U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

BioenergizeME Office Hours

Integrating Bioenergy into the 9th—12th Grade Classroom

December 10, 2015

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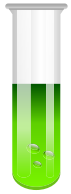
Agenda

1. Overview Of Energy Literacy 
2. Overview of Next Generation Science Standards 
3. Bioenergy Basics 
4. 2016 BioenergizeME Infographic Challenge 

5. Incorporation of Bioenergy into the Classroom 

Questions and Comments

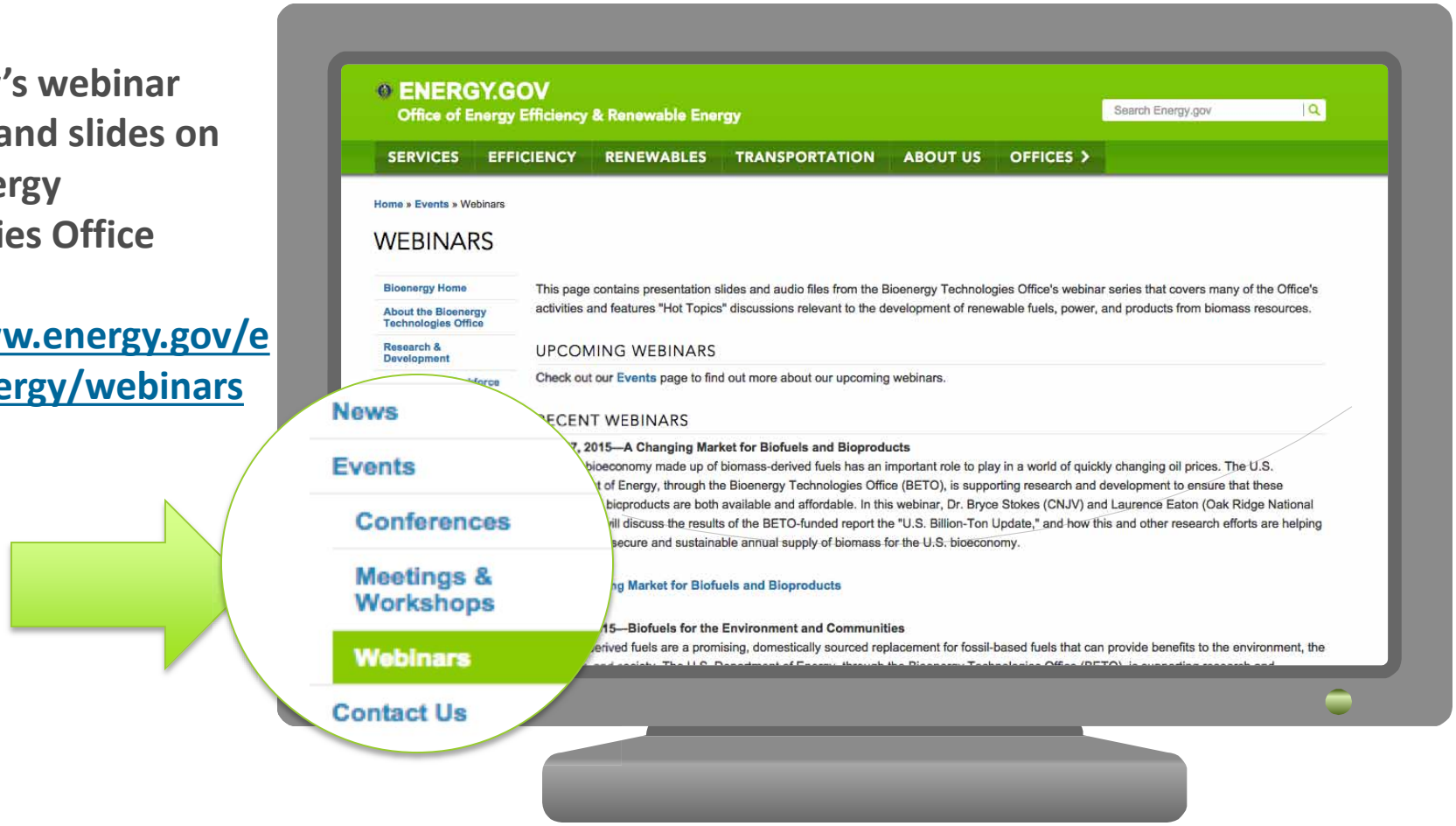
Please record any questions and comments you may have during the webinar and send them to BioenergizeME@ee.doe.gov

As a follow-up to the webinar, the presenter(s) will provide responses to selected questions.

For general questions regarding the BioenergizeME Infographic Challenge, please email BioenergizeME@ee.doe.gov

Webinar Recording

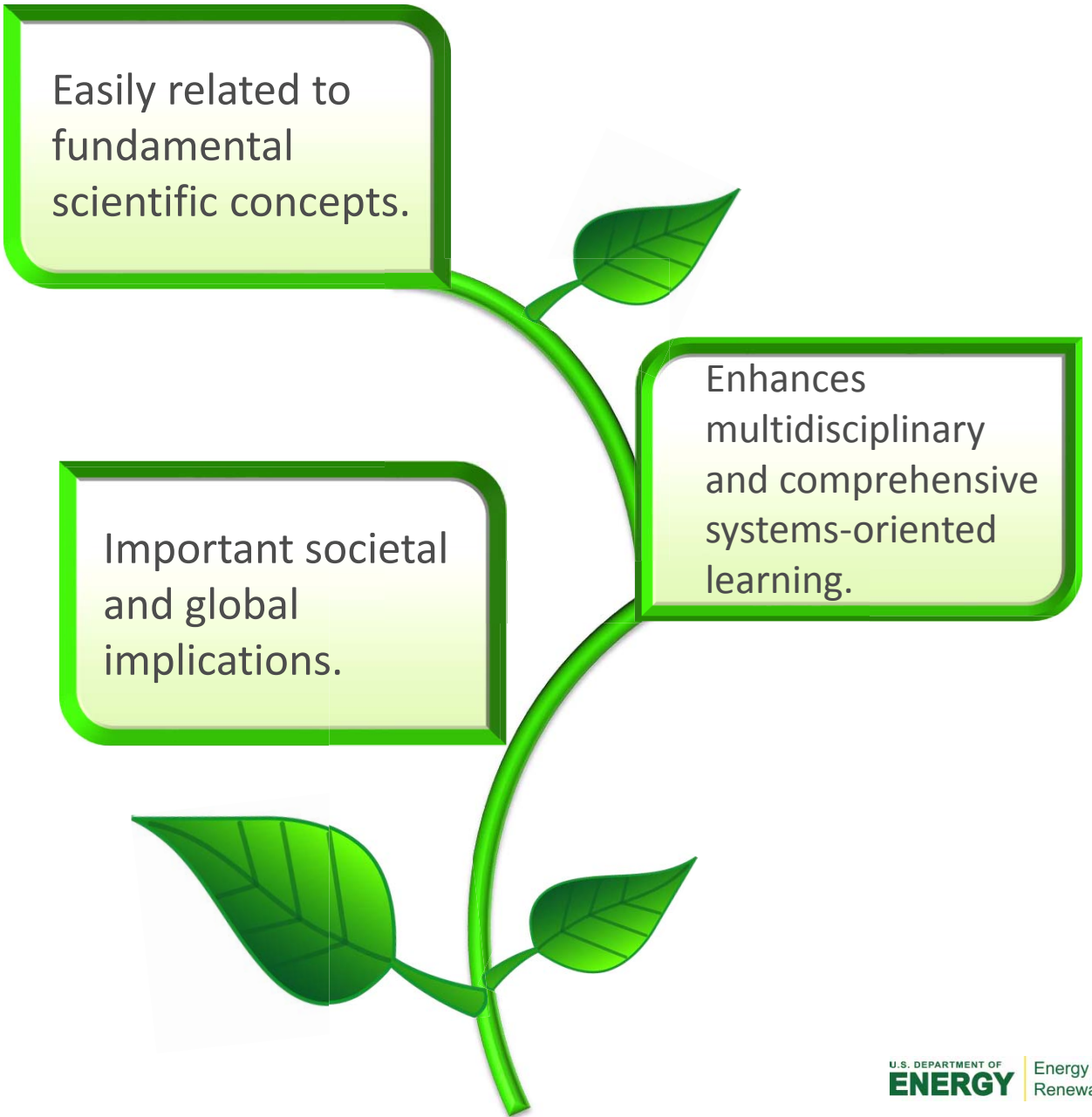
Find today's webinar recording and slides on the Bioenergy Technologies Office website: http://www.energy.gov/eere/bioenergy/webinars

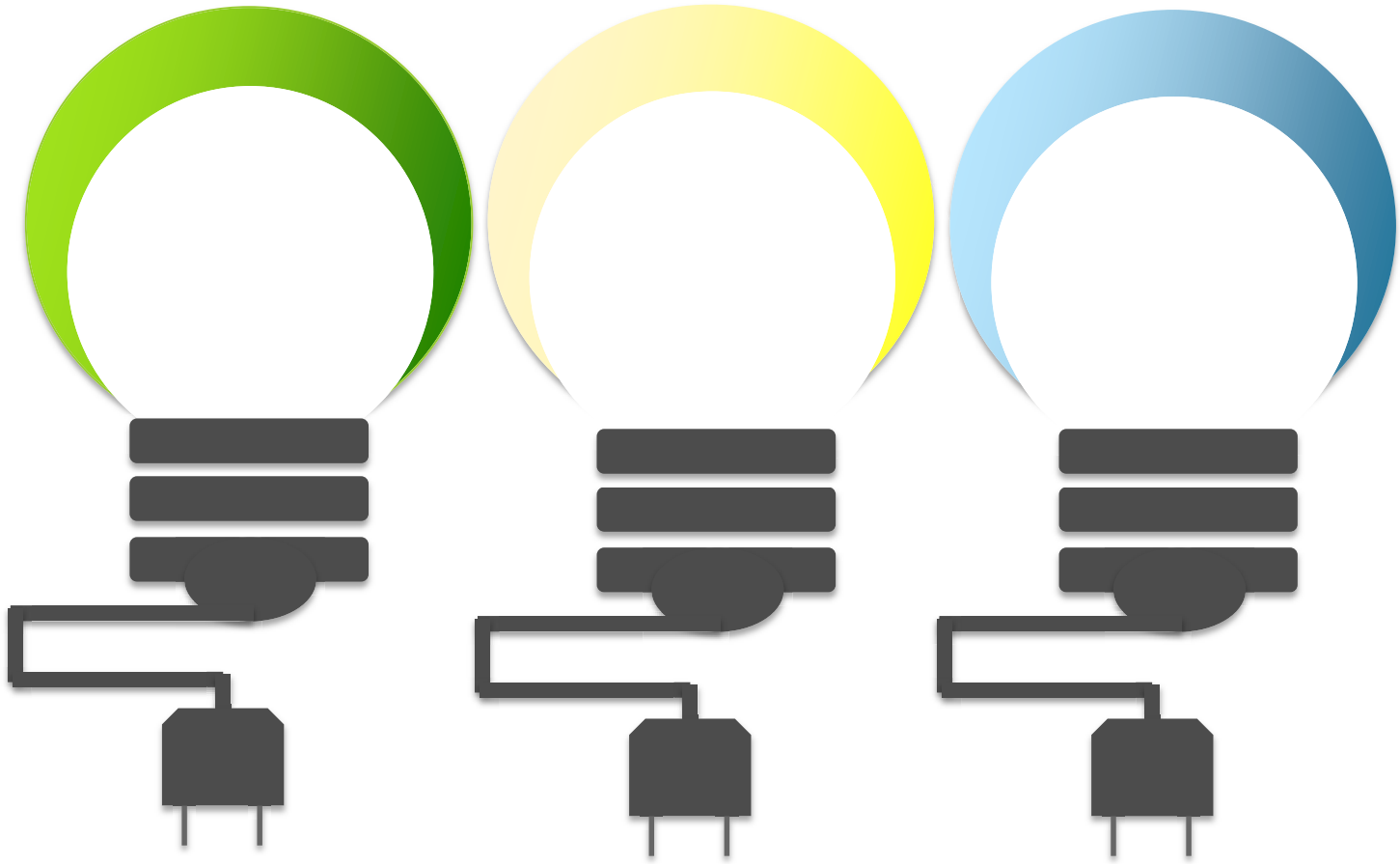


Why Bioenergy? Why Now?

- **Bioenergy** use has changed over time
- **Bioenergy** is part of a variety of resources used to meet America's energy needs
- **Important to understand:**
  - Basic energy principles
  - Energy resource & technology options available
  - Benefits & challenges of various energy resources
  - How students & their peers can play an important role in shaping America's energy future

Bioenergy in the Classroom





Overview Of Energy Literacy

What is Energy Literacy & Why does it matter?

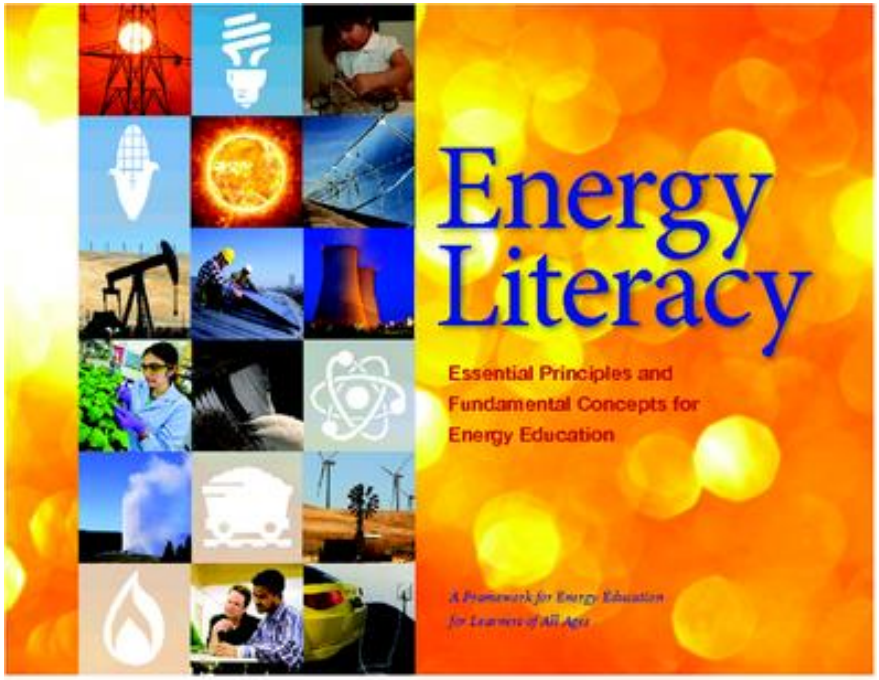
Energy literacy is an understanding of the nature and role of energy in the universe and in our lives. It is the ability to apply this understanding to answer questions and solve problems.

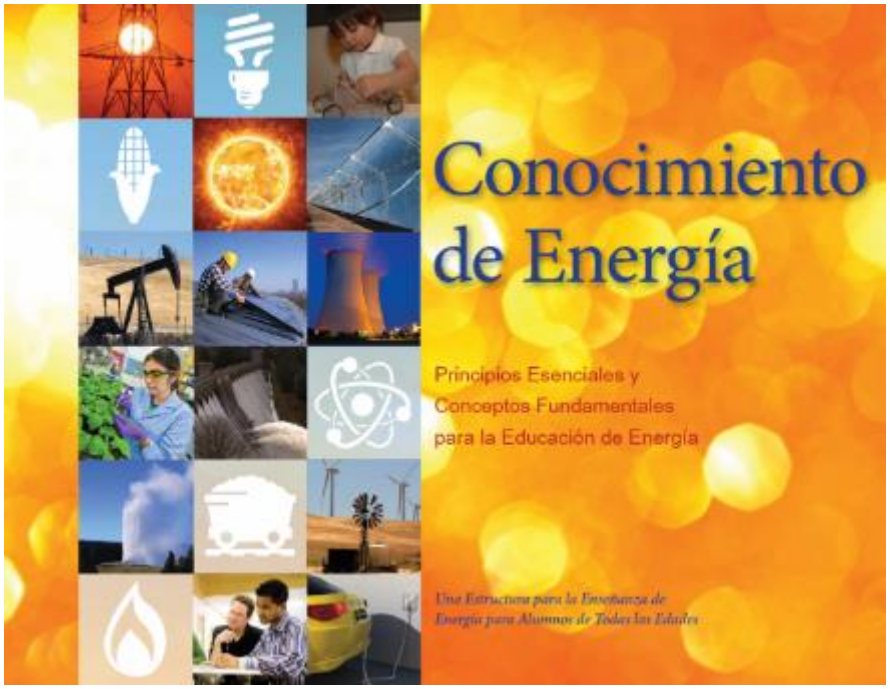
- **An energy-literate person:**
  - **can trace energy flows and think in terms of energy systems**
  - **knows how much energy he or she uses, for what, and where that energy comes from**
  - **can assess the credibility of information about energy**
  - **can communicate about energy and energy use in meaningful ways**
  - **is able to make informed energy and energy use decisions based on an understanding of impacts and consequences**
  - **continues to learn about energy throughout his or her life**

A better understanding of energy can:

- **lead to more informed decisions**
- **improve the security of the nation**
- **promote economic development**
- **lead to sustainable energy use**
- **reduce environmental risks and negative impacts**
- **help individuals and organizations save money**

Energy Literacy





To download or request a copy of the framework, visit:

www.energy.gov/energyliteracy

The Energy Literacy Scaffold

The Energy Literacy Framework is not prescriptive, it is a scaffold intended for energy curriculum developers and instructors.

- The principles are meant to be broad categories representing big ideas.
- Each fundamental concept under the principles is intended to be unpacked and applied as appropriate for the learning audience and setting.
- The concepts are not intended to be addressed in isolation. A given lesson on energy will most often connect to many of the concepts.

Energy Literacy Principles

01

Energy is a physical quantity that follows precise natural laws.

02

Physical processes on Earth are the result of energy flow through the Earth System.

03

Biological processes depend on energy flow through the Earth system.

04

Various sources of energy can be used to power human activities & must be transferred from source to destination.

05

Energy decisions are influenced by economic, political, environmental, and social factors.

06

The amount of energy used by human society depends on many factors.

07

The quality of life of individuals and societies is affected by energy choices.

Aligned to NGSS

Alignment between the **Energy Literacy Framework** and the **Next Generation Science Standards** (NGSS)

CLICK BELOW TO SEE ALIGNMENT FOR YOUR GRADE LEVEL:

ELEMENTARY SCHOOL (K-2)

ELEMENTARY SCHOOL (3-5)

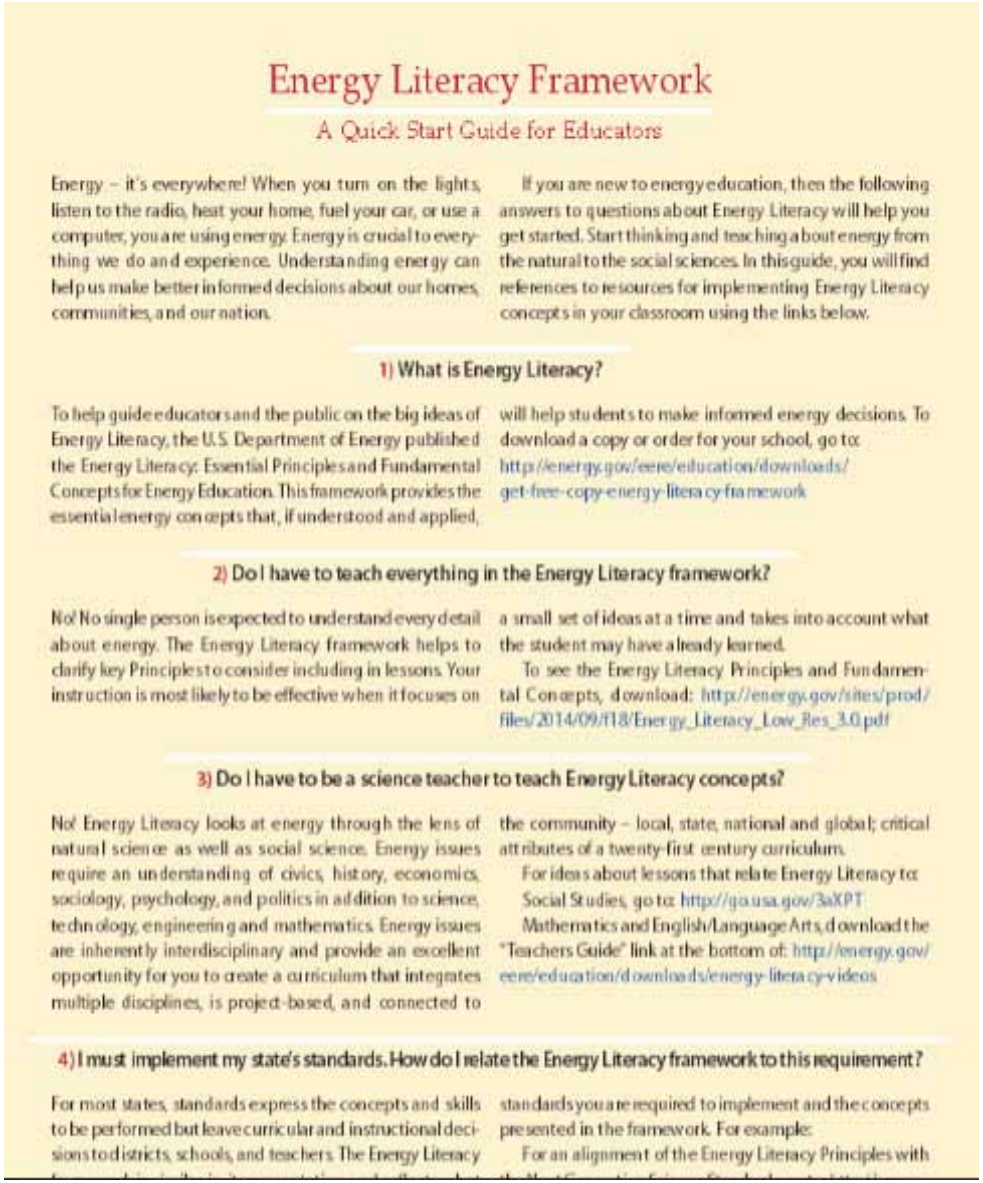
MIDDLE SCHOOL (6-8)

HIGH SCHOOL (9-12)

NEXT GENERATION SCIENCE STANDARDS
For States, By States

STRAND	NGSS.K-PS.	PHYSICAL SCIENCE
TITLE	K-PS3.	Energy - Students who demonstrate understanding can:
PERFORMANCE EXPECTATION / FOUNDATION	K-PS3-1.	Make observations to determine the effect of sunlight on Earth's surface. ELF 2.3 Earth's weather and climate is mostly driven by energy from the Sun. ELF 2.4 Water plays a major role in the storage and transfer of energy in the Earth system. ELF 2.6 Greenhouse gases affect energy flow through the Earth system.
PERFORMANCE EXPECTATION / FOUNDATION	K-PS3-2.	Use tools and *materials* to design and build a structure that will reduce the warming effect of sunlight on an area. ELF 1.2 The energy of a system or object that results in its temperature is called thermal energy.

Resources for Teaching Energy



Energy Literacy Framework

A Quick Start Guide for Educators

Energy – it's everywhere! When you turn on the lights, listen to the radio, heat your home, fuel your car, or use a computer, you are using energy. Energy is crucial to everything we do and experience. Understanding energy can help us make better informed decisions about our homes, communities, and our nation.

If you are new to energy education, then the following answers to questions about Energy Literacy will help you get started. Start thinking and teaching about energy from the natural to the social sciences. In this guide, you will find references to resources for implementing Energy Literacy concepts in your classroom using the links below.

1) What is Energy Literacy?

To help guide educators and the public on the big ideas of Energy Literacy, the U.S. Department of Energy published the Energy Literacy: Essential Principles and Fundamental Concepts for Energy Education. This framework provides the essential energy concepts that, if understood and applied, will help students to make informed energy decisions. To download a copy or order for your school, go to: http://energy.gov/eere/education/downloads/get-free-copy-energy-literacy-framework

2) Do I have to teach everything in the Energy Literacy framework?

No! No single person is expected to understand every detail about energy. The Energy Literacy framework helps to clarify key Principles to consider including in lessons. Your instruction is most likely to be effective when it focuses on a small set of ideas at a time and takes into account what the student may have already learned.

To see the Energy Literacy Principles and Fundamental Concepts, download: http://energy.gov/sites/prod/files/2014/09/f18/Energy_Literacy_Low_Res_3.0.pdf

3) Do I have to be a science teacher to teach Energy Literacy concepts?

No! Energy Literacy looks at energy through the lens of natural science as well as social science. Energy issues require an understanding of civics, history, economics, sociology, psychology, and politics in addition to science, technology, engineering and mathematics. Energy issues are inherently interdisciplinary and provide an excellent opportunity for you to create a curriculum that integrates multiple disciplines, is project-based, and connected to the community – local, state, national and global; critical attributes of a twenty-first century curriculum.

For ideas about lessons that relate Energy Literacy to: Social Studies, go to: http://go.usa.gov/3aXPT

Mathematics and English/Language Arts, download the "Teachers Guide" link at the bottom of: http://energy.gov/eere/education/downloads/energy-literacy-videos

4) I must implement my state's standards. How do I relate the Energy Literacy framework to this requirement?

For most states, standards express the concepts and skills to be performed but leave curricular and instructional decisions to districts, schools, and teachers. The Energy Literacy standards you are required to implement and the concepts presented in the framework. For example:

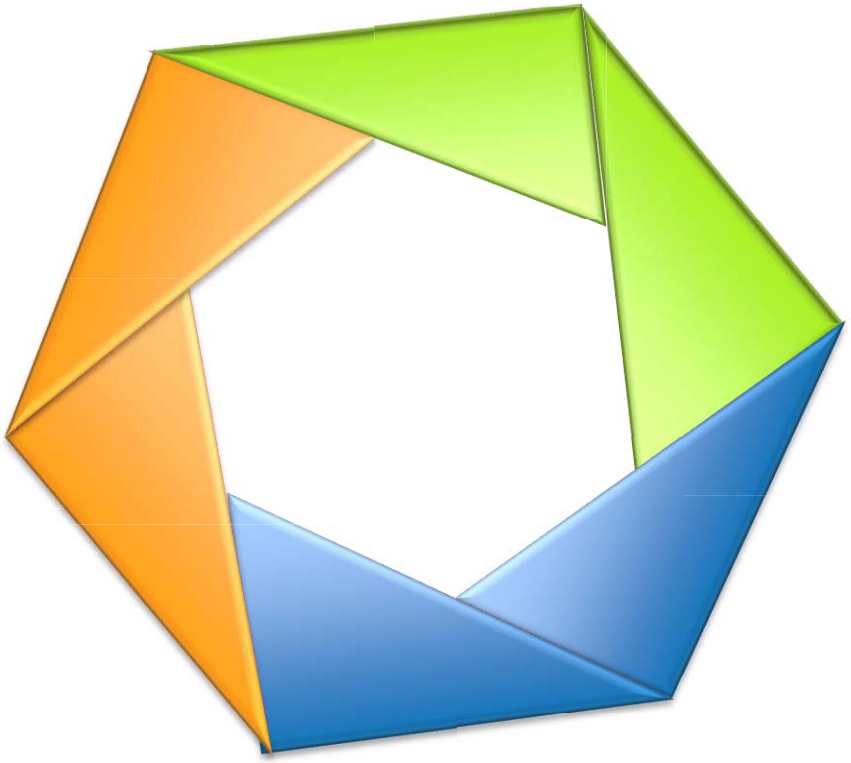
For an alignment of the Energy Literacy Principles with

New:

- Quick Start Guide
  - Basic info
  - Tips to get started
  - Sample activities
  - Sample Resources

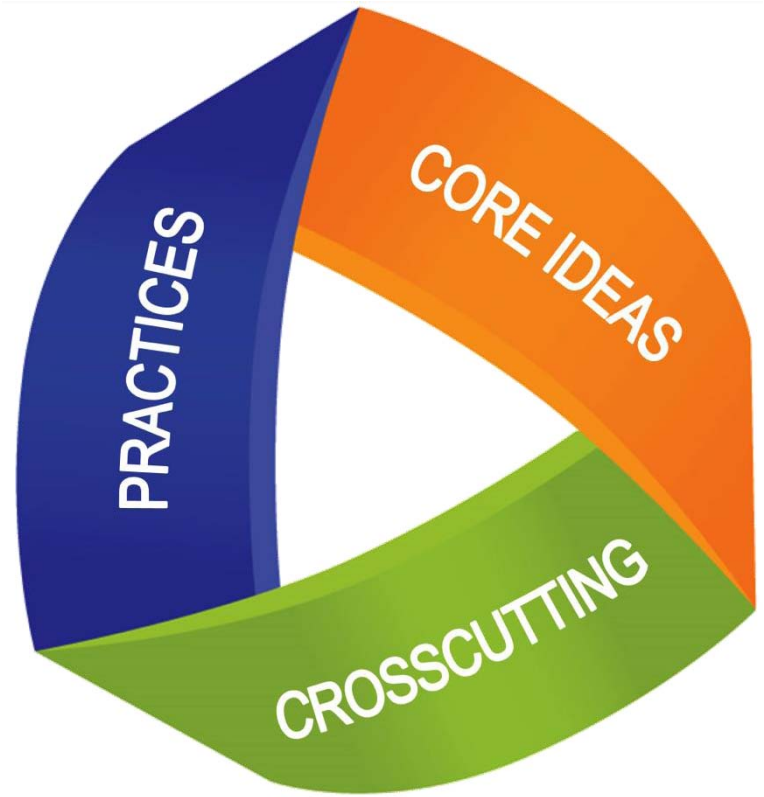
Download it!

EnergyLiteracy_QuickStartGuide.pdf



OVERVIEW OF NEXT GENERATION SCIENCE STANDARDS

Next Generation Science Standards



- Disciplinary Core Ideas
- Crosscutting Concepts
- Science and Engineering Practices

Disciplinary Core Ideas

LIFE SCIENCE

LS1: From Molecules to Organisms: Structures and Processes
LS2: Ecosystems: Interactions, Energy, and Dynamics
LS3: Heredity: Inheritance and Variation of Traits
LS4: Biological Evolution: Unity and Diversity

PHYSICAL SCIENCE

PS1: Matter and Its Interactions
PS2: Motion and Stability: Forces and Interactions
PS3: Energy
PS4: Waves and Their Applications in Technologies for Information Transfer

EARTH & SPACE SCIENCE

ESS1: Earth's Place in the Universe

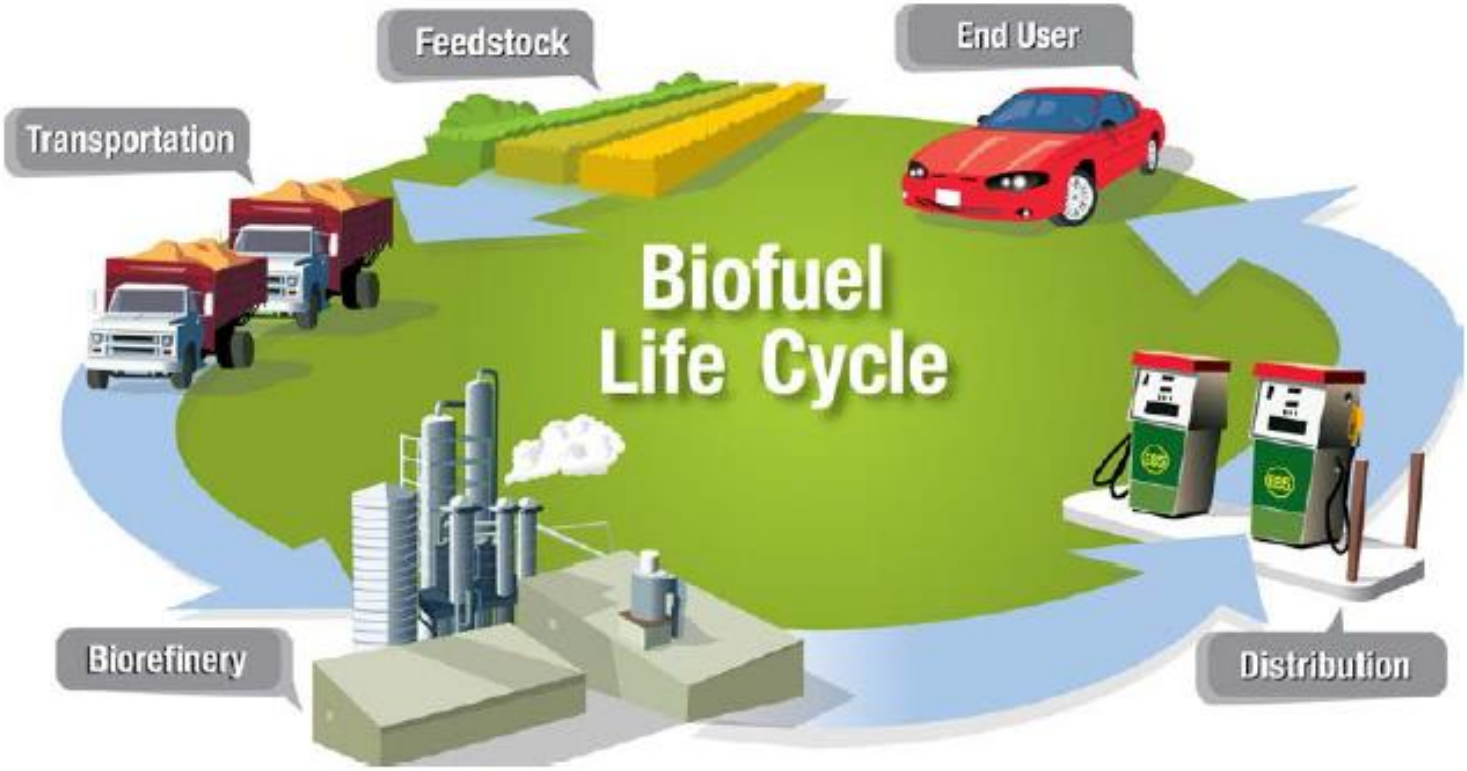
ESS2: Earth Systems

ESS3: Earth and Human Activity

ENGINEERING TECHNOLOGY

ETS1: Engineering Design

ETS2: Links Among Engineering, Technology, Science, and Society



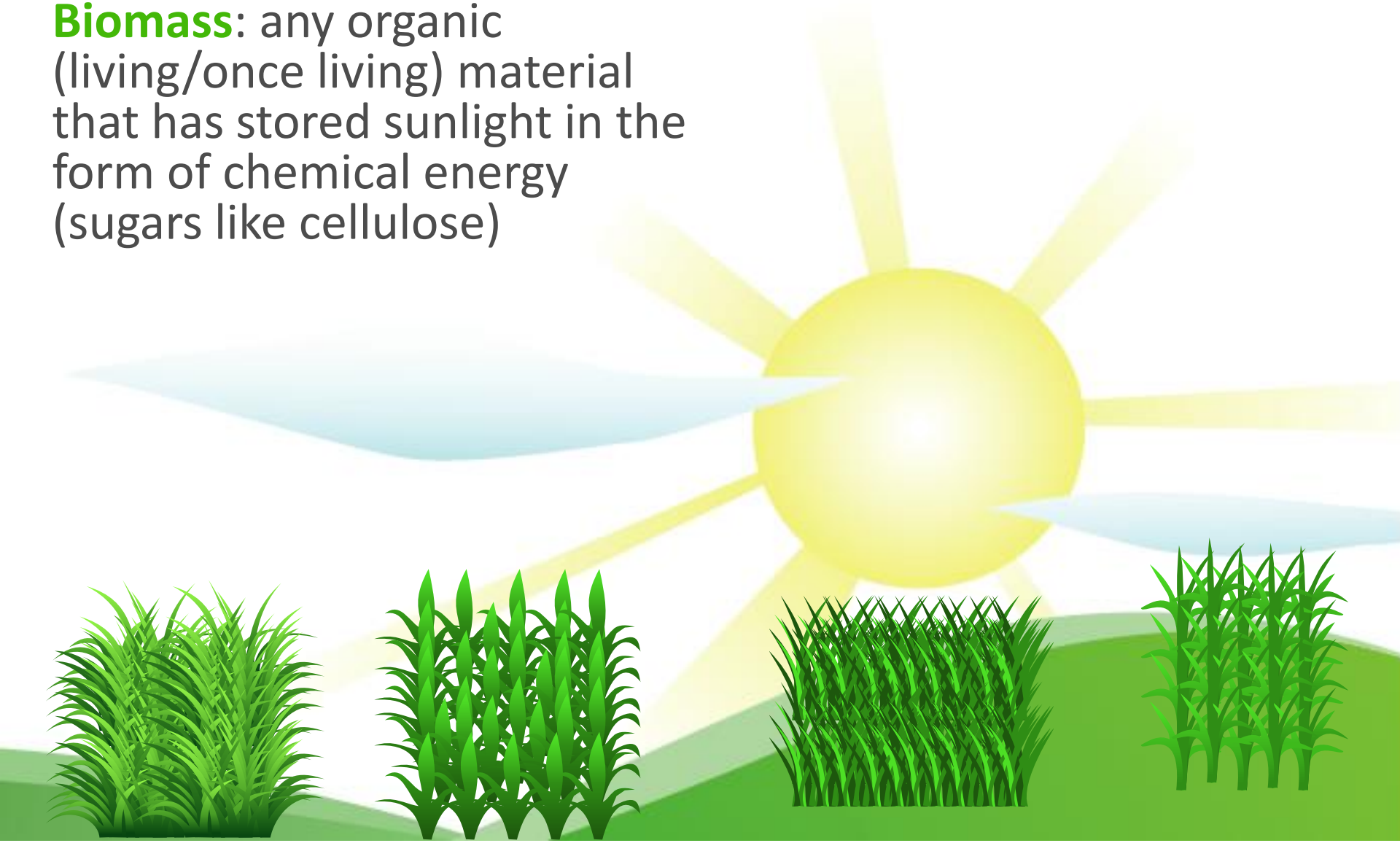
Bioenergy Basics

What is Bioenergy?

Bioenergy is a form of renewable energy derived from biomass to generate heat and electricity (biopower), biofuels (transportation fuels), biochemicals, and other energy-related bioproducts that are produced from biomass.

What is Biomass?

Biomass: any organic (living/once living) material that has stored sunlight in the form of chemical energy (sugars like cellulose)



Sustainable Feedstocks

Agricultural Residues

Plant parts left in the field after harvest are commonly called agricultural residues. This plant matter and secondary residues like manure and food processing wastes can be useful feedstocks.

Energy Crops

Fast growing trees and perennial grasses are specifically grown for energy uses. Trees and perennial grasses can be grown on marginal land and also have high biomass production potential

Forest Resources

Leftover wood or plant material from logging operations, forest management, and land-clearing are available feedstock resources. Secondary residues like mill wastes supplement this category.

Waste

Waste has potential as a gasifier feedstock. Its near-term availability and pre-existing collection and transport infrastructure make it an attractive resource.

Algae

Many species of algae carry out photosynthesis to drive rapid biomass growth. Algae biomass can contain high levels of oil, making it a promising feedstock.

What Bioenergy Is Not

Bioenergy **does not** include solar, wind, water, geothermal, or nuclear energy.

Bioenergy **does not** include non-renewable fossil energy sources, like coal, oil, or natural gas.

General Perspectives of Bioenergy

- **Bioenergy** is one of several renewable energy resource options for the United States
- **Bioenergy** itself is neither good nor bad—it needs to be produced in ways that provide benefits and overcome challenges.

2016 BioenergizeME Infographic Challenge

BioenergizeME Infographic Challenge

Purpose

- Provide an engaging virtual venue for 9-12th-grade participants to gain foundational knowledge about bioenergy and to educate others about what they have learned.
- Their enhanced energy literacy will enable them to be better consumers of energy information and to dispel energy myths they encounter in the media and from other sources.

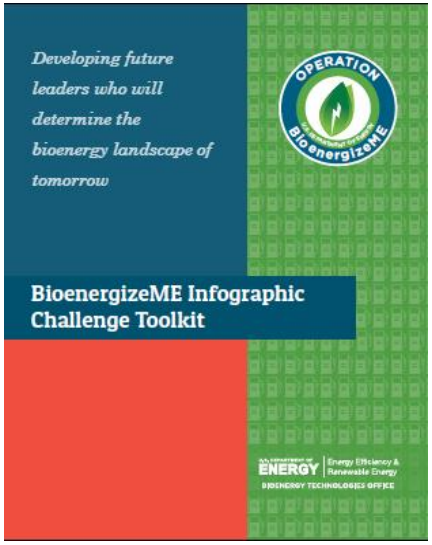
Challenge Activities

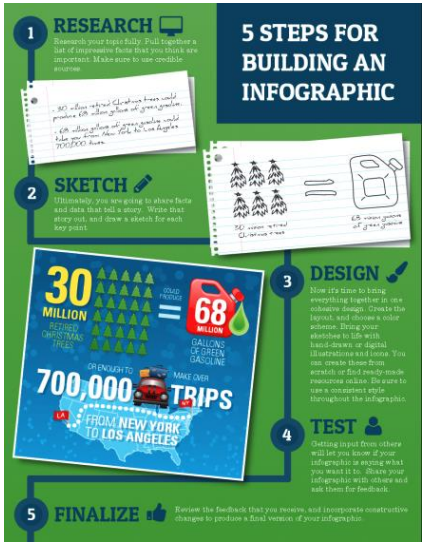
- Student teams research bioenergy topics and report their findings in an infographic.
- Selected teams promote their infographic in an 11-day social media challenge.
- Winners are selected in two categories: quality of infographic and effectiveness of social media campaign.

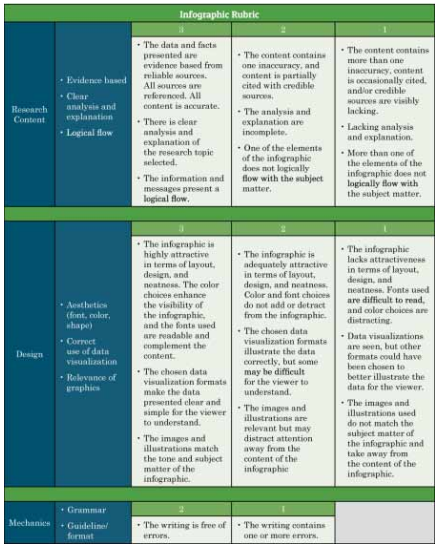
Classroom-Ready Support Materials!

BioenergizeME resources provided

- Challenge rules, research topics and prompts, evaluation rubrics
- Guidance on doing research, creating infographics, and developing a social media campaign
- Research references, search phrases, and links to government-funded publications
- Easy for educators and fun for students!







2016 Challenge Topic Areas

Topic Area 1

Bioenergy History

Topic Area 2

Workforce & Education

Topic Area 3

Science & Technology

Topic Area 4

Environmental Impacts

2016 Challenge Topic Areas

Topic Area 1 – Bioenergy History

Possible areas of focus: history of biomass; history of bioenergy; low-carbon future

Topic Area 2 –Workforce & Education

Possible areas of focus: bioenergy/biofuels careers; STEM education and bioenergy; non- traditional bioenergy careers

Topic Area 3 – Science & Technology

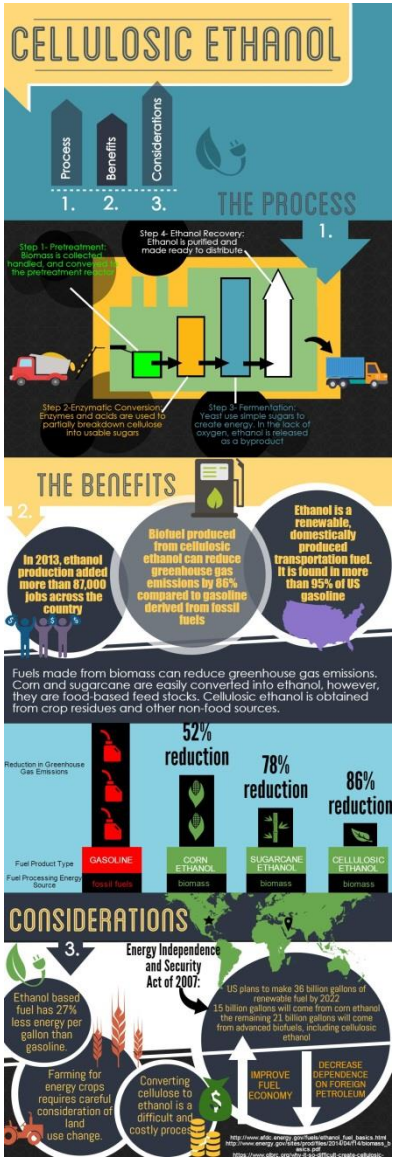
Possible areas of focus: advanced biofuel conversion; second- generation conversion; bioenergy feedstock

Topic Area 4 - Environmental Impacts

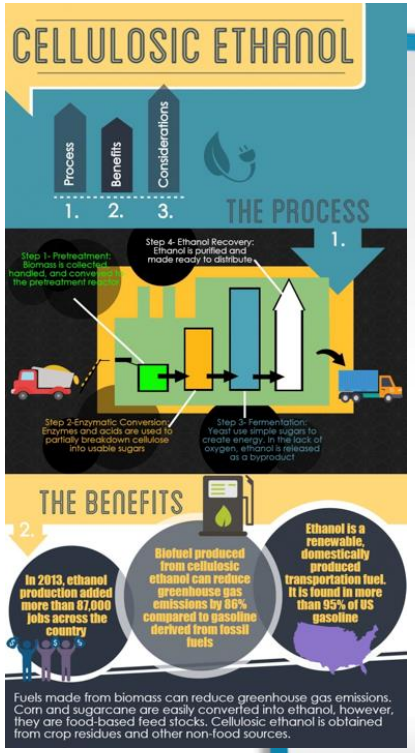
Possible areas of focus: life-cycle analysis, bioenergy systems cradle-to-grave; environmental benefits of bioenergy

Spring 2015 Finalists

1

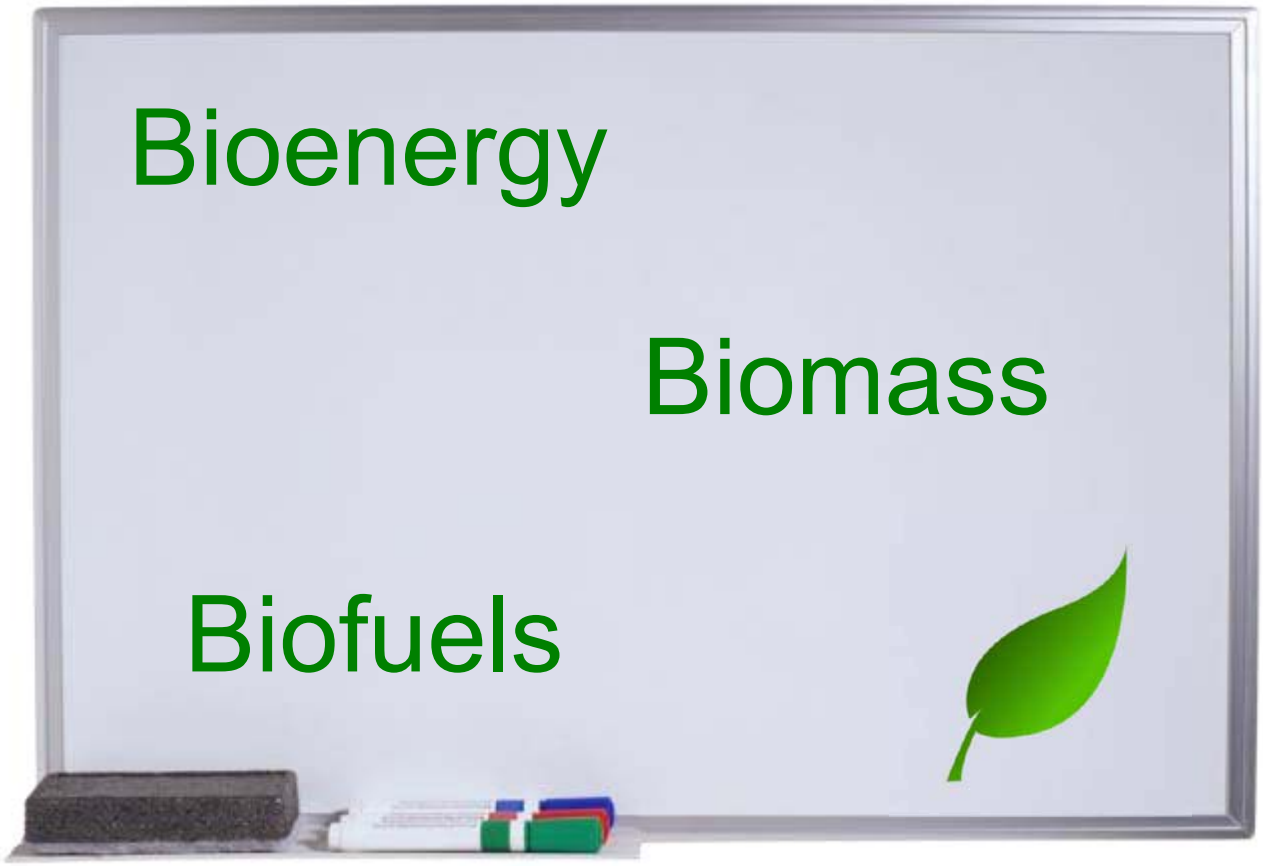


Put Your School On the Map



http://energy.gov/eere/bioenergy/bioenergizeme-infographic-challenge-map

BioenergizeME Infographic Challenge Map



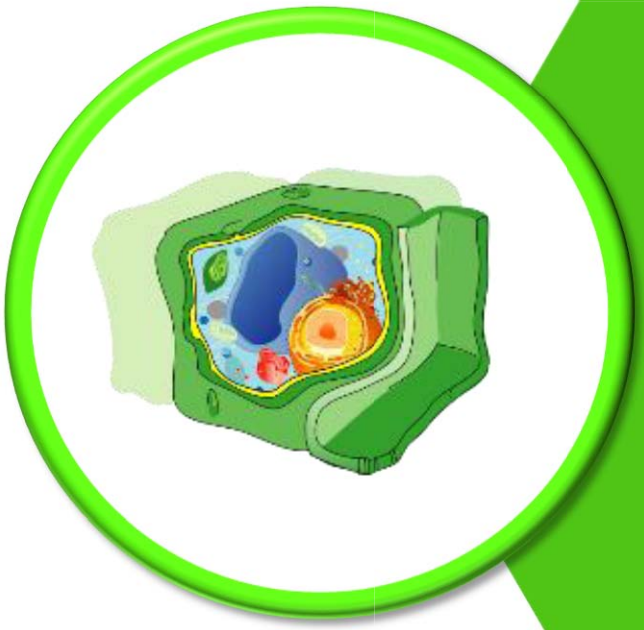
Incorporation Of Bioenergy Into The Classroom

LS1: From Molecules to Organisms: Structures and Processes

3

4

Topic 3



How do organisms live and grow?

- Structure and Function
- Growth and Development
- Organization for Matter and Energy Flow in Organisms

Potential Bioenergy Applications

- **Macromolecules and Plant Cell Structure**

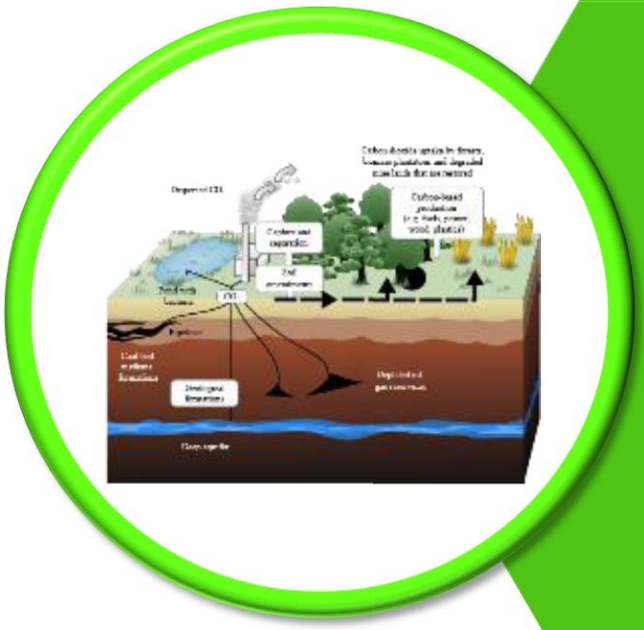
Bioenergy as a model to illustrate: the process of photosynthesis; the global importance of macromolecules such as cellulose (polysaccharide found in the cell walls of plants) and cellulases (family of enzymes that facilitate the breakdown of cellulose); and plant cell wall structure.

LS2 Ecosystems: Interactions, Energy, and Dynamics

Topics 3 & 4

3

4



How do organisms interact with their environment?

- Interdependent Relationships in Ecosystems
- Cycles of Matter & Energy Transfer in Ecosystems
- Ecosystem Dynamics, Functioning, and Resilience
- Biodiversity and Humans

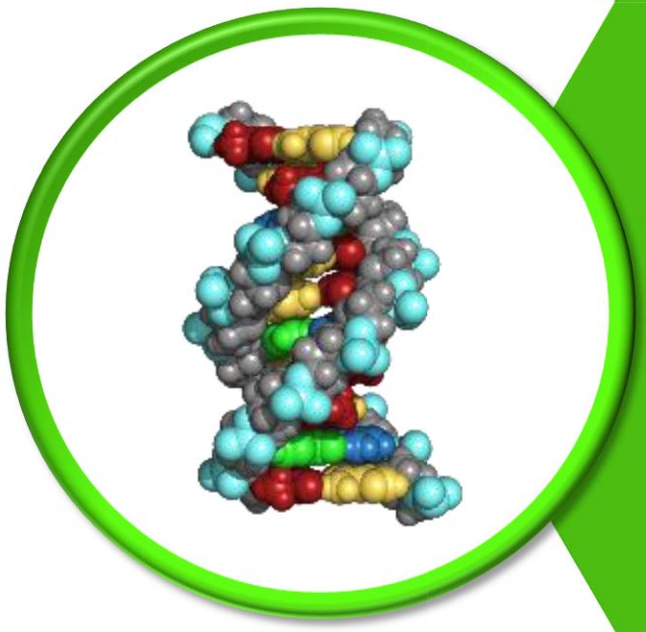
Potential Bioenergy Applications

- **The Carbon Cycle & Biodiversity**

Bioenergy as a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among earth's systems as well as a potential solution for reducing the impacts of human activities on the environment and biodiversity.

LS3 Heredity: Inheritance and Variation of Traits

Topics 2, 3 & 4



How are traits passed to the next generation?

- Structure and Function
- Inheritance of Traits
- Variation of Traits

Potential Bioenergy Applications

- **DNA, Mutation, Protein Synthesis & Bioengineering**

Bioenergy as a practical application to demonstrate how changes in the DNA sequence can result in a functional change for an organism and have a favorable outcome on the traits that would be ideal for biofuel production.

LS4 Biological Evolution: Unity and Diversity

Topics 2, 3 & 4

3

4

What evidence shows that species are related?

- Evidence of Common Ancestry and Diversity
- Natural Selection
- Adaptation
- Biodiversity and Humans

Potential Bioenergy Applications

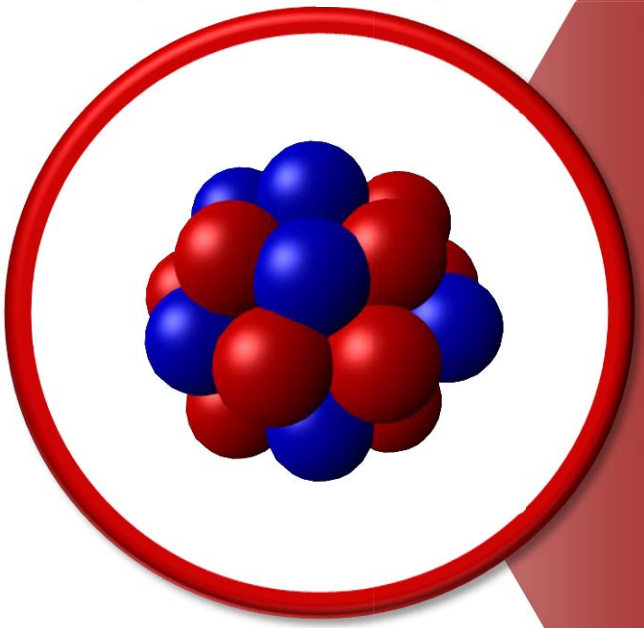
- **Sustainability & Biodiversity**

Biofuel feedstock development to explore the best management practices used to sustainably grow crops to produce energy resources, earn income, and improve biodiversity and ecosystem services.

Topic 3

1

6



The structure, properties, and interactions of matter.

- **Structure and Properties of Matter**
- **Chemical Reactions**
- **Nuclear Processes**

Potential Bioenergy Applications

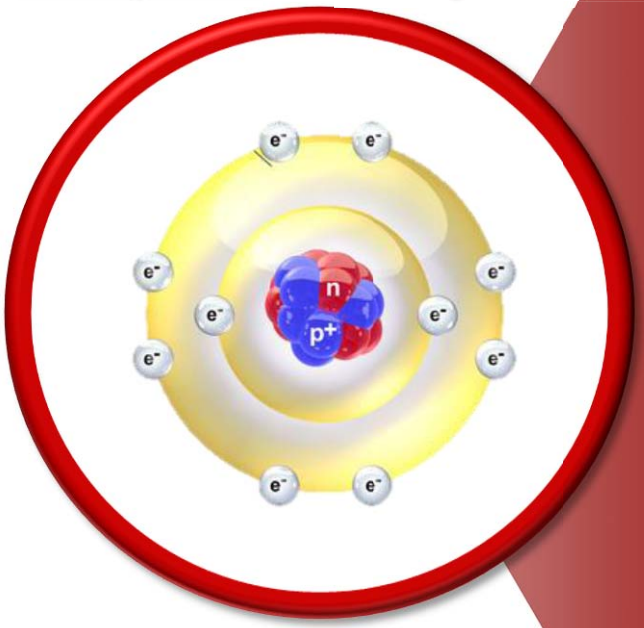
- **Chemical Reactions & Reaction Rates**

The chemical conversion of cellulosic biomass to biofuel and the associated energy transfers as a tool to explain: the structure, properties, and interactions of matter; how substances combine or change to make new substances; and how to characterize and explain these reactions to make predictions about them?

Topic 3

1

4



How is energy transferred and conserved?

- Definitions of Energy
- Conservation of Energy and Energy Transfer
- Relationship Between Energy and Forces
- Energy in Chemical Processes

Potential Bioenergy Applications

- Energy in Reactions & Energy Transfer

Biofuel as part of a discussion centered on how energy manifests itself in multiple ways (e.g. chemical energy or the energy that can be released or stored in chemical processes). The conversion of cellulosic biomass to biofuel to demonstrate that chemical reactions may release or consume energy and how energy and mass are converted from one form to another.

ESS2: Earth's Systems

Topic 3

2

How and why is Earth constantly changing?

- Earth Materials and Systems
- Plate Tectonics and Large-Scale System Interactions
- Roles of Water in Earth's Surface Processes
- Weather and Climate

Potential Bioenergy Applications

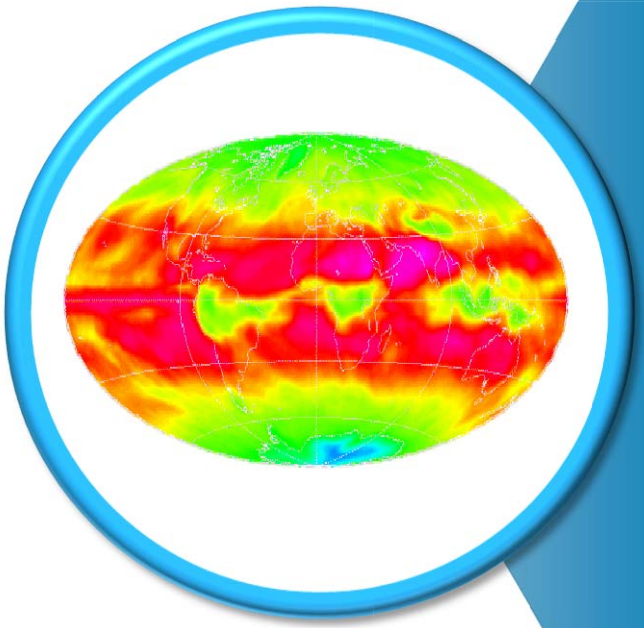
- **Systems, Biogeochemical Cycles & Climate**

Renewable and nonrenewable energy sources in a discussion of how changes to the Earth's surface can create feedbacks that cause changes to other Earth systems (e.g. carbon cycle) and to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.

ESS3: Earth and Human Activity

Topics 1,2,3, & 4

2 3 4



5 6 7

How do human activities affect the earth?

- Natural Resources
- Natural Hazards
- Human Impacts on Earth Systems
- Global Climate Change

Potential Bioenergy Applications

- **Natural Resources & Climate Change**

The difference between renewable and nonrenewable resources. How are humans affecting the carbon cycle and how can bioenergy minimize human impacts on environments and local landscapes by: (1) reducing pollution, and (2) reducing the release of greenhouse gases.

ETS1: Engineering Design

Topics 3 & 4

4

5

6

7

How can engineering solve real world problems?

- Defining and Delimiting Engineering Problems
- Developing Possible Solutions
- Optimizing Design Solution

Potential Bioenergy Applications

- Solving Engineering Problems

How challenges in developing commercial scale bioenergy production can be addressed through engineering.

Resour

This lesson plan may contain links to other resources, including suggestions as to where to purchase materials. These links, product descriptions, and prices may change over time.

The Bio-Fuel Project

AUTHORS:
Matthew A. Brown and Raymond I. Quintana

GRADE LEVEL/SUBJECT:
10th, 11th, 12th Chemistry & Technology Education

Relevant Curriculum Standards:
From The National Science Education Content Standards

Science as Inquiry Standard A:

- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Develop descriptions, explanations, predictions, and models using evidence
- Think critically and logically to make the relationships between evidence and explanations.

Physical Science Standard B:

- Structure and Properties of Matter - The physical properties of compounds reflect the nature of the interactions among its molecules. Carbon atoms can bond to one another…to form a variety of structures, including synthetic polymers, oils, and the large molecules essential to life.

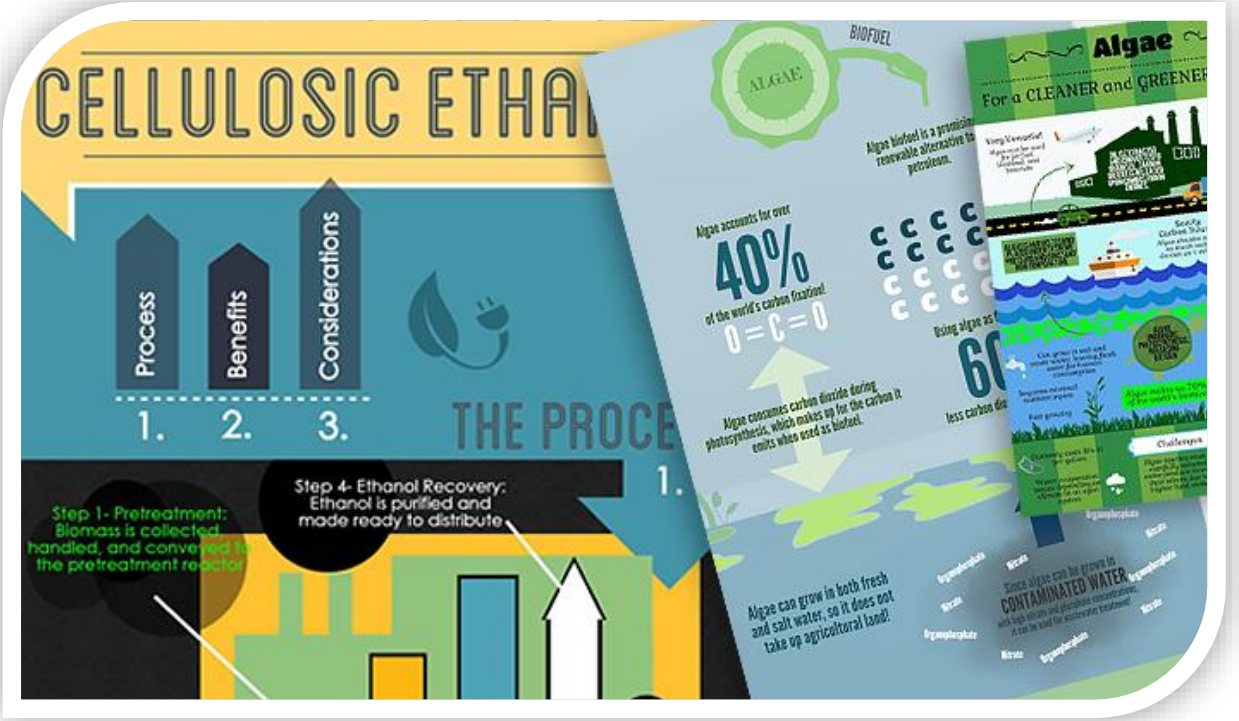
BioenergizeME Infographic Challenge

Registration Closes Feb. 4, 2016, at 5 p.m. Central Time

Submissions Due By March 4, 2016, at 5 p.m. Central Time.

Register your student teams by Dec. 31 and get access to an exclusive webinar!

https://www4.eere.energy.gov/bioenergy/bioenergizeme-infographic-challenge-registration



Thank you for your attention!

Questions? Email us:
BioenergizeME@ee.doe.gov

BioenergizeME Challenge Website
http://energy.gov/eere/bioenergy/infographic-challenge

EERE Education Toolbox
http://energy.gov/education-toolbox/search

More Information:
http://www.energy.gov/eere/bioenergy/