a map of Wisconsin and ask them to draw or color the areas of the state where that particular biomass fuel source grows. Ask them to compare Wisconsin's biomass fuel sources to other states and other countries. Where do the most biomass fuel plants grow and why? Are countries taking full advantage of the use of biomass fuels? Do the students think this type of alternative fuel source will grow and become more widely used? Are they (or their families) willing to use it in their homes or in their cars?

Extensions

• 9-12: Take the grasses that were grown in this activity and burn the same weight of each variety to discover which grass possesses the most energy (the one that burns the longest or produces the most heat). Answer these questions: Would the plants hold more energy if they were allowed to mature? Do other types of grasses (or plants) produce more biomass?

• Have each student bring in a different plant seed and their own milk carton. Each student will be responsible for caring for their own plant species. Have each student graph the growth of their plant every two days. Have two or more students grow the same plant to see if their plants grow at the same rate. Possibly put the same plant species in different areas of the classroom to expose them to different growing conditions. Decide as a class whether the plants they brought in are native to the area and whether they would make a good fuel source for Wisconsin.

• Invite a guest speaker who uses biomass at home or in a business to present to the class. A list of guest speakers can be found on the KEEP Web site at www.uwsp.edu/keep/resources. Have each student prepare at least one question for your visitor. Also, have your students discuss their class experiment with the speaker. Make sure to ask the speaker why he/she chose the fuel he/she did.

Resources:

Web sites
- Biomass Resources Center
  www.biomasscenter.org/
- Focus on Energy Biomass Fact Sheets
  www.focusonenergy.com/page.jsp?pageId=557
- Pellet Fuels Institute
  www.pelletheat.org
- United States Department of Energy
  www.energy.gov/energysources/bioenergy.htm

Related KEEP Activities:

"Corn in Your Car" - *BioFutures*

Charts

		Plant Growth and Development									
		Germination					Average Height				
Seed Type	Date Planted	Date of 1st sprout	Date of 10th sprout	Date of 20th sprout	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9
Wheat or Rye											
Corn											
Rye											

		Weight	
		Fresh Weight (oz.)	Dry Weight (oz.)
Test Plants	Wheat or Rye		
	Corn		
	Rye		

Roadside Renewables

Summary: Students build a model landfill, observe the decomposition process, and collect the gas that is emitted from the model.

Objectives

Students will be able to

- explain why we use landfills;
- identify materials that go into a landfill and what is recycled; and
- explain how methane is collected from a closed landfill.

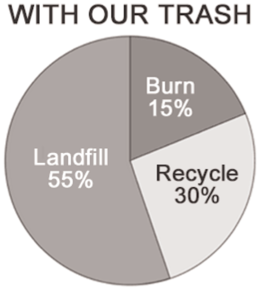
Materials

Samples of commonly discarded waste materials, including recyclable materials (kitchen scraps, leaves, newspaper, plastic bottles etc.) **NOTE**: Natural materials and food waste will work best for this activity. Think about what items decompose quickly.

Each group of students will need the following:

- Copies of *Pre- and Post-Activity Worksheets, How to Build a Model Landfill – Student Activity Sheet,* and *Roadside Renewables – Data Sheet*
- Glass or plastic jars with tight covers
- Drill for drilling holes in jar covers.
- Scissors
- Plastic bag or other lightweight bag/balloon
- Rubber bands
- Clear plastic wrap
- One foot of plastic or glass tubing
- Ceramic clay in slip (liquid) form

WHAT WE DO
WITH OUR TRASH



Background

What is a Landfill?

A landfill is not simply a hole in the ground where we dispose of trash, but a thought out system of disposing of waste. Landfills are designed to protect the soil, groundwater, and air from being polluted by the items we throw away. Landfills have a liner of clay and a synthetic material that keeps the liquids in a landfill inside so they will not leach into the soil or groundwater. Landfills also get a layer of soil put on top of them at the end of the day, called a daily cover, to reduce problems with animals and smells and to keep debris from blowing away.

Why Do We Use Landfills?

Throughout the world, humans dispose of things they do not need anymore. In the United States, we also use landfills to hold the things we no longer want. Most households have a trash can and a recycling bin somewhere, and once a week the trash and recycling are picked up by a truck and taken away. What happens after it leaves the curb? It goes to two separate places. 30% of the waste is recyclable materials that go to a recycling plant where they are sorted and shipped to other places to be reused. 55% of our trash goes to a landfill where it is dumped, piled, and plowed, to be contin-

While 30% of our trash is recycled, there is still more than 50% that goes into landfills. This never-ending pile of waste can provide renewable energy for years to come.

Source: Energy Kid's Page, Energy Information Administration (EIA). 2006. www.eia.doe.gov/kids/energyfacts/saving/recycling/solidwaste/landfiller.html. Original image is from National Energy Education Development (NEED) Project, *Museum of Solid Waste*, 2006

Grade Level: 5-8 (9-12)

Subject Areas:
Science, Family and Consumer Education, Environmental Education

Setting: Classroom

Time:
Preparation: 90 minutes
Activity: One 50-minute class period to construct models, plus several weeks to watch the process unfold

Vocabulary: Anaerobic digestion, Decomposition, Landfill, Leachate, Methane

Major Concept Areas:
Themes III & IV

- Quality of Life
- Managing Energy Resources

Related KEEP Activities:
"Community Design - It's agas" – *BioFutures*
"Biomass Gazette" – *BioFutures*

Academic Standards:
Science: A.8.7, A.8.8, B.8.6, C.8.4, C.8.10, F.8.10
FCE: A2, C3
EE: A.8.3, B.8.1, D.8.4

Credits:
Adapted with permission from The Infinite Power of Texas. "Follow Up Activity "A" - Making Landfill Gas" p. 13 in Clean Energy from Texas Landfills Activity Guide. Austin, TX. Used with permission.

Resources:

Web sites

- Renewable Energy from Landfill Waste – Waukesha, WI www.wayne.com/internet/businessunits/waukesha/pages/documents/publications/casehistory/landfill_4pg.pdf
- Milwaukee Journal Sentinel www.jsonline.com/story/index.aspx?id=123597
- How Stuff Works www.howstuffworks.com/landfill.htm
- WI DNR www.dnr.wi.gov/org/aw/wm/solid/landfill/

ued forever. The remaining 15% of trash is burned by incineration.

Lifecycle of a Landfill

A landfill location must be approved before the building begins. This can be a long and complicated process because many people do not want to live next to a landfill. There is often a lot of public opinion on the location. Then an environmental impact study must be conducted in order to determine what effect, if any, the landfill will have on the environment. The impact study is reviewed by the Wisconsin Department of Natural Resources, and, if the environmental impact study is completed without raising concern then the local government or private company must submit forms to obtain permits and raise the money to build a landfill. A vote from the public is often needed to raise the money to build a landfill. After these first steps have been completed, the landfill is built.

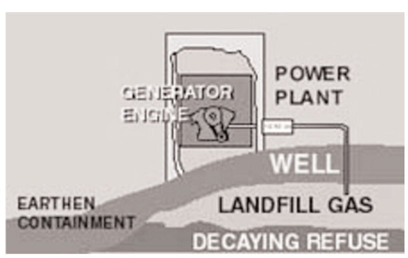
Once the landfill is operating, our waste begins to be brought by truck and local citizens to be disposed of. A landfill has small areas called cells that dumping takes place in during the day. This is done so it is easier to manage and easier to cover the smaller area with dirt at the end of the day (daily cover). Once a cell is closed, it is covered with a six-inch layer of soil and another section is used the next day. Once a cell is closed and permanently capped the methane generated from decomposition can be collected (see section on Energy from Landfills below).

Once the landfill is closed and capped, it must be monitored. The landfill is monitored to look for leaks in the liner and several groundwater wells are also tested regularly in order to determine if any liquid/leachate from the landfill has leached into the groundwater.

Energy from Landfills

The material in a landfill decomposes because there are anaerobic bacteria that thrive in the oxygen-free (anaerobic) environment. As decomposition takes place, gases are given off. This process is called anaerobic digestion. Methane, carbon dioxide, and other landfill gases are pulled out of the landfill through well and vacuum systems that are piped into the landfill. 50% - 60% of the gas given off by a landfill is methane. Methane is a gas that can be used to generate electricity and can be used like natural gas for heating spaces, heating water, and cooking. Natural gas is a non-renewable fuel that is usually burned to produce heat and to generate electricity. Methane is a very harmful greenhouse gas and must therefore be burned, or flared, as it is released from the landfill.

While the United States has reduced the waste going into our landfills by recycling, there will always be landfills. Because landfills will remain the main place to dispose of our waste, this source of energy is considered renewable. Not only are we generating energy from the methane, but we are reducing the amount of climate changing gases that are released into the atmosphere. This reduces smog, pollution, and global climate change and generates energy.



This graphic shows a simple cross section of a landfill and how energy can be harnessed from it.

Source: Primary Power International. Ithica, MI. www.primarypower.com/images/landfill_diagram.jpg.

Procedure

Orientation

Ask students what happens to their trash after it is taken to the curb. They should reply that it is picked up by the garbage truck and then it is taken to the landfill. Make sure students know the difference between what happens to their recycling and their garbage.

Show students the collection of sample waste materials. Hold up each of the materials and ask students where each item should go (landfill or recycling). Separate them into two piles and have the landfill materials ready for the activity. **NOTE**: You can identify biomass materials as any organic matter, such as any plant material.

Ask students to share what they know about landfills and how they operate. Correct or supplement their answers with information found in the Background and other sources. Make sure students understand the following key points:

- 55% of our trash goes to a landfill
- It takes many years for the trash to decompose and the landfill will eventually be full and a new landfill will need to be built.
- Landfills need to be covered and monitored to protect the environment.
- The trash in the landfill decomposes even when the landfill is covered.
- The process of decomposition gives off gases that are harmful to the environment. Because the gas is considered a source of pollution, it must be burnt or collected. The gas being collected is composed of carbon dioxide, methane, and many other gases.
- One thing that can be done with the gas is to burn it to create electricity and/or heat.

Steps

1. Divide the class into groups of four and explain that each group will be building a model landfill.

2. Provide each group with a copy of the **How to Build a Model Landfill** handout. Review the steps and, after students understand the activity, provide each group with a bag of landfill materials (the bulk of the materials should be organic matter such as food waste and yard waste). Hand out or have one student from each group collect the other materials needed for the activity.

3. After students have completed building their model, tell them that their landfill has been closed by the city and that it is time to seal it up. Explain that when the material in the landfill breaks down, it generates gases and those gases need to be vented out of the landfill.

4. After students have completed sealing their landfill, ask why the landfill needs to be sealed tightly. **NOTE**: If students are not able to seal their landfills with the rubber bands, they might use extra clay. The landfill needs to be sealed so the gas will not escape.

5. Hand out the **Pre-Activity Worksheet**. Students should complete the form as a group.

6. If possible, place the models outside in the sun, in a sunny interior window, or another warm place. Hand out copies of **Roadside Renewables - Data Sheet** and have students monitor their landfills and complete the questions at the end. This activity may take an extended amount of time to produce enough gas to be viewed by the students. The more easily broken down the materials are and the more tightly the jar is sealed, the better off you will be.

7. Ask students what they think cities and municipalities do with the collected gas. Explain that in closed landfills which do not collect the methane for energy, the methane must be burned off. You can sometimes see this as you drive by a landfill at night. Inform them that because the city has decided to use the gas from the landfill for energy, they must burn the methane so it is not released into the atmosphere (see Background). Methane is burned and used much like natural gas. **Caution**: Students should release the gas from their landfills outdoors in a well ventilated area; it is too risky to try to burn the gas their landfills might generate.

Closure

Review the discussion in the Orientation about which materials are recycled and which items are not. Hold up a few items and ask students where they should go. Have students review the purpose of a landfill and how it works for communities. See if they list landfills as a potential energy source within their descriptions.

Have students complete the **Post-Activity Worksheet** and discuss the results.

Ask students why landfills need to be closed when they are full. Ask them to explain what happens inside the landfill. Why does the gas need to be collected and flared off? What is another option besides flaring or burning off?

Assessment

Formative

- Can students describe the purpose of a landfill and how it works for the community?
- Have students list materials that should go into a landfill and what should be recycled.
- Ask students to explain how landfills can be an energy source for the community.
- Can they identify the gas that is collected from landfills?
- How thoroughly did students complete their Roadside Renewables - Data Sheet?

Summative

Have students conduct additional research on landfills as an energy source, listing pros and cons of this resource. Do they think capturing and using gas from landfills is a good option? Why or why not?

Extension

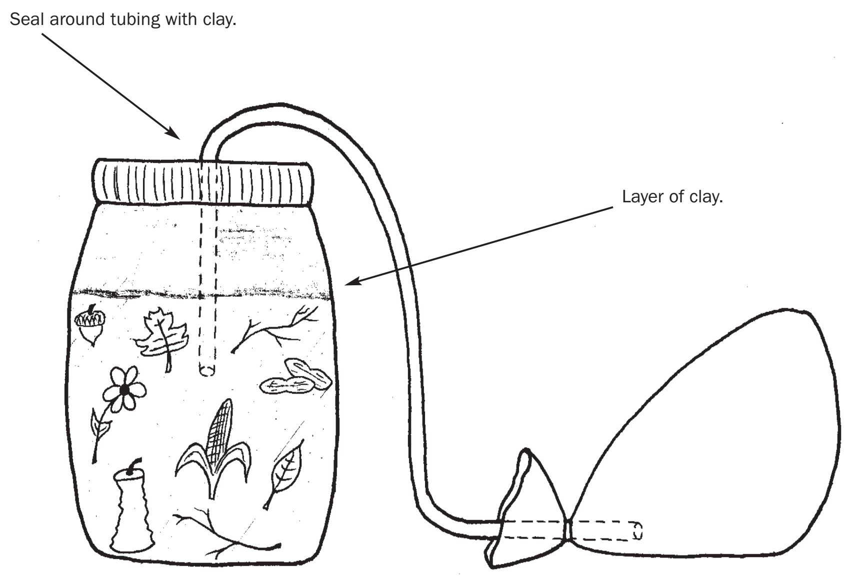
Have students work in groups to find out if there are any landfills in Wisconsin that use anaerobic digestion to generate energy. Put a state map on the board and have students mark them as they locate them. Have one student call the local landfill to find out the history of the landfill. How long will it last? Where was the last landfill and what is it being used for now? Are there any closed landfills nearby? What are those used for?

Take students on a field trip to a landfill so students can see how much waste is generated.

NOTE: This activity uses materials that can also be composted or put into a yard waste facility. These materials were used in the activity because they decompose much faster than the other materials we put into a landfill. Consider building a compost bin withyour students to discuss this process as well.

How to Build a Model Landfill

1. Drill a hole in the lid of your container the size of the plastic tubing.
2. Fill your landfill with materials from the landfill pile. Write down the materials you put in your landfill on the **Roadside Renewables – Data Sheet**.
3. Add a couple drops of water.
4. Insert the plastic tubing into the landfill pile and then cover the top of the waste with a layer of clay.
5. Push the other end of the plastic tube through the lid of the container and carefully seal the container with clay.
6. Put a light-weight plastic bag (or balloon) on the end of the tubing and seal it tightly with a rubber band.
7. Make sure that the landfill is sealed against any leaks and pay special attention to the area surrounding the plastic tube.



Roadside Renewables
Pre-Activity Worksheet

1. What did you put in your landfill?

2. How long do you think it will take for the plastic bag to fill with gas?

3. Fill out the data sheet.

Roadside Renewables
Post-Activity Worksheet

1. How many days did it take for your landfill to produce gas?

2. Did your landfill produce gas before other students, at the same time as others, after others, or not at all? Why?

3. What would you do differently next time you build a landfill in order to produce gas more quickly?

Roadside Renewables - Data Sheet

Date	Observations

Summary: Students use research skills to investigate various viewpoints surrounding the issue of ethanol as a fuel in Wisconsin.

Biofuel Beliefs

Grade Level: 9-12 (5-8)

Subject Areas:
Agriculture, English, Science, Social Studies, Environmental Education

Setting: Classroom, Library, Computer lab

Time:
Preparation: 30 minutes
Activity: Up to one week

Vocabulary: Energy input, Energy output, Ethanol, Net energy value (NEV)

Major Concept Area:
Themes II & III
- Consumption of Energy Resources
- Quality of Life

Getting Ready:
It may be helpful to involve the school librarian with research.

Academic Standards:
Science: A.12.5, C.12.6, C.12.7, E.12.1, E.12.4
ELA: A.12.4, C.12.1-3
SS: B.12.11, C.12.8, D.12.4
AG: A.12.1, B.12.4, C.12.2
EE: A.12.4, B.12.10, D.12.8

Objectives

Students will be able to
- provide an overview of ethanol production;
- identify at least two different viewpoints about ethanol; and
- write an objective paper about the opinions of different people involved in the ethanol debate.

Materials

- **Ethanol Viewpoint Form**
- Articles and Web sites on ethanol (see the *Resources* section of the KEEP Web site for *BioFutures* and the articles).

Background

To better understand environmental issues, it is helpful to analyze the viewpoints surrounding the issue. Investigating the viewpoints involves research, observation, and critical thinking skills.

See background material from “Corn in Your Car.”

Read the articles listed below (found on the KEEP Web site in the Resource < BioFutures section) to gain a better understanding of the debate about ethanol.
- History of Ethanol Production
- Why are there disparities in the net energy value of ethanol? Read the United State Department of Agriculture's article, The Energy Balance of Corn Ethanol: an Update. A summary of the article is on page iii.
- Read David Pimentel’s article Biomass Utilization, Limits of section C is specifically about ethanol production.
- PowerPoint from UW Extension

Procedure

Orientation

Write the word “ethanol” on the board and ask students what they have heard or know about the topic. Note their responses.

Survey students to get an idea of their opinions and knowledge on the topic. Ask students if they think there is agreement about the use of ethanol as fuel. Help students understand that there are disagreements about the benefits of ethanol and that they are going to learn about the varying viewpoints.

Provide students with a basic description of what ethanol is and how it is made. Make sure students understand all vocabulary words.

Steps

1. Tell students they are going to investigate different people’s opinions about the positive and negative impacts of producing and using ethanol as a fuel.

2. Discuss sources where students can find articles and Web sites on ethanol. Students should mention the Internet, journal articles, news reports, and books. Invite the school librarian to speak to the class about researching information.

3. Have students work in pairs or groups of three to investigate the various viewpoints. The groups can designate responsibilities for each member. For example, one student can be responsible for looking at Web sites and newspapers. Another student can research journal articles and books. Students can use various strategies to research viewpoints. Following is one approach:
- Each group should find at least six sources of information on ethanol. Allow about a week for students to research the information. Out-of-class assignments may be necessary.
- Ask the group to select two sources to investigate further. At this time, students can share their choices with you to make sure a diversity of resources are being investigated.
- Have students use the **Ethanol Viewpoint Form** to summarize their findings. Review the different parts of

the form. The “Viewpoint” is a one-sentence summary that succinctly states the author’s opinion. Students should use the “Additional or supplementary information” section to explain the reasoning or background behind the viewpoint. Ideally, students should cite scientific facts that were referenced within the source. The “Source” section should include reference information to help the reader find the resource, but it also identifies who authored the resource. (Knowing if the author is a member of a certain organization or receives funding from a particular agency can provide insight into motivations or influences behind the viewpoint presented).

- Everyone in the group should read all the sources, but each group member can be responsible for drafting the **Ethanol Viewpoint Form** for one of the sources. They should then meet as a group and share their work and edit and revise the form together.

4. After the groups have investigated at least two different sources of viewpoints about ethanol, have each group present their findings to the class.

5. When the students finish their presentations, have them post the **Ethanol Viewpoint Form** on the wall. Challenge the class to group similar or related viewpoints together. They can create a diagram similar to the one on the next page, where ethanol is in the center and the viewpoints are grouped around the center.

Closure

Have students summarize the various opinions presented in the diagram (Step 5). Were they aware of these different viewpoints before they conducted this research? Why do students think there are varying opinions?

Ask students to present their own viewpoints (compare to the survey conducted in the orientation). Do they find themselves agreeing with one or more of these viewpoints? Generate a list of questions about what else they would like to know about ethanol before they form an opinion.

Have students examine their energy use in relation to transportation.

NOTE: You can also conclude the activity with a debate on the pros and cons of using ethanol. You can divide students into groups and assign them each a role to play (farmer, politician, feed company president, investor, etc.).

Assessment

Formative

- Did students use effective research strategies to identify a variety of different viewpoints about ethanol?
- By reading students’ **Ethanol Viewpoint Forms**, can the reader quickly understand the viewpoint of the source?
- Were students able to group similar viewpoints together?

Summative

Have students write an informative article about ethanol and the various viewpoints involved. Encourage students to be objective and not to favor any viewpoint. Discuss the challenges with developing a paper of this format and the strategies they use to remain impartial. They can submit the article to the school newspaper or their local paper.

Extensions

Have students each pick a viewpoint and stage a debate.

Take students on a field trip to an ethanol production facility or invite staff from the facility to come be a guest speaker in the classroom.

Resources:

Web sites

- Making Ethanol – www.canren.gc.ca/tech_appl/index.asp?CaId=2&PgId=116
- Powering Cars with Ethanol – www.canren.gc.ca/tech_appl/index.asp?CaId=2&PgId=117
- Ethanol Across America – www.ethanolacrossamerica.net/education.html
- All About Ethanol – www.ethanol.org/
- Renewable Fuels Association – www.ethanolrfa.org
- Ethanol Promotion and Information Council – www.drivingethanol.org
- Opposition to Ethanol – www.energyjustice.net/ethanol/

Books

Title: Energy Alternatives: Opposing Viewpoints
Editor: Helen Cothran
Publisher: San Diego, CA: Greenhaven Press, 2002

Title: Alternative Fuels and the Environment
Editor: Francis S. Sterrett
Publisher: Boca Raton: Lewis Publishers, 1995

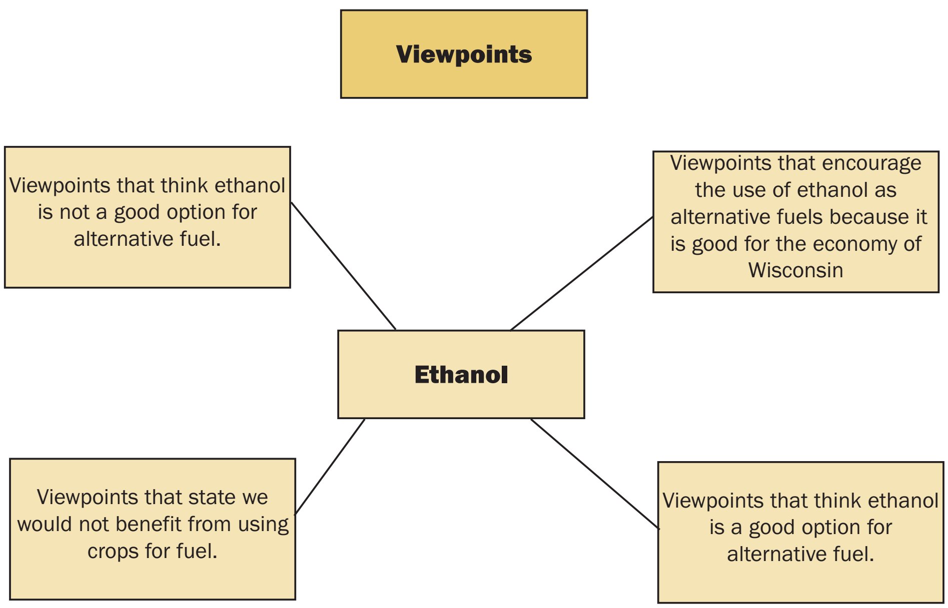
Title: Alternative Energy
Editor: Neil Schlager and Jayne Weisblatl
Publisher: The Thomson Corporation

Viewpoints

Pro-Ethanol Viewpoint
- Net Energy Value (NEV) is positive
- Good for Wisconsin's farming economy
- Low air pollutant emissions

Anti-Ethanol Viewpoint
- Net Energy Balance (NEV) is negative
- Not enough corn for food and/or feed
- More research needed

Ethanol – (Issues) Viewpoints that think there is not enough corn for food or feed. Viewpoints that think the Net Energy Balance is negative. Viewpoints that think the net energy balance is positive. Viewpoints that think there should be more research.



Ethanol Viewpoint Form

Viewpoint
Write a one or two sentence summary for the information in this source.

Additional or supplementary information

Source
Author or organization:

Title (of article or Web site):

Title of book or journal:

Date:

Other reference information (Web site address or volume number):

Summary: Students will act as reporters assembling a newspaper on biomass energy.

Biomass Gazette

Grade Level: 9-12 (7-8)

Subject Areas:
Language Arts, Science, Social Studies, Environmental Education

Setting: Classroom, Computer lab, Library

Time:
Preparation: One hour
Activity: One - two weeks

Vocabulary: Bioenergy, Biomass

Major Concept Area:
Themes II & III
- Development of Energy Resources
- Quality of Life

Academic Standards:
Science: C.12.7, E.12.1, E.12.14, G.12.3, G.12.5
ELA: A.12.4, B.12.1-3, E.12.1, E.12.2
SS: B.12.10, C.12.8, E.12.14
EE: A.12.4

Objectives

Students will be able to
- describe how bioenergy works;
- provide examples of biomass energy use in Wisconsin; and
- describe how a news article is different than an essay.

Materials

- Resources and reference materials about bioenergy resources
- Computer lab with Internet access

Background

Points of Journalism:

Writing a news article is different from writing an essay. In a news article, there is no conclusion. The reader should be able to stop reading the story at any time and still know what the story is about. The headline of a story is usually short and should send a message about the article. The headline can be clever, as long as the cleverness does not interfere with the message. The lead is the first sentence of a story and is one of the most important parts of the article. If the reader likes the lead, then he/she will continue to read the story. The lead usually contains six elements: the who, what, why, when, where, and how of the story. The most important information of the article should be at the beginning and the least important at the end. Paragraphs should be short and concise; two to three sentences is usually enough.

When writing a news article, every good journalist must keep journalism ethics in mind. Ethics deal with what is good/bad and moral/immoral. Journalists have four basic rules to follow, according to the Society of Professional Journalists:

1. Seek truth and report it – "Journalists should be honest, fair, and courageous in gathering, reporting, and interpreting information."
2. Minimize harm – "Ethical journalists treat sources, subjects, and colleagues as human beings deserving of respect."
3. Act independently – "Journalists should be free of obligation to any interest other than the public's right to know."
4. Be accountable – "Journalists are accountable to their readers, listeners, viewers, and each other."

Biomass

Biomass is any plant-derived organic matter available on a renewable basis, including dedicated energy crops, agricultural crop wastes and residues, wood wastes and residues, aquatic plants, animal wastes, municipal wastes, and other waste materials. These sources can provide energy in the form of electricity, heat, steam, and fuels.

Some biomass topics include:
(* indicates a more difficult topic.)

Direct burning – Burning biomass only for energy.
Examples: Wood burner, pellet stove.

Co-firing – Burning biomass along with a fossil fuel.
Example: Combining coal and biomass to generate energy.

Anaerobic digestion – Bacteria decomposes biomass in liquid to produce biogas in an air-tight vessel or enclosure. Biogas is then used to generate energy.
Example: Anaerobic digesters are being used on farms to generate biogas from animal waste.

Bio-fuels – Alternative fuels made from biomass; used for transportation.
Examples: Biodiesel and ethanol.

*__Gasification__ – The solid form of biomass is heated up and it changes into a gas. The gas is then changed into other fuels or burned in a boiler. The gas can be used as a substitute for natural gas.

*Pyrolysis – Pyrolysis uses a process similar to gasification except it eliminates the presence of oxygen altogether. The result is a liquid instead of a gas. This liquid is comparable to oil in its uses, as it can be burned for fuel or used to make products.

Biomass is a controversial topic. When writing their articles, it is important for students to understand what makes a good article (see Points of Journalism in Background). Before reporting, they should verify that their information is from a reputable source and make sure they address both sides of the story.

See *Resources* for more information on biomass.

NOTE: For examples of newspaper articles on biomass, see the following newspapers: *The Country Today, Agri-View, Wisconsin Farmer,* or *The Agriculturist.*

Procedure

Orientation

Ask students where people get news (TV, newspapers, radio, etc.). Ask them what makes a good story. List this on the board. Ask students what rules they think a reporter must follow in order to do a good job reporting a story (see Points of Journalism). List these on the board.

Ask students if they think renewable energy is a newsworthy topic. What might make renewable energy headline news? Have students look through newspapers and see if renewable energy is mentioned.

Tell students they are going to be assembling a newspaper about bioenergy, or energy made from biomass. Make sure students understand the components of a good article and the ethics of journalism. Have students explore newspapers (or on-line papers) looking for information on energy use in Wisconsin and throughout the world. Have them analyze their articles utilizing the Points of Journalism. Have students identify the ways in which information is given to the reader. Is it always text, or are charts, graphs, and pictures used to tell a story as well?

When discussing new, innovative, or advanced topics (including biomass energy in Wisconsin), journalists are challenged to help the public understand technical concepts in a clear manner. Remember, a picture speaks a thousand words. Use diagrams and illustrations to help explain. Think of other strategies journalists use to educate the public in an interesting manner.

Steps

1. Provide students with a brief background on biomass energy (see Background). Discuss the differences between the different types of bioenergy.

2. Have students break into groups and select a topic to write about. See list of "Selected Topics" for suggestions. (* indicates a more difficult topic.)

Selected Topics:

- basic bioenergy facts
- alternative fuel - ethanol
- alternative fuel - biodiesel
- * positive and negative aspects of bioenergy use
- energy from landfill gases
- energy from cow/pig/poultry waste
- energy from wood
- * how businesses use their waste wood for energy (paper mills and other businesses that use wood)
- biomass energy use worldwide

3. Encourage the groups to assign tasks to each group member (e.g., researcher, writer, editor), making sure that one member acts as the graphic designer. The editors and graphic designers should meet to establish guidelines for font style and size, length of each article, etc. They may need to research this topic by visiting the local newspaper or talking to the school newspaper advisor.

Resources

Web sites

- National Corn Growers Association www.ncga.com/ethanol/main/killing_myths.htm
- Wisconsin Alternative Fuels Program www.doa.state.wi.us/section_detail.asp?linkcatid=419&linkid=7&sname=Public%20Services
- Wisconsin Ethanol Coalition www.wisconsinethanol.com
- UW Department of Life Sciences Communication (journalism careers related to bioenergy and biotechnology) www.lsc.wisc.edu/overview.htm
- DNR Listing of Wood Burning Industries in Wisconsin www.dnr.state.wi.us/org/land/forestry/Usesof/woodburners.htm
- DNR Uses of Wisconsin's Forests www.dnr.state.wi.us/org/land/forestry/Usesof/Index.htm
- Wisconsin's first biodiesel production plant will be built by Anamax (Green Bay & DeForest) www.anamax.com
- wfrv.com/topstories/local_story_339092315.htm
- EPA Alternative Fuels www.epa.gov/otaq/consumer/fuels/altfuels/altfuels.htm

4. Provide the groups with time to research their topic in the library and computer lab.

5. Have students hand in their articles in one week. Edit their reports and have students make recommended changes.

Closure

Discuss the results of their research and publication. What do students know about biomass energy use in Wisconsin as well as the rest of the world? What is their opinion of its use? Have the class discuss how to distribute their production. How might they use this publication to educate others in the community about renewable energy?

Assessment

Formative

Did students find and write up information on their selected topic.

Summative

Have students perform Internet searches for other articles on biomass energy. Then have them analyze the article for parts, ethics, and intrigue within the story.

Extensions

This can be repeated in other classes with different renewable topics (solar, wind, hydro, and geothermal). The newspapers can be shared and discussed in other classes.

Ask students to identify whether any biomass resources are being used in their community. What government agencies or utilities could they contact to find out? What makes biomass energy a good or poor choice for their community?

Biomass Gazette - Student Pages

For this project you will be researching different types of biomass energy and will be putting together a newspaper that includes articles from each member in your group. You will be responsible for your own article and for the final layout of the newspaper.

In your article you should: (see grading rubric)

- Define your topic
- Describe how it works
- Explain where/how it is produced
- Provide examples of uses in Wisconsin
- Include graphs/charts/pictures
- Include an interview (extra credit)
- Include a headline, lead, and short paragraphs
- Use correct spelling and grammar
- Keep the readers attention

Writing a news article is different from writing an essay. In a news article there is no conclusion. The reader should be able to stop reading the story at any time and still know what the story is about.

The headline of a story is usually short and sends a message about the article. The headline can be clever, as long as the cleverness does not interfere with the message.

The lead is the first sentence of a story. It is one of the most important parts of the article. If the reader likes the lead, then he/she will continue to read the story. The lead usually contains six elements: the who, what, why, when, where, and how of the story.

The most important information of the article should be at the beginning and the least important at the end. Paragraphs should be short and concise; two to three sentences is usually enough.

When writing a news article, every good journalist must keep journalism ethics in mind. Ethics deal with what is good/bad and moral/immoral. Journalists have four basic rules to follow, according to the Society of Professional Journalists:

1. Seek truth and report it – “Journalists should be honest, fair, and courageous in gathering, reporting, and interpreting information.”

2. Minimize harm – “Ethical journalists treat sources, subjects, and colleagues as human beings deserving of respect.”

3. Act independently – “Journalists should be free of obligation to any interest other than the public’s right to know.”

4. Be accountable – “Journalists are accountable to their readers, listeners, viewers, and each other.

Biomass Gazette - Student Pages (continued)

Biomass is defined as any plant-derived organic matter available on a renewable basis, including dedicated energy crops, agricultural crop wastes and residues, wood wastes and residues, aquatic plants, animal wastes, municipal wastes, and other waste materials. These sources can provide energy in the form of electricity, heat, steam, and fuels.

Some biomass topics include: (* indicates a more difficult topic.)

Direct burning – Burning biomass only for energy.
Examples: Wood burner, pellet stove.

Co-firing – Burning biomass along with a fossil fuel.
Example: Combining coal and biomass to generate energy.

Anaerobic digestion – Bacteria decomposes biomass in liquid to produce biogas in an airtight vessel or enclosure; biogas is then used to generate energy.
Example: Anaerobic digesters are being used on farms to generate biogas from animal waste.

Bio-fuels – alternative fuels made from biomass; used for transportation.
Examples: Biodiesel and ethanol.

*__Gasification__ – The solid form of biomass is heated up and it changes into a gas. The gas is then changed into other fuels or burned in a boiler. The gas can be used as a substitute for natural gas.

*__Pyrolysis__ – Pyrolysis uses a process similar to gasification except it eliminates the presence of oxygen altogether. The result is a liquid instead of a gas. This liquid is comparable to oil in its uses, as it can be burned for fuel or used to make products.

Biomass Gazette - Grading Rubric

	Easily understood by reader	Hard to understand for some readers	Most readers won't understand	Too difficult to understand
Definition of topic	15	10	5	0
Describes how it works	15	10	5	0
Explains where/how it is produced	15	10	5	0

	More than one good example	One example	One example but not in Wisconsin	No examples given
Examples of uses in WI	15	10	5	0

	Easily understood/ related to topic	Not easy to understand/or not quite related to topic	Takes too much time to understand/or not quite related to topic	Too difficult to make sense of/or not related to topic	Doesn't make sense at all/or not related to topic
Graphs/charts/images	10-9	8-7	6-5	4-3	2-0

	Excellent	Good	Poor
Interview (extra credit)	10-9	8-7	6-1

	Captures attention/catchy	Somewhat catchy	Average	Could be better	Poor
Headline	10-9	8-7	6-5	4-3	2-0

	All info; gets attention	All info; loses attention	Missing some info; loses attention	Missing a lot of info; loses attention	Missing most info; reader gets bored & stops reading
Lead	10-9	8-7	6-5	4-3	2-0

	Article form; good spelling/grammar	Loses article form; some spelling/grammar mistakes	Not in article form; a lot of spelling/grammar mistakes	Reads like an essay; many spelling/grammar mistakes	Format is wrong; spelling/grammar is poor
Layout/spelling & grammar	10-9	8-7	6-5	4-3	2-0

	Short, concise, easy to understand; reader remains interested	Short, not very concise, easy to understand; reader loses some interest	Too long, not concise, not easy to understand; reader gets bored	Run on paragraphs, not concise, hard to understand; reader stops ½ way through	Sentence/paragraph structure very poor, very difficult to understand; reader stops reading immediately.
Paragraphs	20-18	17-16	15-14	13-12	11-0
Keeps attention	20-18	17-16	15-14	13-12	11-0

Participation – 25 points

Total Individual Grade _____________

Corn in Your Car

Summary: Through mapping and research, students measure the availability of ethanol-blended fuels in their community, and the environmental benefits of using these fuels.

Grade Level: 9-12

Subject Areas:
Agriculture, Science, Technology Education, Environmental Education

Setting: Classroom, Community

Time:
Preparation: One hour
Activity: One - two weeks

Vocabulary: Bioenergy, Biomass, Ethanol, Fermentation, Flexible-fuel vehicle (FFV)

Major Concept Area:
Theme IV
- Management of Energy Resource Use

Getting Ready:
For this activity, the number and size of student groups will depend on the size of your community. In a larger community, divide the community into regions and assign a group of students to each region. In a small community, you may want to assign individual streets to student groups.

Resources
Web sites
- Alternative Fuel Data Center - www.eere.energy.gov/afdc/altfuel/ethanol.html
- How Stuff Works - www.howstuffworks.com

Academic Standards:
Science: C.12.1, D.12.4, E.12.4,
AG: A.12.1, D.12.1, E.12.3, E.12.5, E.12.6
TE: B.12.2, B.12.5, B.12.6
EE: B.12.9, D.12.6, D.12.8

Objectives

Students will be able to
- identify the plant resources used to produce ethanol;
- describe the process of converting corn to ethanol;
- map the distribution of ethanol-blended fuel stations in their community; and
- explain the pros and cons of ethanol fuels.

Materials

- Copies of Experimentation in Fermentation worksheet (optional)
- Street maps of your community
- Small colored stars or circles
- Materials for posters/displays

Background

The term bioenergy, or biomass energy, means any plant-derived organic matter available on a renewable basis, including dedicated energy crops and trees, agricultural food and feed crops, agricultural crop wastes and residues, wood wastes and residues, aquatic plants, animal wastes, municipal wastes, and other waste materials. These sources can provide energy in the form of electricity, heat, steam, and fuels.

Biomass is a renewable resource—it can be replaced fairly quickly without permanently depleting Earth's natural resources. By comparison, fossil fuels, such as petroleum and coal, require millions of years of natural processes to be produced. Drilling for petroleum is considered a nonrenewable process since it depletes Earth's resources for thousands of generations.

More than 60% of petroleum resources in America are imported, and a majority of this petroleum is used as gasoline for automobiles. The burning of fossil fuels, such as gasoline, is a major contributor to air pollution and increased greenhouse gas. Ethanol represents an option for vehicle fuel that burns cleaner than gasoline, can be produced in the United States, and could reduce U.S. dependence on foreign oil.

Ethanol is ethyl alcohol. It is made via an advanced distillation process from crops and vegetable matter, such as corn (see **Experimentation in Fermentation** for more information). With many of Wisconsin's farmers growing corn, ethanol fuel production could benefit the state's economy. There are already a number of ethanol plants in Wisconsin, with others being proposed and planned.

Liquid ethanol can be used as a fuel when blended with gasoline or in its original state. There are three primary ways that ethanol can be used as a transportation fuel:
- As a blend of 10% ethanol with 90% gasoline (known as E-10)
- As a component of reformulated gasoline, directly and/or as ethyl tertiary butyl ether (ETBE)
- As mixture called E-85 that consists of 85% denatured ethanol blended with 15% gasoline: E-85 does not burn well in conventional vehicles, but flexible-fuel vehicles (FFV) are designed to run on all blends up to 85%.

Ethanol can be used to increase octane levels, decrease engine emissions, and extend the supply of gasoline. According to the United States Deptarment of Agriculture, 3.9 billion gallons of ethanol were produced in the United States in 2005. Each bushel of processed corn yields 2.5 gallons of ethanol, along with several valuable by-products. The first blends in the 1970s were 10% by volume (E-10), and a blend of 85% by volume (E-85) was introduced in the mid 1990s.

Methanol, which is similar to ethanol, is a racing fuel for major sporting events such as the Indianapolis 500. Aside from being a component of fuel, ethanol is also widely used as a solvent, in industrial applications, and as the intoxicating ingredient in alcoholic beverages.

Procedure

Orientation

Ask students what they know about ethanol. Some students may know of farmers who grow corn for ethanol production or they may know of ethanol plants in Wisconsin. Describe some of the uses of ethanol in the United States (see Background).

Do students think that ethanol-blended products are already available in their community? Explain to students that through this activity, they will find out what resources are available.

Steps

1. Divide the class into working groups (see Getting Ready).

2. Each group will receive a street map of the community that shows their assigned study region. Encourage students to share responsibilities and come up with innovative ways to complete their research.

3. Allow students one to two weeks to conduct the following research:

- Develop a one-page fact sheet about ethanol, summarizing how it is produced, how it is used, and its economic and environmental costs and benefits.
    - Students can conduct Internet research to learn more about ethanol.
    - Make sure students explore E-10 and E-85 blends and understand the costs and benefits of each.
    - See **Experimentation in Fermentation** for a hands-on activity that illustrates some aspects of ethanol production.
- Map stations in their region that do and do not sell ethanol fuel (students can visit or call the stations).
- Classify stations that sell ethanol based on fuel blend:
    - Fuel stations that sell E-10 fuel (10% ethanol, 90% gasoline)
    - Fuel stations that sell E-85 fuel (85% ethanol, 15% gasoline)

4. Have the groups transfer their researched information to a class map. The class can create a key, using colored stars or dots to represent fuel stations of different classifications. **NOTE:** This step may not be necessary in small communities.

5. Challenge student groups to create a one-page informational flyer (or some other public service announcement) that provides an overview of ethanol and identifies fuel stations that sell ethanol-blended fuels. Encourage students to be creative! These flyers can be posted around the school or students can contact community planners about displaying the flyers around the community.

Closure

As a class, review the presence (or absence) of ethanol and ethanol blends in your community. Based on students' research and perceptions, discuss pros and cons of ethanol use in your community.

Assessment

Formative

- Did the students properly identify the major sources of ethanol production?
- How well did the students explore and map the fuel stations in the community?
- Are students able to identify the environmental benefits of using ethanol fuels?
- How extensively and thoughtfully did students develop their marketing strategy?
- Did students create plans that appropriately addressed the availability of ethanol-blended fuels in the community and reasons to use these fuels?

Summative

How has this activity increased students' knowledge of ethanol and their attitudes toward ethanol use? Have each student write a reflective essay to summarize.

Extensions

There are many resources available that describe how to produce ethanol or how to transform a gasoline vehicle into a FFV. Depending on the level and curriculum of your classroom, investigate these avenues for a possible student project. In urban areas such as Milwaukee, residents are required to purchase "reformulated gasoline" year round, but the formulation of the gas changes with the season. Have students explore this concept and survey community residents on their knowledge and perceptions of ethanol and reformulated gasoline. Integrate this data into a marketing strategy for promoting ethanol use.

Although methanol is the main component of superior racing fuels, other fuels utilized for racing contain varying amounts of ethanol. If students are interested in racing, have them research and analyze racing fuels and octane ratings. How do racing vehicles differ from FFVs? What effect would using an ethanol-blended fuel have on a non-racing car?

Math skills can be put to the test by having students calculate the miles an automobile can be driven using ethanol derived from a certain crop of corn. For example, have students compute the miles from 750 acres of corn in an automobile using E-10 (10% ethanol blend) that gets 26 miles per gallon. Consider that an acre of corn produces an average 127 bushels and each bushel produces about 2.5 gallons of ethanol.

Experimentation in Fermentation

Ethanol is made from a variety of plant substances including corn, sugar cane, and wood. The process used to make ethanol is called fermentation. Fermentation was discovered many years ago when bubbles or foam formed while making wine and beer. Studies by Louis Pasteur described fermentation as changes caused by yeasts growing in the absence of air. Fermentation is an energy-yielding process in which fuel molecules such as glucose (sugar) are broken down in the absence of oxygen. Changing corn to ethanol by fermentation takes many steps. Starch in corn must be broken down into simple sugars before fermentation can occur. In earlier times, this was done by chewing the corn. This allowed the salivary enzymes to naturally break down the starch. Today, this is achieved by cooking the corn and adding the enzymes alpha amylase and gluco amylase. These enzymes function as catalysts to speed up the chemical changes. Once a simple sugar is obtained, yeast is added. Yeast is a single-celled fungus that feeds on the sugar and causes fermentation. As the fungi feed on the sugar, they produce alcohol (ethanol) and carbon dioxide. In fermentation, the ethanol retains much of the energy that was originally in the sugar, which is why ethanol is an excellent fuel.

This experiment can be modeled by the teacher or used as a laboratory exercise.

Materials:
- 8 or more pkgs of yeast
- ice
- measuring spoons
- 4 clear half-liter glass containers
- stirrers
- heating element
- flour, salt, sugar, vinegar

Steps:
1. Empty a package of yeast into each half-liter (1 pint) beaker of warm water. Stir for 1 minute.
2. Add 10 ml (2 tsp.) of flour to each beaker and stir again.
3. Add 5 ml (1 tsp.) of salt to the first beaker, 5 ml of sugar to the second beaker, 5 ml of vinegar to the third, and do nothing to the fourth. Stir again.
4. Wait 5 minutes and record your observations.

Beaker 1______________________________
Beaker 2______________________________
Beaker 3______________________________
Beaker 4______________________________

5. Wait 15 minutes and record your observations.

Beaker 1______________________________
Beaker 2______________________________
Beaker 3______________________________
Beaker 4______________________________

6. Let the solutions sit overnight and record your observations.

Beaker 1______________________________
Beaker 2______________________________
Beaker 3______________________________
Beaker 4______________________________

On a separate piece of paper, describe the fermentation that is taking place, or have students answer the following questions:
1. What is the evidence that reactions are going on in the containers?
2. How are these observations related to fermentation?
3. State any conclusions about which of the substances tested was most helpful to yeast fermentation.

Appendix

Appendix | Table of Contents

Cross Reference Charts
Grade Levels

Activity	K-4	5-8	9-12
Photosynthesis Promenade	X		
Would You Heat With Wood?	X		
Advertising Biodiesel		X	
Community Design - It's a Gas		X	
Don't Waste Waste		X	
Grasses for the Masses		X	
Roadside Renewables		X	
Biofuel Beliefs			X
Biomass Gazette			X
Corn in Your Car			X

Subject Areas

Arts: Art, Drama, Dance, and Music
Eng: English and Language Arts
Living: Family Living and Consumer Education, Technology Education, and Agriculture
Math: Mathematics
Phy Ed: Physical Education
Science: Environmental, Life, Earth, and Physical Sciences
Soc St: Geography, History, Global Studies, Economics, and Government

Activity	Arts	English	Living	Math	Phy Ed	Science	Soc St
Photosynthesis Promenade	X				X	X	
Would You Heat With Wood?	X	X				X	
Advertising Biodiesel	X	X	X			X	
Community Design - It's a Gas						X	X
Don't Waste Waste				X		X	
Grasses for the Masses			X			X	
Roadside Renewables			X			X	
Biofuel Beliefs		X	X			X	X
Biomass Gazette		X				X	X
Corn in Your Car			X			X	

Teaching Methods

Read: Reading
Write: Writing
Calcul: Calculating
Discuss: Discussing
Debate: Debating
Demo: Demonstrating
Design: Designing, creating
Hands: Working hands-on, including playing card game
Body: Using whole body
Invest: Investigating, researching, experimenting
Map: Mapping, graphing

Activity	Read	Write	Calcul	Discuss	Debate	Demo	Design	Hands	Body	Invest	Map
Photosynthesis Promenade				X		X			X		
Would You Heat With Wood?	X	X		X				X			
Advertising Biodiesel	X	X		X			X			X	
Community Design - It's a Gas				X			X			X	X
Don't Waste Waste			X	X				X		X	
Grasses for the Masses			X	X	X			X		X	X
Roadside Renewables				X			X	X		X	
Biofuel Beliefs	X	X		X	X					X	
Biomass Gazette	X	X		X			X			X	
Corn in Your Car	X	X		X				X		X	X

Assessment Strategies

Oral: Student-generated oral work including debates, dramatizations, reports, simulations/role-playing, and speeches
Write: Student-generated written work including essays, reports, journals and logs, letters, worksheets, and survey results
Prod: Student products including models, artwork, exhibits, and portfolios
Graph: Graphic organizers including concept maps, collages, computer logs, and Venn diagrams
Prob: Problem solving process
Discuss: Discussion including open-ended and guided response

Activity	Oral	Write	Prod	Graph	Prob	Discuss
Photosynthesis Promenade	X		X			
Would You Heat With Wood?			X	X		
Advertising Biodiesel		X	X			X
Community Design - It's a Gas	X		X		X	
Don't Waste Waste					X	X
Grasses for the Masses		X			X	X
Roadside Renewables		X				X
Biofuel Beliefs	X	X				X
Biomass Gazette		X	X			
Corn in Your Car		X				X

Conceptual Framework

KEEP's *A Conceptual Guide to K-12 Energy Education in Wisconsin* (Conceptual Guide) was designed to direct the development of the KEEP *Activity Guide*. Below is an abbreviated version of the framework; the charts on the previous page show how the activities address the concepts identified in the framework.

Theme II: Developing Energy Resources

Development of Energy Resources

- Primary energy sources are those either found or stored in nature; the sun is Earth's principle energy source
- Secondary energy sources are produced from primary energy sources using technology (e.g., electricity generation)
- Energy sources are considered to be resources by individuals and society when they serve societal needs and wants
- The ways human societies have obtained energy resources have evolved over time
- Some energy sources are concentrated and others are diffuse; geographically Earth's energy sources are unevenly distributed
- **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**
  NOTE: Most of the activities in *Doable Renewables* relate to this concept.
- Wisconsin imports most of the energy resources it uses (nuclear and fossil fuels); 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

- Supply and demand influence energy resource development and use; global demand for resources is increasing.

Theme III: Effects of Energy Resource Development and Use

Quality of Life

- Energy use has affected the quality of human life, including our lifestyles, health and safety, economy, sociopolitical structure, and culture.

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.

Theme IV: Managing Energy Resource Use

Management of Energy Resource Use

- Energy resource management involves societies deciding which resource to use and determining how to use them efficiently; Wisconsin has a variety of energy conservation programs available.
- Citizens can make decisions and take actions that determine how the energy they use will be managed; these decisions and actions are influenced by barriers and incentives.

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 in the future.

Glossary

Glossary

Introduction

The glossary lists words and terms found in the vocabulary sections of each activity in *BioFutures*. Definitions of words and terms are often restricted to their usage in an activity or to an energy- or science-related usage. Hence not all definitions and usages for a word or term are listed.

Advertising
The activity of using various forms of media (e.g., newspapers, television, radio, etc.) to inform people about products or services and persuade people to buy them.

Alternative fuels
Any fuel besides gasoline and diesel used to power an automobile. Examples: Natural gas, propane, biodiesel, ethanol, electricity, methanol, and hydrogen.

Anaerobic digestion
Bacteria decomposes biomass in water to produce biogas in an airtight vessel or enclosure. Biogas can then be used to generate energy. Example: Anaerobic digesters are being used on farms to generate biogas from animal waste.

Bioenergy
See Biomass.

Biofuels
Alternative fuels from biomass. Used for transportation. Examples: Biodiesel and ethanol

Biogas
A mixture of methane and carbon dioxide produced by bacterial decomposition of organic matter used as a fuel.

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.

Biodiesel
A biofuel usually made from organic sources (soybean or rapeseed oils, animal fats, waste vegetable oils, or microalgae oils) that are used as a substitute for diesel fuel. Biodiesel can be blended with diesel or used alone.

British thermal unit (abbrev. Btu; pl. Btu)
1. A unit of energy equal to 1,055 joules or 252 calories.
2. The amount of energy needed to raise the temperature of one pound of water one degree Fahrenheit.
3. The approximate amount of energy stored in one wooden match.

Btu
See British thermal unit.

Carbohydrate
An organic compound produced by photosynthesis, such as sugar, starch, and cellulose and used as a source of food energy by organisms.

Carbon dioxide (formula: CO_2)
A colorless, odorless gas formed during respiration, organic decomposition, and combustion of fossil and other carbon-based fuels. Carbon dioxide is taken up by green plants during photosynthesis, dissolved in bodies of water, and circulated in Earth's atmosphere.

Chemical potential energy
The energy stored in chemical bonds holding the atoms of a compound together. Food, wood, batteries, and fossil fuels contain chemical potential energy.

Chlorophyll (formula: $C_{55}H_{72}MgN_{405}$)
The green pigments found in the chloroplasts of plants that are essential for producing carbohydrates by photosynthesis. It occurs in a bluish-black form.

Co-firing
Burning biomass along with a fossil fuel. Example: Combining coal and biomass to generate energy

Decompose
1. To decay 2. To break down into basic elements.

Decomposition
See decompose

Diesel
A fuel from non-renewable resources that is used in a diesel engine.

Direct burning
Burning biomass only for energy. Examples: Wood burner, pellet stove.

Dry weight
The weight of something when moisture has been removed.

Efficiency
The ratio or percentage of useful output to the total input in any system. See Efficient, Energy efficiency, Inefficient.

Efficient
Accomplishing a task with a minimum effort and waste.

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. See Efficiency, Efficient, Inefficient.

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

Energy input
The amount of energy that is put into making an energy resource.

Energy output
The amount of energy output from an energy resource.

Ethanol
Ethyl alcohol. It is made by fermentation and distillation process from crops and vegetable matter such as corn.

Fermentation
An anaerobic process in which yeast converts sugars to carbon dioxide and alcohol.

Flexible-fuel vehicle (FFV)
Vehicles designed to run on all ethanol/gasoline blends up to 85 percent ethanol and 15 percent gasoline.

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

Fresh weight
The weight of an item when it is freshly cut (not dried).

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

Gasification
A process that converts carbonaceous materials, such as coal, petroleum, petroleum coke or biomass, into carbon monoxide, hydrogen and carbon dioxide.

Glucose (formula: $C_6H_{12}O_6$)
A type of sugar compound found in most plant and animal tissue and used as a major food energy source by organisms.

Greenhouse
An enclosed structure (with glass or plastic) that controls heat and humidity to cultivate plants.

Harvest
The process of gathering a crop.

Heat
The transfer of energy from one object at a higher temperature to another object at a lower temperature. Heat can be transferred by conduction, convection, or radiation. Although technically incorrect, the word heat is often used to mean "thermal energy." See Thermal energy.

Heat energy
See Heat.

Industrial wood residue
Any part of the tree that is not used for the primary product such as paper or timber. This can include leaves, stumps, branches, or any other part of the tree that is determined unusable by the company.

Inefficient
1. Producing only a small useful output from a large total input. 2. Wasteful of time, energy, or materials; not efficient; ineffective. See Efficiency, Efficient.

Joule
A unit of energy. One joule equals 0.2388 calories or 0.0009481 Btu.

Landfill
A site for solid waste disposal that is underground or in a low-laying area and involves layering solid waste and soil.

Leachate
A solution formed by leaching. It may contain contaminates that were picked up as the solution leached through the soil.

Light
A form of electromagnetic radiation composed of different wavelengths ranging from violet to red that are visible to the naked eye. Light is also a means by which energy can be transferred.

Light energy
See Light.

Methane (formula: CH_4)
An odorless and colorless gas that is flammable. Methane is the product of the process of organic matter decomposing. It can be used as a fuel.

Miles per gallon (abbrev. mpg)
A unit of vehicle fuel efficiency expressed as the number of miles a vehicle can travel on one gallon of motor fuel. The higher the miles per gallon figure for a vehicle, the more fuel efficient it is.

Molecule
1. The smallest combination of atoms making up a substance and retaining its chemical and physical characteristics. 2. A group of atoms held together by chemical bonds.

Native species
A species that originates in the area or region it is in.

Net energy value (NEV)
The difference between the energy input and energy output.

Non-native species
A species that does not originate in the area or region it is in.

Nonrenewable energy resource
Energy resource that is either replenished very slowly or is 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 examples of nonrenewable energy resources.

Oxygen
An element that by itself exists as a gas (O_2). It is essential for plant and animal respiration and for the process of combustion.

Pellet stove
An apparatus that burns pellets (small compressed fuel pellets made of wood, grasses, and paper waste). Pellets burn efficiently.

Photosynthesis
The process by which green plants use sunlight to produce carbohydrates such as glucose, other nutrients, and oxygen from simple compounds such as water and carbon dioxide. In energy terms, photosynthesis converts solar energy into chemical potential energy that is stored in carbohydrates.

Pyrolysis
Pyrolysis uses a process similar to gasification except it eliminates the presence of oxygen altogether. The result of this is a liquid instead of a gas. This liquid is comparable to oil in its uses as it can be burned for fuel and it can be used to make products.

Renewable energy resource
Energy resource that can be quickly replenished. Certain renewable resources will always be available no matter how they are used (e.g., solar energy), while other renewable resources can be depleted when their rate of use exceeds their rate of replacement (e.g., wood).

Solar energy
Energy transferred from the sun to Earth in the form of electromagnetic radiation. See Sun.

Sun
A yellow star around which Earth and the other planets of the solar system orbit. The sun provides nearly all the energy needed to sustain life on Earth. See Solar energy.

Synthesis
1. The combination of separate elements or substances to form a coherent whole. 2. Formation of a compound from simpler compounds or elements.

Thermal energy
The total internal kinetic and potential energy of an object due to the random motion of its atoms and molecules. An object that feels hot has more thermal energy inside it than it does after it has cooled down. Although technically incorrect, the word "heat" is often used to mean thermal energy. See Heat.

Wood
The hard, fibrous substance beneath the bark that makes up most of the stems, roots, and branches of a tree or shrub.

Wood burner
An apparatus used to burn wood to be used for heat to cook food or provide warmth.

Wisconsin Center for Environmental Education
Learning Resource Center — University of Wisconsin — Stevens Point
Stevens Point, Wisconsin 54481-3897
715.346.4770 • Fax 715.346.4698 • Email: energy@uwsp.edu
www.uwsp.edu/keep