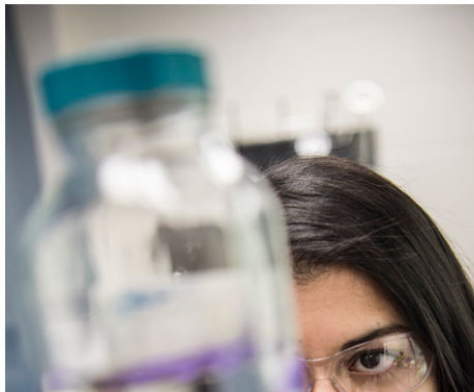
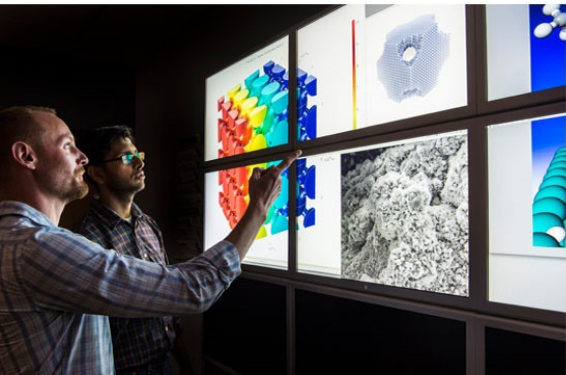


## BIOENERGY RESEARCH AND EDUCATION BRIDGES PROGRAM

### BRIDGES Bioenergy 101 Webinar : Introducing Educators to Bioenergy National Laboratory Research



# WEBINAR HOUSEKEEPING

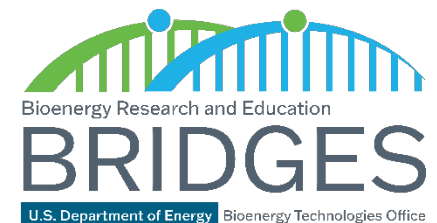
- Attendees will be in listen-only mode
- Audio connection options:
  - Computer audio
  - Dial-in through your phone (best connection)
- Automated closed captions are available
- Technical difficulties? Contact us through the chat feature
- Use the Q&A feature to ask questions
- Today's webinar will be recorded and posted to the BETO website: [energy.gov/eere/bioenergy/beto-webinars](https://energy.gov/eere/bioenergy/beto-webinars)

Visit the BRIDGES website:

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# BRIDGES PRESENTERS



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Communications and Stakeholder  
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**JENNIFER JACKSON**

Program Manager  
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Communications Fellow  
U.S. Department of Energy  
Bioenergy Technologies Office



**CAIT MCGRAW**

STEM Education and  
Outreach Coordinator  
Idaho National Laboratory



**KELLY STURNER**

Learning Center  
Program Coordinator  
Argonne National Laboratory



A large industrial facility, likely a wood processing plant, with a yellow crane bucket dumping wood chips into a large pile. The background shows a large building with corrugated metal walls and a crane structure. The foreground is dominated by a large pile of wood chips, with a stream of chips falling from the bucket into the center of the pile.

## WHY WAS BETO BRIDGES CREATED?

*Photo by iStock*



# WE WANT YOUR FEEDBACK!

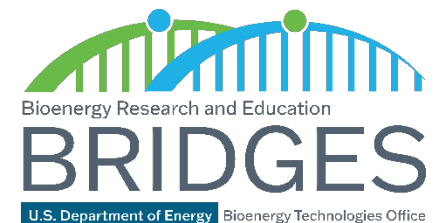
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# Today's Webinar:

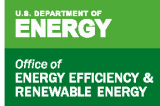
- What's included in the BRIDGES toolkit
- Access to the toolkit with guided demonstration
- Deep dive into a case study
- Case studies in action
- Bioenergy researcher panel
- What's next and how to reach us

JET FUEL  
MAX. PRESSURE  
50 P.S.I.  
MAX. SUCTION  
11 P.S.I.  
0.8 BARS

Photo by iStock

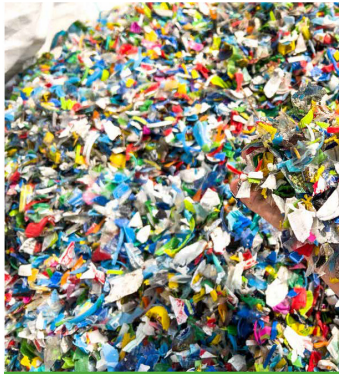


# BRIDGES STUDENT AND INSTRUCTOR GUIDES NOW AVAILABLE



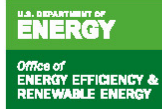
## STUDENT GUIDE

Upcycling: Could My Plastic Bag Sor Become the Sustainable Alternative?



### ABSTRACT

Students will be introduced to the challenges and benefits of upcycling as well as to exciting careers in the industry, by taking on the role of a materials chemist to learn how scientists and industry professionals are reimagining the life cycle of plastics in the U.S. economy.



## STUDENT GUIDE

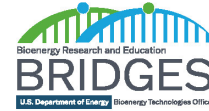
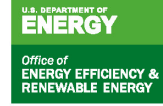
Solid Waste to Energy: Traditional Ecology and Environmental Justice

Bioenergy Research and Education Bridge (BRIDGES) Program



### ABSTRACT

Students will be introduced to the challenges of managing municipal solid waste, opportunities for turning these products into usable energy sources, issues of environmental justice, and exciting careers in the bioenergy industry.



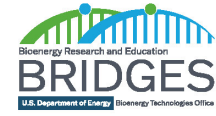
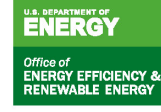
## STUDENT GUIDE

Farm to Flight: Are Sustainable Aviation Fuels Good for the Environment?



### ABSTRACT

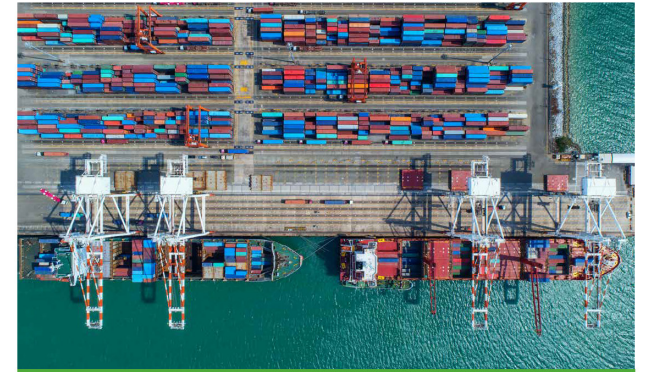
Students will be introduced to the challenges and benefits of sustainable aviation fuels as well as to exciting careers within the industry. Students will take the role of a sustainability specialist in the cutting-edge biofuel industry to compare the use of sustainable and petroleum jet fuels, including greenhouse gas emissions.



## STUDENT GUIDE

Regional Feedstocks: Are They the Answer to Achieving a Net-Zero Future?

Bioenergy Research and Education Bridge (BRIDGES) Program




### ABSTRACT

Students will be introduced to the sustainability challenges facing the transportation industry as it meets the rising demands of air and marine travel with increasing fuel costs. Students will explore the challenges of transportation biofuels, their impact on greenhouse gas emissions, as well as exciting careers in the bioenergy industry.




# MATERIALS THAT SUPPORT BRIDGES – LIVE DEMONSTRATION

## FACT SHEETS AND PRIMER



**Municipal Solid Waste-to-Energy: Traditional Ecology and Environmental Justice**

Bioenergy Research and Education Bridge (BRIDGES) Program Case Study Fact Sheet



According to the Environmental Protection Agency (EPA) we generate 290 of trash end up in landfills. Image from Idaho National Laboratory.


**Sustainable Solutions for a Waste-to-Biofuels Challenge**

Students will be introduced to the challenges of managing municipal solid waste, opportunities for turning these products into usable energy sources, and exciting careers in the bioenergy field.

Students will explore the challenges associated with any community designing a sustainable waste management strategy, and the unique challenges experienced by an over-burdened and underserved community. Students will focus on the ways that science and technology can inform potential solutions that are culturally responsive.

In this case study, students introduced to the Shoshone Tribes, located on the Fort Reservation in southeastern Idaho. Like many communities, the challenge of identifying practices to deal with their solid waste (MSW), also known as landfills.

Students will assume the role of a chemical engineer at Idaho National Laboratory, who will assist the Youth Council in exploring solutions for managing waste related career paths.



**Bioenergy Research and Education BRIDGES Program Prepares a National Bioenergy Workforce**


**What is BETO?**

The Bioenergy Technologies Office within the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy supports the research, development, and demonstration of technologies aimed at reducing domestic renewable carbon resources for the reduction of greenhouse gas emissions across the U.S. economy.

Bioenergy can help create an economically sound and secure future while reducing environmental impacts by:

- Developing affordable domestic fuels and products.
- Advancing clean energy sources.
- Generating domestic jobs to support the growth of the U.S. economy.

**Get Involved!** For more information about the BRIDGES program or to access BRIDGES materials, visit [energy.gov/BRIDGES](http://energy.gov/BRIDGES), or email [BRIDGES@eere.doe.gov](mailto:BRIDGES@eere.doe.gov).

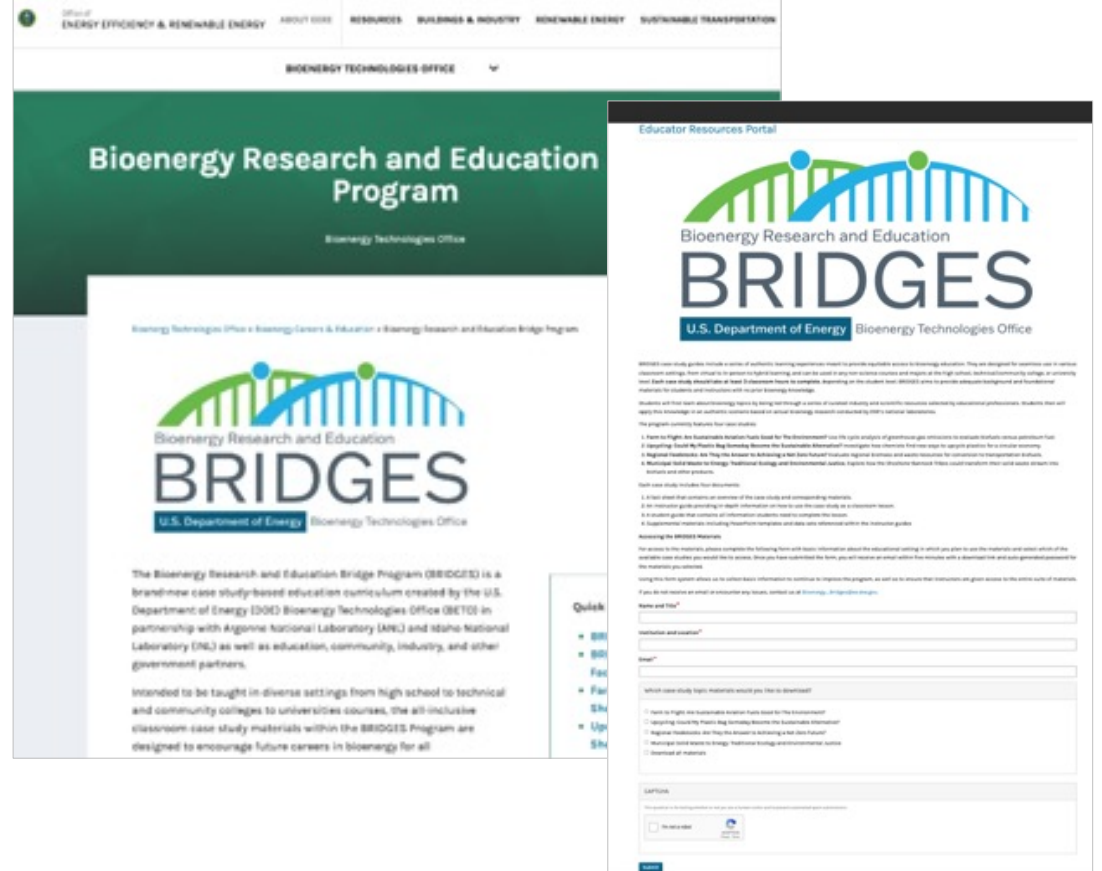


For more information, visit [energy.gov/BRIDGES](http://energy.gov/BRIDGES)

2013.12.2013 | March 2015

Content created from the National Renewable Energy Laboratory, Argonne National Laboratory, and INEL.

## WEB PORTAL FOR DIGITAL DOWNLOAD



The screenshot shows the Bioenergy Research and Education BRIDGES web portal. The main header reads "Bioenergy Research and Education Program" and "Bioenergy Technologies Office". Below this is the "BRIDGES" logo with the U.S. Department of Energy and Bioenergy Technologies Office text.

The main content area features a large "BRIDGES" logo and a description of the program: "The Bioenergy Research and Education Bridge Program (BRIDGES) is a brand-new case study-based education curriculum created by the U.S. Department of Energy (DOE) Bioenergy Technologies Office (BETO) in partnership with Argonne National Laboratory (ANL) and Idaho National Laboratory (INL) as well as education, community, industry, and other government partners." It states that the program is intended to be taught in diverse settings from high school to technical and community colleges to universities courses, and that all inclusive classroom case study materials within the BRIDGES Program are designed to encourage future careers in bioenergy for all.

On the right side, there is an "Educator Resources Portal" section with a list of resources:
 

1. Paper to Fight an Sustainable Aviation Fuels based for the Environment
2. A student guide that contains an overview of the case study and accompanying materials.
3. A student guide that contains an overview of the case study and accompanying materials.
4. A student guide that contains an overview of the case study and accompanying materials.

 Below this is a "Quick" section with a search bar and a list of filters: BR, BI, Fac, Far, Sh, Up, Sh. At the bottom, there is a "CAPTCHA" section with a checkbox for "I am a robot" and a "Submit" button.

# INSIDE A BRIDGES CASE STUDY...



Topic Introduced with Authentic Scenario



Students Explore Resources



Students Demonstrate Learning

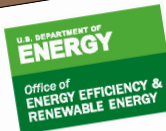


Career Exploration



# Overview

JET FUEL  
MAX. PRESSURE  
50 P.S.I. 3.5 BARS  
MAX. SUCTION  
11 P.S.I. 0.8 BARS



## STUDENT GUIDE

### Farm to Flight: Are Sustainable Aviation Fuels Good for the Environment?

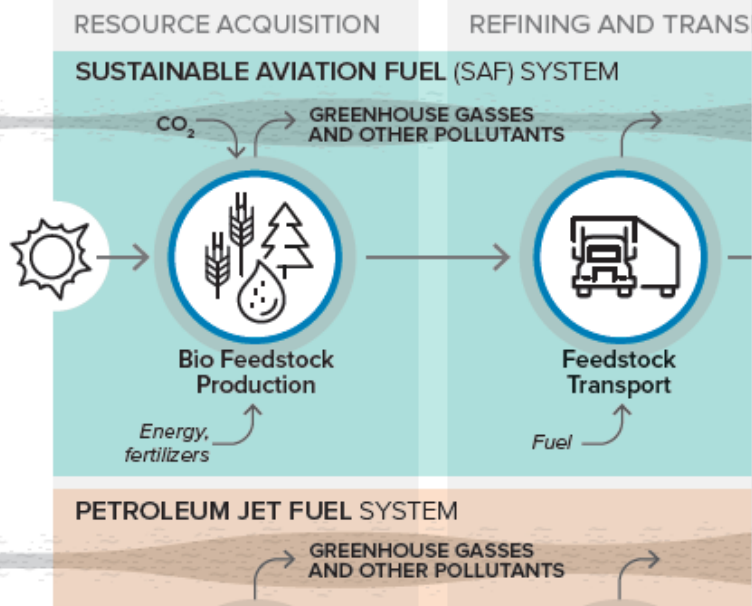
Bioenergy Research and Education Bridge (BRIDGES) Program



#### ABSTRACT

Students will be introduced to the challenges and benefits of bioenergy, as well as to exciting careers within the industry. Students will take on the role of a sustainability specialist in the cutting-edge biofuel industry to compare the use of sustainable and petroleum jet fuels, including their greenhouse gas emissions.

# MAIN TOPICS



## PART 1: Exploring Bioenergy and Life Cycle Analysis (LCA)



## PART 2: Working with a Computational Model to Conduct a Life Cycle Analysis

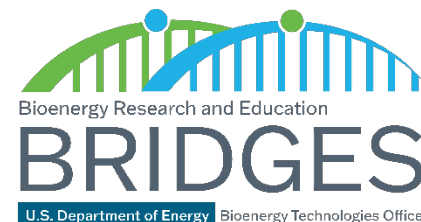


## PART 3: Explore a Career in Bioenergy



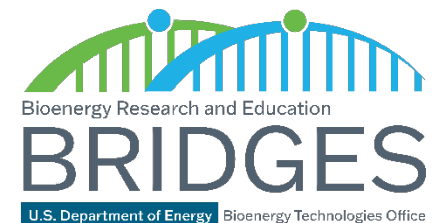
# Learning Goals

- Describe what bioenergy and sustainable aviation fuels are and how fuels are evaluated for environmental impact (metrics: energy, water usage, air pollutants, and greenhouse gas emissions).
- Explain life cycle analysis and describe the well-to-wake jet fuel pathways of petroleum jet fuels and biofuels from two example feedstocks (waste and biomass).
- Explain what a computational model is, as well as system boundaries, processes, inputs, and outputs.
- Compare the greenhouse gas emissions of petroleum jet fuel and sustainable aviation fuel using data from the GREET model.
- Describe the role and skills necessary for a sustainability specialist in the bioenergy industry.



## Quick Start Guide for Students

- Before you begin, please read or skim through the student guide to get an idea of what to expect.
- Pay special attention to the Background Information section. It is highly recommended that you take the time to review it before you begin, as it will save you time in the end.
- You will be working in small groups, and tasks should be delegated to group members.





A long train of black tanker cars is visible on a track, stretching into the distance. The train is positioned next to a lush green cornfield. The sky is clear and blue. The text "SAFs = SUSTAINABLE AVIATION FUELS" is overlaid in white on a semi-transparent dark blue band across the middle of the image.

**SAFs = SUSTAINABLE AVIATION FUELS**

*Photo by iStock*



# TOPIC INTRODUCED WITH AUTHENTIC SCENARIO

- Students play role of a sustainability specialist
- Phone call comes in from an airline CEO saying the board of directors is concerned
- The board requires an expert analysis... are sustainable aviation fuels good for the environment?





## Preparation

- You and the other sustainability specialists have just been assigned this project by your supervisor.
- Provide information on the environmental impact of SAFs to the airline's board of directors as a presentation.
- Educate the board on SAFs and conduct a life cycle analysis of their greenhouse gas emissions to present, as well as other factors affecting SAF sustainability

## Instructor Notes

- This portion sets up the goals of the case study in line with the scenario.

## Tasks and Questions

- What are SAFs and how do they differ from petroleum jet fuels? Why do scientists, engineers, industry, and government organizations suggest that SAFs are the best option compared to other decarbonization investments one might use to make the airline industry more green or sustainable?
- What are the environmental benefits of switching from petroleum jet fuel to SAFs?
- Qualitatively compare the use of SAF and petroleum jet fuel, making sure to include, but not limited by, the following:
  - Greenhouse gas (GHG) emissions.
  - 1–2 other types of air pollution emissions – Choose based on research comparing petroleum jet fuels to SAFs.
  - 1–2 other environmental impacts – Consider the environmental impacts of sourcing the feedstock and how you would measure those impacts.

## Instructor Notes

- Tasks and questions help students fill in their background knowledge while also answering the questions that were brought up by the board
- All of the resources are available as background reading and information in the case study. Students can also look these up elsewhere.

### Terminology List

Term	Definition
Bioenergy	The energy produced from biomass; includes biofuels, bio-based products, and biopower.
Biofuel	Fuel produced from biological resources (plant or animal material)
Biomass	An energy resource derived from waste and food waste. It includes agricultural residues (such as waste from food crops and animal manures), forest resources, purpose-grown energy crops (such as perennial grasses and woody energy crops), urban wood waste, and food waste.
Carbon dioxide equivalent (CO <sub>2e</sub> )	Used to measure and compare emissions from greenhouse gases based on how severely they contribute to global warming. Metrics for CO <sub>2e</sub> would show how much a particular gas would contribute to global warming if it were carbon dioxide.
Carbon footprint	The net amount of carbon dioxide emissions attributable to a product or service (emissions from production and combustion, minus absorption during plant growth). For fossil fuels, the absorption of carbon dioxide occurred millions of years ago, so their carbon footprint is simply 100% of their carbon output.

### Feedstock Summary Table<sup>1</sup>

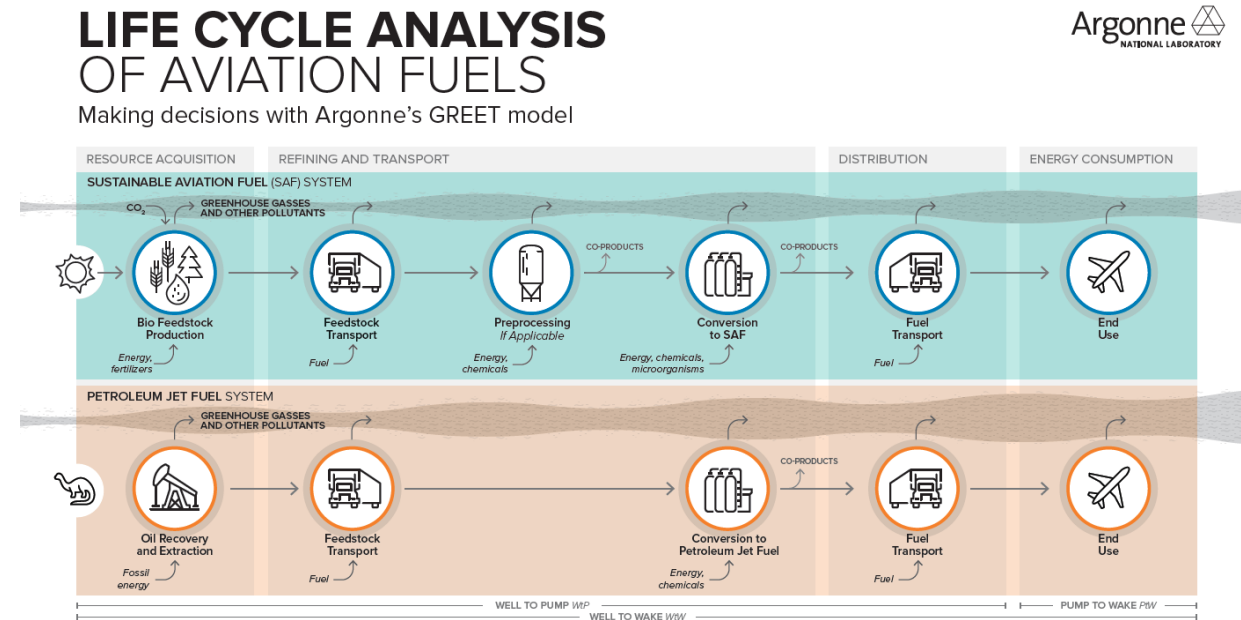
	Description	State of Development	Emission Reduction Factor (ERF)
<b>Wastes</b>			
Municipal solid waste (MSW)	Following sorting to remove any recyclable components, typical organic MSW can be processed into SAF.	Substantial quantities of MSW exist globally that are not used for energy production, and nearly all end up in landfills. A number of MSW feedstock plants are under construction, with the first major facility close to completion.	Current ERF: 70%
Forestry waste residues		Opportunities are substantial but tend to be linked to specific regions (such as the Nordics) that have an existing timber or paper industry.	Current ERF: 70%-80%



## More Tasks and Questions

- What are the main categories of SAF feedstock? Give examples of each. Briefly mention the main benefit and drawbacks of each.
- Explain the concept of life cycle analysis of greenhouse gas emissions using the following LCA diagrams for both petroleum jet fuel and SAFs as a guide. Make sure to include the following:
  - Explain the terms well to pump (WTP), pump to well (PTW), and well to wake (WtW). Make sure to point out and explain what processes are contributing to each of these stages.

## Instructor Notes



# PART 2: Working with a Computational Model to Conduct a Life Cycle Analysis

- Introduction to GREET (Greenhouse gases, Regulated Emissions, and Energy use in Technologies) model designed by the Systems Assessment Center at Argonne National Laboratory and the Well to Wake Calculator

Argonne GREET Model  
greet.es.anl.gov

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GREET Building Module

**GREET® Model**  
The Greenhouse gases, Regulated Emissions, and Energy use in Technologies Model

The GREET model is a one-of-a-kind analytical tool that simulates the energy use and emissions output of various vehicle and fuel combinations. Sponsored by the U.S. Department of Energy's (DOE) Office of Energy Efficiency and Renewable Energy. GREET offers two free platforms to use: the GREET.net model and the GREET Excel model.

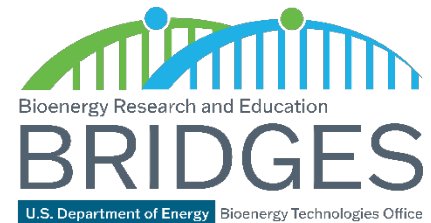
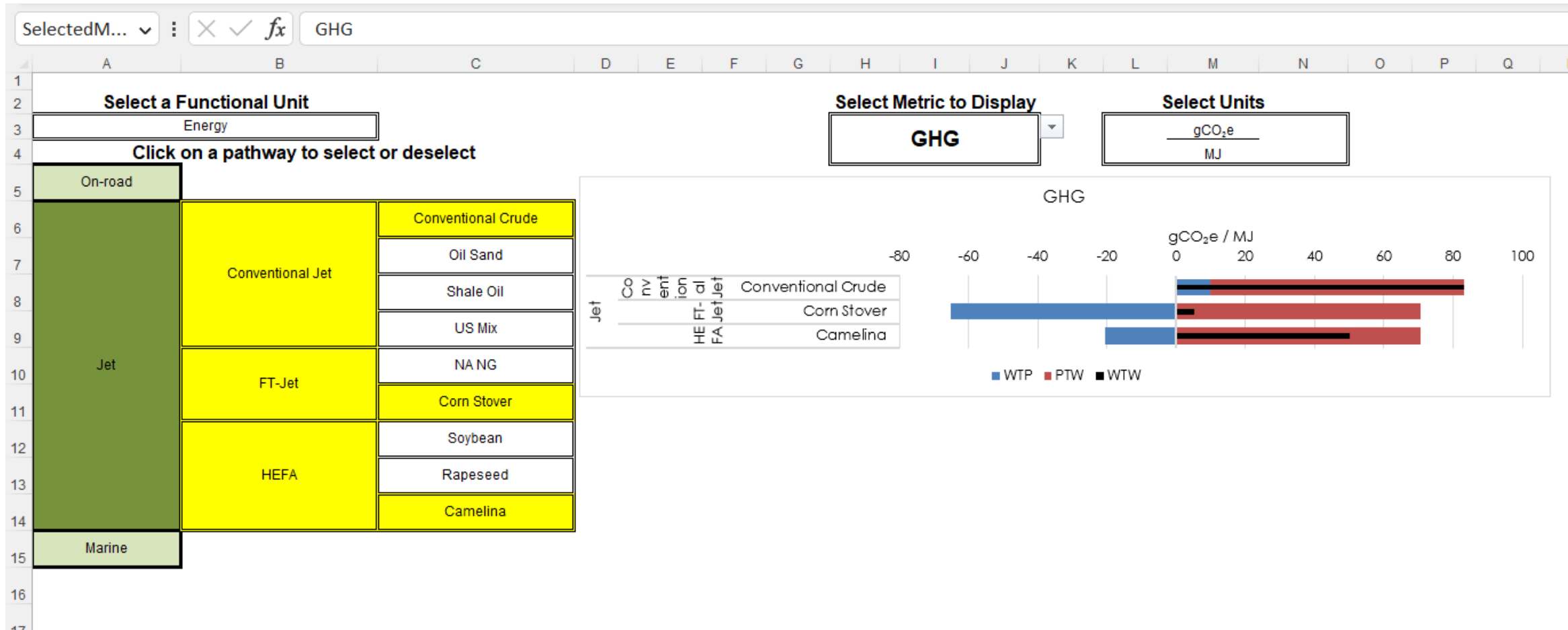
To get a complete picture of the energy and environmental impacts of a technology, it is important to consider the full life cycle – from well to wheels for fuels and from raw material mining to vehicle disposal for automobiles.

VEHICLE CYCLE (GREET 2 Series)  
RECYCLING OF MATERIALS  
FUEL CYCLE (GREET 1 Series)





# GREET Well to Wake Calculator



# STUDENTS DEMONSTRATE LEARNING

- **Students develop and communicate their findings as presentations for a board of directors**
- **Students demonstrate understanding of bioenergy, sustainable aviation fuels, life cycle analysis**
- **Students are supported in making professional presentations that communicate technical knowledge and findings to a non-technical audience**

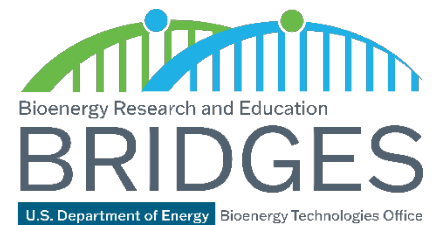




## PART 3: Explore a Career in Bioenergy

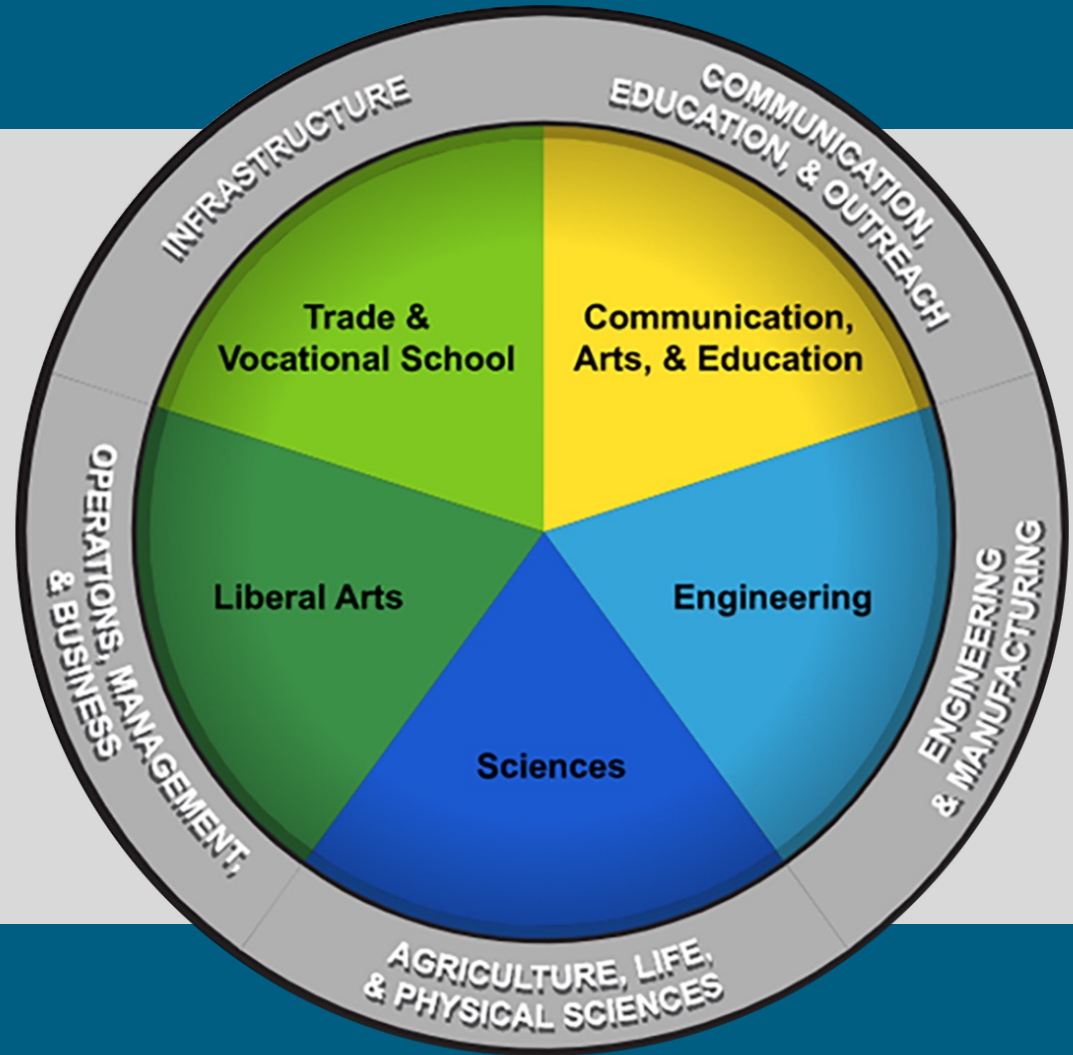


[https://www.youtube.com/watch?v=nLCAHlyqbMo&list=PLQYE9hUcD1\\_L0\\_nBNc9CfQT3yBV9sxl7H&index=3](https://www.youtube.com/watch?v=nLCAHlyqbMo&list=PLQYE9hUcD1_L0_nBNc9CfQT3yBV9sxl7H&index=3)



## CAREER HIGHLIGHT SUSTAINABILITY SPECIALIST

- Average salary
- Common majors for this position
- Responsibilities of a sustainability specialist
- Students then explore the career wheel to identify a career of interest to them





## ASSUMES NO BIOENERGY BACKGROUND

- Case study introduction/background
- Learning objectives
- Prerequisite knowledge
- Classroom implementation strategies
- Rubrics
- Example answers to background questions
- Additional resources



**U.S. DEPARTMENT OF ENERGY**  
Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Bioenergy Research and Education  
**BRIDGES**  
U.S. Department of Energy | Bioenergy Technologies Office

## INSTRUCTOR GUIDE

Farm to Flight: Are Sustainable Aviation Fuels Good for the Environment?

Bioenergy Research and Education Bridge (BRIDGES) Program



**ABSTRACT**  
Students will be introduced to the challenges and benefits of bioenergy, as well as to exciting careers within the industry. Students will take on the role of a sustainability specialist in the cutting-edge biofuel industry to compare the use of sustainable and petroleum jet fuels, including their greenhouse gas emissions.

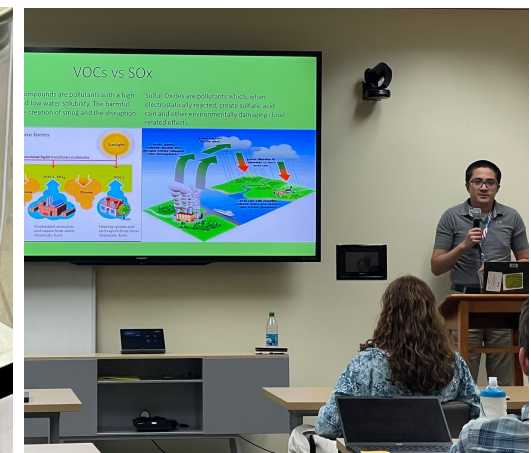
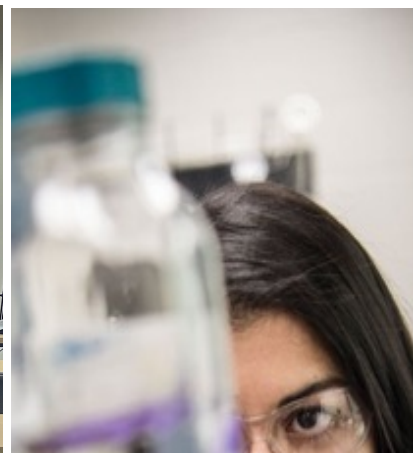
# Case Studies in Action

*“What I liked about working with the case studies was that they presented real-world problems that we got to get our hands on and solve...there was a little bit of leeway on how we wanted to get to our solution, and as long as our evidence supported it, we were free to find our own path.”*

-Shaelynn Nixon,  
INL High School Intern

*“The case study was a great way to learn about the industrial applications of processes like hydrogenolysis and how you can make something useful from something most would generally perceive as waste”*

-Brecken Allegood,  
INL High School Intern





## Rubric

Instructors may choose to use the following rubric. Percentage breakdowns of each category have been included as suggestions to assist in the grading of the project. Instructors may also choose to share the rubric with their students ahead of time.

### Infographic Rubric

	Beginning	Developing	Accomplished	Exemplary
Pictures/Graphics 15%	Pictures/graphics are not clear or relevant	A few of the pictures/graphics are not clear or relevant	Most of the pictures/graphics are clear and relevant	Pictures/graphics are clear and relevant
Data/Results 20%	Data and results included are not significant	Most significant data and results are included; there may also be some unnecessary data or results included	All significant data and results are included, along with some unnecessary data or results	All significant data and results are included; no unnecessary data or results are included
Organization of Data and Results 15%	Results are disorganized, poorly recorded, or do not make sense; not enough data were included to justify results	Data and results are unclear, missing labels, do not show obvious trends, or are disorganized, but there are enough data to show experiment was conducted	Data and results are clearly recorded and labeled; trends are not obvious, or there are minor errors in the organization	Data and results are clearly recorded and organized so it is easy for the reader to see trends; all appropriate labels are included

## Guiding Questions

### Part 1

- What are SAFs made from? **Feedstocks**—typically waste or biomass
- What other non-GHG emissions do SAFs reduce? **Particulate matter (PM), sulfur dioxide (SO<sub>2</sub>), nitrous oxides (NO<sub>x</sub>)**
- Define “sustainable” in this context. *See terminology chart for definition*
- Define “feedstock” in this context. *See terminology chart for definition*
- What are the main categories or types of sustainable aviation fuels? **Fats, oils, and greases (FOG); biomass; waste (agricultural, forest, municipal solid); power-to-liquid**

## Option 1: Face-to-Face Class, One-Class Meeting

### Homework: Assign Part 1

If the case study is completed in one 90-minute period, students should be assigned Part 1 as homework to be completed either individually or in assigned small groups. Depending on the instructor’s goals, students may be allowed to generally search the internet or be given the handout [Sample Sources of Information for Student Research](#) at the end of this instructor





# Researcher Panel Q & A

Photo by iStock



# Researcher Panel Q & A



**REBECCA BROWN**

Idaho National Laboratory  
*Microbiologist*  
*Materials Recycling and Recovery*



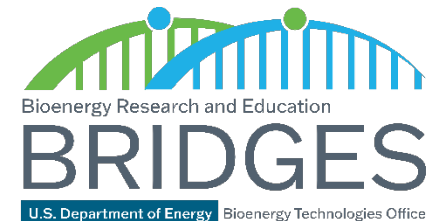
**MELTEM URGUN-DEMIRTAS**

Argonne National Laboratory  
*Group Leader for Process Development*  
*Research*  
*Energy Systems*



**ANDREW BURNHAM**

Argonne National Laboratory  
*Principal Environmental Scientist*  
*Transportation Fuels*



## WEBINARS

- **SEPTEMBER 14**  
BRIDGES Launch Professional Development Webinar
- **OCTOBER 5**  
Cross-Advertised Webinar from the Bioenergy Technologies Office and National Association of Biology Teachers

## OFFICE HOURS (registration only)

- **SEPTEMBER 21**
- **OCTOBER 19**
- **NOVEMBER 2, 16, 30**
- **DECEMBER 7**

For more information or support, email [Bioenergy\\_BRIDGES@ee.doe.gov](mailto:Bioenergy_BRIDGES@ee.doe.gov)

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# PARTNERSHIPS



# Thank you!

Contact us with additional questions & comments: [Bioenergy\\_BRIDGES@ee.doe.gov](mailto:Bioenergy_BRIDGES@ee.doe.gov)



Feedstock



Algae



Conversion



Systems



Data

