

# Conservation of Mass: A Case Study in Renewable Energy

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for the STEM Education Center at WPI's Summer 2022 Research Experience for Teachers program

**Subject:** Chemistry

**Grade Level:** 10-12

**United Nations Sustainable Development Goal 7:** Affordable and Clean Energy

## Overview

You are a Worcester City Council member that is being asked to vote on whether or not the city should continue its' energy contract with Eversource, a natural gas company, or switch to purchasing bio-oil and methane from the newly constructed Bio-Crude plant that has opened at the Upper Blackstone Clean Water treatment facility. You will be given a variety of data and informational texts to learn about the differences between fossil fuels and renewable energy; the process required to make both natural gas and biocrude; and the costs associated with each energy source.

## Standards & Learning Targets

### Lesson Group 1: HS-PS1-7

Use mathematical representations and provide experimental evidence to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. Use the mole concept and proportional relationships to evaluate the quantities (masses or moles) of specific reactants needed in order to obtain a specific amount of product.

Vocabulary	Tier 1	Tier 2	Tier 3
<i>supp vocab words in italics</i>	conserved evidence sustain	reaction representation mass <i>renewable</i> <i>clean energy</i>	atoms <i>mass balance</i> <i>carbon balance</i>
What do students need to <b>KNOW</b> ?	<ol style="list-style-type: none"> <li>Students will know the definitions of the following vocabulary terms/phrases: mathematical representations; experimental evidence; atoms, mass, chemical reaction, conservation of mass</li> <li>Students will know that the reactants of a chemical reaction determine the possible products of a chemical reaction (both by masses and by atoms)</li> <li>Students will know the basics of why clean, affordable energy is important and how the concept of renewable energy relates to the conservation of mass.</li> </ol>		



<p>What do students need to <b>DO</b>?</p>	<ol style="list-style-type: none"> <li>Students will use the following vocabulary words in context: atoms, reaction, conserved, mass, renewable, clean energy, mass balance, carbon balance</li> <li>Students will be able to describe the importance of renewable energy sources and show how it relates to the conservation of mass</li> <li>Students will be able to identify: <ol style="list-style-type: none"> <li>the possible products of a chemical reaction of SS from a list of compounds</li> <li>the "optimal" conditions for formation of biocrude from teacher-provided data</li> </ol> </li> </ol>
<p>What will students <b>CREATE</b>?</p>	<ol style="list-style-type: none"> <li>Students will create a written artifact describing how the matter in wastes such as sewer sludge can be used to create bio-oil. This can take the form of either: <ol style="list-style-type: none"> <li>a blog entry;</li> <li>a newspaper article</li> <li>a comic strip or children's "book";</li> <li>a pamphlet or full-page advertisement promoting the use of using bio-oil as a fuel source</li> <li>a script for a commercial/infomercial</li> </ol> </li> <li>Students will create a verbal argument about whether it is economically feasible to change over to buying energy in the form of biocrude from Upper Blackstone Clean Water instead of natural gas from Eversource during a mock City Council meeting.</li> </ol>

<p><b>ELA Standard: W.9-10.1.d</b> Establish and maintain a style appropriate to audience and purpose (e.g., formal for academic writing) while attending to the norms and conventions of the discipline in which they are writing.</p>			
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## Prior Knowledge

Student prior knowledge about the energy crisis and the effect of fossil fuel use on the environment will vary. As such, all students will be led through a series of articles, videos, and other learning materials to make sure all have adequate background knowledge. Students will also be provided review materials, if needed, for balancing chemical equations, types of chemical reactions, and the law of conservation of mass.

## Materials/Resources

## Timeline of Activities

Duration	Activity	Instructions	Product
1 class	Overview of energy crisis and why biocrude valorization is important	Students will identify problems with using fossil fuels and possible solutions	background knowledge for written artifact
1 Class	separation of a mixture lab	Students will perform a separation of a mixture to identify how physical properties can be used to separate mixtures into components	lab worksheet; identification of physical
1 class	review of conservation of mass, overview of HTL process	Students will review data from AT-HTL and identify the conditions that lead to the highest yield of biocrude	Written analysis and explanation of data; prediction about why there is an apparent "loss" of mass in this experiment (follow up to balloon, vinegar and baking soda experiment)
2 classes	research and draft of written artifact	students will continue research on fossil fuel use and alternative	



		energy sources, including predicted costs	
1 class	peer review of written artifact	students will give (and receive) feedback from their peers	peer feedback review sheet
1 class	prepare for debate	Students will be shown portions of a city council meeting, including public participation portion, to get a sense of the way discussions are held in these public meetings; roles drawn	short quiz on procedures during a city council meeting
1 class	Mock City Council meeting	Students will be assigned roles (councilor, mayor, or citizen) and need to defend with evidence their reasons for or against converting the city to biocrude from natural gas	Peer review feedback sheet

## Culturally Responsive Teaching Strategies

UDL (universal design for learning)	students are given the choices of articles they read for their research, as well as the medium through which they chose to present their written work
Virtual and wet labs	students are given the choice of using Labster lab simulation and/or physically doing lab portions of these lessons
encouraging interpersonal relationships	students are encouraged to work in small groups to complete research and prepare projects; students are given the opportunity to give and receive feedback from peers before final project submission

## Career Connections

During research component, students will be exposed to STEM careers such as: chemical engineering, environmental scientist, chemist, civil engineering, and science writer

## Assessment

Students will be assessed by two projects: the first is a written artifact and the second is an oral presentation of their knowledge. Their overall performance on these tasks will be assessed according to the following [rubric](#).



