Lesson 2: What can we find out about greenhouse gas emissions resulting from waste in our school food system?

MS/HS Climate Change Design Challenge Unit

Previous Lesson….Where we've been: Students learned about the district's solid waste plan and discuss how our school can save or decrease emissions by reducing solid waste at our school.

This Lesson….What we are doing now: This lesson explores our school food system and identifies the ways in which greenhouse gases result from food waste in our school system. We then need to develop an investigation about food waste at our school in order to know what should change.

Lesson Question	Phenomena	Lesson Performance Expectation(s)	What We Figure Out (CCCs & DCIs), *New Questions* and **Next Steps**
L2: What can we find out about greenhouse gas emissions resulting from waste in our school food system? 2 periods *Building toward* ↓ *NGSS PEs: HS-ESS3-4 HS-ETS1-3*	Food Waste Article Greenhouse Gas Calculator	**Developing and using models** of the school food system to understand how energy flows into and out of a system in terms of the energy embodied in food and the greenhouse gas emissions that result. **Using mathematics and computational thinking** to determine greenhouse gas emissions from different parts of the system and to understand the total impact at different scales**,** emphasizing how a change in one part of the system causes an effect in another part and in the resulting greenhouse gas emissions.	Last class, we decided we could have an impact on Greenhouse Gas (GHG) emissions by reducing food waste at school. We develop an initial model to figure out what the whole food system looks like-from growing food to processing, packaging, transporting, being ordered at school, being eaten (or not) and thrown in the trash or landfill and then resulting in methane or carbon dioxide emissions. We read an article that gave us some more information about food waste and we updated our models. We used a Greenhouse Gas calculator to determine how many pounds of Greenhouse Gas emissions result from our whole class sum of estimated waste from breakfast, and then we estimate how much Greenhouse Gas emissions result from our whole school food system. Then we estimate how much that would be for the whole school or all US schools. We check in with our Driving Questions Board to see which questions we have answered and we add new questions we have about our food system so that we could make an action plan as the basis for the changes we would like to make. **Now we are wondering how we could study our school's food system to know how we should change or improve it?**

Next Lesson….Where we're going: Next, we will explore how to design and carry out an investigation to audit our school's food waste system.

Getting Ready: Materials Preparation

Materials For Each Student

- Student Activity Sheet

Preparation of Materials (15 min.)

- Slides
- Post "Notice and Wonderings" chart from previous lesson.

Getting Ready: Teacher Preparation

Background Knowledge

ESS3.C from the FRAMEWORK:
By the end of grade 8: Human activities have significantly altered the biosphere sometimes damaging or destroying natural habitats and causing the extinction of many other species. However, changes to Earth's environment can have different impacts (negative and positive) for different living things. Typically, as human populations and per capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.

ESS3.D from the FRAMEWORK:
By the end of grade 8: Activities such as the release of Greenhouse Gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior, applying that knowledge wisely, decisions, and activities.

ESS3 from the FRAMEWORK:
"Thus science and engineering will be essential both to understanding the possible impacts of global climate change and to informing decisions about how to slow its rate and consequences…"

Rate of and region of change matters for understanding climate change. Cities are changing faster because of their characteristics - localized amplification because of things black tops, resulting in heat islands in cities. However, this isn't the entire explanation for climate change. Overall, regionally and globally human activities are increasing CO_2 and Greenhouse Gases, which result in global warming.

Alternative Student Conceptions

Students are going to have very different understandings of how food systems work. It's a good idea to get a sense for what they already know so you can build on prior knowledge and correct some of the gaps in understanding.

Linking Our Understanding to Scientific Terminology

- Food waste sum
- Conversions
- Food system
- Methane

Learning Plan: What can we find out about greenhouse gas emissions resulting from waste in our school food system? (120 min)

1. (5 min) Begin class with a discussion to re-orient students to the storyline.

Suggested Prompts:

- What did we figure out last class?
- What were the questions we came up with in the last class?
- What do we need to know to be able to recommend or make changes to the food system?

Listen for student responses such as:

- *We watched a video to show us that food waste is a major contributor to Greenhouse Gas emissions.*
- *We figured out that if you could change just a small part of the system you could save a lot of Greenhouse Gas emissions if that happened all over the school or all over the state or country.*
- *We decided we needed to learn more about our school food system so that we could figure out how to change it.*

2. (10 min) Guide students in an Initial Ideas Discussions to help students identify the interacting pieces to develop their model of the food system[A].

Suggested prompts:

- What are some the parts (people, places, things, ideas, processes) of our food system?
- How do these parts interact?
- Who makes decisions within the different parts?

Listen for student responses such as:

- *Businesses, farmers, school cafeteria staff, principal, parents, students, custodians, etc.*
- *If the cafeteria staff order food that we don't like we don't order it or we take it and then throw it in the trash.*
- *My parents make some of the decisions for what I have for lunch. The school or district decides how much money we get for the cafeteria.*

Teacher Supports & Notes

Strategies for this Initial Ideas Discussion

A: The purpose of this discussion is to get students to start thinking about how big and complicated the food system is and their role in it. Also, students are going to have very different experiences with the food system based on their life experiences. Try to involve everyone in this discussion so that you can hear a wide range of ideas.

3. (20 min) Next, direct students to make an initial model of the food system, as they understand it. Once students have had enough time to draw out their model, have them share it with another person. Then, as a class, make a table to compare and contrast the pieces of the model.

Suggested prompts:

- ➔ What are some things that both you and your partner had in your models (or that we definitely all agree should be in this model?)
- ➔ What are some differences between your models (or things that we aren't sure if they should be in the models?)

Accept any responses that emphasize the components, interactions and mechanisms of this system such as:

- ➔ *Components: food, farms, kitchens, cafeterias, waste management, landfills, greenhouse gases (methane, carbon dioxide), school, students*
- ➔ *Interactions: transportation, emissions,*
- ➔ *Mechanisms: breakdown of food waste, combustion of gas (transporting food and waste)*

Emphasize with students that their list of things they aren't sure of (the differences in their models) is a good place to start[B] and a lot of it lines up with their driving questions.

Suggested prompts:

- ➔ It seems like the are unsure of many of the ways this system works, especially the connection between food waste and Greenhouse Gases. How could we get some of these questions answered?

Listen for students responses that set them up to read about food waste systems and Greenhouse Gases:

- ➔ *We could read something that tells us about the systems.*

4. (30 min) Instruct students to read the "Food Waste" article in their Student Activity Sheet. Then engage students in a Building Understandings discussion.

Suggested prompts:

- ➔ What is one thing you did not know that you learned from this article?
- ➔ What are some key ideas about food waste you learned from the article?
- ➔ What information from the article is applicable to us?
- ➔ What components of the food waste system can we directly impact?
- ➔ How could we apply what we learned from the article to our initial models? How should we revise them?
- ➔ Where in the system are Greenhouse Gases emitted?
- ➔ What processes or decisions result in food waste emissions?

Supporting Students in Developing Models

B: The goal here is to point out the gaps in understanding. A good way to do this is to compare models so that students can see that they all have very different ideas and could not come to a consensus about what this model should include at this time, thus motivating the rest of this lesson and beyond.

Note taking

C: Make sure the students annotate wherever they can to keep organized. This is a long article

Accept any relevant student responses such as:

- ➔ *The article told us that food waste is a worldwide problem.*
- ➔ *Food waste emits methane, which is 25 times worse than carbon dioxide.*
- ➔ *There is food wasted at a variety of stages in the system.*
- ➔ *We should add some things to our models.*

5. (10 min) Now, engage students in a discussion using the models to identify what we should study and to identify and support our action steps.

Suggested prompts:

- ➔ Where are some possible places we could have an impact?
- ➔ How can we study how much food waste comes from these different places?
- ➔ What would we do with that information?
- ➔ What other questions might we ask to help us figure this out?

Listen for *student responses*, such as:

- ➔ *We think we could have the biggest impact in our homes or at school.*
- ➔ *We can't really control what happens on farms, grocery stores, or manufacturing sites.*
- ➔ *What evidence do we need to collect?*
- ➔ *What type of data would we need to analyze?*
- ➔ *What materials could we experiment with to investigate our question?*
- ➔ *How would we measure food waste in our school?*
- ➔ *How should we keep track of food waste in our school?*
- ➔ *Who in our school knows about food waste?*
- ➔ *Does anyone in our school already look at food waste?*

6. (10 min) Next, shift to a Sharing Initial Ideas Discussion. Use the following prompts to guide students to articulate what they think they should focus on in upcoming lessons[C].

Strategies for this Initial Ideas Discussion

D: The purpose of this discussion is really to set up the rest of this unit. Push students to think of solutions that we could control in our school setting. If students suggest things like installing solar panels or unrelated ideas, emphasize that they are looking at the methane released from food waste as that seems like a manageable issue to tackle and part of designing solutions is being realistic in plans and expectations.

Suggested Prompts:

- ➔ What do you think we could/should do to help us decide what the food waste situation is at our school?
- ➔ How should we record/keep track of the amount of food waste and who, if anyone, knows about it.
- ➔ Think about the DPS sustainability plan we looked at last class. What do you notice about the plan and could we implement it here at school?

Listen for *student responses* that mimic the next step in the story line, such as

- ➔ *Because we were wondering if the amount of food waste at our school is significant we need to collect data on how much we waste, why we waste it, could we do something differently, how can we affect change if we can't change how the food is delivered or offered?*
- ➔ *We could gather data and see if we need to change. We could present our findings to the principal and try to change the policies.*
- ➔ *We could talk to other students about why we should change to help our environment.*

7. (15 min) Guide the students through some calculations in their Student Activity Sheets to estimate how much food is wasted at our school on any given day. When the calculations are complete, have to students reflect on these calculations by answering the following questions in their Student Activity Sheets and then sharing out in a whole class discussion.

- ➔ How much would Greenhouse Gas emissions be reduced if we cut food waste in our school?
- ➔ What would that mean if reducing food waste was scaled up to the whole Colorado school system; for the entire, US school system?
- ➔ Are we confident in our estimations? How could we know for sure how much food is wasted? How should we study our school food system to know what should be changed to reduce food waste?

8. (10 min) Before dismissing students, ask student to take stock of what they figured out today and brainstorm what our next steps should be in our investigations.

Suggested Prompts:

- ➔ What did these calculations help us figure out?
- ➔ What do we need to do in our school to better understand the food waste situation?
- ➔ What else are we wondering about when planning this design challenge?
- ➔ What should make sure to do in our next class?
- ➔ What do we need to investigate next time we meet for science?

Listen for *student responses* such as:

- ➔ *These calculations helped us figure out that school based programs for reducing food waste could have a significant impact on Greenhouse Gas contributions worldwide.*
- ➔ *We are wondering who we can ask for help or support in our school?*
- ➔ *We should figure out what we do with the waste in our cafeteria.*
- ➔ *Can we make a plan to sort out the waste in the cafeteria?*

Alignment With Standards

Building Toward Target NGSS PE

- **HS-ETS-3**: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

Building Toward Common Core Standard(s)

- **HSN.Q.A.1:** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.