

Preparation 2.3-W Renewable Energy

- (1) Calculate the following values.
 - (a) What percent of 20 is 2?

 - (b) 28 is what percent of 80?

 - (c) What percent is $18/24$?

- (2) A school principal of 810 students needs to determine what percent of students passed and did not pass a statewide examination. Round to the nearest percent.
 - (a) If 550 students passed the exam, what percent passed the test?

 - (b) What percent did not pass the test?

- (3) A laptop computer that you want to purchase was originally priced at \$1,225. You will receive a 20% student discount, and the sales tax rate is 8%. How much money will you pay for the laptop?

In Collaboration 2.3C, we will look at an important issue in environmental science: energy use and alternative energy sources. The video, “The Future of Energy?”, from Cambridge University, provides a brief overview of the dilemma we are facing with energy and alternative sources of energy. Watching this will help you understand some of the concepts in the problem situation. It will introduce different sources of energy, their benefits and drawbacks, and how energy is produced.

Please watch this video here before Collaboration 2.3C:

<https://carnegiemathpathways.org/go/pbsenergy>

After Preparation 2.3 (survey)

You should be able to do the following things for the next collaboration. Rate how confident you are on a scale of 1–5 (1 = not confident and 5 = very confident).

Before beginning Collaboration 2.3 you should understand the concepts and demonstrate the skills listed below.

Skill or Concept: I can...	Rating from 1 to 5
find a percent of a number.	

Self-Regulated Learning: Reflect

How much time and effort per week is this course taking? Is it what you expected? Is there anything you need to adjust in your weekly schedule to make sure you are successful?

2.3-W: Renewable Energy Environmental Technologies

SPECIFIC OBJECTIVES

By the end of this collaboration, you should understand that

- a relative change is different from an absolute change.
- a relative measure is always a comparison of two numbers.

By the end of this collaboration, you should be able to

- calculate a relative change.
- explain the difference between relative change and absolute change.

SPECIFIC LANGUAGE AND LITERACY OBJECTIVES

By the end of this collaboration, you should be able to

- read and comprehend the problem situation and the “renewable energy” chart.
- complete the Double-Entry Journal with using challenging vocabulary words from the problem situation.
- demonstrate an understanding of mathematics by writing complete and correct responses to questions.
- demonstrate the ability to interpret, predict, analyze, and compare information about energy use and renewable energy generation.
- use appropriate quantitative and environmental science vocabulary to discuss mathematics in this collaboration.

INTRODUCTION

Double-Entry Journal for Problem Situation

In this collaboration, you can use a Double-Entry Journal (DEJ) to help you better understand the problem situation.

The DEJ is designed to give you a better understanding of the reading. Sometimes a problem situation has additional information about a situation. A DEJ helps you focus on the key ideas in a problem situation. Sometimes DEJs help to outline key ideas in a reading. Other times, as in this collaboration, DEJs can help to organize important vocabulary or phrases. As you read through **Problem Situation: Renewable Energy**, you may want to complete the Double-Entry Journal using the steps below:

- In the Left Column, list the **key vocabulary words, key phrases, or key concepts** in the problem situation. These words include words you think are important in the problem situation. Or, these words can be ones that you are not familiar with and want to understand better.
- In the Right Column, **write your definition of the words, phrases, or concepts. You don't need to write a "dictionary definition."** Your definition should be based on what the words, phrases, or concepts seem to mean in the problem situation and your own ideas and understandings.

Key Vocabulary or Concept in the Problem Situation	My Definition
1.	1.

PROBLEM SITUATION: RENEWABLE ENERGY GENERATION

Congratulations! You just started a new job as an environmental researcher. As an environmental researcher, you study new environmental policies and technologies used around the world. You create reports and presentations to talk about policies and technologies that could be used in your state. You work for a non-profit organization called the S&G Energy Association. The S&G Energy Association advocates for clean and sustainable sources of energy. Sustainable means that the source is continuously available. That is, it is a source that we will not run out of quickly. S&G is a local leader in your state on environmental issues.

Nearly 85% of the energy produced in the United States comes from fossil fuels. Fossil fuels were formed millions of years ago from the remains of living organisms. Fossil fuels include oil, natural gas, and coal. There are three main environmental concerns about using fossil fuels as a source of energy. First, burning fossil fuels creates air pollution. Second, burning fossil fuels is a source of a large amount of carbon dioxide (CO₂), which is a colorless and odorless gas that is produced when we breathe, and when we burn fossil fuels. CO₂ contributes to global warming. Third, fossil fuels take millions of years to form and so they are limited resources. We will run out of fossil fuels eventually.

For these reasons, governments, organizations, and individuals are interested in finding alternative sources of energy. Renewable energy comes from resources that can naturally be replenished at a rate equal to their consumption.¹ In other words, *renewable resources* can be renewed or replenished at the same rate at which they are consumed. Some renewable sources of energy are sunlight, wind, water, and plant matter.

In 2010, the world used approximately 18,051 billion kilowatt hours (kWh) of electricity. But countries consume energy at very different rates. For example, the United States used 3,884 billion kWh of electricity in 2010. Germany used only 538 billion kWh of electricity in 2010.²

Countries also produce energy at different rates. This is especially true for the amount of renewable energy that countries produce. Some countries produce more renewable energy than others. Other countries rely more on using fossil fuels. It is important to know which countries are able to produce the most renewable energy and their policies. Knowing their policies will help you determine what policies might work in your state.

Your first task is to find out which countries produced the most renewable energy between 2000-2010. These countries are leaders in using renewable energy in the world. *Table 1* shows a list of some countries' renewable energy generation in 2000 and 2010.

¹ http://www.ucsusa.org/sites/default/files/legacy/assets/documents/clean_energy/renewablesready_fullreport.pdf

² <http://www.eia.gov/cfapps/ipdbproject/iedindex3.cfm?tid=2&pid=2&aid=2&cid=regions&syid=2000&eyid=2010&unit=BKWH>

Table 1: Renewable Energy Generation of Electrical Power in 2000 and 2010

	Renewable Energy Generation 2000 (measured in billion kWh)	Renewable Energy Generation 2010 (measured in billion kWh)
United States	361	440
Russia	165	168
Germany	41	110
Norway	140	117
Brazil	309	433
Canada	363	366
Saudi Arabia	0	0
World	2872	4177

- (1) Based on the data in Table 1, predict which nation has the technologies and policies that best support renewable energy development? Explain why you chose this nation. **Write your answer in 1-2 complete sentences.**

One way to compare which countries supported renewable energy best is to look at absolute and relative change. **Absolute change** is the total amount of change. **Relative change** is change that is relative to another point in time. In our example of renewable energy,

- The **absolute change** in a country's renewable energy generation tells us the total amount of change in a country's renewable energy generation. For example, the absolute change in the world's renewable energy generation between 2000 and 2010 is 1,305 billion kWh.

Absolute change has the same units as the original measurement.

- The **relative change** is the change from earlier renewable energy generation. In other words, we need to compare the change to what a country produced in an earlier time. Relative change is often given as a percentage. For example, the relative change in the world's renewable energy generation between 2000 and 2010 is 45% ($1305/2872$).

Relative change is the absolute change expressed as a percent of the original amount.

(2) Use the information in Table 1 to help you calculate answers to the following questions about the changes in renewable energy generation in Germany and Brazil.

(a) Calculate the absolute and relative change of Brazil's renewable energy generation from 2000-2010.

(b) Calculate the absolute and relative change of Germany's renewable energy generation from 2000-2010.

(3) In the chart below, predict how much renewable energy Germany will generate in 2020 using absolute and relative change.

- First, make a prediction using absolute change. Put this in the (a) box in the table below.
- Remember, the relative increase in generating renewable energy in Germany is 168% between 2000 and 2010. Assume that it will be the same between 2010 and 2020. Now, predict how many billion kWh Germany will generate by 2020. Put this in the (b) box in the table below.

Germany's Renewable Energy Generation	Actual Value of Renewable Energy Generation in 2000 (Billion kWh)	Actual Value of Renewable Energy Generation in 2010 (Billion kWh)	Predicted Value of Renewable Energy Generation in 2020 (Billion kWh)
Absolute Change: 69 Billion kWh	41	110	(i) _____
Relative Change: 168%	41	110	(ii) _____

(b) Now, think about and discuss the calculations you made above. When do you think it's important to use absolute change? When do you think it's important to use relative change?

(4) In Table 1, notice that Russia and Canada both increased their renewable energy generation by 3 billion kWh.

(a) Does 3 billion, in this statement, represent absolute change or relative change?

(b) Compare Russia's relative change to Canada's relative change from 2000 to 2010. Which country do you think has better renewable energy generation policies? Why?

Table 2 shows the percentage of each country's total energy generation that is renewable energy.

Table 2: Percent of Total Energy Generation that comes from Renewable Energy

	Percent of Total Energy Generation that is Renewable Energy in 2000	Percent of Total Energy Generation that is Renewable Energy in 2010
United States	9.5 %	11.7 %
Russia	19.9 %	17.1 %
Germany	7.6 %	18.7 %
Norway	99.3 %	96.7 %
Brazil	90.4 %	85.4 %
Canada	61.7 %	62.3 %
Saudi Arabia	0 %	0 %
World	19.6 %	20.6 %

- (5) The table shows that in 2010, 20.6% of the world's energy generation was from renewable energy generation. **Using 1-2 complete sentences**, describe what this means.
- (7) Using the information in Table 2, and using absolute and relative change, compare Norway to the other countries in terms of renewable energy generation. Would you be interested in researching Norway's renewable energy policies and technologies? Explain your answer in 1-2 complete sentences.
- (7) (a) Brazil showed a decrease in percent of energy generation from renewable sources between 2000 and 2010. Calculate the relative change for Brazil. Round your answer to two decimal places.
- (b) How is the answer to Question 7(a) possible given the data discussed in Table 1??

FURTHER APPLICATIONS

The table below shows total solar energy generation for several countries in 2000 and 2010.

Table 3: Total Solar Energy Generation by Country

	Total Solar Energy Generation in 2000 (measured in billion kWh)	Total Solar Energy Generation in 2010 (measured in billion kWh)
United States	0.49	1.21
Germany	0.06	11.68
Norway	0.01	0.02
Japan	0.35	3.80

- (8) Which of the above countries most actively pursued a policy of developing solar energy? Explain.
- (9) Compare Germany's relative change in total solar energy generation over the decade to Japan's, using Japan's as a reference value.
- (10) Suppose, as a U.S. politician, you wish to use the example of Germany to set goals for solar energy development. Would the absolute or relative change in Germany's total solar energy generation be a more realistic goal?

MAKING CONNECTIONS

Record the important mathematical ideas from the discussion.

Exercise 2.3-W

Renewable Energy

MAKING CONNECTIONS TO THE COLLABORATION

- (1) Which of the following was one of the main *mathematical* ideas of the collaboration?
- (i) Absolute change is measured as a quantity (for example, an increase of \$3). Relative change is measured as a percentage compared to the reference value (for example, an increase of 3%).
 - (ii) To find relative change, subtract the original number from the new number and divide by the original.
 - (iii) Consider this situation: Quantity 1 increases by 15%. Quantity 2 increases by 20%. Quantity 2 must have increased by a larger amount than Quantity 1.
 - (iv) The need for more renewable energy requires that all countries use more solar power.

DEVELOPING SKILLS AND UNDERSTANDING

- (2) The following headlines all refer to change. Identify the change as *absolute* or *relative*.
- (a) "Enrollments at Northeastern University are expected to increase by 1,500!"
 - (i) Absolute change
 - (ii) Relative change
 - (b) "Another 14% tuition increase is expected."
 - (i) Absolute change
 - (ii) Relative change
 - (c) "A new proposal has sales tax rates dropping from 3% to 1%, a drop of only 2%."
 - (i) Absolute change
 - (ii) Relative change
 - (d) "A new proposal has sales tax rates dropping from 3% to 1%, a 67% drop!"
 - (i) Absolute change
 - (ii) Relative change

- (3) The two questions below refer to data taken from the U.S. Census.³ The dollar values take into account the changes in the economy over the years (i.e., inflation).
- (a) A typical high-income household in 1980 earned \$125,556. A similar household in 2009 earned \$180,001. What was the relative increase in income for these households from 1980 to 2009? Round to the nearest one percent.
- (b) A typical middle-income household in 1980 earned \$34,757. A similar household in 2009 earned \$38,550. What was the relative increase in income for these households from 1980 to 2009? Round to the nearest one percent.
- (4) After the U.S. Congress passed temporary tax cuts in 2010, persons in the U.S. who earned \$50,000 per year had a lower tax rate. On average, these persons retained 2% more of their income than before the cuts. The 2010 law also gave the same persons a separate \$850 credit on their federal tax return.
- (a) How much extra money did a typical person earning \$50,000 receive due to the federal tax cuts?
- (b) This extra money represents what percent of the typical person's salary? Round to the nearest tenth of a percent.
- (5) Due to the same 2010 law, persons earning \$500,000 per year were taxed at a lower rate on the first \$106,800 they earned, saving them 2% of this portion of their salary. The same persons also received \$14,250 more on their federal tax return. Fill in the blanks to complete the statements below.
- (a) A person earning \$500,000 a year received \$_____ more of their income. Round to the nearest dollar.
- (b) A person earning \$500,000 a year received _____% more of their income. Round to the nearest tenth of a percent.

³ <https://www.census.gov/data/tables/time-series/demo/income-poverty/historical-income-households.html>

MAKING CONNECTIONS ACROSS THE COURSE

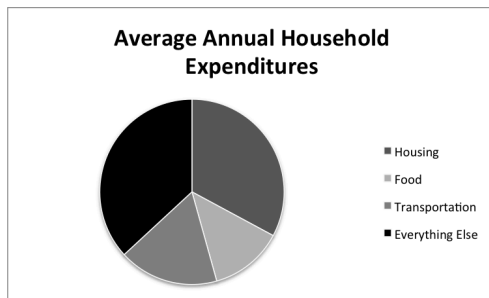
- (6) In Collaboration 1.4, you used results from the 2012 Consumer Expenditure Survey on how Americans spend their income. A summary of this information is given in Table 1.⁴

Table 1: Percentages of Average Annual Household Expenditures

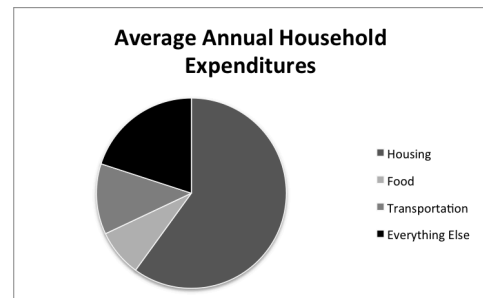
Housing	32.83%
Food	12.83%
Transportation	17.49%
Everything Else	36.85%

Which pie chart best represents the data given in Table 1?

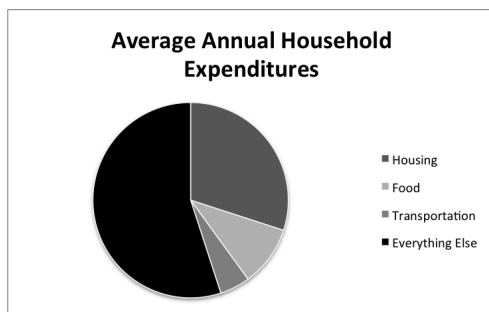
(i)



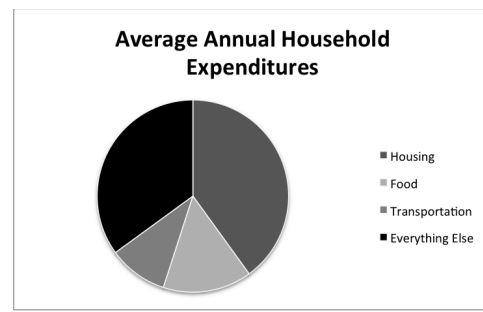
(iii)



(ii)



(iv)



⁴ <http://www.bls.gov/cex/csxann12.pdf>

- (7) Many egg producers keep chickens in small cages that do not allow the chickens to move. Some people believe that this is unhealthy, so they buy eggs from chickens that are not caged 24-hours a day. These are sometimes called “free-range” chickens. The United States Department of Agriculture (USDA) allows chickens to be called free-range as long as the chickens spend some of their time outside. The European Union (EU), however, has several additional restrictions. One of these is that the farmers must provide enough outside area so that if all the chickens were outside, the density of chickens would be no more than 0.25 chickens/sq meter.⁵

(a) How many square meters does the EU require for one chicken?

- (b) A farmer in the United States wants to meet the EU guidelines. She measures her area in square yards (1 sq meter = 1.196 sq yards). How many square yards does she need for 1,100 chickens?

- (i) 301.1 square yards
- (ii) 4,400.0 square yards
- (iii) 4,812.2 square yards
- (iv) 5,262.4 square yards

⁵ http://en.wikipedia.org/wiki/Free_range_eggs