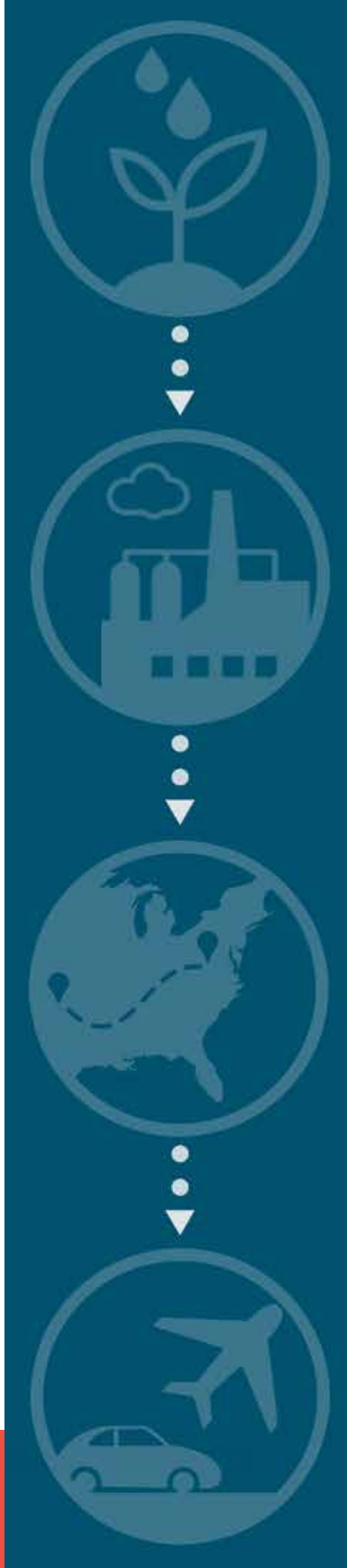
*Developing future leaders to support the next generation of bioenergy*


# BioenergizeME Infographic Challenge Toolkit

U.S. DEPARTMENT OF ENERGY | Office of ENERGY EFFICIENCY & RENEWABLE ENERGY
BIOENERGY TECHNOLOGIES OFFICE

# TABLE OF CONTENTS





# 1 INTRODUCTION

Welcome to the U.S. Department of Energy's (DOE's) Bioenergy Technologies Office (BETO) BioenergizeME Infographic Challenge, where participants use research, art and technology to learn about bioenergy. Participants research, interpret, and then design an infographic that responds to one of four bioenergy topics.

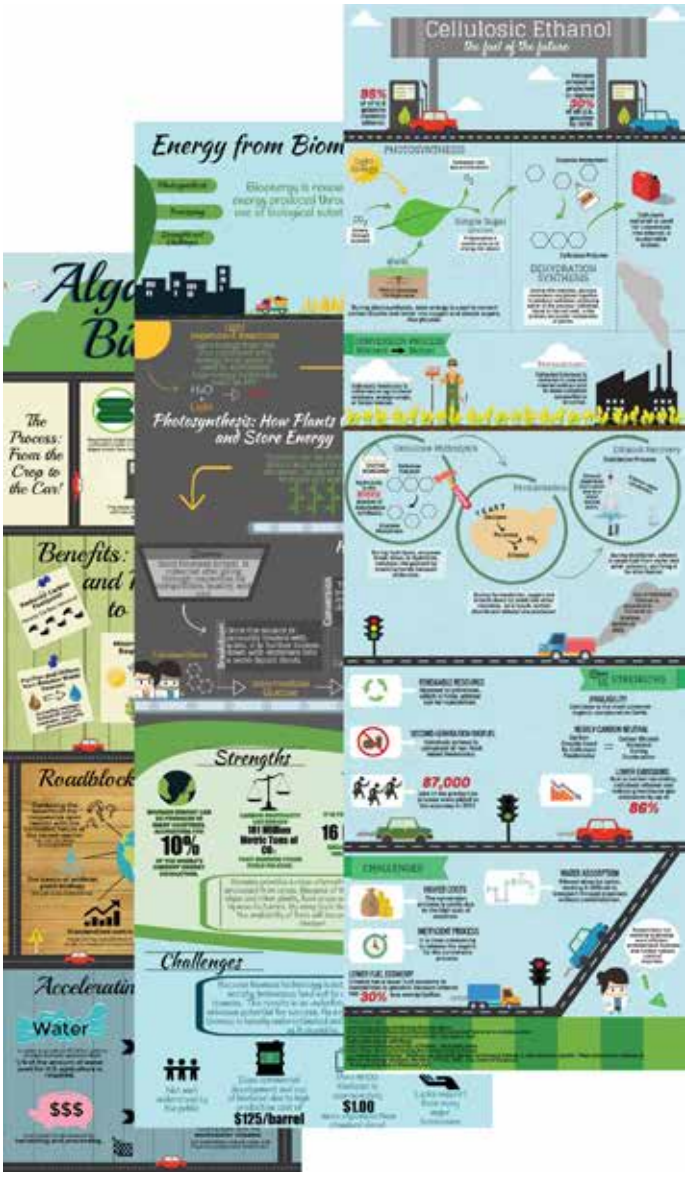
- Topic Area 1 - History of Modern Bioenergy
- Topic Area 2 - Science and Technology
- Topic Area 3 - Workforce and Education
- Topic Area 4 - Next-Generation Bioenergy

BioenergizeME is DOE and BETO's educational "base camp," providing resources and activities to help future leaders learn more about next-generation bioenergy.

The purpose of the BioenergizeME Infographic Challenge is for participants to gain foundational knowledge about bioenergy and to educate others about what they have learned. As bioenergy literacy increases, participants will be better equipped to form educated opinions about bioenergy information that they encounter.

To make research easy, BioenergizeME has prepared "Appendix A - Practical Research Tips." The U.S. Library of Congress has also prepared a BioenergyizeME Research Strategy Guide that includes steps for tackling tough research questions.

You can check out the interactive BioenergizeME Infographic Map to see infographics that participants from across the country have created.




Infographics Courtesy of Smithtown High School East, St James, NY

## WHY BIOENERGY? WHY NOW?

Bioenergy has come a long way since wood, dung, and other organic matter was first burned for light and heat by early human civilization. There are many ways to capture bioenergy from organic materials, and technologies are advancing continually to use bioenergy more efficiently.

In the United States, biomass is one of many varied resources used to meet America's energy needs. As our awareness increases about the uncertain availability of energy resources, other socially important effects of producing and using them, as well as U.S. opportunities for bioenergy careers and other economic development growth, it is more important than ever to understand

- Basic next-generation bioenergy concepts
- Next-generation biomass resources and bioenergy technologies, as well as their benefits
- How U.S. citizens can play an important role in shaping America's energy future.

## USING THIS TOOLKIT

The BioenergizeME Infographic Challenge is suitable for both classroom and independent educational use and is designed to provide an opportunity for educators to incorporate arts-based learning of STEM into their classrooms.

In the classroom environment, students learn to present BioenergizeME projects in the form of infographics, which is an interesting and quick way to communicate ideas and educate others. A strong BioenergizeME infographic should convey a well-focused message that is predominantly image-led and that a general audience can understand in just a few minutes.

This toolkit and the BioenergizeME website provide the tools and direction that make it easy to implement the BioenergizeME Infographic Challenge in the classroom.

### Research Aids

Suggested key words, subject headings, and search phrases are included throughout this toolkit to assist users in finding credible research sources. Insert these words or phrases into the URL address bar or web browser search field.

## 2 BIOENERGY FUNDAMENTALS

Keep the following considerations in mind when researching and developing infographics:

- Bioenergy is one of several energy resource options for the United States
- Biomass is a versatile resource in the United States and can be used to produce bioenergy and supplement fossil fuels
- Next-generation bioenergy can provide a renewable alternative for the many industrial products and materials made from petroleum or natural gas, such as plastics, fertilizers, lubricants, and industrial chemicals
- Next-generation bioenergy needs to be produced in a manner that protects natural resources and provides U.S. opportunities.

### WHAT NEXT-GENERATION BIOENERGY IS, AND ISN'T

Bioenergy is produced from organic materials that contain stored energy from the sun. Only products that do not compete with food and feed demands are used as feedstocks to produce next-generation bioenergy. Next-generation bioenergy feedstocks can be produced from a variety of organic resources, including

- Non-grain agricultural residues such as corn stover (stalks, leaves, and cobs) and grain straws
- Processing wastes such as sugar cane bagasse or distillers dried grains
- Energy crops, such as switchgrass, miscanthus, or energy cane
- Forest residues
- Woody plantation crops
- Algae
- Municipal solid waste.

Bioenergy can be in the form of

- Renewable transportation biofuels
- Chemicals, foods, plastics, and fabrics, that can be produced from biomass
- Products that evolve from the biofuel industry, such as lignin, electricity, and processing heat.

Next-generation bioenergy ***DOES NOT*** include

- Solar, wind, water, geothermal, or nuclear energy
- Fossil energy sources, like coal, oil, or natural gas
- Agricultural grains, such as corn kernels and wheat.

# 3 UNDERSTANDING NEXT-GENERATION BIOENERGY CONCEPTS

## RESEARCH TOPIC AREAS/PROMPTS

The research topic areas help participants explore the role of bioenergy in the context of an energy landscape that has changed many times throughout human history. Within each topic area are prompts that are foundational, broad, and open-ended to foster discovery. Suggested key words, subject headings, and search phrases are included to assist participants in finding credible research sources. Insert these words or phrases into the URL address bar or web browser search field. To limit researched sources to the most relevant and science-based content, participants can couple key words, subject headings, and/or search phrases with "biomass, "bioenergy," "biobased," or other phrases included in the topic areas and prompts. For research guidance, see Appendix A - Practical Research Tips.

### Topic Area 1 - History of Modern Bioenergy

Discuss the progression of first-generation bioenergy feedstocks to next-generation or advanced bioenergy feedstocks.

- What is bioenergy? What is biomass?
- What is a feedstock? What is a first-generation feedstock? What is a next-generation or advanced feedstock?
- Why have researchers expanded our biomass resources to include next-generation feedstocks?
- Name some benefits and research challenges associated with next-generation feedstocks?

*Suggested key words, subject headings, and/or search phrases: bioenergy, biomass, feedstock, next-generation feedstocks*

### Topic Area 2 - Science and Technology

There are a variety of technology pathways used to convert algae, diverse cellulosic resources, and other emerging feedstocks into final bioenergy products. Please choose one pathway from the list below and describe/illustrate the progression from feedstock to finished product.

1. Algae and Biochemical Processing

   Algae Biomass → Harvesting → Dewatering → Extraction → Fractionation → Upgrading → Finished Fuel Product

2. Algae and Hydrothermal Liquefaction

   Algae Biomass → Harvesting → Dewatering → Hydrothermal Liquefaction → Upgrading → Finished Fuel Product

3. Cellulosic Biomass to Ethanol

   Cellulosic Biomass → Pretreatment → Hydrolysis → Fermentation → Distillation → Ethanol

4. Cellulosic Biomass to Renewable Hydrocarbon Fuels (Biochemical)

   Cellulosic Biomass → Pretreatment → Deconstruction with Microorganism or Biological Molecule → Sugar → Chemical Upgrading → Hydrocarbon Fuel

5. Cellulosic Biomass to Renewable Hydrocarbon Fuels (Thermochemical)

   Cellulosic Biomass → Pyrolysis/Gasification → Bio-oil/Synthesis Gas → Chemical Upgrading → Hydrocarbon Fuel

6. Biomass to Biobased Products

   Biomass resource → conversion pathway (including illustration of the supply chain and any associated co-products) → end product → unique benefits and challenges.

*Suggested key words, subject headings, and/or search phrases: algae biomass, renewable, crop residues, forest biomass, bio-oil, hydrothermal liquefaction, catalysis*

## Topic Area 3 - Workforce and Education

Bioenergy relies on biological resources to produce biofuels, biobased co-products, and biopower. For the bioenergy industry to thrive, a diverse and skilled technical and non-technical workforce will be required. Discuss bioenergy-related workforce development resources and/or programs as well as the characteristics of the workforce needed to support this growing industry.

- Describe one or more technical fields or disciplines that could lead to a career in bioenergy
- Describe one or more non-technical fields or disciplines that could lead to a career in bioenergy
- Research a bioenergy-related higher education program or career development institution in your state or region. How can the skills or knowledge gained from this program/institution apply to a career in the bioenergy industry?

*Suggested key words, subject headings, and/or search phrases: bioenergy career map, communications specialist, natural resource manager, chemical engineer, chemical technician*

## Topic Area 4 - Next-Generation Bioenergy

Bioenergy is being explored to find the best ways to incorporate it into society, which may differ from location to location, depending on biomass resources available and industry demands.

Discuss the goals, technical and market-based opportunities and challenges, and feedstock-to-finished product supply chains for specific next-generation bioenergy applications that DOE is exploring.

### Alternative Aviation Fuels

Biofuels are needed in the aviation industry, where liquid fuels are currently the only viable fuel source. The commercial aviation industry and the military have goals to increase the domestic renewable jet fuel supply.

### Co-Optima

BETO and DOE's Vehicles Technologies Office are working together to explore synergies among the fuels, engines, and powertrains used in today's traditional vehicles. Co-Optima is also investigating opportunities related to hybrid and plug-in hybrid technologies, as well as advanced compression-ignition solutions.

### Waste to Energy

Wet waste, solid waste, and gaseous waste streams are potential high-impact resources for the domestic production of biogas, biofuels, bioproduct precursors, heat, and electricity. These streams are available now without land-use change, and in many cases, their use helps to address the unique and local challenges of disposing of them.

### Performance-Advantaged Biobased Products

The ideal biobased product could allow for new functionality in end products and generate new markets for manufacturers of biobased materials. These products could increase the value of domestic biomass resources and provide a new revenue stream for biorefineries.

*Suggested key words, subject headings, and/or search phrases: Co-Optima, hybrid vehicle technologies, aviation biofuels, municipal solid waste, waste to energy, biorefineries, co-products, lignin, valorization*

## 4 INFOGRAPHIC RUBRIC

A grading rubric is provided for students as they create their infographics and teachers as they grade the students' work.

| Infographic Rubric | | | | |
|---|---|---|---|---|
| **Category/Point Value** | **1 Points** | **2 Points** | **3 Points** | **4 Points** |
| **Organization** | No clear organization. | Very little organization; difficult to follow. | There is some organization and the infographic can be followed. | Well organized and the infographic is easy to follow. |
| **Concept Summary** | Student fails to explain in her/his own words. | Some concepts are explained; not all concepts are explained in the student's own words. | Most concepts are explained using student's own words. | Student explains things completely and in his/her own words. |
| **Grammar Spelling** | There are 4 or more spelling and/or grammatical errors. | There are 3 spelling and/or grammatical errors. | There are 1 or 2 spelling and/or grammatical errors. | No spelling and/or grammatical errors. |
| **Design** | No clear design or flow; the design is not related to the content; the font is difficult to read. | The design is not clearly organized and has some unrelated content; the font is difficult to read. | The infographic is mostly organized and has an appealing design; some of the font is difficult to read. | The infographic is neatly organized and has an appealing design; all fonts are easy to read. |
| **Total Points** | | | | |

Suggested grading scale:

4 = A
3 = B
2 = C
1 = D

# 5 RESEARCH AND INFOGRAPHIC GUIDANCE

## RESEARCHING NEXT-GENERATION BIOENERGY

Approaching the research process with a plan in mind will give direction to your efforts and help you stay focused. DOE has compiled a variety of resources to assist students in developing a strategic plan for their research efforts, as well as identifying peer reviewed, academic, or professional sources (Appendix A – Practical Research Tips).

*Suggested key words, subject headings, and/or search phrases for information on evaluating the credibility, or scholarly perspective, of your research: evaluating research sources, peer review, or editorial process*

Before you create your own infographic, look at a few professionally developed, high-quality infographics that were produced for DOE; these may provide useful examples for students in designing their own. You can also check out the interactive BioenergizeME Infographic Map to see infographics created by teams from across the country.

*Suggested key words, subject headings, and/or search phrases for infographic examples: DOE infographics, warding off energy vampires, BioenergizeME infographics*

## CREATING BIOENERGIZEME INFOGRAPHICS

Infographics are graphic visual representations of information and data that convey a story or message quickly and clearly to an audience. The Infographic Guide was developed specifically for BioenergizeME to provide tips and guidance for creating an infographic (Appendix B – 5 Steps for Building an Infographic).

*Suggested key words, subject headings, and/or search phrases for information on developing an infographic: online infographic maker, creating an infographic*

## DOCUMENTING IMAGE RESOURCES

Documenting sources for images can be challenging, especially with the variety of electronic resources available. Images, diagrams, and artistic works should be cited as you would cite any other type of information. Please follow the instructions for citations listed on the source website, which typically include copyright information and a statement of permission for use.

## GRADING BIOENERGIZEME INFOGRAPHICS

Teachers and advisors review and grade infographics based on the Infographic Rubric (Section 4).

# 6 ADDITIONAL LEARNING ACTIVITY OPTIONS

## BIOENERGIZEME INFOGRAPHIC CHALLENGE COMPETITION

The BioenergizeME Infographic Challenge Competition is designed for teams of two to six students (grades 9–12). Each infographic responds to one of the research topics and prompts provided in Section 3 - Next-Generation Bioenergy Concepts, and on the BioenergizeME Infographic Challenge website. Students should make sure their infographic communicates a well-focused thesis. The final team infographics are judged by a review committee. Examples of a challenge structure, challenge rules, reviewing and judging recommendations, and incentive ideas are included below.

### BioenergizeME Infograpic Challenge Competition Structure

- Student groups are separated into inforgraphic teams
- Student teams research a bioenergy topic area/prompt
- Student teams decide on a focusing message or thesis
- Student teams create an infographic to communicate what they have learned about bioenergy
- Review team judges the infographics according to the infographic rubric.

### Challenge Rules

- Infographics must exclude personal identifiable information (e.g., names, emails)
- Each infographic must respond to one topic area/ prompt found in the BioenergizeME Toolkit and on the BioenergizeME Infographic Challenge website
- Each infographic must be image-led, using illustrations and/or graphics to communicate the team's research findings
- Infographics must cite sources for all facts, numbers, and images; sources should be referenced as footnotes at the bottom of the infographic
- Each submission must be the contestants' original work and must not plagiarize, infringe, misappropriate, or otherwise violate any intellectual property rights, privacy rights, or any other rights of any person or entity
- Infographics must be suitable for general audiences (i.e., contain no explicit language, crude/suggestive humor, drug innuendo, or mature/suggestive themes).

### Review and Judging Recommendations

#### Review Team

Assemble an infographic judging/review team that can include students, teachers, and team advisors.

#### Images and Messaging

Review images to make sure they convey messaging that is consistent with the text. For example, infographics that use images of yellow corn kernels rather than corn plants are inconsistent with messaging about advanced biofuels, which do not use feedstocks that compete with food and feed demands.

#### Infographic Scoring

Infographics are reviewed and scored using the BioenergizeME Infographic Rubric (Section 4).

#### Incentivizing Student Participation

Challenge host(s) may provide an award or incentive. Low- and no-investment examples include recognition of the finalists with official letters of recognition and certificates that can accompany college and scholarship applications.

## DESIGN AND CONDUCT A SOCIAL MEDIA CAMPAIGN

### Share Your Infographic on Social Media

Teachers and advisors can instruct teams to share the links on the students' personal social media outlets. Finalists can be determined by the number of unique page views of their infographic page, and metrics can include unique page views and other interactions, such as likes and shares. Page views and interactions can be reported by the teams. Infographics that receive more than a preselected number of unique page views can qualify as finalists. Appendix C – Designing and Conducting a Social Media Campaign was developed specifically for a BioenergizeME Infographic social media sharing activity to provide tips and guidance to students who are conducting their own social media campaigns.

# PRACTICAL RESEARCH TIPS

**Successful research requires thinking and planning. To help ensure your success, this research guide will help participants tackle tough research questions.**

## Select your Topic/Prompt

Begin by selecting a bioenergy topic and prompt that you are interested in learning about. If you are not familiar with the topic, start gathering background information by exploring encyclopedias, dictionaries, or scholarly web sites.

## Plan Your Research Strategy

Use the graphical organizers for teachers at the BioenergizeME website and see the U.S. Library of Congress suggestions: https://www.loc.gov/rr/scitech/SciRef-Guides/bioenergizeme-strategy.html

## Select Scholarly Resources

Evaluate the credibility of your resources and make sure they are "scholarly," which generally means they are written by experts in the field and are vetted for accuracy and scientific rigor via accepted scholarly publishing standards, such as peer review or editorial processes.

*Suggested key words, subject headings, and/or search phrases: "peer review" or "editorial process" and "evaluating resources"*

## Internet Research

Picking internet resources from an internet browser list gives no guarantee of credibility, but it can be used to guide you to resources that are published by experts or by established institutions who are interested in providing reliable public knowledge. You may use web-based encyclopedias, like Wikipedia, to learn about your topic and find credible resources, but they should not be cited as credible resources in your infographic.

## Search Tips

Suggested key words, subject headings, and search phrases can be useful when searching databases and the internet. Some are provided in Section 3 of this toolkit and on the BioenergizeME website.

*Suggested key words, subject headings, and/or search phrases: "finding and evaluating resources"*

### Research Aids

Suggested key words, subject headings, and search phrases are included throughout this toolkit to assist users in finding credible research sources. Insert these words or phrases into the URL address bar or web browser search field.

### Cite your Research Resources

Learn how to, and make it a priority to, respect the intellectual property rights of those who produced the information you are researching. Be consistent in following the citation guidelines your teacher requires, or learn a new citation method.

*Suggested key words, subject headings, and/or search phrases: APA, MLA, AP Stylebook, Chicago Manual of Style*

### Persistence and Networking

Demonstrate resilience by pursuing information in spite of challenges. Use social networks and other tools to explore your topic. Learn appropriate information-sharing skills and avoid plagiarism.

*Suggested key words, subject headings, and/or search phrases: "research skills for students"*

### Consult with a Reference Librarian

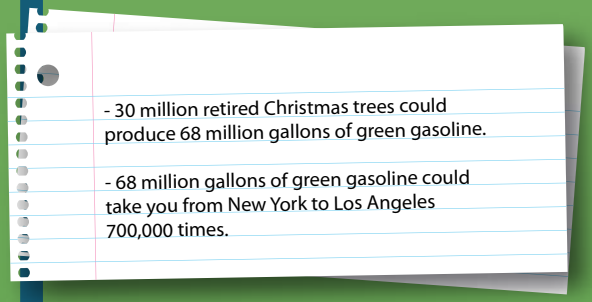
Get expert research guidance from a reference librarian at your school, public or college library, or the U.S. Library of Congress. Reference librarians can help identify useful keywords, subject headings, and search phrases, as well as provide guidance on taking research notes and evaluating and citing your sources.

**Budget your Time and Have Fun!**
Remember to balance your time between research and infographic development. Selecting a topic area/prompt that you are interested in will make your research and your infographic more engaging.

# 5 STEPS FOR BUILDING AN INFOGRAPHIC

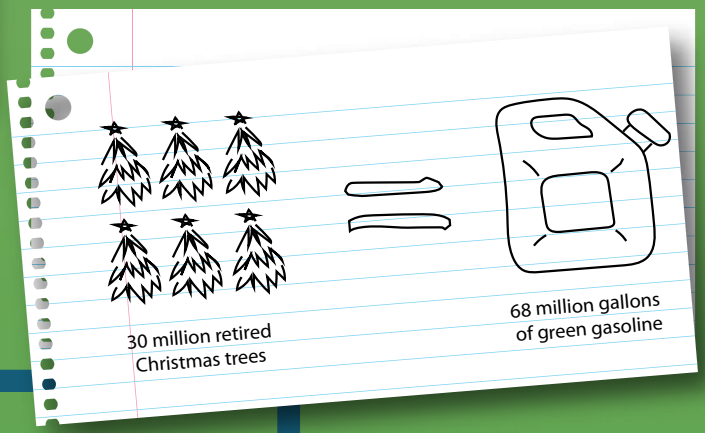
## 1 RESEARCH

Research your topic fully. Pull together a list of thought-provoking facts that you think are important. Make sure to use credible sources, such as those found in the BioenergizeME Toolkit.




## 2 SKETCH

Ultimately, you are going to share facts and data that tell a story. Outline the story, and draw a sketch for each key point.





## 3 DESIGN

Now it's time to bring everything together in one cohesive design. Create the layout, and choose a color scheme. Bring your sketches to life with hand-drawn or digital illustrations and icons. Be sure to use a consistent design style throughout the infographic.

## 4 TEST

Share your infographic with others and ask them for feedback.

## 5 FINALIZE

Consider the feedback that you receive, and implement constructive changes as you see fit to produce a final version of your infographic.


# DESIGNING & CONDUCTING A SOCIAL MEDIA CAMPAIGN

**GOAL:** Share what you have learned about bioenergy through a social media campaign!

## HOW TO DO IT:

### Assign team roles

**Determine what role each person will play in the campaign.**

**1. Team Director**

Lead and organize your team, keep your team on schedule, and monitor progress (views, likes, and shares) during your social media campaign.

**2. Content Manager**

Determine key messages you want to convey to your audiences about your infographic, and write text to engage viewers.

**3. Engagement Manager**

Identify the various social media networks (Twitter, Instagram, Facebook, etc.) for your campaign. Respond to questions and comments from followers.

### Plan a strategy & timeline

**Plan ahead by preparing a strategy and timeline. This is necessary to design a successful campaign.**

**Tasks**

- Choose the social media networks you will use.
- Write content (catchy text—just a sentence or two) that promotes your infographic.
- Schedule the days and times your team will send out your posts in the various social media networks, and make plans about how you will respond to comments.
- Be sure your schedule does not interrupt your classes!

### Start your campaign & monitor progress

**Posting Social Media**

Be creative to bring attention to your infographic and encourage audiences to share your infographic across their social media networks.

**Responding to Comments**

Reply quickly and courteously to comments about your infographic. See how your viewers react and what they are learning about bioenergy.

**Monitor Progress**

Measure your success by tallying unique page views, likes, shares, and comments, and consider adjusting your outreach strategy based on your progress.

**Tips:**

- Stay positive and be thoughtful towards your audience. They may not be familiar with your topic. "Thank you for checking out my infographic" is a good backup response.
- If you receive aggressive or hostile comments, you may ignore or delete them. If this continues tell your teacher or team advisor.
- Be active. Like, share, and comment on others' posts, and they may do the same for you.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