Should We Use Wood for Energy?

A High School Education Program

TEACHER INTRODUCTION

Some of the more complex issues facing our society today are associated with energy production, generation, and consumption. Coupled with increasing demand for energy is heightened concern regarding impacts of climate change, energy security, and the long-term sustainability of the United States’ energy sector. Specifically, according to the United States Energy Information Administration (2008a), primary domestic energy use is projected to increase 19 percent by the year 2030. Currently in the United States (U.S.), fossil fuels (for example, coal, petroleum, and natural gas) account for approximately 86 percent of the nation’s energy supply (U.S. EIA, 2008a). Concerns exist regarding the long-term viability of fossil fuels as a primary energy source. Although fossil fuels were once thought to be inexhaustible resources, today many scientists warn that the world has already surpassed peak rates of oil extraction and production (Environmental Literacy Council, 2008a). The combustion of fossil fuels increases the overall amount of carbon dioxide in the atmosphere, a key factor in global climate change. In addition, there are a number of other environmental impacts associated with the extraction, production, and utilization of fossil fuels, including greenhouse gas emissions, acid rain, water pollution, and land disruption (Environmental Literacy Council, 2008a).

These concerns suggest that we must consider utilizing a combination of domestically available alternative energy sources. Scientists contend there is no one ideal solution to energy challenges we face today. Making use of all renewable energy technologies and resources will likely be the most effective method to meet growing energy demands, while also reducing greenhouse gas emissions (Union of Concerned Scientists, 2008). To actively participate in making decisions and adopting solutions, consumers and citizens need to know where and how energy is generated and produced, how much energy the U.S. consumes, and how individuals can contribute to energy conservation and the creation of a secure, sustainable energy future.

Woody biomass is one renewable energy option that may be feasible for communities in the southeastern U.S. Like any other energy source, using wood for energy has potential advantages and disadvantages. When making decisions about whether to use wood for energy, communities need to thoroughly consider the related factors, questions, and impacts of such decisions. As the next generation of decision makers, high school students are well-suited for exploring questions about local renewable energy sources. Furthermore, providing youth with the skills needed to address issues surrounding the energy sector, now and in the future, is a fundamental aspect of confronting energy challenges and adopting workable solutions.
Education Program Goals and Themes

The goals of this educational program are:
1. to increase students’ knowledge of energy and the possibilities of using wood for energy through interactive, investigative activities;
2. to teach critical-thinking and systems-thinking skills;
3. to engage students in examining and weighing advantages and disadvantages of using wood for energy; and
4. to engage students in evaluating how using wood for energy relates to the three components of sustainability: environment, economy, and society.

The 18 activities in this program fall under the following overarching thematic question: Should our community use wood for energy?

The activities tie in components of sustainability, critical thinking, and systems thinking. Table 1 identifies activities which either focus on or touch on one of the components of sustainability (environment, economy, or society), critical thinking, or systems thinking.

The following sections introduce these concepts and will help you apply them as you teach.

### TABLE 1. Sustainability, Critical Thinking, and Systems Thinking Activities

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<tr>
<th>Activity</th>
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- Activity emphasizes/focuses on concept/skill
- Activity touches on concept/skill

(continued)
The term sustainability is often used but can be difficult to define. To be sustainable is to continue indefinitely; to use something sustainably means to not use it up, but to use it in a way that it can regenerate. Often, sustainability is defined in the context of sustainable development. The United Nations World Commission on Environment and Development (1987) defines sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” When developing new ways to meet growing energy demands, sustainable development should be taken into consideration.

Many people think about the environment when they consider sustainability. The environment is a key component of sustainability because the natural resources that constitute the environment are part of what sustains life on Earth. How humans use resources affects the future availability of these resources and the overall health of the environment. However, other factors must also be considered. For example, decisions focusing on the environment may not be sustainable if people are not able to earn a living or have adequate food and water supplies. Therefore, a sustainable decision also takes into consideration economic and social factors. In assessing sustainability, it is necessary to consider the health and vitality of three areas over time: environment, economy, and society (Wheeler, Wheeler, & Church, 2005). Sustainable decisions must take into account choices that are fair and equitable as well as choices that allow businesses and industries to thrive. For example, the ability to earn a livable wage, to be healthy and safe, to have a say in community decisions, and to have clean air and water are all factors that a sustainable community should include in their decision-making processes.

Sustainable decisions are those that consider the current and future impacts of actions undertaken today and which explore environmental, economic, and social outcomes of alternate options.
the environment, economy, and society, which are the three components of sustainability. These components are related to one another and are often illustrated by three overlapping circles (Figure 1).

Energy is essential to all aspects of life and development and, therefore, is a key aspect of sustainable development. Today, the world is faced with the challenge of finding ways to meet growing energy needs without compromising the health of the environment, the economy, or society. Therefore, the impacts of an energy decision can be organized by using the concept of sustainability. For example, when making decisions about energy generation and consumption, we can ask three overall questions: How does this method of generating energy influence future generations and nonhuman organisms, ecosystem functions, natural resources, or global climate change? How does this method work toward creating a viable and secure economy? How does this method fairly contribute to quality of life for all groups of people who are impacted by such a decision?

The “society” component of sustainability deserves additional attention, since unlike environmental and economic topics, many high schools do not have classes that explore how decisions and choices relate to equity and justice. “Ethics” refers to a set of principles or morals that guide our lives and the decisions we make in a complex world. Inherent to various environmental issues are pertinent ethical questions, such as: where do our resources come from; what are the consequences of using those resources; and how do our decisions about resource use affect others, with “others” including both human and nonhuman organisms. In this way, ethics is related to making fair and just decisions about energy systems. It recognizes that any resource decision related to energy will have an effect on various life forms and ecosystems, including the humans who reside in those communities.

Ethical decisions are usually made based on a mix of rational thinking, including cost/benefit analysis (for example, deciding if biomass is a viable economic investment) and emotions, including emotional responses to trees and forests or attachments to inexpensive energy sources that maintain a specific lifestyle.

As teachers, you are able to facilitate discussions that help students understand the ethics of a decision without telling them the “right” answer. In fact, the “right” answer often depends on the perspective of the person who is analyzing a problem and its potential solutions. Bringing ethical discussions into the classroom means recognizing the role ethics play in our lives and giving students the skills to examine the ethical component of decision-making processes, in this case exploring approaches and responses to biomass energy.

While all of the activities help students explore one facet of sustainability (environment or economy), most of the activities also have discussion questions that ask students to reflect on the society component of sustainability (such as influences on quality of life, the fairness of decisions, and the creation of equitable solutions). Activity 9: Can Energy Be Sustainable? in Section II: Digging Deeper and each of the activities in Section IV: Wrapping Up aim to incorporate all three components of sustainability.
Critical Thinking

Because participating in decisions regarding sustainable energy sources involves critical thinking, many of the activities require students to practice and apply critical-thinking skills. Critical thinking involves critiquing complex information, identifying bias, and taking on the responsibility to use these skills to shape future actions (Jacobson, McDuff, & Monroe, 2006). Teaching your students to become critical thinkers involves not only teaching appropriate skills and strategies but also helping your students develop a mental attitude or frame of mind, what is often called a habit of inquiry—a commitment to questioning one's own thinking and ideas, as well as others' thinking and ideas. A critically thinking person is willing to examine the reasoning and assumptions that underlie beliefs, ideas, and conclusions; to engage thoughtfully and deliberately with information and ideas, even those which may conflict with his or her opinions or beliefs; and to take responsibility for choosing a position based on an objective analysis and thoughtful evaluation of all relevant information and evidence.

Applying critical thinking, therefore, requires an individual to activate his or her higher-order thinking skills:
- analysis (breaking down the subject or problem into its parts in order to see how they fit together as a whole);
- evaluation (assessing or judging the merits as well as strengths and/or weaknesses of assumptions and conclusions); and
- synthesis (creating a solution or developing a conclusion based on the essence of the most reliable and valid information and perspectives).

The activities in this program incorporate critical-thinking skills through evaluation of multiple viewpoints, long-term impacts, advantages and disadvantages, and sources of information and bias.
thinking in your teaching methods, you can help to develop a citizenry that can more effectively address environmental issues (Jacobson, McDuff, & Monroe, 2006). Teachers can help students realize that they are thinking about the system by reminding them of interconnected factors, by making a concept map, and by generating discussion about consequences of actions—foreseen and unforeseen. Systems thinking is incorporated into the activities in Section IV: Wrapping Up, as these activities seek to bring together several considerations and questions regarding using wood for energy. In addition, Activity 9: Can Energy Be Sustainable? and Activity 11: Woody Biomass as a System in Section II: Digging Deeper are designed to emphasize this skill.

**Education Program Framework**

This program is intended for grades 10 through 12. The activities are designed so that you can use the program as a unit on woody biomass or select the portions that best relate to your subject areas—Social Studies, Language Arts, Science, or Mathematics. Table 2 identifies which activities correlate to 2008 Science, Social Studies, Mathematics, and Language Arts Next Generation Sunshine State Standards for grades 9 through 12.

**Table 2. Subject Correlations**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Science</th>
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<th>Mathematics</th>
<th>Language Arts</th>
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<td><strong>Section III: Applying Knowledge</strong></td>
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<td>17 Community Forum to Explore Using Wood for Energy</td>
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<td>18 Making Connections: Reflection Essay</td>
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SECTION I: GATHERING INFORMATION

Objectives
Students should be able to
1. explore various topics related to woody biomass,
2. investigate and gather information on various woody biomass topics and issues, and
3. analyze and synthesize information through higher-order thinking discussion questions.

Activities
- **Activities 1 to 4: Web-quests**
  These are inquiry-oriented activities that use the Internet to investigate a topic related to woody biomass. Students are directed to visit Web sites to learn about the topic and gather information. As a culminating project, students create posters and present to the class. The four Web-quests are:
  - **Activity 1: Energy in the U.S.**
  - **Activity 2: Carbon Cycle and Greenhouse Gases**
  - **Activity 3: Biomass Basics**
  - **Activity 4: The World’s Forests**

- **Activity 5: Case Study Jigsaw**
  Using a cooperative learning technique, each student will share information on various facilities, operations, and industries in the Southeast that use woody biomass for energy and learn about wood to energy conversion technologies.

SECTION II: DIGGING DEEPER

Objectives
Students should be able to
1. think critically about advantages and disadvantages of woody biomass,
2. analyze varying perspectives on woody biomass,
3. analyze sources of information for bias and fairness, and
4. explain justifications for opposition to woody biomass.

Activities
- **Activity 6: Biomass Perspectives**
  This activity engages students in reading and analyzing editorials regarding bioenergy and examining multiple perspectives on the issue. Students participate in group and class discussions and complete a worksheet to analyze and critique the perspectives on biomass presented in the editorial articles. In addition, students take part in a panel discussion/debate regarding the various perspectives presented in the articles.

- **Activity 7: Who’s Against Renewable Energy (And Why!)?**
  This activity introduces students to public opposition to renewable energy. Student groups are assigned to research a Web site of an organization that is opposed to utilizing renewable energy sources in their community. Student groups complete a worksheet related to the content and information on the Web site. Finally, groups teach the class what they have learned about opposition to renewable energy and synthesize the information in a class discussion.

- **Activity 8: Citizen Survey on Using Wood for Energy**
  Students survey community members to find out what they know and want to know about using wood for energy, as well as some of the common concerns and perspectives on the issue. In addition, the class compiles and analyzes the survey responses to draw conclusions about public perceptions regarding using wood for energy.
• **Activity 9: Can Energy Be Sustainable?**
  Students learn about the concept of sustainability and how it relates to energy production. In groups, students practice systems thinking as they research various energy sources and compare the potential impacts of each energy source on the three components of sustainability: environment, economy, and society. The individual groups present this information to the class using visual aids.

• **Activity 10: Forests in Your County**
  In Part I, students use Google Earth to locate forested areas in their county, create their own land cover maps, and estimate the percent of forest cover. In Part II, a forester or another natural resource professional is invited as a guest speaker to provide information about forest areas and ownership within the county.

• **Activity 11: Woody Biomass as a System**
  In Part I, students explore the inputs and outputs of the woody biomass to ethanol system. Students create their own depiction of the system by placing the input and output cards in the correct part of the system and relating these inputs and outputs to impacts on the environment, economy, and society. In Part II, students predict how different policies could impact portions of the woody biomass to ethanol system.

• **Activity 12: Pyrolysis Lab**
  In this lab activity, students learn about converting biomass into energy through the process of pyrolysis. The experiment demonstrates pyrolysis through the heating of biomass material in the absence of oxygen to produce gas, liquid oil, and char. Students conduct the experiment in groups and complete a lab journal.

• **Activity 13: Energy from Biomass Lab**
  In this lab activity, students build a calorimeter to test how much energy is contained in various biomass materials. Students complete a Student Lab Journal to compare temperature change, mass change, calories, and British thermal units.

• **Activity 14: Creating a Woody Biomass Supply Curve**
  In this activity, students go to various Web sites, compile data, and make calculations to construct woody biomass supply curves for their region.

• **Activity 15: Regional Economic Impact Analysis**
  In this activity, teachers present a lecture on assessing regional economic impacts and students use this knowledge to calculate the effects of a wood to energy facility on a hypothetical regional economy.

### SECTION III: APPLYING KNOWLEDGE

**Objectives**
Students should be able to
1. collect and assess data and research regarding various woody biomass topics;
2. demonstrate scientific processes related to using wood for energy;
3. conduct hands-on, interactive experiments and research projects; and
4. apply knowledge of woody biomass to specific subject areas.

### SECTION IV: WRAPPING UP

**Objectives**
Students should be able to
1. apply and extend knowledge about woody biomass in their community;
2. critically analyze the meaning of sustainability and how this concept relates to woody biomass in their community;
3. conduct research and prepare presentations; and
4. synthesize knowledge and experiences gained through the completion of activities in Sections I, II, and III.
Activities

- **Activity 16: Considering Using Wood for Energy: A Role Play**
  In this role play activity, students participate in a mock town-hall meeting where community leaders are seeking input on using wood for energy. Students play the roles of stakeholders and community leaders to examine various perspectives, concerns, and questions in the local community. This activity can serve as a culminating exercise for this unit.

- **Activity 17: Community Forum to Explore Using Wood for Energy**
  This activity summarizes and applies the knowledge students have acquired about using wood for energy and helps students facilitate public involvement in energy decisions. Students work in groups to plan and conduct a community forum in which they provide information to the public, answer questions, and discuss ideas and concerns. Students from other classes, parents, and community members can be invited to represent the public.

- **Activity 18: Making Connections: Reflection Essay**
  Students draw a concept map to organize the factors that should be discussed when a community is considering using wood for energy. Students then write a one to two page essay. The essay should reflect their experiences with learning about the use of wood for energy and demonstrate their understanding of the issue’s complexity.

**ADDITIONAL PROGRAM RESOURCES**

**Teacher Answer Keys**

When applicable, answer keys are provided for student worksheets. While many of the answers will vary, sample answers are given for assessment purposes. To prevent students from
accessing answer keys online, they are available upon request. Please see the program Web site www.sfrc.ufl.edu/extension/ee for more information.

**Supplemental Reading**

Each activity contains a Background Information section and provides an introduction to the topics or issues being addressed in the activity. If time permits and you would like to incorporate reading comprehension into the activity, you can assign students to read this information before doing the activity. In addition to the Background Information provided at the beginning of each activity, you can find additional, more detailed fact sheets, case studies, and other materials in the Supplemental Reading section. If a fact sheet is particularly relevant to an activity, you will be referred to this fact sheet in the Teacher Instructions section of the activities.

The materials in the Supplemental Reading section include the following:

**Fact Sheets**
- An Invitation to Explore Possibilities
- Climate Change and Carbon
- Common Concerns
- Economic Impacts of Generating Electricity
- Environmental Impacts
- Federal Policies and Incentives
- Financing Woody Biomass Facilities
- State and Local Policies and Incentives
- Sustainable Forest Management
- Systems That Convert Wood into Energy
- Technological Processes: Bio-Chemical
- Technological Processes: Thermochemical

**Case Studies**
- Co-firing with Wood and Switchgrass
- Converting from Natural Gas to Waste Wood
- Forest Industry Creates Its Own Power
- Power to the People
- Using a Mix of Fuels to Produce Heat and Power
- Wood and Paper Trim the Energy Bill
- Wood Power Heats a Public School

**Other**
- Assessing the Economic Availability of Woody Biomass
- Community Forum Journal Article
- Do-It-Yourself Supply Curves
- Florida Community Economic Profile
- Gainesville Report
- Sample Community Forum Questions

In addition, the Resources section of each activity provides a list of online resources.

**Presentations**

Three PowerPoint® presentations are provided in this program. The introductory presentation, Should We Use Wood for Energy? An Introduction, is a useful tool to prepare students for thinking about the many issues related to this topic. Presentations for Activity 11: Woody Biomass as a System and Activity 15: Regional Economic Impact Analysis provide students with relevant background information. Each presentation includes notes to help you guide the lecture and discussion.

**Glossary**

The glossary provides a list of key terms and definitions found in bold type throughout the program materials.