Bioenergy Research and Education

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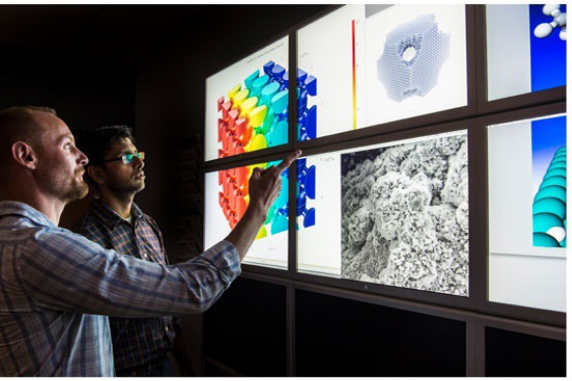
BIOENERGY RESEARCH AND EDUCATION **BRIDGES PROGRAM**

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

Visit the BRIDGES website:
https://www.energy.gov/eere/bioenergy/bioenergy-research-and-education-bridge-program

Send questions: Bioenergy_BRIDGES@ee.doe.gov

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WHY WAS BETO BRIDGES CREATED?

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WE WANT YOUR FEEDBACK!

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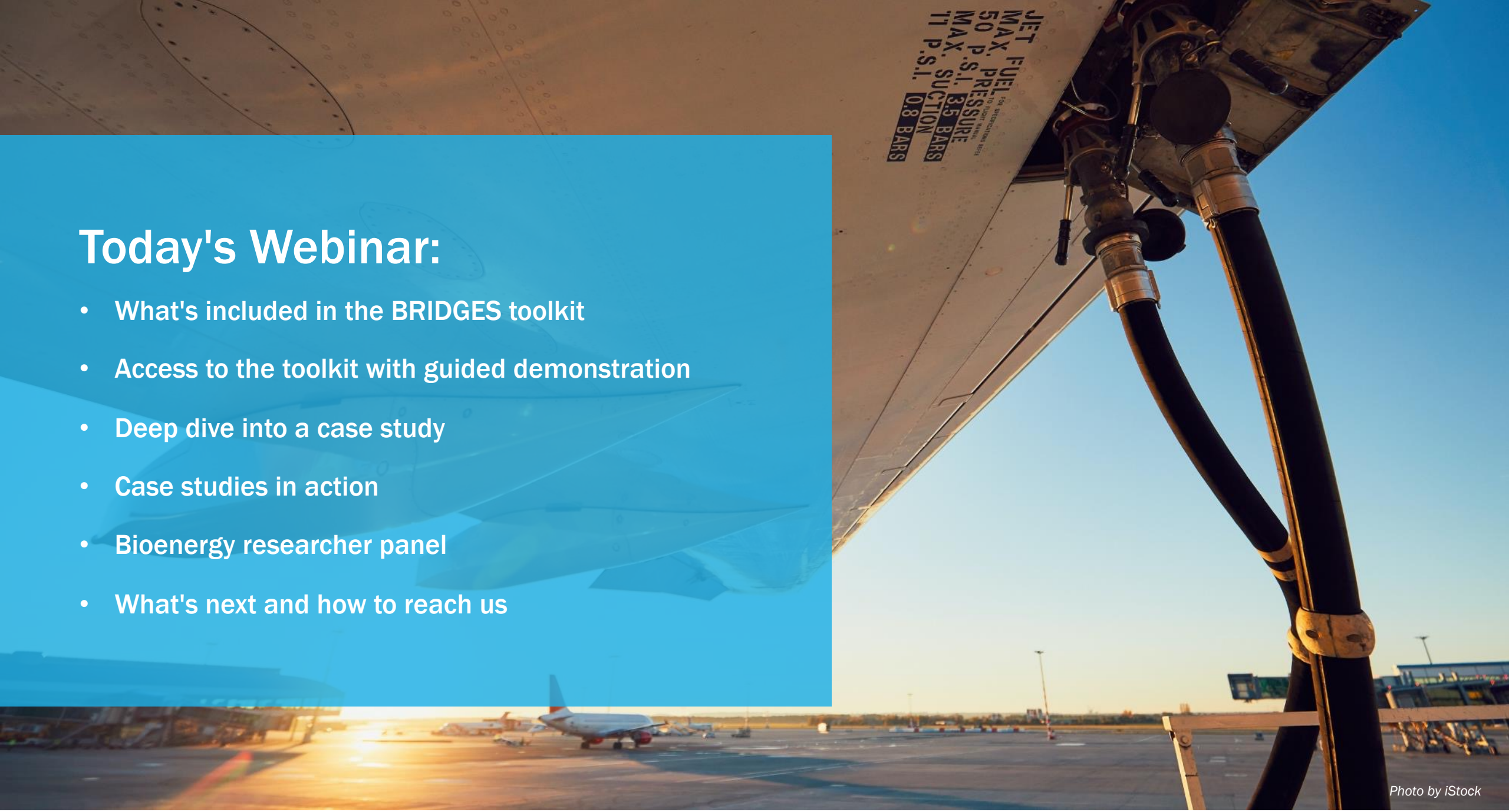
Today's Webinar:

- 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



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BRIDGES STUDENT AND INSTRUCTOR GUIDES NOW AVAILABLE

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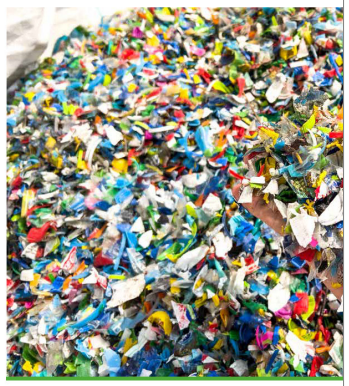
STUDENT GUIDE

Upcycling: Could My Plastic Bag Sor
Become the Sustainable Alternative



ABSTRACT

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

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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.

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STUDENT GUIDE

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

ABSTRACT

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

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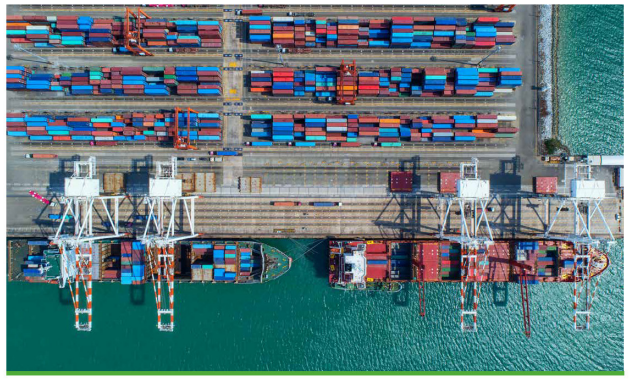
STUDENT GUIDE

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

Bioenergy Research and Education Bridge (BRIDGES) Program

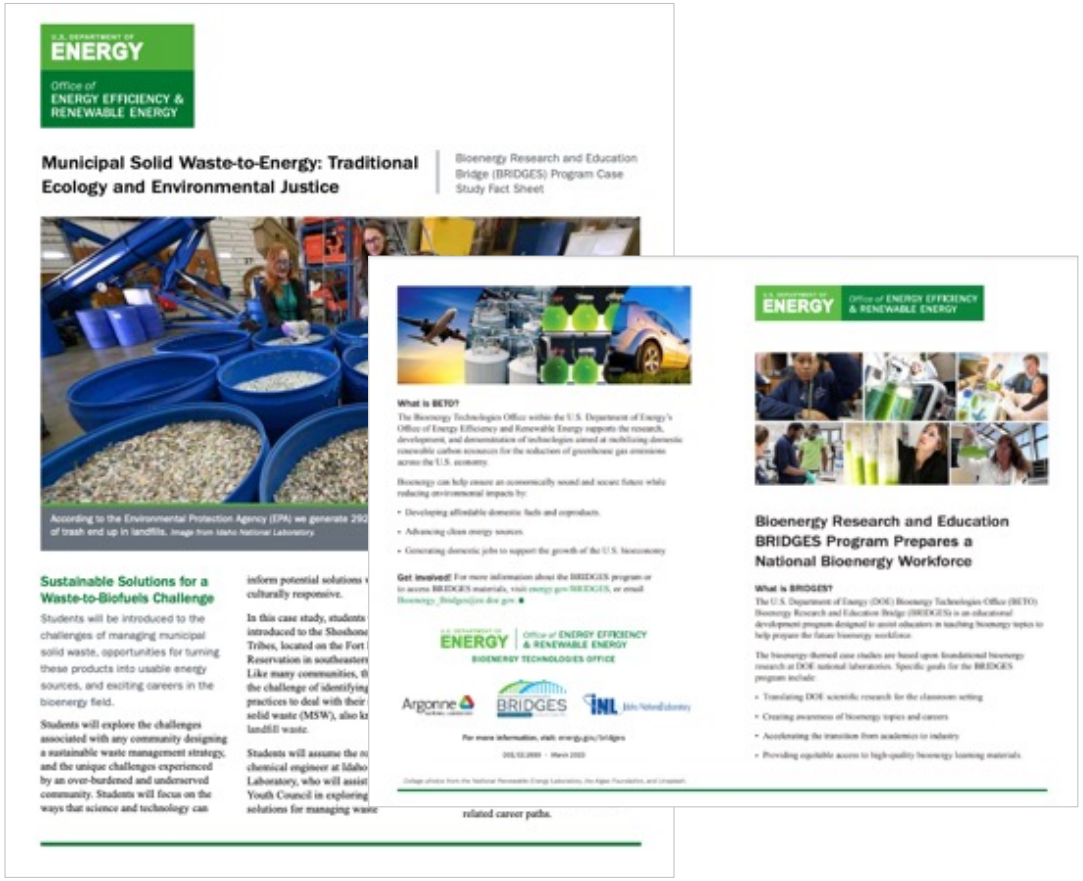


ABSTRACT

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



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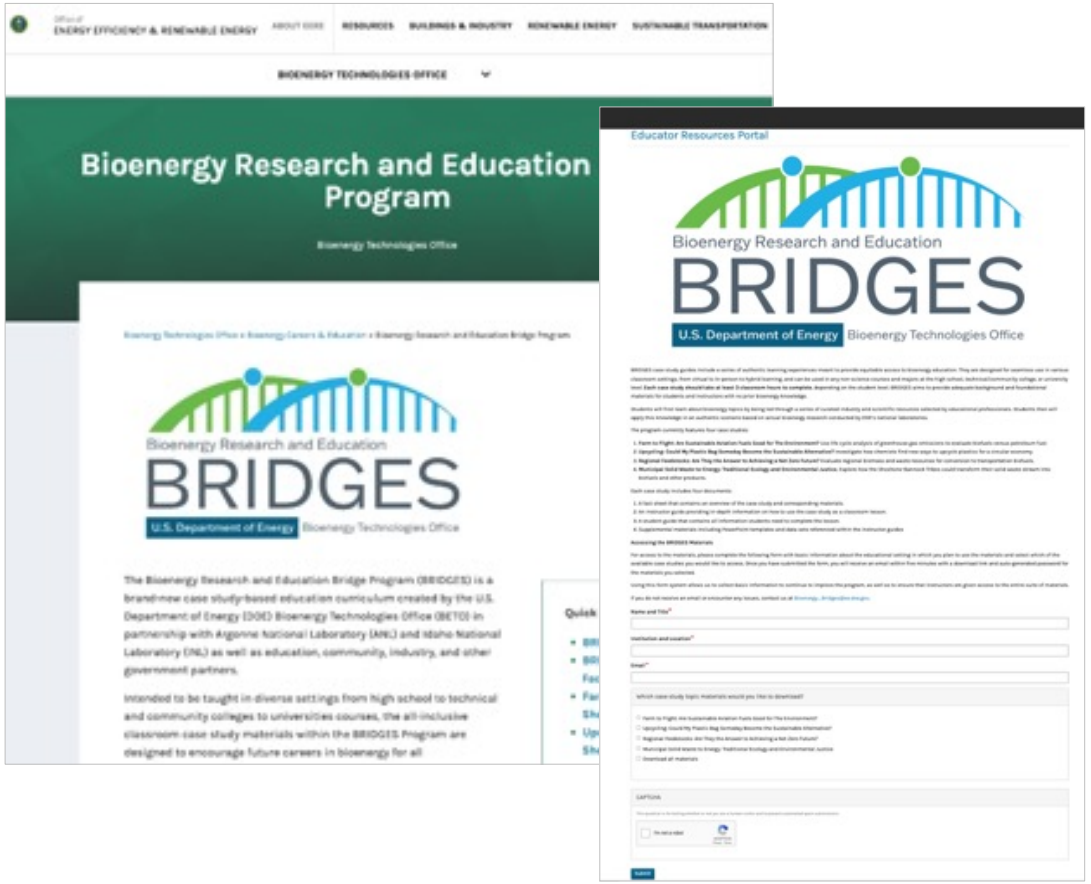
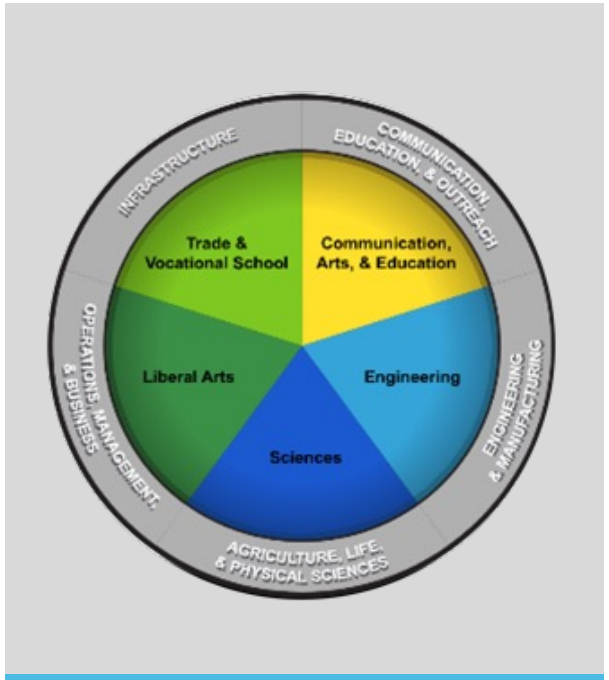


INSIDE A BRIDGES CASE STUDY...

Topic Introduced with Authentic Scenario

Students Explore Resources

Students Demonstrate Learning

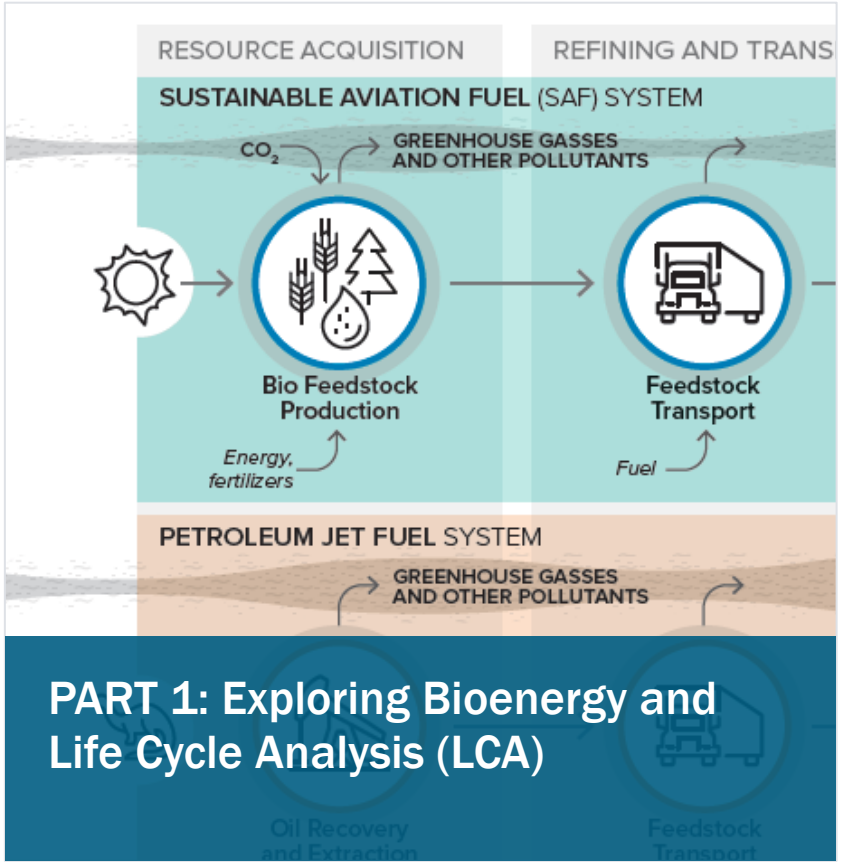


Career Exploration

Overview

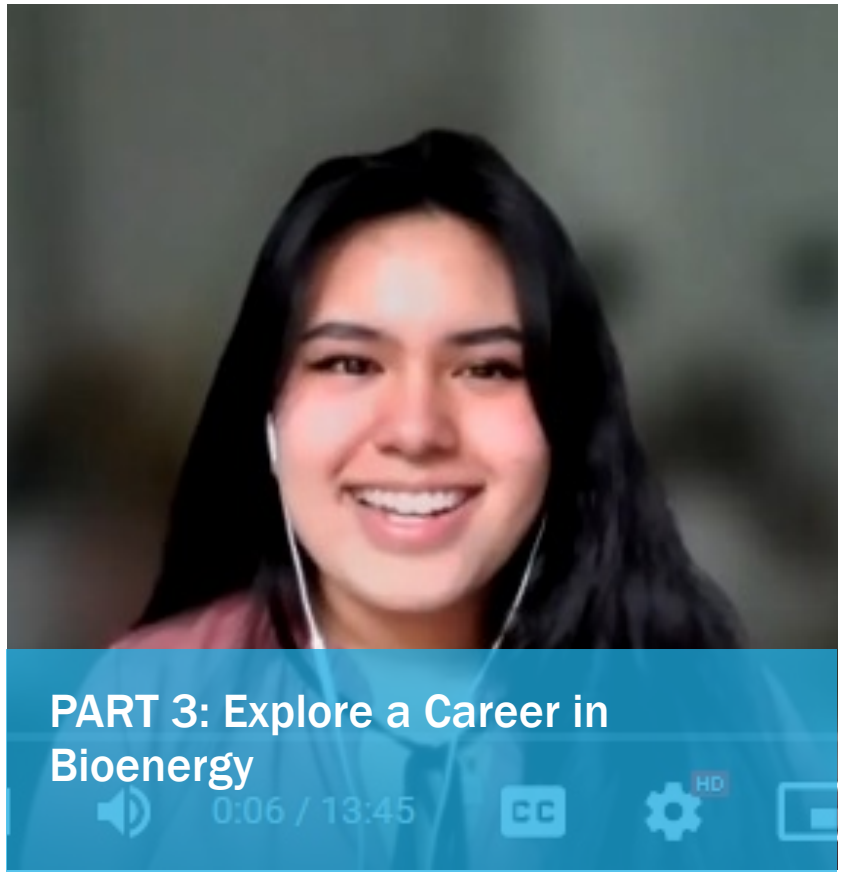
Photo by iStock

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.

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QUICK START GUIDE FOR STUDENTS

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.

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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

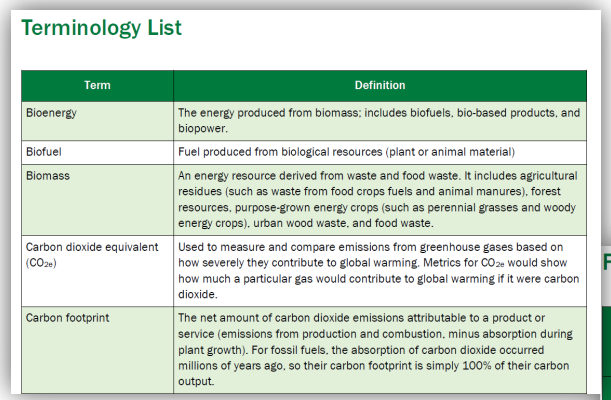
- This portion sets up the goals of the case study in line with the scenario.

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.

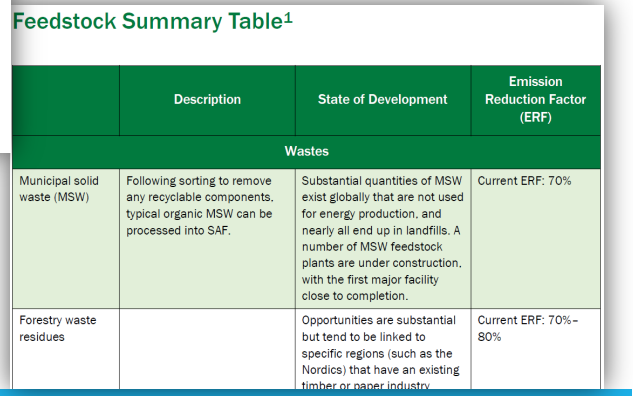
Instructor Notes

- 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 fuels 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_{2e})	Used to measure and compare emissions from greenhouse gases based on how severely they contribute to global warming. Metrics for CO_{2e} 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.



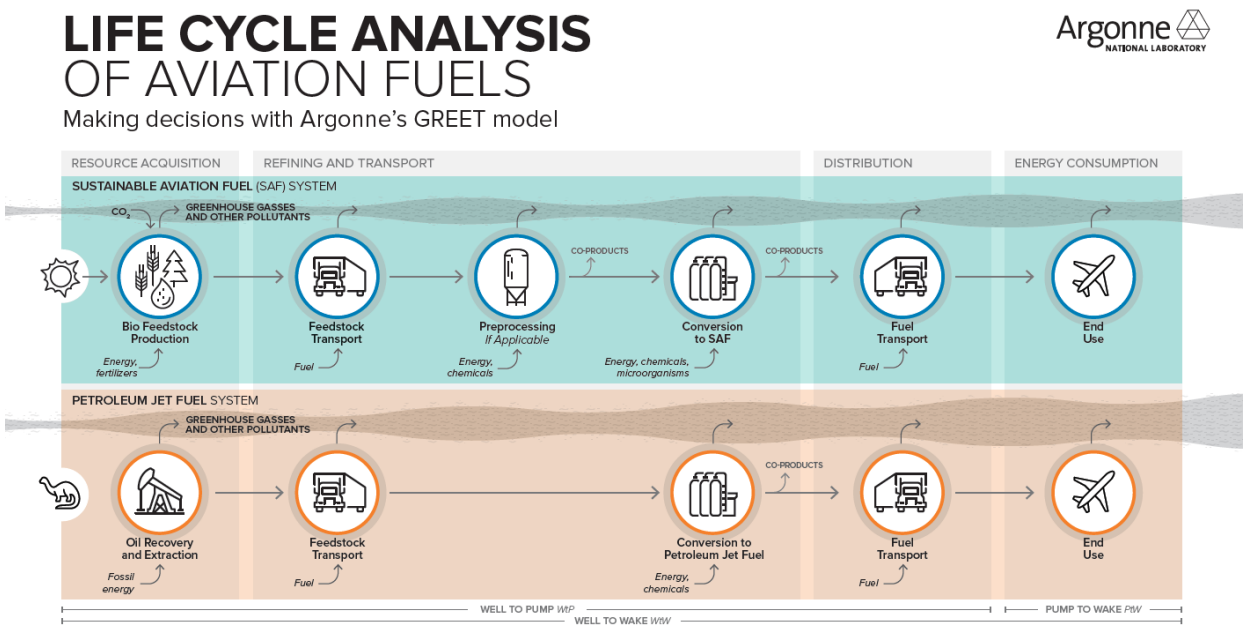
Feedstock Summary Table[1]

	Description	State of Development	Emission Reduction Factor (ERF)
Wastes			
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

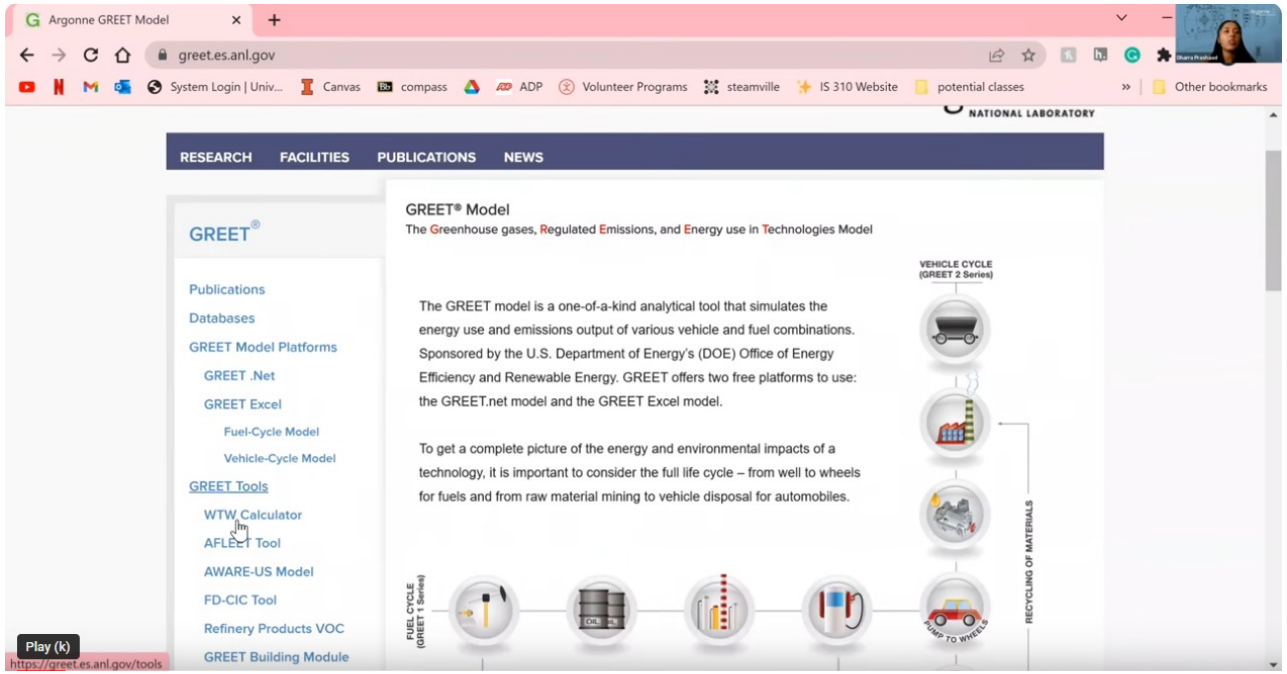
- What are the main categories of SAF feedstock? Give examples of each. Briefly mention the main benefit and drawbacks of each.
- Explain the concept of life cycle analysis of greenhouse gas emissions using the following LCA diagrams for both petroleum jet fuel and SAFs as a guide. Make sure to include 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



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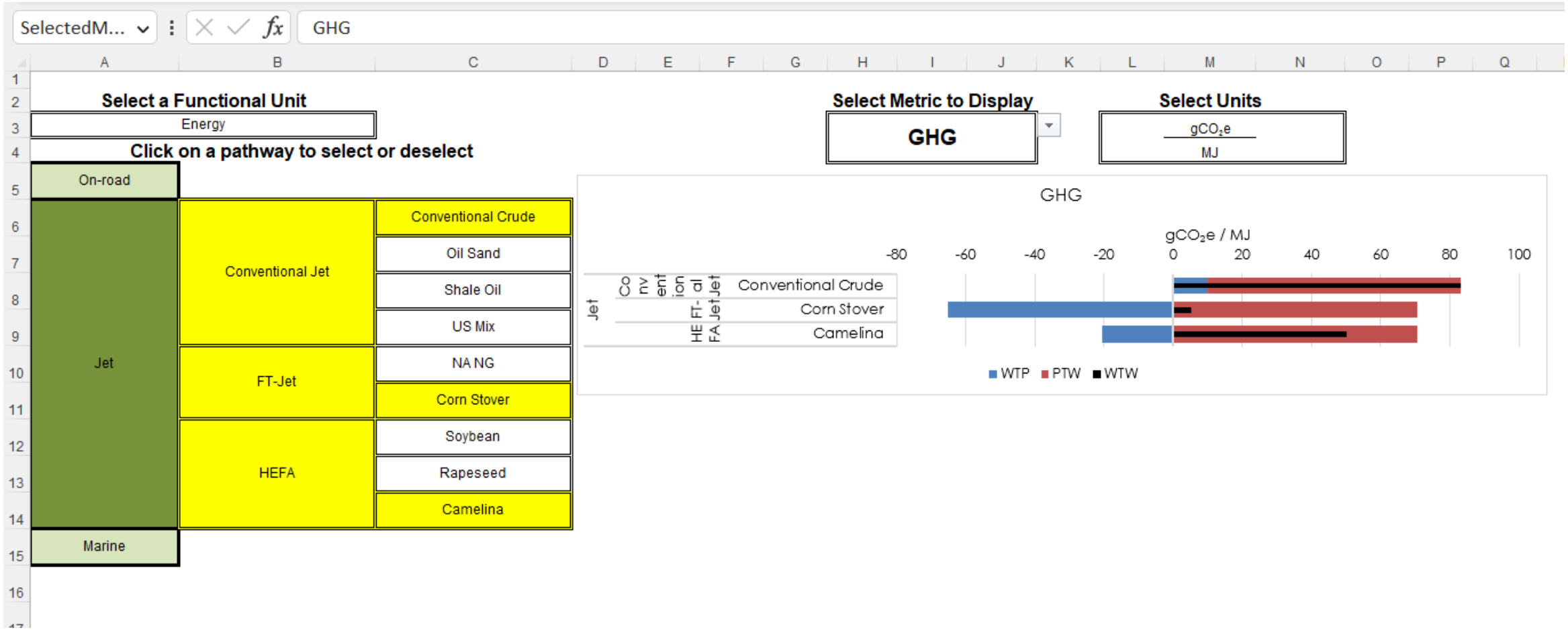
GREET Well to Wake Calculator



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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_nBNc9CfQT3yBV9sxI7H&index=3

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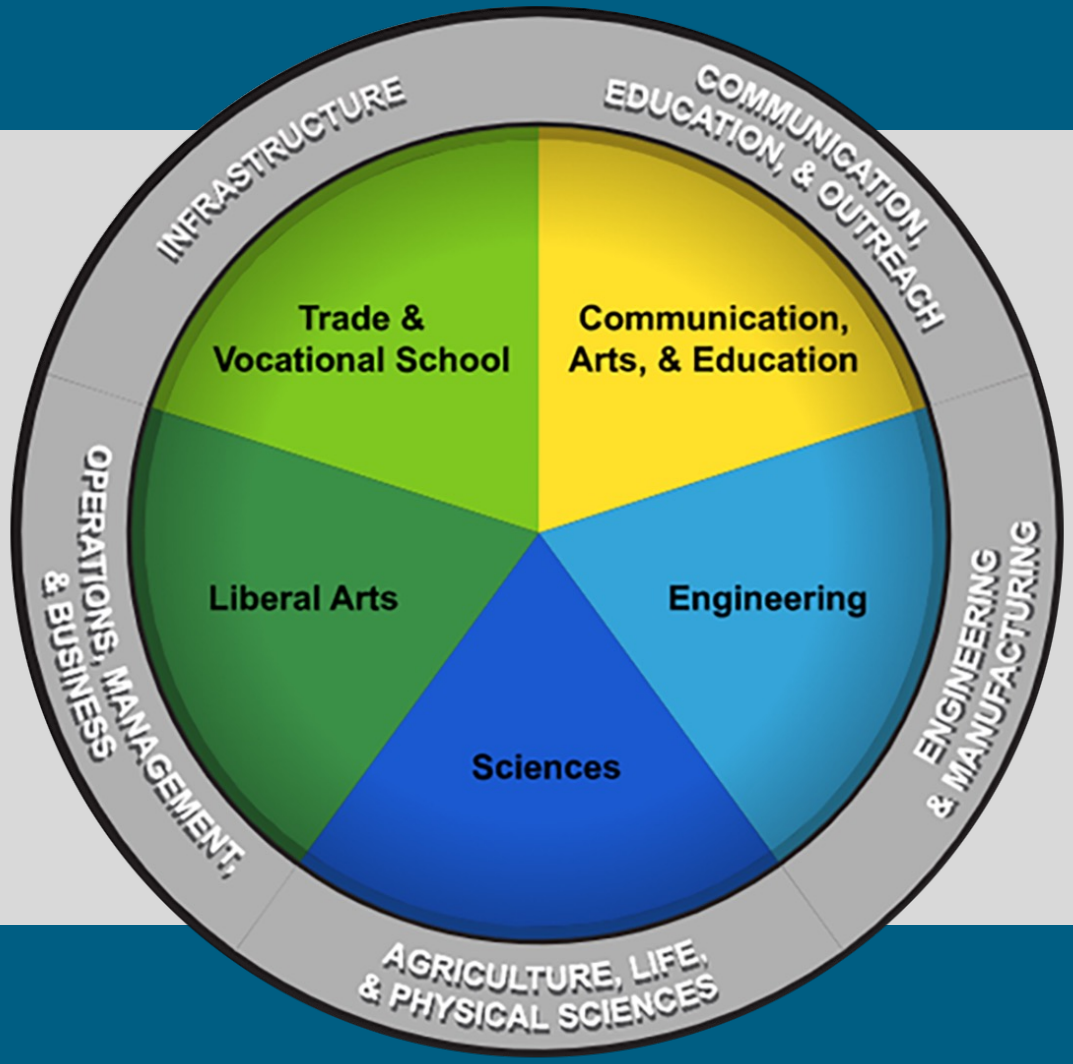
STUDENTS EXPLORE BIOENERGY CAREERS

CAREER HIGHLIGHT
SUSTAINABILITY SPECIALIST

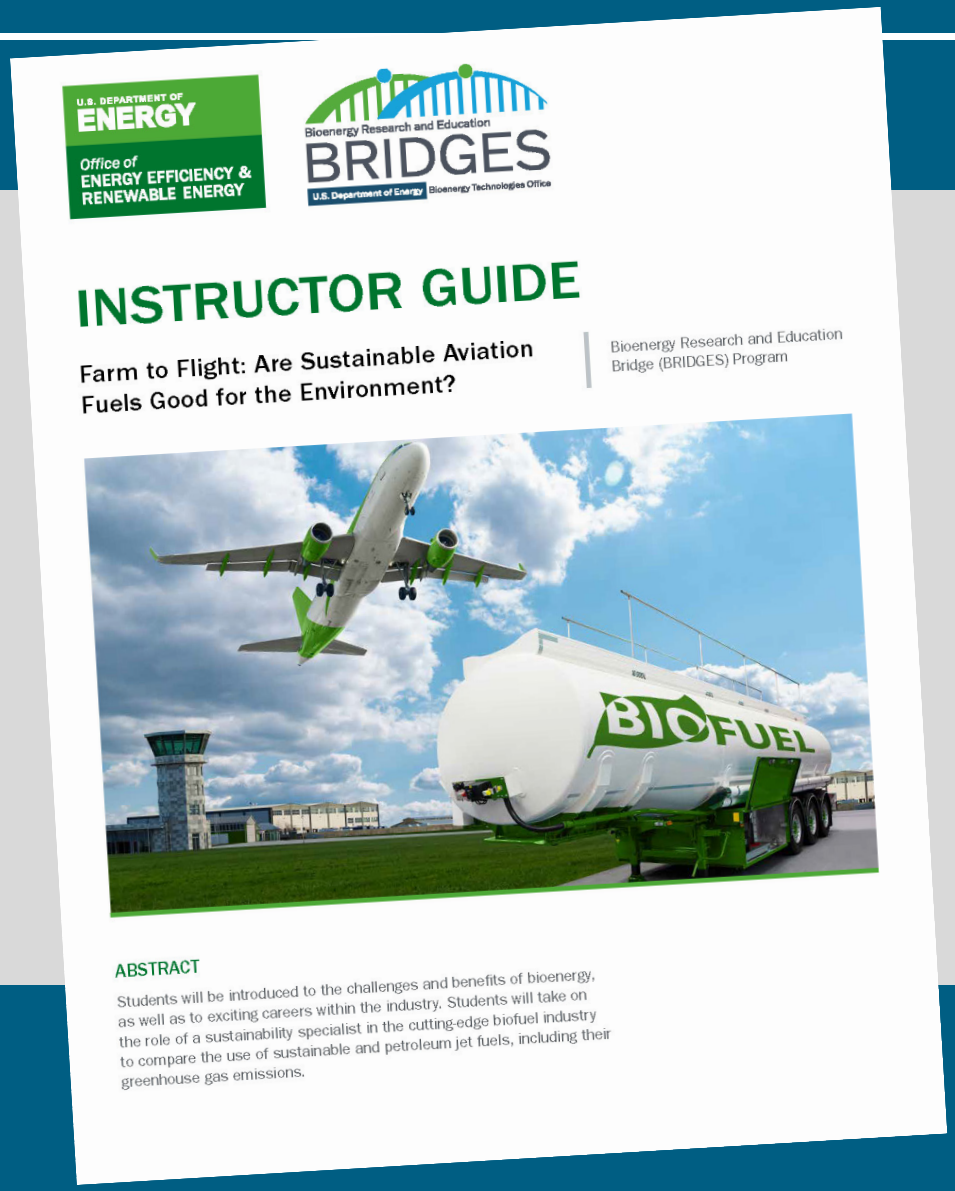
- Average salary
- Common majors for this position
- Responsibilities of a sustainability specialist
- Students then explore the career wheel to identify a career of interest to them



COMPREHENSIVE INSTRUCTOR GUIDE

ASSUMES NO BIOENERGY BACKGROUND

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



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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.

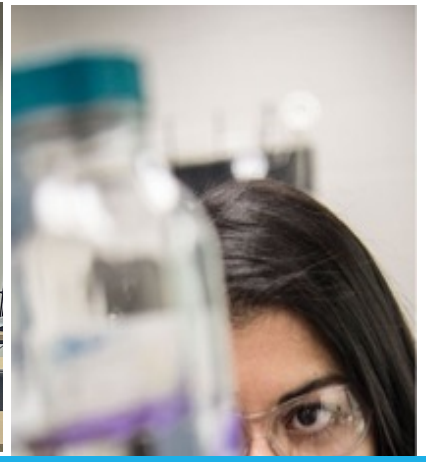
Case Studies in Action

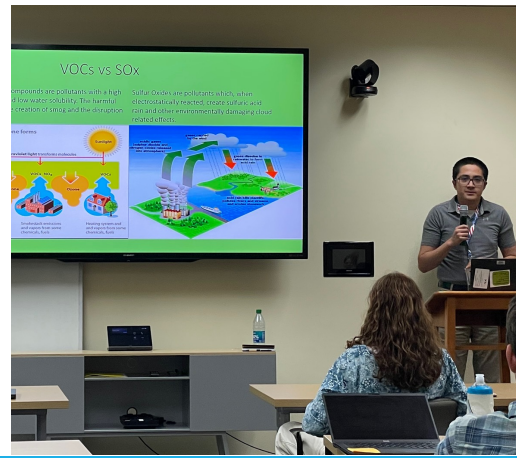
“What I liked about working with the case studies was that they presented real-world problems that we got to get our hands on and solve…there was a little bit of leeway on how we wanted to get to our solution, and as long as our evidence supported it, we were free to find our own path.”

-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



Instructor Resources

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_2), nitrous oxides (NO_x)
- 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

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UPCOMING EVENTS TO SUPPORT EDUCATORS IN TEACHING BRIDGES CASE STUDIES

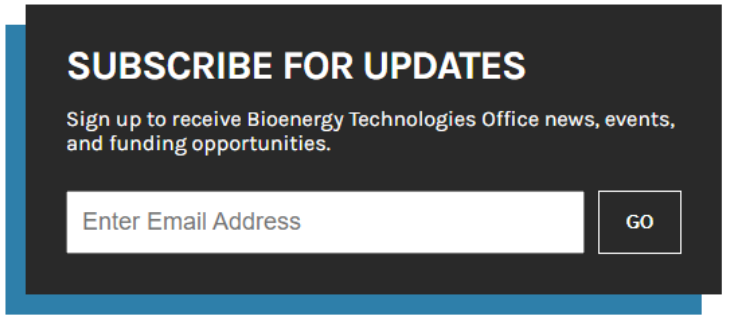
WEBINARS

- **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**



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Learning Lab

Thank you!

Contact us with additional questions & comments: Bioenergy_BRIDGES@ee.doe.gov