STUDENT GUIDE
ELABORATE 2 LESSON 13

Food and Agriculture Center for Science Education

Part 1: Our Motivation

Record what we were trying to figure out that led to this investigation.

At the end of Lesson 12, we figured out that the dairy and agriculture industries have relatively lower greenhouse gas emissions compared to other industries. We were still concerned with what might happen to Earth's temperature in the future if greenhouse gas emissions from all industries continue.

Questions that led to this investigation are:

- What will happen to climate change in the future?
- How can we change our emissions to help stop climate change?
- What actions can be taken to help stop climate change?

Part 2: Making Predictions About Future Global Temperature Changes

Analyze the Greenhouse Gas Emissions by Sector data and share your predictions about how these trends will change in the future by completing the "Predicted Future Trends" column in the table below. List any of the factors that these trends are dependent upon in the "Dependent Factors" column.

Data Source	Predicted Future Trends	Dependent Factors
Dairy Industry Emissions Data	If changes are not made to the ways in which dairy products are processed and packaged, emissions in this area will stay the same and not improve. However, if changes are made in these areas, it is expected that these emissions will decrease.	The type of energy that is used by a dairy and how it is produced in a region influence trends in production, processing, and transportation. Producing packaging material is energy intensive and boosts emissions.
EPA Emissions Data by Sector	The data seem to indicate that there has been a recent decrease in emissions from all sectors overall, so perhaps this can continue. But emissions from transportation are increasing.	The emissions from this sector depend on the choices we make in transit, such as electric cars or gas cars, or where our electricity comes from, such as wind and solar or coal power. Changes to transportation would cause the emissions in that area to decrease. Areas in agriculture that continue to implement solutions related to transporting products, for example dairy products, would cause emissions to decrease overall in that category.

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Data Source	Predicted Future Trends	Dependent Factors
Our World in Data Emissions by Sector	Agricultural and fugitive methane emissions have increased over time, so maybe that will continue.	If agriculture industries implement new technologies related to energy use and fix their fugitive emissions, emissions in that area will decrease.

Based on the data you analyzed and what you know about the dairy system, make a suggestion for how the dairy system could decrease its greenhouse gas emissions.

The dairy industry can look at ways to improve the areas that seem to have the greatest impact on GHG emissions, such as by engineering more energy efficient methods for dairy product packaging. Doing so would be another way to reduce human impact on temperature change due to GHG emissions.

Part 3: Using a Computational Model to Make Predictions

Record the variables you changed to achieve less than 2°C of global temperature increase. Describe how each of these changes results in less greenhouse gas emissions in the future.

- To find out more information about what each variable means, click on the three-dot icon next to the variable name.

Variable Changed	How This Change Results in Less Greenhouse Gas Emissions in the Future
Increase taxes on using coal for electricity	More taxes on the coal industry would result in burning of coal for electricity being more expensive, which might make it be used less and thus produce less greenhouse gas emissions
Encourage building of more nuclear power plants	Nuclear power does not produce greenhouse gas emissions, so encouraging more nuclear power plants can reduce emissions
Increase building energy efficiency	Homes require heat, which comes from either electricity or burning of fossil fuels. If homes are able to hold in more heat, they require less additional heating and therefore less fossil fuel use.
Decrease methane and other emissions from agriculture	There are a few different sources of greenhouse gases in the agriculture industry, so different farming methods could decrease their emissions.

Reflect on your use of the computational model.

- Explain how the computational model was useful to understand how changing different industrial systems' contributions of greenhouse gases to the atmosphere can result in different future predictions of how global average temperatures will change.
- Explain what strengths and limitations this model has.

If various industrial systems, including agricultural systems, remain on the same path, global average temperatures could increase by an estimated +3.6^{o}C. One of the strongest merits to this computational model is that it is clear that if we make certain changes to various industry emissions, we can have X% impact on the overall temperature changes Earth experiences. The simulation showed that, by increasing energy efficiency and creating taxes on natural gas, oil, and coal, for example, GHG emissions could be reduced. Additionally, low population and economic growth tend to have a large impact on the temperature reduction. Carbon removal technologies also play a role in future GHG emissions. This is where agriculture systems (particularly the dairy system) could play a role in reducing methane and other gases being emitted into the atmosphere. Developing or strengthening existing solutions to mitigate negative impacts on GHG emissions of methane could make a difference in decreasing global temperatures. This computational model has a few limitations, as there are other policy assumptions that are not built into this system for comparison. It also does not give specifics on what "high" and "low" mean quantitatively, so it is up for interpretation by people who are using the scenarios it generates to develop policy.