ND EPSCoR Lesson Plan

Life Cycle Assessment and Renewable Energy from and Indigenous Perspective

## Lesson Title: Life Cycle Assessment and Renewable Energy from and Indigenous Perspective

## Lesson Overview: This lesson focuses on ways of reclaiming sustainability as an in Indigenous way of knowing and focuses on the western science concepts of energy from wastes and life cycle assessment. Students will explore how chemical engineering concepts allow for us to take the idea of converting food (traditional corn ethanol) into fuel and how we should be looking at converting waste materials into fuel. Using concepts within traditional engineering along with chemical engineer’s ability to use biochemical means to break down waste and generate a fuel. The second part of this lab will compare our current food system and look at all of the inputs of the lunch we just had and compare it to our ancestors food systems’. What energy went into the walleye we caught and ate, what energy goes into the manoonim we harvested and prepared, what energy comes from the picking of berries or the drying of sage?

The first part of the lesson focuses on how engineering can be used to help make use of “waste” sources. We will have discussion of the bison or the deer (depending on tribes) and how all parts were used. There was no such thing as waste in indigenous culture. We will discuss the effects of traditional fuels and how scientist came up with using our food as a fuel. Students will be asked to brainstorm other ways in which we can get fuel and help reduce waste. Students will perform a demo using a food source. Students will then preform a second demo where we use a waste material to form a biofuel and then using chemical engineering concepts we will apply enzymes to our waste and watch as fuel is formed. This process takes a while so may need to be wrapped up in a different period.

This second part of the lesson introduces students to life cycle assessment.In this lesson, students will consider what raw materials and energy that went into our lunch. In addition, students are tasked with considering ways in which these resources can be reduced using indigenous knowledge. Following a discussion of the  life cycle of our foods, students are asked to compare and contrast our lunch we had with how our ancestors ate.

1. Introduction to myself and chemical engineering (15 minutes)
2. Complete Initial Demo with traditional sources (15 minutes)
   * 1. Attempt Second Demo (5 minutes)
3. Reflect and Discuss the two demos (5-10 minutes)
4. Complete Third Demo (20 minutes)

**Lunch**

1. Wrap up demo, compare and contrast the three demos (5 minutes)
2. Introduction to sustainability (15) -
3. Fill out worksheet/small group activity (20 minutes)
4. Compare and Contrast (15 minutes)

## Lesson Objectives:

## To recognize how indigenous knowledge and ways of knowing are already embedded within engineering.

## To understand where the resources and energy we consume everyday come from within in a life cycle assessment context

## To understand that in proper LCA design mentality there is no such thing as waste, engineers can come up with creative solutions using engineering principles to use earth's resources sustainably.

## NSF Subject Classification: Environmental Engineering and Chemical Engineering

**National Next Gen Standards:**

|  |  |
| --- | --- |
| **HS-PS3-3.** | **Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.\*** |
| **HS-LS2-4.** | **Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.** |

**North Dakota Standards:** ET1.A: Defining and Delimiting Engineering Problems

ET1.C: Optimizing the Design Solution Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (tradeoffs) may be needed.

**Grade or Grade Band: 8-12**

**Time Needed (estimate) (2 hours)**

**Lesson Author: Bethany Klemetsrud**

**Scientist/K12 Collaborator & University: Bethany Klemetsrud University of North Dakota**

**Scientist Bio:** Dr. Bethany Klemetsrud is an assistant professor in Chemical Engineering at the University of North Dakota. Bethany grew up on the White Earth Nation and is excited to be able to work close to her home and family. She received her undergraduate degree from the University of Minnesota Duluth and completed her PhD at Michigan Technological University in 2016. Her dissertation is titled “EXPERIMENTAL AND THEORETICAL INVESTIGATION OF SUSTAINABLE FAST PYROLYSIS BIOFUELS FROM WOODY BIOMASS”. Her passions include advocating for the broadening participation of Native students in STEM, developing technologies that can convert waste into useful products or energy. Beth’s primary form of research within the chemical engineering department looks at using fast pyrolysis to thermochemically convert waste materials into use chemicals and energy dense products. Bethany comes from a large family and is committed that her younger siblings and niece and nephews be able to see themselves at Scientists and Engineers if that’s what path they choose.

**Summary of Research and/or Problem Being Studied:** This work focuses on developing renewable or sustainable energies from materials from agriculture and municipal wastes. This work employs biochemical and thermochemical solutions. Due to the dangers of thermochemical in a high school setting we will focus on biochemical conversion. All renewable/sustainable energy must be evaluated in terms of its ability to solve climate issues. This can be done mathematically with life cycle assessment. Measuring all of the inputs and outputs of a system from extraction to final use and disposal of that product or process. This work looks at novel solutions for turning waste into energy and evaluating it at a much larger scale of sustainability. Life cycle assessment will be used to quantify environmental impacts however the use of stakeholder and community participations will look at the larger question of sustainability and if these sources of energy are beneficial to communities in terms of social and economic impacts.

# Preparation/Materials

**Background knowledge students must have to be successful:** Basic science and math courses.

**Essential Terminology**

**Resources:**

**Websites: None**

**Materials needed:** Erlenmeyer flasks, yeast, sugar, corn syrup, balloons, wood chips, pretreated wood chips, enzymes, pipettes, white boards or work sheets.

*PowerPoint – found as separate attachment*

# Procedure/Activities

## Lesson 1: How to convert sugars into energy

## Lesson 2: How to evaluate the sustainability of a process and products?

## Extensions for above average students: Students who are above average can measure balloon circumference and use the ideal gas law to calculate how many moles of CO2 have evolved.

## Mediation/Support for students that need it: Help those students with measuring. Draw connections to baking in the kitchen.

## Lesson Outline (for research-based lessons)

1. Observe Phenomena
2. What questions should we be able to answer?
3. Write a Hypothesis
4. Come up with a Research Plan
5. Carry out investigation
6. Revisit the Background Research
7. Construct Explanations. (TASKS-Publish/Communicate Findings)

# Standards Alignment

## ND Science Standard(s):

**Disciplinary Core Idea: e.g.** Life Science – cells and cancer (example is from SD EPSCoR lesson)

All living things are made of cells. In organisms, cells work together to form tissues and organs that are specialized for particular body functions.

**North Dakota DPI Standards:**

**Next Gen Standards:**

## Science and Engineering Practices

2. Developing and Using Models

## Cross Cutting Concepts

* Structure and Function

## Unit Objectives

* Students will be able to create a model in order to identify structures of a cell and cell membrane and the functions of each.

## Assessment

* When given a model of a cell membrane, students can identify the structures of the cell membrane and their functions. Students could construct a written explanation to compare and contrast the cell membrane function of a healthy cell versus a cancerous cell.

# Daily Plans and Assessments

## Learning Target for each day/activity

## Criteria for Success/Assessment for each activity

# Additional Lesson Resources / Materials

## References:

## Websites for purchasing materials