VOLUME 4

THINK ENERGY

ENVIRONMENT IN MATH

SOUTHWEST IN

3

HIDEKA YAMAGUCHI, PH.D.

PREFACE

The objective of Think Environment in Math is to provide quality education to young children in Southwest Indiana. This book is specifically designed for elementary students (grades 1-5) in this community.

Environmental problems have been a part of our human history ever since human activities started to negatively affect the ecological balance of the earth thousands of years ago. Excessive human activities have induced local environmental destruction such as air pollution, water degradation, and resource depletion and have adversely impacted local people and societies.

Now with the emergence of global-scale ecological destruction, environmental problems are no longer just local problems. In this contemporary age, few societies are being left unaffected by global environmental problems, and all societies are now required to simultaneously provide concerted responses to those global environmental challenges, while finding solutions for ongoing local environmental problems.

In such an era when redesigning each community in which all needs are met in sustainable ways is a key to the success of the community, provision of education on our environmental challenges becomes more critical than ever. Our community is no exception.

Currently, however, there are two fundamental problems when promoting environmental education through public/parochial elementary schools here in Southwest Indiana. First, due to time and curriculum constraints, local elementary schools are unable to allocate time and resources to teach environmental issues. Secondly, there is no educational material that provides accurate and collective information on the environmental challenges in our community.

To address these problems, the Think Environment in Math was created. While traditional educational materials on either environment or existing subject areas, including math, language arts, science, and history, have provided information on their focuses, this book attempts a marriage of those independently existing subject areas and integrated environmental subjects into core subjects. In this book, a focus was given to mathematics. By taking this new and unique approach, this book intends to improve students' knowledge on the local environmental issues while promoting their math skills and critical thinking skills.

Math skills targeted in this book are listed below.

Skills (Gr.1-5)

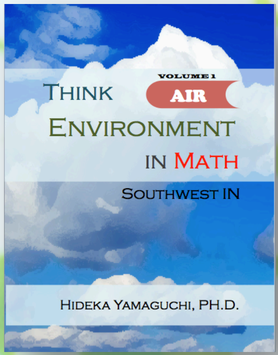
1. Addition / Subtraction
2. Rounding
3. Estimating
4. Ordinal numbers
5. Use <, >, =
6. Number comparison
7. Place value
8. Expanded notation
9. Percentages / Fractions /Decimals
10. Multiplication / Division
11. Data analysis (line, bar, circle graphs & tables)
12. Range, mean, mode & median
13. Three-dimensional objects
14. Measurement (temperature, length & weight)
15. Probability

Very importantly, this book focuses specifically on the development of young children in southwestern Indiana to make up for disadvantages of using traditional educational materials that generalize local environmental problems. This book centers on local environmental problems and local environmental protection efforts, as well as state and Nation-level problems to help students understand the local environment as part of a wider context.

I firmly believe that quality education is a powerful tool to influence individual behavior. I strongly hope that "Think Environment in Math" provides an opportunity to improve your students' critical thinking skills and abilities, increase their environmental awareness, effectsignificant changes in their decisions and actions, invite positive bottom-up changes in this community, and help ensure an environmentally sound and economically prosperous future in Southwest Indiana, in the end.

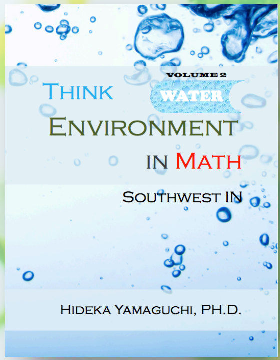
Hideka Yamaguchi, Ph.D.

Also available…



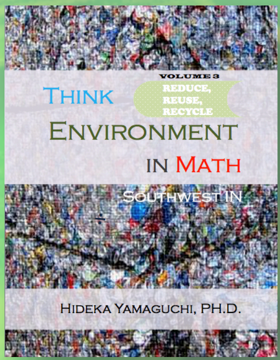
VOL. 1

AIR



VOL. 2

WATER



VOL. 3

REDUCE
REUSE
RECYCLE

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Overview of problems

ENERGY

1 2 3 4 5

1. Our path to cleaner air

Subtraction (4 digits)

Title of the problem

Suited grade level: In this case, this problem is suited for 4th and 5th grades

Skills: Students use 4 digits subtraction to answer questions

Area level

global | national | state | county

page

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1 2 3 4 5

41. The history of our energy

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42. Our nation's energy sources

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43. Do we use lots of energy?

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44. 10 states with the highest energy users

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45. How many coal mines does our community have?

<, >, = (1 digit)

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Mean, range, mode, median

ENERGY

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1 2 **3 4 5**

46. What state produces the most coal?

- Number comparison (3 digit)
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1 **2 3 4 5**

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- Subtraction (decimals)
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1 2 3 **4 5**

49. Solar energy in our country

- Addition (decimals)
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1 2 3 **4 5**

50. Solar power on Swonder

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1 2 **3 4 5**

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ENERGY

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1 2 3 **4** **5**

52. Our wind power

Addition (3 digits)
Subtraction (4 digits)
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Line graphs (4 digits)

1 2 3 **4** **5**

53. Wind race : U.S. vs. China

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1 2 **3** **4** **5**

54. What is the biggest electricity eater in your house?

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Addition (up to 1,000)
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1 2 3 **4** **5**

55. How much energy & money do new light bulbs save?

Multiplication (large number)

1 2 3 **4** **5**

56. Local energy saving efforts

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List of Problems by Contents

ENERGY

List of Problems by Math Skills

ENERGY

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	52	Our wind power	G4-5	355
Decimals	48	Our electricity price—high or low?	G4-5	335
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Whole numbers	44	10 states with the highest energy users	G4-5	300
	46	What state produces the most coal?	G3-5	316
Decimals	49	Solar energy in our country	G4-5	340
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	45	How many coal mines do our community have?	G1-2	308
Decimals	48	Our electricity price—high or low?	G4-5	335
Number comparison				
2 digits	43	Do we use lots of energy?	G3-4	292
3 digits	44	10 states with the highest energy users	G3	300
	46	What state produces the most coal?	G3-5	316
Up to 1,000	54	What is the biggest electricity eater in your house?	G3-4	365
decimals	48	Our electricity price—high or low?	G4-5	335

Number and Operations

Place value

	Problem #	Title	Grades	Page
	44	10 states with the highest energy users	G4-5	300
	46	What state produces the most coal?	G3-5	316

Expanded notation

	Problem #	Title	Grades	Page
	44	10 states with the highest energy users	G3	300
Decimals	49	Solar energy in our country	G4-5	340

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	Problem #	Title	Grades	Page
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3 digits x 2 digit	56	Local energy saving efforts	G4-5	379
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	Problem #	Title	Grades	Page
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3 digits / 2 digits	56	Local energy saving efforts	G4-5	379

Multiplication and division

	Problem #	Title	Grades	Page
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Data Analysis

Bar graphs

	Problem #	Title	Grades	Page
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2 digits	43	Do we use lots of energy?	G2-4	292
2-3 digits	46	What state produces the most coal?	G4-5	316
3 digits	52	Our wind power	G4-5	355
Up to 1,000	44	10 states with the highest energy users	G3-5	300
Up to 1,500	51	Solar power at Vanderburgh Public Library	G3-5	351
Up to 4 digits	49	Solar energy in our country	G4-5	340
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Mean, range, median & mode	45	How many coal mines do our community have?	G3-4	308

ENERGY

Energy plays one of the most essential roles in many aspects of our lives. Without energy, cities won't light up during the night and cars won't move.

In our state, we depend largely on coal as an energy source. In 2014, Indiana ranked 8th in coal production, and coal-fired electric power plants supplied 85 percent of our state's electricity. However, dependence on coal is not without problems. More than 80% of greenhouse gas emissions in our country come from burning fossil fuels including coal, contributing to climate change. In Evansville, almost all electricity is produced by burning fossil fuels, and Indiana as a whole releases the 8th largest amount of carbon dioxide in the United Sates.

To solve these problems, our nation strives to increase clean electricity production. Due to those efforts, wind power capacity in our country is now the second largest in the world, and solar power capacity increased by 7 times over the last 5 years. Indiana ranks 12th in the United States in wind power generation and has the largest geothermal heating and cooling system in the United States at Bell State University in Muncie. Indiana has moderately good potential for solar power production, especially in the southern part of the state.

our energy sources

We consume energy in many forms. Most of our energy supply comes from fossil including coal, oil, and natural gas, and the rest is generated from nuclear power and renewable sources, such as hydropower, wind, solar, biomass and geothermal. All of these energy sources can be used directly as primary energy sources by converting them into heat or mechanical applications. They are also used as secondary energy sources by converting them into electricity. The table below shows how these sources produce energy and how they are used in our country.

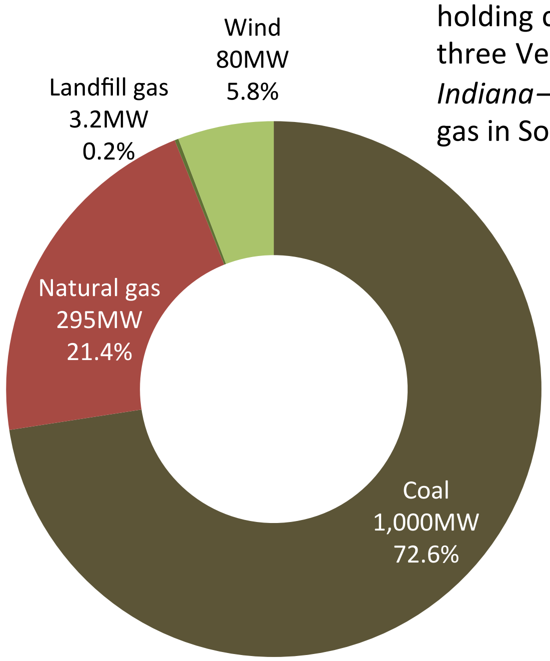
Type of energy sources	Production	Uses
Non-Renewable Energy Sources		
Coal	Coal, a fossil fuel, is mined and transported by trains, barges, ships, and trucks. Coal is mined in 25 states, and Wyoming produces the largest amount of coal. Indiana produces the eighth most.	Over 90% of the coal consumed in this country is burned to produce electricity at coal-fired power plants.
Oil (Petroleum)	Oil is a fossil fuel and usually found underground and extracted by drilling and creating wells and pipelines. About 31% of oil we consume is produced in Texas, and 20% is produced in the Gulf of Mexico. Our country depends on about 40% of our oil consumption from imports.	Our country is the world's largest oil consumer. About 70% of our oil is used in transportation as gasoline, diesel, and jet fuel, while about 1% of oil is burned to generate electricity. The remainder is used in industrial, commercial, and residential sectors.

	and stored as liquid—liquid natural gas (LNG). About 29% of the natural gas we consume is produced in Texas.	such as stoves and clothes dryers. Natural gas is also used in transportation.
Nuclear Energy	Uranium is a fossil fuel and the most widely used fuel to produce nuclear energy. Most uranium used in our country is mined in the western United States.	When bonds of uranium atoms are broken, enormous energy, in the power of nuclear power, is released. All of the nuclear energy produced in the U.S. is used to generate electricity.
Renewable Energy Sources		
Hydropower	Hydropower is produced from the flow or fall of water. About 29% of the total U.S. hydroelectricity is generated at the Grand Coulee Dam in Washington—the largest dam in the U.S. Most hydropower is produced at large plants built by the federal government.	Hydropower has been used for irrigation and operation of mechanical devices, such as watermills. At the same time, hydropower is used for electricity generation.
Wind energy	Wind energy generates electricity, and our country produces the second most wind electricity in the world. The largest amount of wind electricity, about 20% of the total wind electricity generated in the United States, is generated in Texas. The world's largest wind farm is located in California.	Wind energy can be used for operation of mechanical devices such as the windmills for water pumping or drainage. Wind energy is also used to generate electricity by using wind turbines.
Solar energy	Solar energy generates electricity through solar panels (photovoltaics or PVs) or solar thermal power generating plants. Arizona has the world's largest solar electricity generating facility through PVs, and California has the world's largest solar thermal power plant.	Solar energy can be used for heating spaces (e.g., greenhouse) and water (e.g., shower water and swimming pool) with solar thermal collectors. Solar energy can also be used to generate electricity by using solar panels.
Biomass energy	Biomass is organic material made from plants and animals.	Biomass is burned as fuel to produce energy for heating and cooking. Biomass is also converted to methane gas for electricity generation and space heating. Biomass energy in the forms of ethanol and biodiesel is used as transportation fuel.
Geothermal energy	Geothermal technology uses heat generated in the Earth's core—geothermal energy—as an energy source. The United States produces the largest amount of geothermal power in the world.	Geothermal energy can be directly used for heating/cooling spaces. It can also be used to generate electricity.

Who supplies energy to Evansville?

Vectren Corporation

Our energy is provided by Vectren Corporation, which is an energy holding company headquartered in Evansville, Indiana. One of the three Vectren operating utilities, called *Vectren Energy Delivery of Indiana—South*, is in charge of providing electricity and natural gas in Southwest Indiana.



Energy sources

Electricity provided by Vectren is mostly generated by burning coal. Coal makes up 73% and natural gas makes up 21%. Renewable energy in the form of landfill gas is also used to generate electricity at Blackfoot Clean Energy Facility at Veolia's landfill in Winslow, Indiana. Although wind energy is not directly generated by Vectren, the equivalent of 80 MW (mega watts) of wind energy is purchased from wind farms in Northern part of Indiana to increase environmental attributes of electricity generated from renewable energy.

Home weatherization program

Vectren has teamed up with Energizing Indiana, the statewide, utility-supported effort to help further reduce electric demand, on a multi-year home weatherization program for income-eligible electric and gas customers in southwestern Indiana. Launched in July 2012, Vectren intends to weatherize more than 2,000 homes by the end of 2013 (2013 Corporate Sustainability Report)

Landfill gas, gas emitted from landfill, is captured and used as a fuel source to power two generators at Blackfoot Clean Energy Facility

The Renewable Energy Policy in Indiana

Clean energy portfolio

The incentive to increase renewable energy generation has been created mostly by climate change and economic concerns. To promote renewable energy installations, Indiana created the *Clean Energy Portfolio Standard* program in May 2011. This program sets a voluntary goal on electricity supply companies to produce 10% of their electricity from clean energy sources* by 2025.

Net metering

Indiana also has a program called *Net Metering* to support renewable energy expansion among residential, small business, schools, and industrial sectors. This program is applicable for utility customers who connect qualifying renewable generators to a utility's grid. When a renewable generator produces electricity, customers are credited for renewable electricity generation at the full retail rate (the retail price the customer pays for electricity). Customers are charged only for the "net" electricity [Net electricity=Electricity consumption (kWh) – Electricity production (kWh)] to the customer's next monthly bill. When customers are generating more electricity from their renewable generators than they are consuming, they are credited for the excess electricity [Excess electricity=Electricity production (kWh) – Electricity consumption (kWh].

Tax incentives

Indiana also provides *property tax incentives* for systems that generate energy through solar, wind, hydropower or geothermal resources that are exempt from property tax. In addition, several incentives for the installation of renewable energy technologies have been established by the federal government. For example, residents of Indiana can receive 30% of *federal personal tax credit* for purchasing qualifying renewable energy systems and businesses in Indiana can receive *production tax credit* for generating electricity from qualifying renewable energy technologies.

Community conservation challenge

Indiana also established *Community Conservation Challenge (CCC)*, a grant program that offers funds for projects that demonstrate measurable improvements in renewable energy or energy efficiency. CCC grants provide a range of funding from $25,000 to $150,000. Eligible grantees include local units of government, school corporations, businesses, universities, and nonprofit agencies in Indiana.

**Clean energy technologies include wind; solar energy; photovoltaic cells and panels; dedicated crops grown for energy production; organic waste biomass; hydropower; fuel cells; hydrogen; energy from waste to energy facilities; energy storage systems or technologies; geothermal energy; coal bed methane; industrial byproduct technologies that use fuel or energy that is a byproduct of an industrial process; waste heat recovery from capturing and reusing the waste heat*

PROBLEM 41

Number & operation

G4 G5 Subtraction (4-digit numbers)

THE HISTORY OF OUR ENERGY

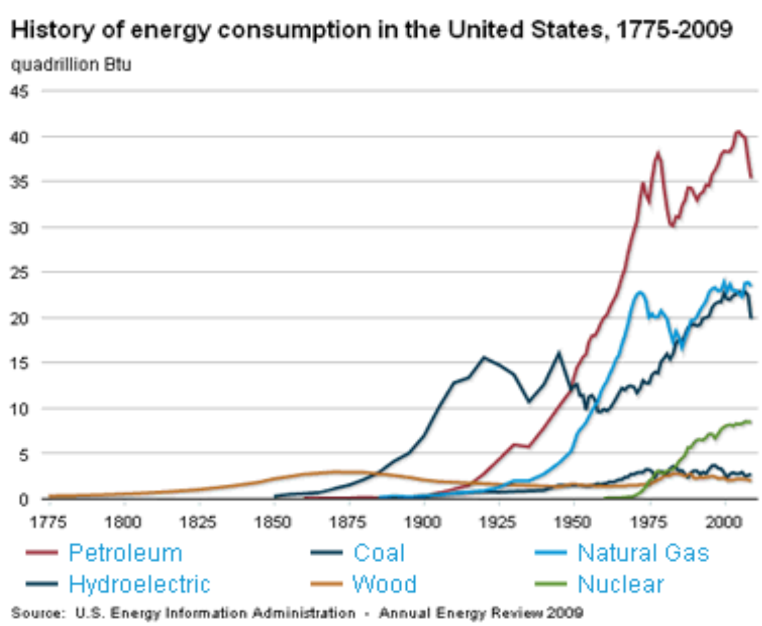
PURPOSE

Through this activity, **3rd – 4th grade** students will

- Subtract 4-digit numbers—**PROBLEM A**
- Understand history of energy in our country
- Develop awareness of our energy use

BACKGROUND FOR THE TEACHER

Energy sources used in this country have changed over time. Up to the mid 1800s, people mainly used wood for their energy sources. Today, about 80% of our energy sources come from fossil fuels, including petroleum, natural gas, and coal. Those changes have been driven by the discovery of energy sources, advancement of technology, changes in energy prices, and pressures to improve energy security in the country.

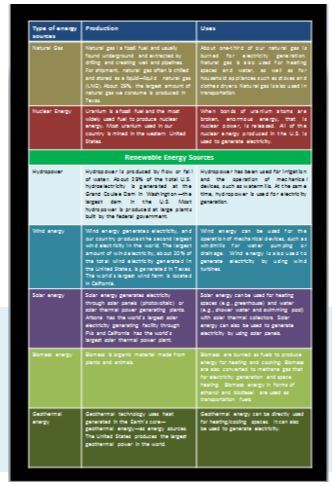


Types of energy sources are explained in pages 278-279.

our energy sources

We consume energy in many forms. Most of our energy supply comes from fossil fuels (non-renewable energy sources), including coal, oil, and natural gas. And the rest are generated from nuclear power and renewable sources, such as hydropower, wind, solar, biomass and geothermal. These energy sources are used directly by converting into heat or mechanical work as primary energy sources. They are also used by converting to electricity as secondary energy sources. The table below shows how these energy sources are produced and used in our country.

Type of energy sources	Production	Uses
Non-Renewable Energy Sources		
Coal	Coal is a fossil fuel and mined by coal miners and transported by train, barge, ship, truck. Coal is mined in 25 states and the largest coal is mined in Wyoming. Indiana ranks the eighth.	Over 90% of the coal consumed in this country is burned to produce electricity at coal-fired power plants.
Oil (Petroleum)	Oil is a fossil fuel and usually found underground and extracted by drilling and creating well and pipelines. About 31%, the largest amount of oil, we consume is produced in Texas, while 20% in the offshore Gulf of Mexico. Our country depends on about 40% of oil we consume from imports.	Our country is the world's largest oil consumer. About 70% of our oil is used in transportation as gasoline, diesel, and get fuel, while about 1% of oil is burned to generate electricity. The remainder is used in industrial, commercial, and residential sectors.



Type of energy sources	Production	Uses
Natural Gas	Natural gas i a fossil fuel and usually found underground and extracted by drilling and creating well and pipelines. For shipment, natural gas often is chilled and stored as a liquid—liquid natural gas (LNG). About 29%, the largest amount of natural gas we consume is produced in Texas.	About one-third of our natural gas is burned for electricity generation. Natural gas is also used for heating spaces and water, as well as for household appliances such as stoves and clothes dryers. Natural gas is also used in transportation.
Nuclear Energy	Uranium is a fossil fuel and the most widely used fuel to produce nuclear energy. Most uranium used in our country is mined in the western United States.	When bonds of uranium atoms are broken, enormous energy, that is nuclear power, is released. All of the nuclear energy produced in the U.S. is used to generate electricity.
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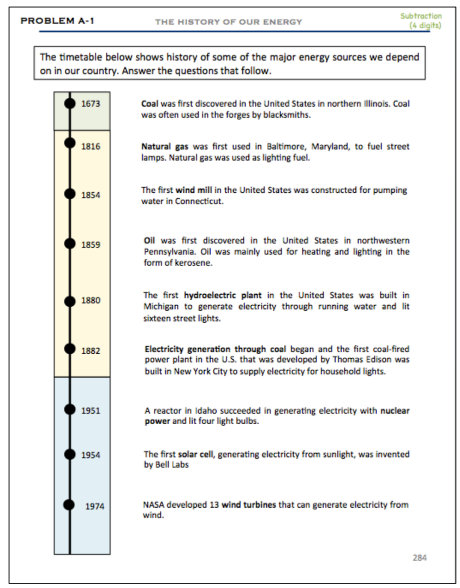
Biomass energy	Biomass is organic material made from plants and animals.	Biomass are burned as fuels to produce energy for heating and cooking. Biomass are also converted to methane gas that for electricity generation and space heating. Biomass energy in forms of ethanol and biodiesel are used as transportation fuels.
Geothermal energy	Geothermal technology uses heat generated in the Earth's core—geothermal energy—as energy sources. The United States produces the largest geothermal power in the world.	Geothermal energy can be directly used for heating/cooling spaces. It can also be used to generate electricity.

TEACHER GUIDE

The purpose of this activity is to enhance students' skills in subtraction of 4-digit numbers. Using a timetable about the history of energy sources in the United States, students subtract numbers to find the difference between two numbers. The timetable was created based on data obtained from the "energy KIDS" prepared by the US Energy Information Administration.



PROBLEM A-1 THE HISTORY OF OUR ENERGY Subtraction (4 digits)

The timetable below shows history of some of the major energy sources we depend on in our country. Answer the questions that follow.

1673	**Coal** was first discovered in the United States in northern Illinois. Coal was often used in the forges by blacksmiths.
1816	**Natural gas** was first used in Baltimore, Maryland, to fuel street lamps. Natural gas was used as lighting fuel.
1854	The first **wind mill** in the United States was constructed for pumping water in Connecticut.
1859	**Oil** was first discovered in the United States in northwestern Pennsylvania. Oil was mainly used for heating and lighting in the form of kerosene.
1880	The first **hydroelectric plant** in the United States was built in Michigan to generate electricity through running water and lit sixteen street lights.
1882	**Electricity generation through coal** began and the first coal-fired power plant in the U.S. that was developed by Thomas Edison was built in New York City to supply electricity for household lights.
1951	A reactor in Idaho succeeded in generating electricity with **nuclear power** and lit four light bulbs.
1954	The first **solar cell**, generating electricity from sunlight, was invented by Bell Labs
1974	NASA developed 13 **wind turbines** that can generate electricity from wind.

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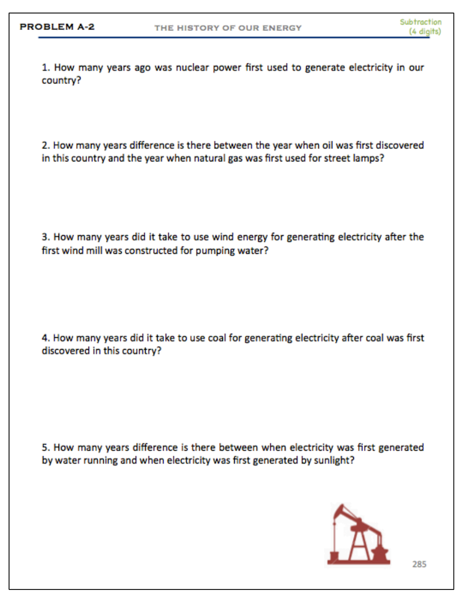
P 284—Student Sheet

PROBLEM A

- *Subtraction (4-digit numbers)*

Using a timetable about the history of energy sources in this country, students are asked to subtract 4-digit numbers to find the difference between two years. Questions include "How many years did it take to use coal for generating electricity after coal was first discovered in this country?"



PROBLEM A-2 THE HISTORY OF OUR ENERGY Subtraction (4 digits)

1. How many years ago was nuclear power first used to generate electricity in our country?

2. How many years difference is there between the year when oil was first discovered in this country and the year when natural gas was first used for street lamps?

3. How many years did it take to use wind energy for generating electricity after the first wind mill was constructed for pumping water?

4. How many years did it take to use coal for generating electricity after coal was first discovered in this country?

5. How many years difference is there between when electricity was first generated by water running and when electricity was first generated by sunlight?

285

P 285—Student Sheet

The timetable below shows history of some of the major energy sources we depend on in our country. Answer the questions that follow.

1673	**Coal** was first discovered in the United States in northern Illinois. Coal was often used in the forges by blacksmiths.
1816	**Natural gas** was first used in Baltimore, Maryland, to fuel street lamps. Natural gas was used as lighting fuel.
1854	The first **wind mill** in the United States was constructed for pumping water in Connecticut.
1859	**Oil** was first discovered in the United States in northwestern Pennsylvania. Oil was mainly used for heating and lighting in the form of kerosene.
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1954	The first **solar cell**, generating electricity from sunlight, was invented by Bell Labs
1974	NASA developed 13 **wind turbines** that can generate electricity from wind.

1. How many years ago was nuclear power first used to generate electricity in our country?

2. How many years difference is there between the year when oil was first discovered in this country and the year when natural gas was first used for street lamps?

3. How many years did it take to use wind energy for generating electricity after the first wind mill was constructed for pumping water?

4. How many years did it take to use coal for generating electricity after coal was first discovered in this country?

5. How many years difference is there between when electricity was first generated by water running and when electricity was first generated by sunlight?

PROBLEM 42

Data Analysis

G2
G3
G4
G5

Circle graphs

OUR NATION'S ENERGY SOURCES

PURPOSE

Through this activity, **2nd – 3rd grade** students will

- Interpret circle graphs—**PROBLEM A**
- Compare portions (percent)—**PROBLEM A**
- Understand primary energy sources in our country
- Develop awareness of our energy use

Through this activity, **3rd – 4th grade** students will

- Interpret circle graphs—**PROBLEM B**
- Convert from percent to fraction—**PROBLEM B**
- Understand primary energy sources in our country
- Develop awareness for our energy use

Through this activity, **4th – 5th grade** students will

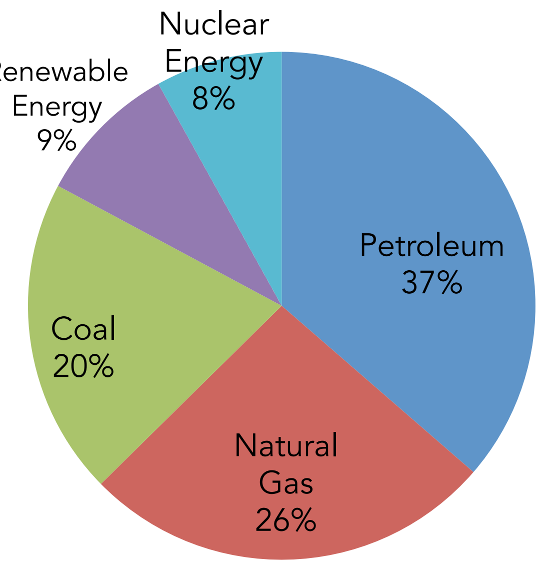
- Interpret circle graphs—**PROBLEM C**
- Calculate the actual amount of energy use from the circle graph—**PROBLEM C**
- Understand primary energy sources in our country
- Develop awareness of our energy use

BACKGROUND FOR THE TEACHER

Our country produces and consumes the world's second largest amount of energy, second only to China. Primary energy consumption in the United States in 2012 was 95.1 quadrillion BTUs, while that in China was 105.9 quadrillion BTUs (EIA).

About 80% of our primary energy sources come from fossil fuels, including petroleum, natural gas, and coal. Of fossil fuels, petroleum makes up the largest portion, and natural gas and coal follow.

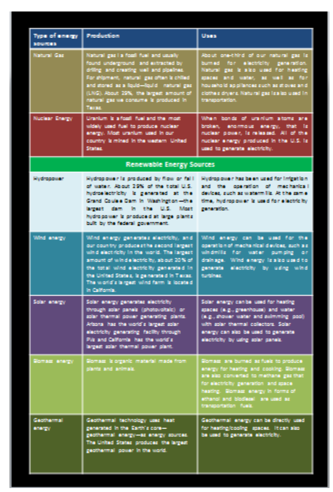
The portions of renewable and nuclear energy account for less than 10% of total energy.



Primary energy consumption by source in 2011 (Total: 97.3 Quadrillion BTUs)

Source: US EIA

Types of energy sources are explained on pages 278-279.



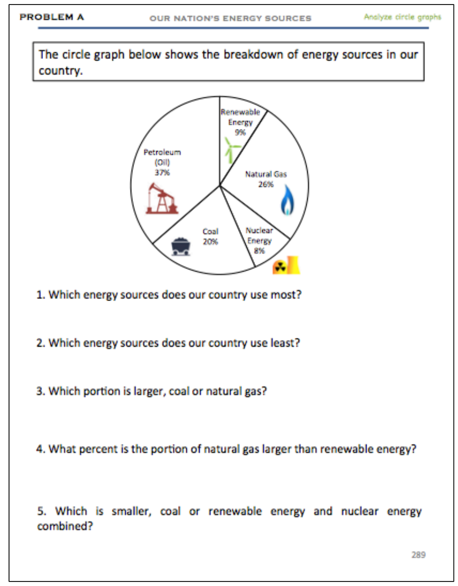
TEACHER GUIDE

The purpose of this activity is to enhance students' skills in interpreting circle graphs. Using information on how much of our energy comes from which energy source in this country, this activity provides 3 tailored to students' understanding levels. The circle graph used in this activity was created based on data obtained from the US Energy Information Administration.

PROBLEM A

- *Interpreting circle graphs*
- *Comparing numbers*

Using a circle graph on primary energy consumption by source in the Untied States, students are asked to find out which portion is largest/smallest. The graph uses percent to show the size of each portion. They are also asked to compare numbers to answer questions that ask which portion is larger/smaller.

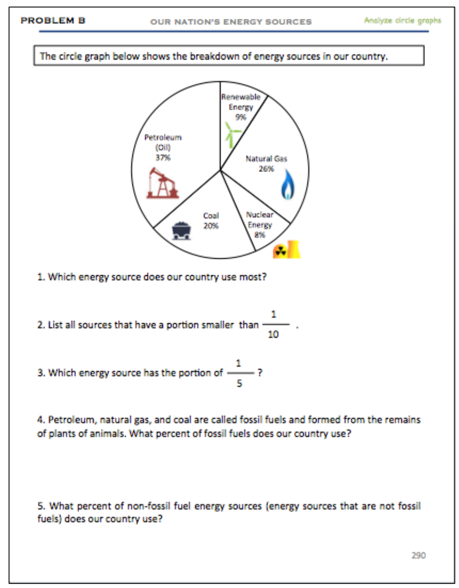


P 289—Student Sheet

PROBLEM B

- *Interpreting circle graphs*
- *Converting percents to fractions*

Using a circle graph on primary energy consumption by source in the Untied States, students are asked to use skills in both percentages and fractions. The graph uses percent to show the size of each portion. Questions include, "Which energy source has the portion of 1/5?"

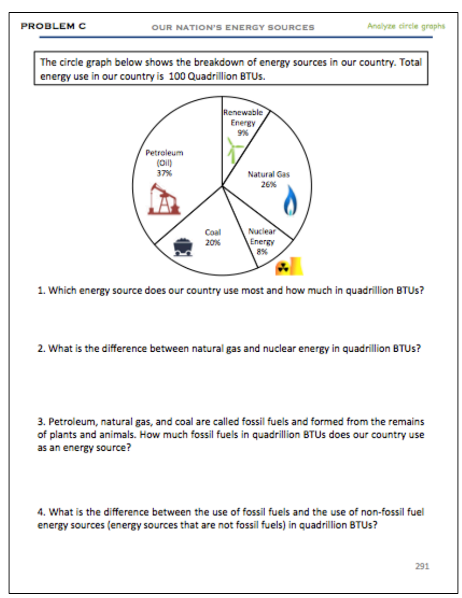


P 290—Student Sheet

PROBLEM C

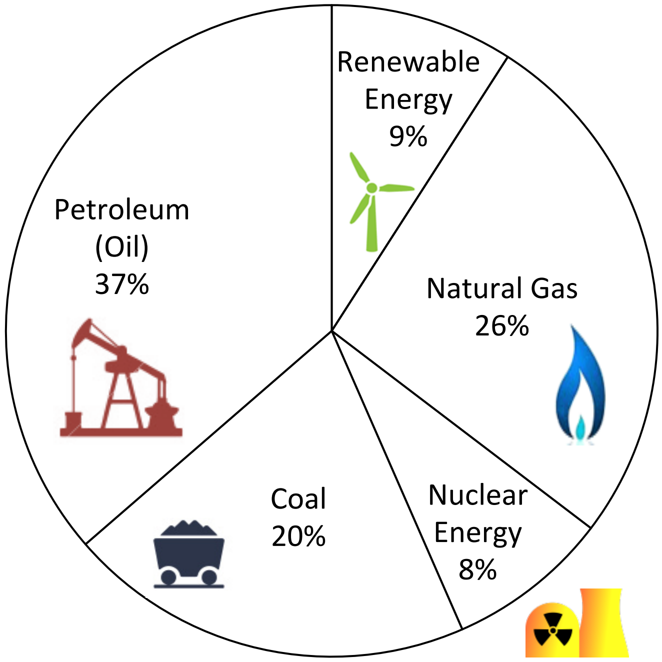
- *Interpreting circle graphs*
- *Comparing numbers*

The primary energy consumption was about 100 quadrillion BTUs in 2011 in this country. Using a circle graph on primary energy consumption by source in the Untied States, students are asked to calculate the actual amount of energy use. Questions include, "What is the difference between natural gas and nuclear energy in quadrillion BTUs?"



P 291—Student Sheet

The circle graph below shows the breakdown of energy sources in our country.



1. Which energy sources does our country use most?

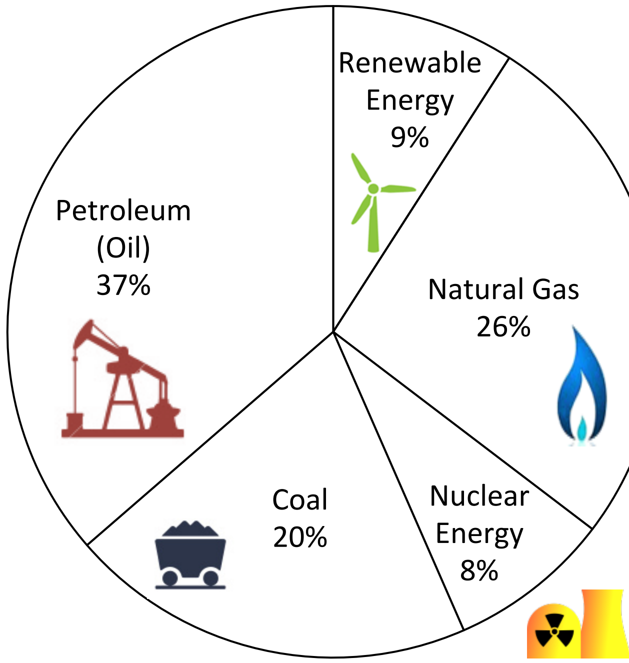
2. Which energy sources does our country use least?

3. Which portion is larger, coal or natural gas?

4. What percent is the portion of natural gas larger than renewable energy?

5. Which is smaller, coal or renewable energy and nuclear energy combined?

The circle graph below shows the breakdown of energy sources in our country.



1. Which energy source does our country use most?

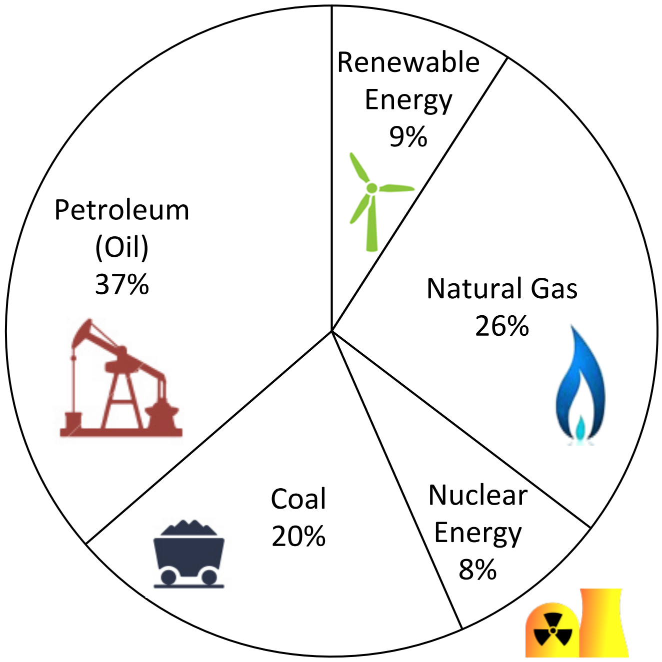
2. List all sources that have a portion smaller than $\frac{1}{10}$.

3. Which energy source has the portion of $\frac{1}{5}$?

4. Petroleum, natural gas, and coal are called fossil fuels and formed from the remains of plants of animals. What percent of fossil fuels does our country use?

5. What percent of non-fossil fuel energy sources (energy sources that are not fossil fuels) does our country use?

The circle graph below shows the breakdown of energy sources in our country. Total energy use in our country is 100 Quadrillion BTUs.



1. Which energy source does our country use most and how much in quadrillion BTUs?

2. What is the difference between natural gas and nuclear energy in quadrillion BTUs?

3. Petroleum, natural gas, and coal are called fossil fuels and formed from the remains of plants and animals. How much fossil fuels in quadrillion BTUs does our country use as an energy source?

4. What is the difference between the use of fossil fuels and the use of non-fossil fuel energy sources (energy sources that are not fossil fuels) in quadrillion BTUs?

Number and Operations

G2	Using <,>,= (2digits)
G3 G4	Addition and subtraction (2 digits)
G3 G4	Number comparison (2 digits)

Data Analysis

G2 G3 G4	Bar graphs (2 digits)

DO WE USE LOTS OF ENERGY?

PURPOSE

Through this activity, **2nd grade** students will

- Create bar graphs (2-digit numbers)—**PROBLEM A**
- Use symbols (<, >, and =) to compare numbers—**PROBLEM B**
- Understand daily per capita primary energy consumption in our country compared to other countries
- Develop awareness of our energy use

Through this activity, **3rd– 4th grade** students will

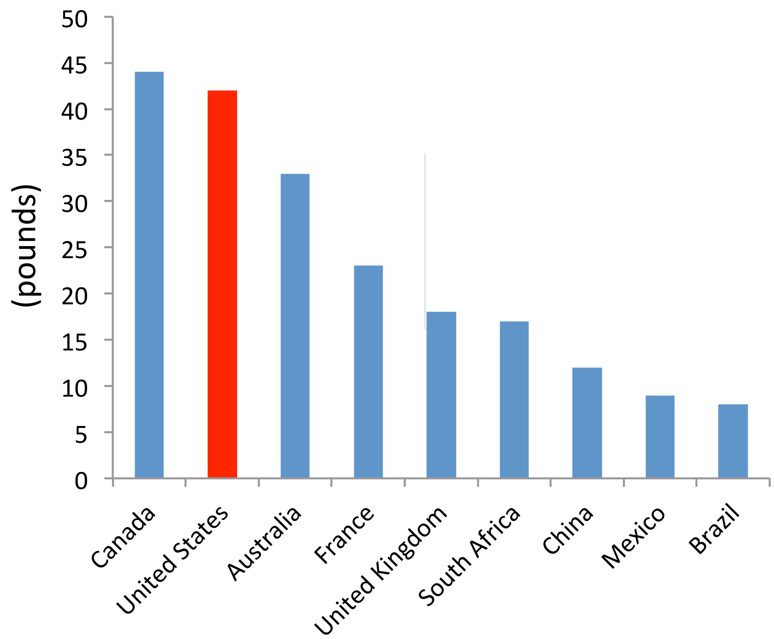
- Create bar graphs (20digit numbers)—**PROBLEM A**
- Add and subtract 2-digit numbers—**PROBLEM C**
- Order and compare 2-digit numbers—**PROBLEM D**
- Understand daily per capita primary energy consumption in our country compared to other countries
- Develop awareness of our energy use

BACKGROUND FOR THE TEACHER

Our country consumes one of the largest amounts of energy in the world. According to the World Bank, per capita energy use in the United States in 2011 was 7,032 kg (15,502 pounds) of oil equivalent per year. It is equivalent to 42 pounds/day.

Our per capita energy consumption is two times larger than that in the United Kingdom and 3.5 times larger than that in China.

Daily per capita primary energy consumption in 9 countries in 2011
Source: World Bank



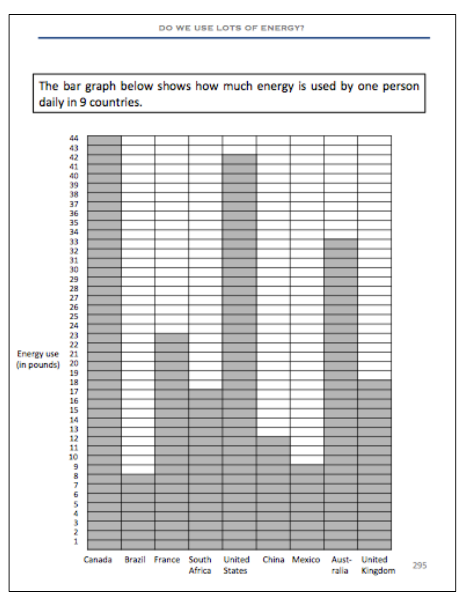
TEACHER GUIDE

The purpose of this activity is to enhance students' skills in creating and interpreting bar graphs (PROBLEM A, B & C) and number operations (PROBLEM D) that include number arrangement (with whole numbers). This activity provides 4 worksheets with information on daily per capita energy consumption in our country and 8 other countries. The data used in this activity was obtained from the World Bank.

PROBLEM A

- *Creating bar graphs*

Using a table on daily per capita energy consumption in 9 countries including the Untied States, students are asked to create a bar graph.



P 296—Student Sheet

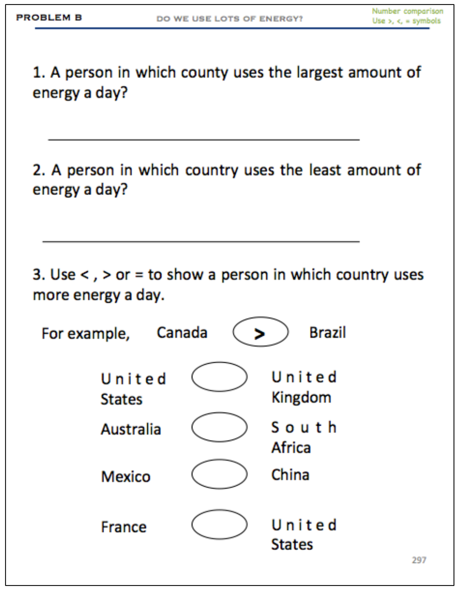
PROBLEM B

- *Interpreting bar graph (2 digits)*
- *Using <, >, = symbols*

Using the bar graph created in the PROBLEM A, students are asked to compare the numbers. They use the symbols <, >, and =.

Note

If your students are not ready for creating bar graphs, use the graph on page 295.



PROBLEM B DO WE USE LOTS OF ENERGY? Number comparison Use >, <, = symbols

1. A person in which county uses the largest amount of energy a day?

2. A person in which country uses the least amount of energy a day?

3. Use < , > or = to show a person in which country uses more energy a day.

For example, Canada > Brazil

United States ◯ United Kingdom

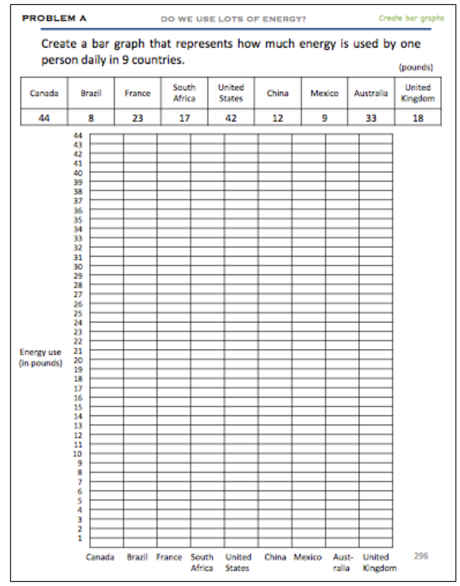
Australia ◯ South Africa

Mexico ◯ China

France ◯ United States

297

P 297—Student Sheet



PROBLEM A DO WE USE LOTS OF ENERGY? Create bar graphs

Create a bar graph that represents how much energy is used by one person daily in 9 countries.

(pounds)

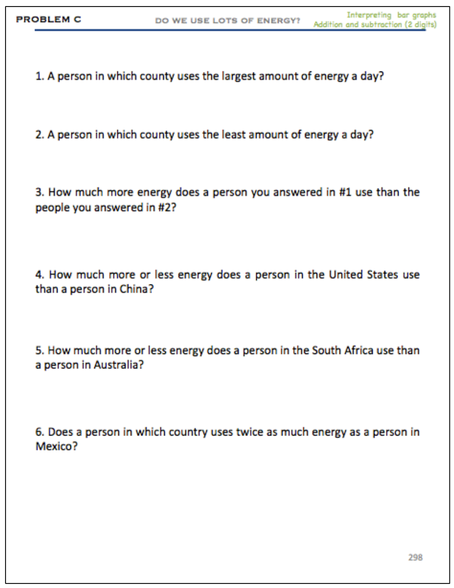
Canada	Brazil	France	South Africa	United States	China	Mexico	Australia	United Kingdom
44	8	23	17	42	12	9	33	18

P 295 or 296—Student Sheet

PROBLEM C

- *Interpreting bar graphs*
- *Addition & subtraction (2-digit numbers)*

Using the bar graph created in the PROBLEM A, students are asked to read the graph by using addition and subtraction. Questions include, “How much more or less energy do people in the United States use than the people in China?”



PROBLEM C DO WE USE LOTS OF ENERGY? Interpreting bar graphs Addition and subtraction (2 digits)

1. A person in which county uses the largest amount of energy a day?

2. A person in which county uses the least amount of energy a day?

3. How much more energy does a person you answered in #1 use than the people you answered in #2?

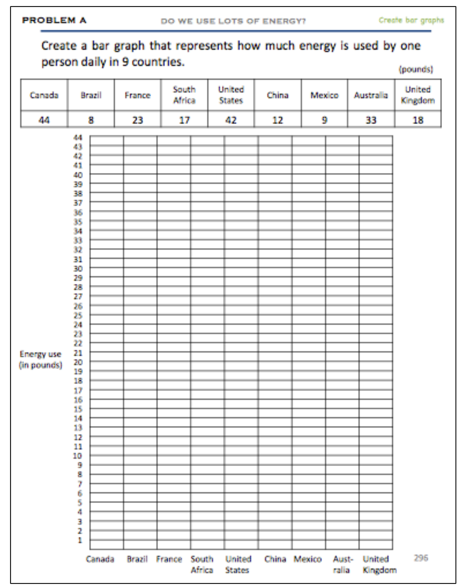
4. How much more or less energy does a person in the United States use than a person in China?

5. How much more or less energy does a person in the South Africa use than a person in Australia?

6. Does a person in which country uses twice as much energy as a person in Mexico?

298

P 298—Student Sheet



PROBLEM A DO WE USE LOTS OF ENERGY? Create bar graphs

Create a bar graph that represents how much energy is used by one person daily in 9 countries.

(pounds)

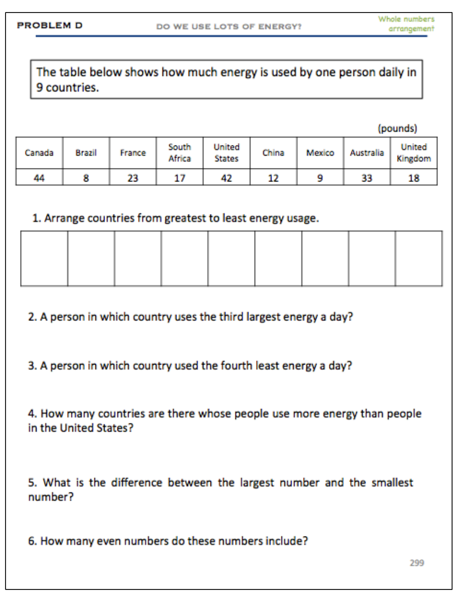
Canada	Brazil	France	South Africa	United States	China	Mexico	Australia	United Kingdom
44	8	23	17	42	12	9	33	18

P 296—Student Sheet

PROBLEM D

- *Ordering and comparing numbers (2 digits)*

Using a table on daily per capita energy consumption in 9 countries including the United States, students are asked to order and compare nine 2-digit numbers. Questions include, “People in which country use the fourth least energy a day?



PROBLEM D DO WE USE LOTS OF ENERGY? Whole numbers arrangement

The table below shows how much energy is used by one person daily in 9 countries.

(pounds)

Canada	Brazil	France	South Africa	United States	China	Mexico	Australia	United Kingdom
44	8	23	17	42	12	9	33	18

1. Arrange countries from greatest to least energy usage.

2. A person in which country uses the third largest energy a day?

3. A person in which country used the fourth least energy a day?

4. How many countries are there whose people use more energy than people in the United States?

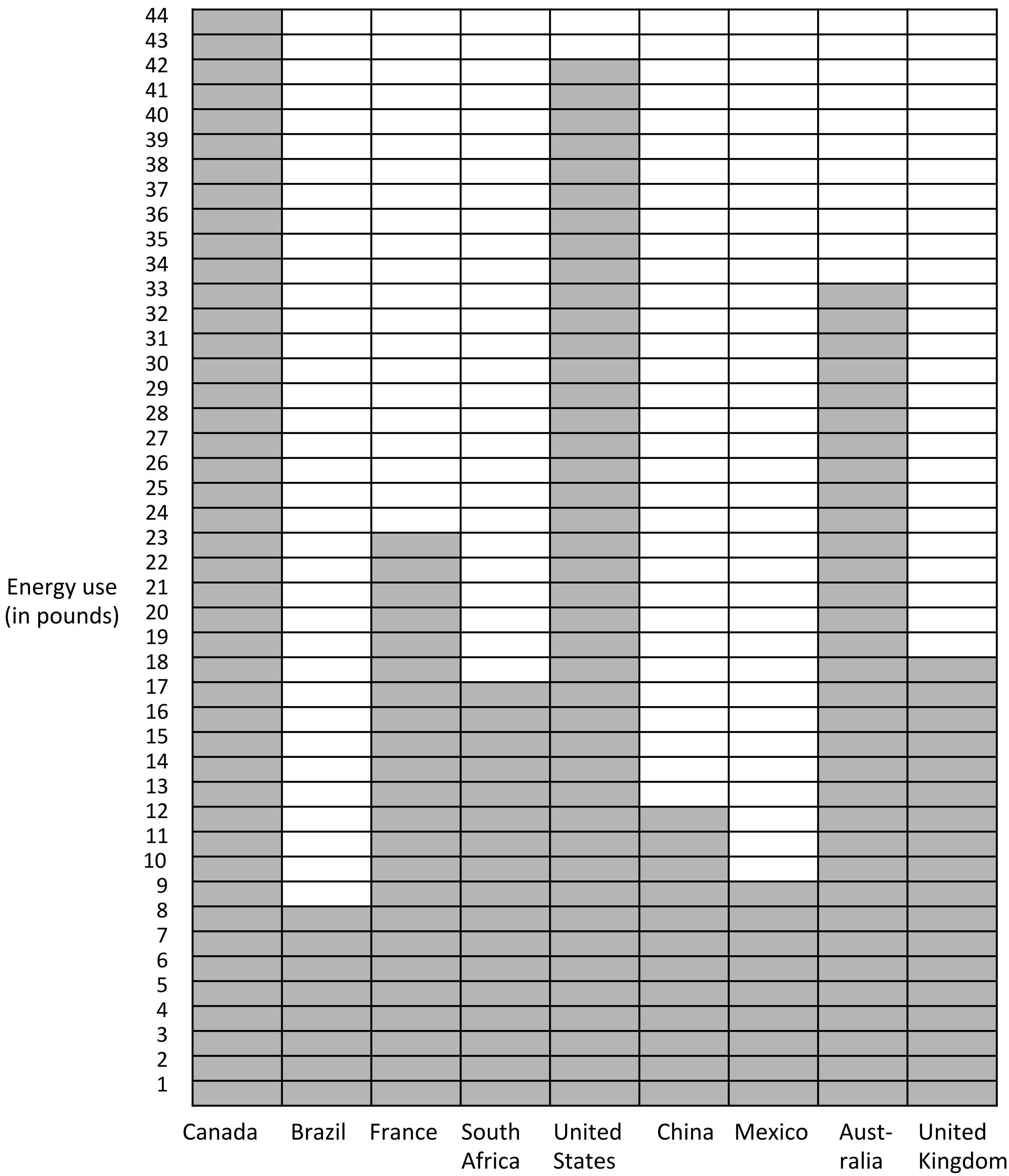
5. What is the difference between the largest number and the smallest number?

6. How many even numbers do these numbers include?

299

P 299—Student Sheet

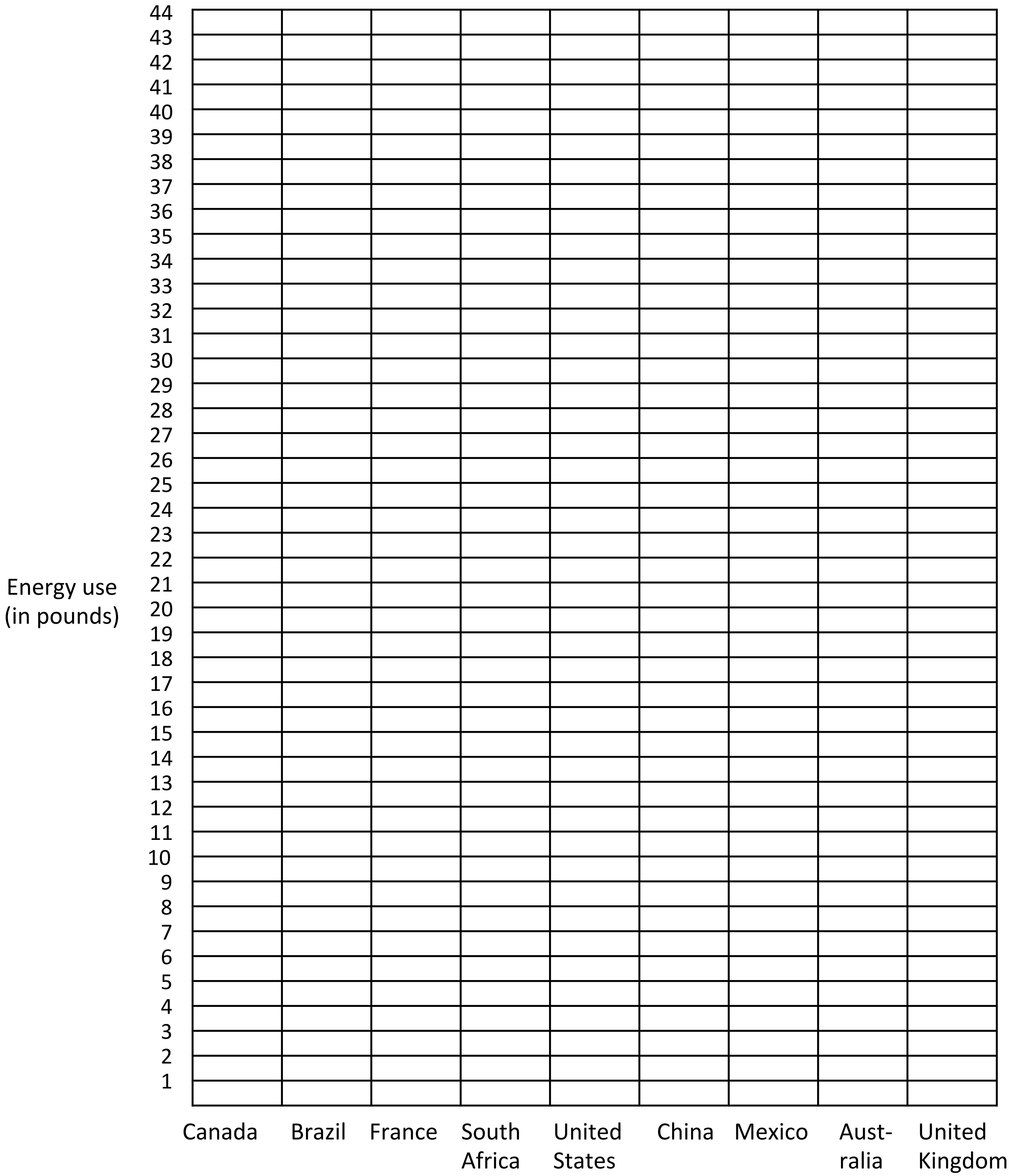
The bar graph below shows how much energy is used by one person daily in 9 countries.



Create a bar graph that represents how much energy is used by one person daily in 9 countries.

(pounds)

Canada	Brazil	France	South Africa	United States	China	Mexico	Australia	United Kingdom
44	8	23	17	42	12	9	33	18



1. A person in which county uses the largest amount of energy a day?

____

2. A person in which country uses the least amount of energy a day?

____

3. Use < , > or = to show a person in which country uses more energy a day.

For example,	Canada	>	Brazil
	United States	( )	United Kingdom
	Australia	( )	South Africa
	Mexico	( )	China
	France	( )	United States

1. A person in which county uses the largest amount of energy a day?

2. A person in which county uses the least amount of energy a day?

3. How much more energy does a person you answered in #1 use than the people you answered in #2?

4. How much more or less energy does a person in the United States use than a person in China?

5. How much more or less energy does a person in the South Africa use than a person in Australia?

6. Does a person in which country uses twice as much energy as a person in Mexico?

The table below shows how much energy is used by one person daily in 9 countries.

(pounds)

Canada	Brazil	France	South Africa	United States	China	Mexico	Australia	United Kingdom
44	8	23	17	42	12	9	33	18

1. Arrange countries from greatest to least energy usage.

2. A person in which country uses the third largest energy a day?

3. A person in which country used the fourth least energy a day?

4. How many countries are there whose people use more energy than people in the United States?

5. What is the difference between the largest number and the smallest number?

6. How many even numbers do these numbers include?

PROBLEM 44

Number and Operations

G3	Expanded notation
G3	Number comparison (3 digits)
G4 G5	Place value
G4 G5	Rounding

Data Analysis

G3 G4 G5	Bar graphs (up to 1,000)

10 STATES WITH THE HIGHEST ENERGY USERS

PURPOSE

Through this activity, **3rd grade** students will

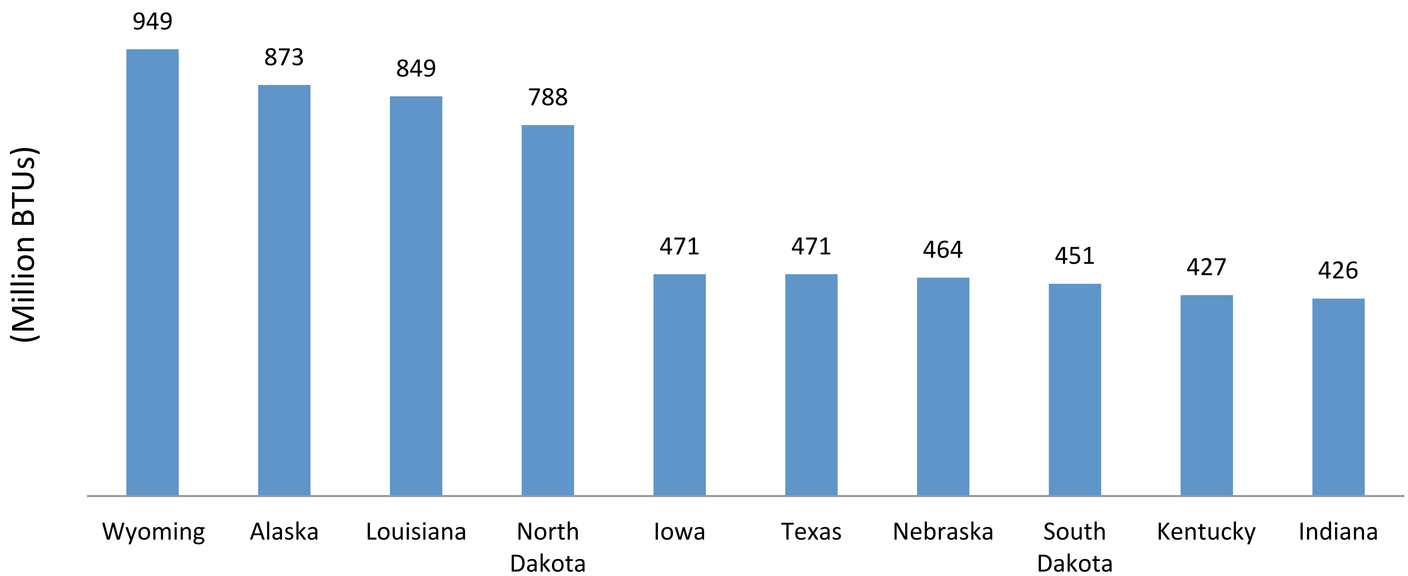
- Compare and order ten 3-digit numbers—**PROBLEM A**
- Use expanded notation—**PROBLEM A**
- Interpret bar graphs**—PROBLEM C**
- Understand energy use in the top 10 largest per capita energy consuming states, including Indiana
- Develop awareness of energy consumption

Through this activity, **4th – 5th grade** students will

- Use place value—**PROBLEM B**
- Round to the nearest 10—**PROBLEM B**
- Interpret bar graphs (up to 1,000)**—PROBLEM D**
- Find the mode and range**—PROBLEM D**
- Understand energy use in the top 10 largest per capita energy consuming states, including Indiana
- Develop awareness of energy consumption

BACKGROUND FOR THE TEACHER

Indiana ranks tenth for per capita energy consumption in the United States. The amount is more than twice as much as the amount in New York. In Indiana, nearly half of our energy comes from burning coal, therefore, this high energy consumption results in a large amount of carbon dioxide emissions, air pollution, and climate change.



Energy use of the top 10 per capita energy consuming states, 2012

(Source: U.S. Energy Information Administration)

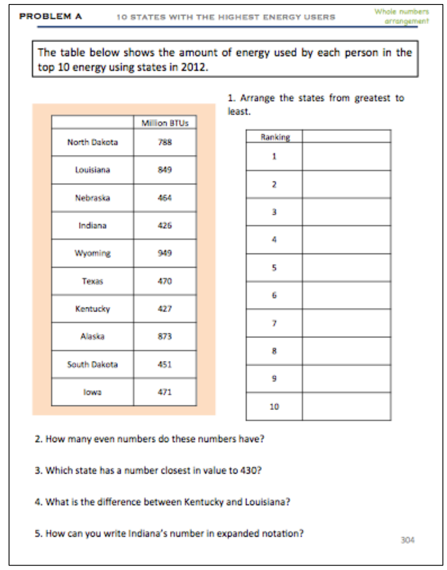
TEACHER GUIDE

The purpose of this activity is to enhance students' skills in numbers and operations that include number arrangement, expanded notation, place value, and rounding (PROBLEMS A and B). PROBLEMS C & D provide questions to strengthen students' skills in interpreting a bar graph. This activity uses the information on energy use of the top 10 per capita energy consuming states. Data was obtained from the U.S. Energy Information Administration.

PROBLEM A

- *Comparing whole numbers*
- *Expanded notation*

Using a table that shows the amount of energy use in the 10 largest per capita energy consuming states, students are asked to answer questions related to number and operations, including comparing and ordering ten 3-digit numbers and using expanded notation.



PROBLEM A 10 STATES WITH THE HIGHEST ENERGY USERS Whole numbers arrangement

The table below shows the amount of energy used by each person in the top 10 energy using states in 2012.

	Million BTUs
North Dakota	788
Louisiana	849
Nebraska	464
Indiana	426
Wyoming	949
Texas	470
Kentucky	427
Alaska	873
South Dakota	451
Iowa	471

1. Arrange the states from greatest to least.

Ranking	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

2. How many even numbers do these numbers have?

3. Which state has a number closest in value to 430?

4. What is the difference between Kentucky and Louisiana?

5. How can you write Indiana's number in expanded notation?

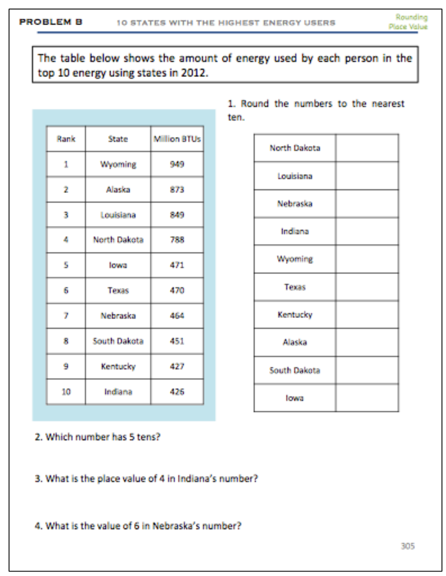
304

P 304—Student Sheet

PROBLEM B

- *Place value*
- *Rounding numbers*

Using a table that shows the amount of energy use in the 10 largest per capita energy consuming states, students are asked to complete questions related to number and operations, including finding place values and rounding 3-digit numbers.



PROBLEM B 10 STATES WITH THE HIGHEST ENERGY USERS Rounding Place Value

The table below shows the amount of energy used by each person in the top 10 energy using states in 2012.

Rank	State	Million BTUs
1	Wyoming	949
2	Alaska	873
3	Louisiana	849
4	North Dakota	788
5	Iowa	471
6	Texas	470
7	Nebraska	464
8	South Dakota	451
9	Kentucky	427
10	Indiana	426

1. Round the numbers to the nearest ten.

North Dakota	
Louisiana	
Nebraska	
Indiana	
Wyoming	
Texas	
Kentucky	
Alaska	
South Dakota	
Iowa	

2. Which number has 5 tens?

3. What is the place value of 4 in Indiana's number?

4. What is the value of 6 in Nebraska's number?

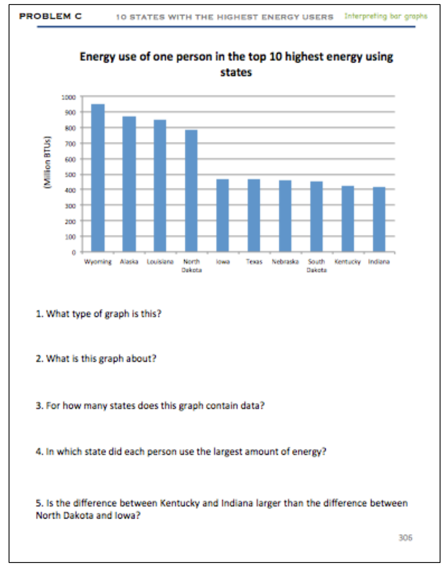
305

P 305—Student Sheet

PROBLEM C

- *Interpreting bar graphs*

Using a bar graph that shows the amount of energy use in the 10 largest per capita energy consuming states, students are asked to find out what the graph is trying to show. Questions include, "For how many states does this graph contain data?"



PROBLEM C 10 STATES WITH THE HIGHEST ENERGY USERS Interpreting bar graphs

Energy use of one person in the top 10 highest energy using states

1. What type of graph is this?

2. What is this graph about?

3. For how many states does this graph contain data?

4. In which state did each person use the largest amount of energy?

5. Is the difference between Kentucky and Indiana larger than the difference between North Dakota and Iowa?

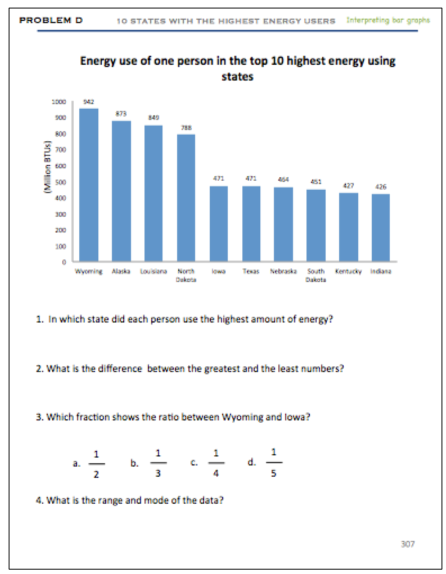
306

P 306—Student Sheet

PROBLEM D

- *Interpreting bar graphs*
- *Finding the range and mode*

Using a bar graph that shows the amount of energy use in the 10 largest per capita energy consuming states, students are asked to read the graph. Questions include "Which fraction shows the ratio between Wyoming and Iowa?" and "What is the range and mode of the data?" Students are also asked to find the range and mode of the data.



PROBLEM D 10 STATES WITH THE HIGHEST ENERGY USERS Interpreting bar graphs

Energy use of one person in the top 10 highest energy using states

1. In which state did each person use the highest amount of energy?

2. What is the difference between the greatest and the least numbers?

3. Which fraction shows the ratio between Wyoming and Iowa?

a. $\frac{1}{2}$ b. $\frac{1}{3}$ c. $\frac{1}{4}$ d. $\frac{1}{5}$

4. What is the range and mode of the data?

307

P 307—Student Sheet

The table below shows the amount of energy used by each person in the top 10 energy using states in 2012.

	Million BTUs
North Dakota	788
Louisiana	849
Nebraska	464
Indiana	426
Wyoming	949
Texas	470
Kentucky	427
Alaska	873
South Dakota	451
Iowa	471

1. Arrange the states from greatest to least.

Ranking	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

2. How many even numbers do these numbers have?

3. Which state has a number closest in value to 430?

4. What is the difference between Kentucky and Louisiana?

5. How can you write Indiana's number in expanded notation?

The table below shows the amount of energy used by each person in the top 10 energy using states in 2012.

Rank	State	Million BTUs
1	Wyoming	949
2	Alaska	873
3	Louisiana	849
4	North Dakota	788
5	Iowa	471
6	Texas	470
7	Nebraska	464
8	South Dakota	451
9	Kentucky	427
10	Indiana	426

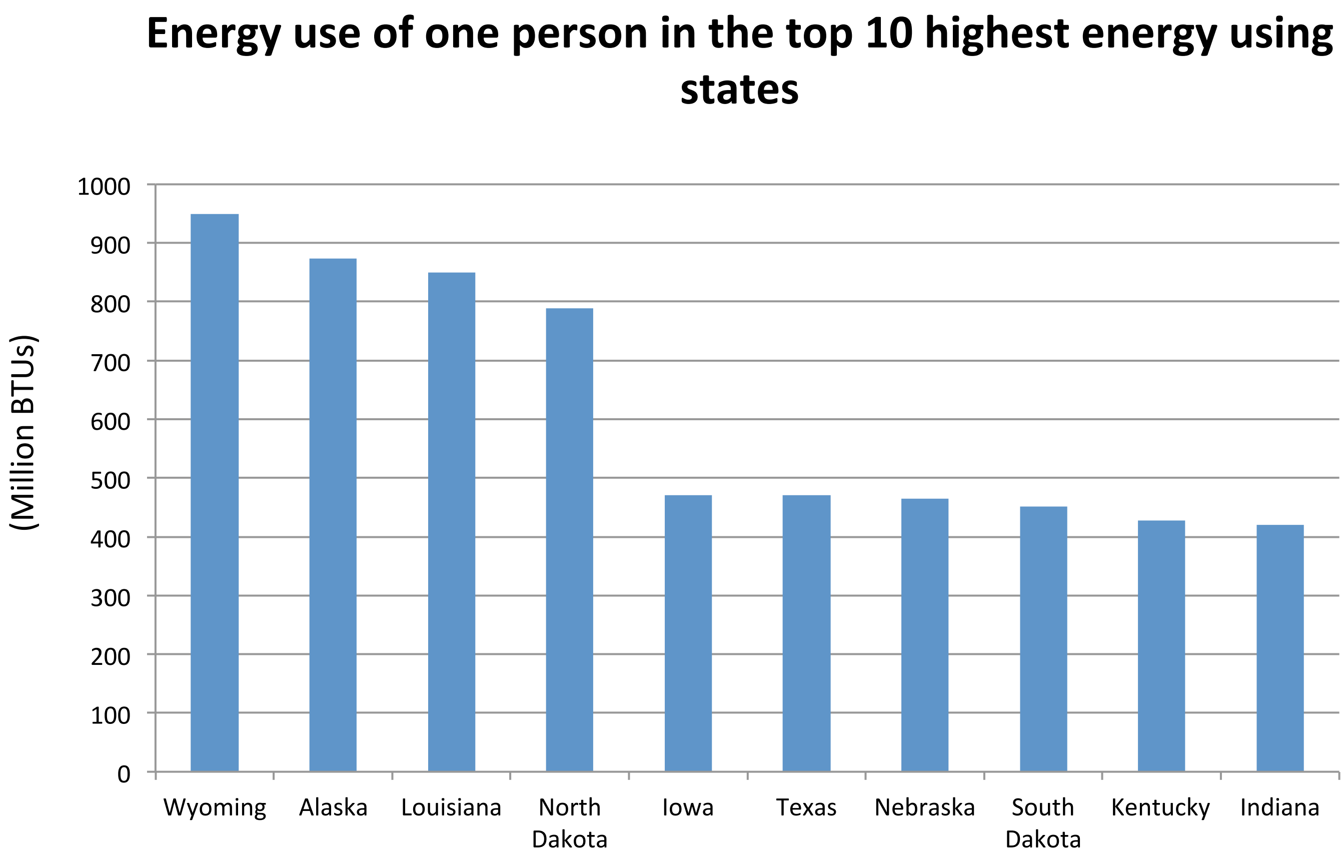
1. Round the numbers to the nearest ten.

North Dakota	
Louisiana	
Nebraska	
Indiana	
Wyoming	
Texas	
Kentucky	
Alaska	
South Dakota	
Iowa	

2. Which number has 5 tens?

3. What is the place value of 4 in Indiana’s number?

4. What is the value of 6 in Nebraska’s number?



1. What type of graph is this?

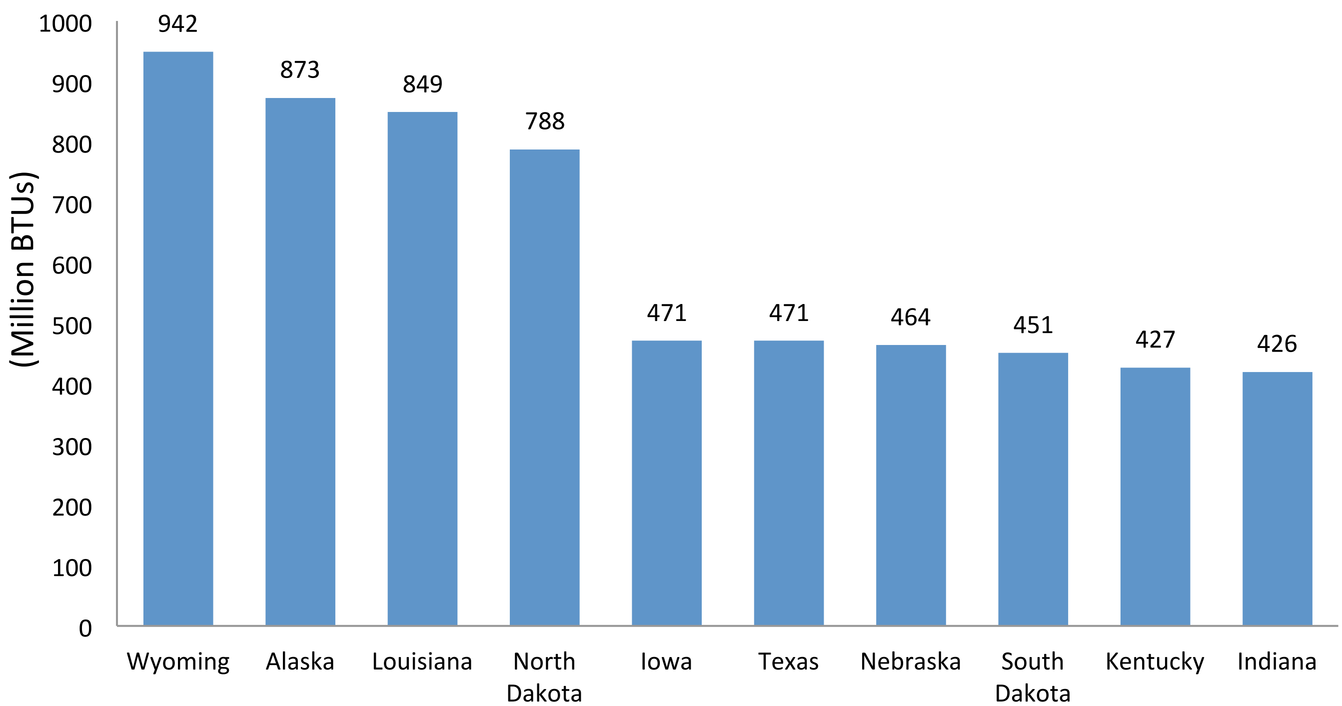
2. What is this graph about?

3. For how many states does this graph contain data?

4. In which state did each person use the largest amount of energy?

5. Is the difference between Kentucky and Indiana larger than the difference between North Dakota and Iowa?

Energy use of one person in the top 10 highest energy using states



1. In which state did each person use the highest amount of energy?

2. What is the difference between the greatest and the least numbers?

3. Which fraction shows the ratio between Wyoming and Iowa?

a. $\frac{1}{2}$ b. $\frac{1}{3}$ c. $\frac{1}{4}$ d. $\frac{1}{5}$

4. What is the range and mode of the data?

PROBLEM 45

Number & Operations

G1 G2	Using >, <, = symbols

Data Analysis

G1 G2 G3 G4	Bar graphs (up to number 6)
G4	Finding range, mode, mean & median

HOW MANY COAL MINES DOES OUR COMMUNITY HAVE?

PURPOSE

Through this activity, **1st -2nd grade** students will

- Create bar graphs (up to 6)-@**PROBLEM A**
- Use the symbols <, >, and = to compare the number--@**PROBLEM A**
- Understand where coal is produced in Indiana
- Develop awareness of our coal production

Through this activity, **3rd -4th grade** students will

- Create bar graphs (up to 6)--@**PROBLEM A**
- Find the range, mean, mode& median --@**PROBLEM B**
- Understand where coal is produced in Indiana
- Develop awareness of our coal production

BACKGROUND FOR THE TEACHER

Indiana has the 8th largest capacity in coal production in the United States. There are 27 coal mines in 9 counties in Indiana and 19 of the mines are located in Southwest Indiana. There are 9 underground coal mines and 18 surface coal mines in our state. Indiana produced 39 million short tons of coal in 2013, of which 57% came from surface mining.

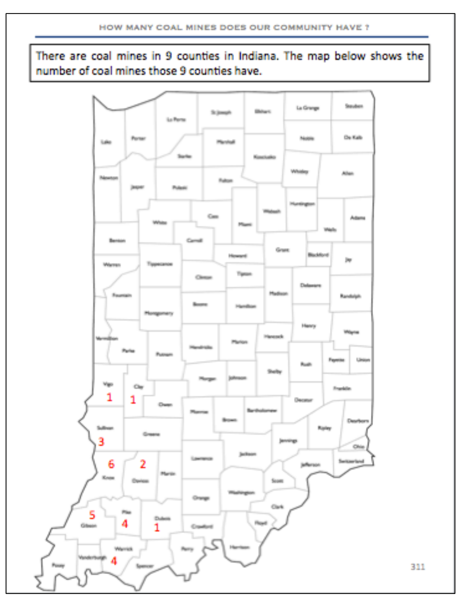
Coal mining involves the displacement of large volumes of soil and rock and severally alters the environment as a result. This raises a number of environmental problems, including soil erosion, destabilization of land, water pollution, and destruction of the local ecosystem.

Coal mine reclamation is required under the federal law, *Surface Mining Control and Reclamation ACT of 1977As*, to rehabilitate the land after coal mining operations have stopped. Reclamation must return the mined land to land that can be used for agriculture, forestry, wildlife habitation, or recreation. The cost of the rehabilitation of the mined land is included in the mine's operating costs.

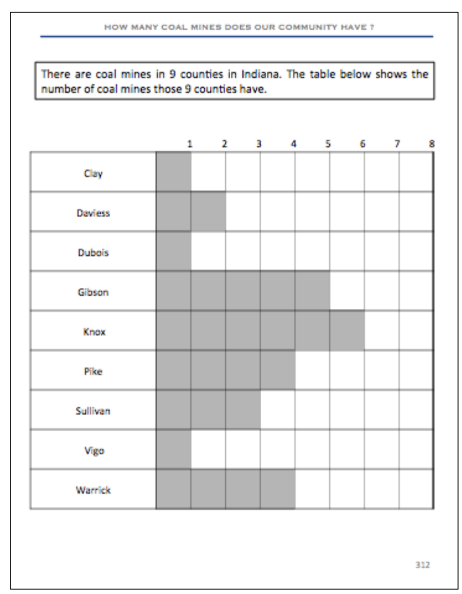
The Farmersburg (Surface) Mine in Vigo County (Photo by Indiana University)

TEACHER GUIDE

The map and the bar graph represent the number and location of coal mines in Indiana, as of 2013. Students are asked to create and interpret a bar graph and compare numbers of coal mines in Indiana. The map and the bar graph are created based on data obtained from the US Energy Information Administration.



MAP: page 311



Bar graph: page 312

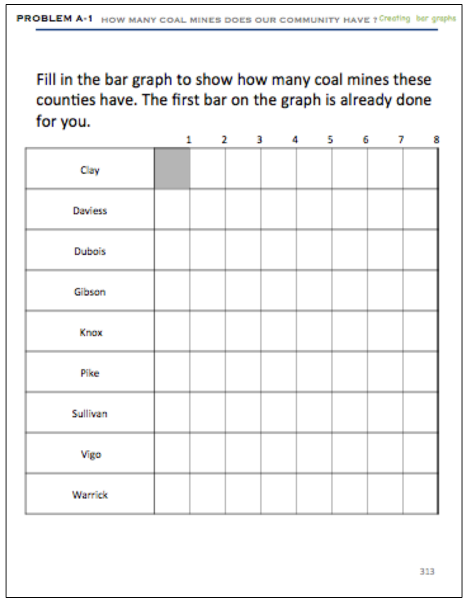
PROBLEM A

- *Creating and interpreting bar graphs (up to 6)*
- *Using <, >, = symbols*

Using the map on page 311, Students are asked to create a bar graph that compares the number of coal mines in 9 counties in Indiana. They use the symbols <, >, and = to compare the number.

-Note-

If your students are not ready to create bar graphs, use the graph on page 312



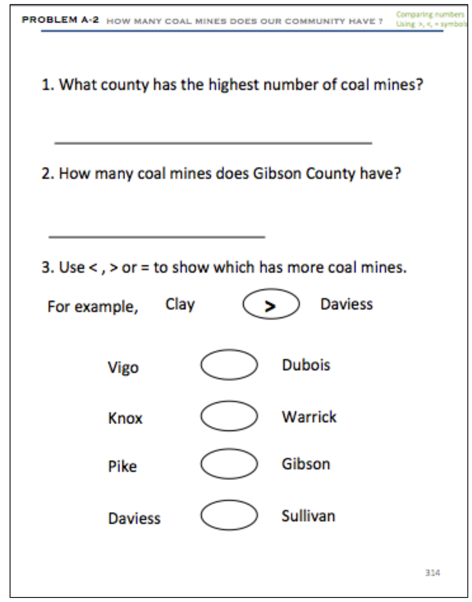
PROBLEM A-1 HOW MANY COAL MINES DOES OUR COMMUNITY HAVE ?

Fill in the bar graph to show how many coal mines these counties have. The first bar on the graph is already done for you.

	1	2	3	4	5	6	7	8
Clay								
Daviess								
Dubois								
Gibson								
Knox								
Pike								
Sullivan								
Vigo								
Warrick								

313

P 313 —Student Sheet



PROBLEM A-2 HOW MANY COAL MINES DOES OUR COMMUNITY HAVE ?

1. What county has the highest number of coal mines?

2. How many coal mines does Gibson County have?

3. Use < , > or = to show which has more coal mines.

For example, Clay (>) Daviess

Vigo ( ) Dubois

Knox ( ) Warrick

Pike ( ) Gibson

Daviess ( ) Sullivan

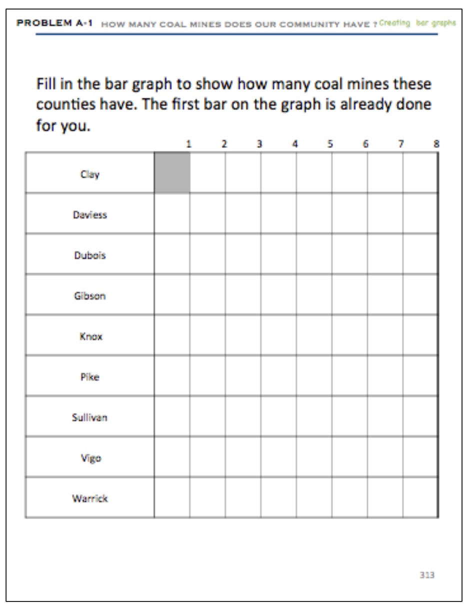
314

P 314—Student Sheet

PROBLEM B

- *Creating and interpreting bar graphs*
- *Finding the range, mode, mean & median*

Using the map on page 311, students are asked to create a bar graph that compares the number of coal mines in Indiana. They answer questions related to the bar graph. They also find the range, mode, mean & median of the data.



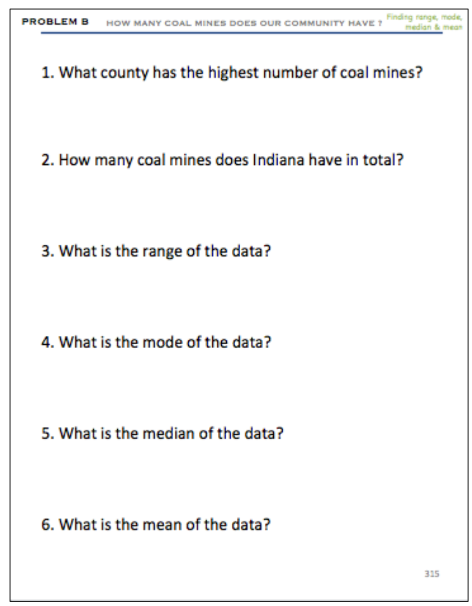
PROBLEM A-1 HOW MANY COAL MINES DOES OUR COMMUNITY HAVE ?

Fill in the bar graph to show how many coal mines these counties have. The first bar on the graph is already done for you.

	1	2	3	4	5	6	7	8
Clay								
Daviess								
Dubois								
Gibson								
Knox								
Pike								
Sullivan								
Vigo								
Warrick								

313

P 313—Student Sheet



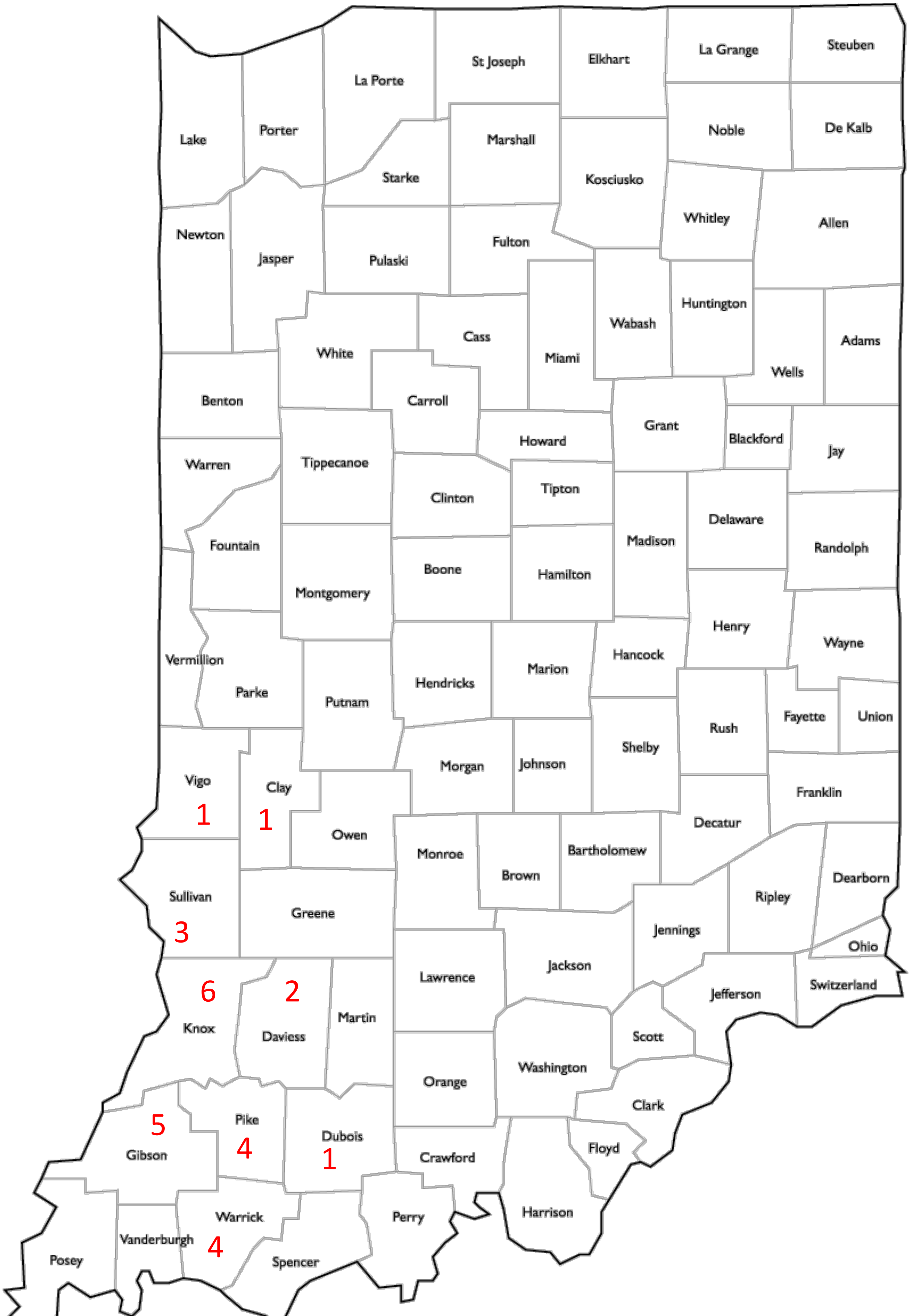
PROBLEM B HOW MANY COAL MINES DOES OUR COMMUNITY HAVE ?

1. What county has the highest number of coal mines?
2. How many coal mines does Indiana have in total?
3. What is the range of the data?
4. What is the mode of the data?
5. What is the median of the data?
6. What is the mean of the data?

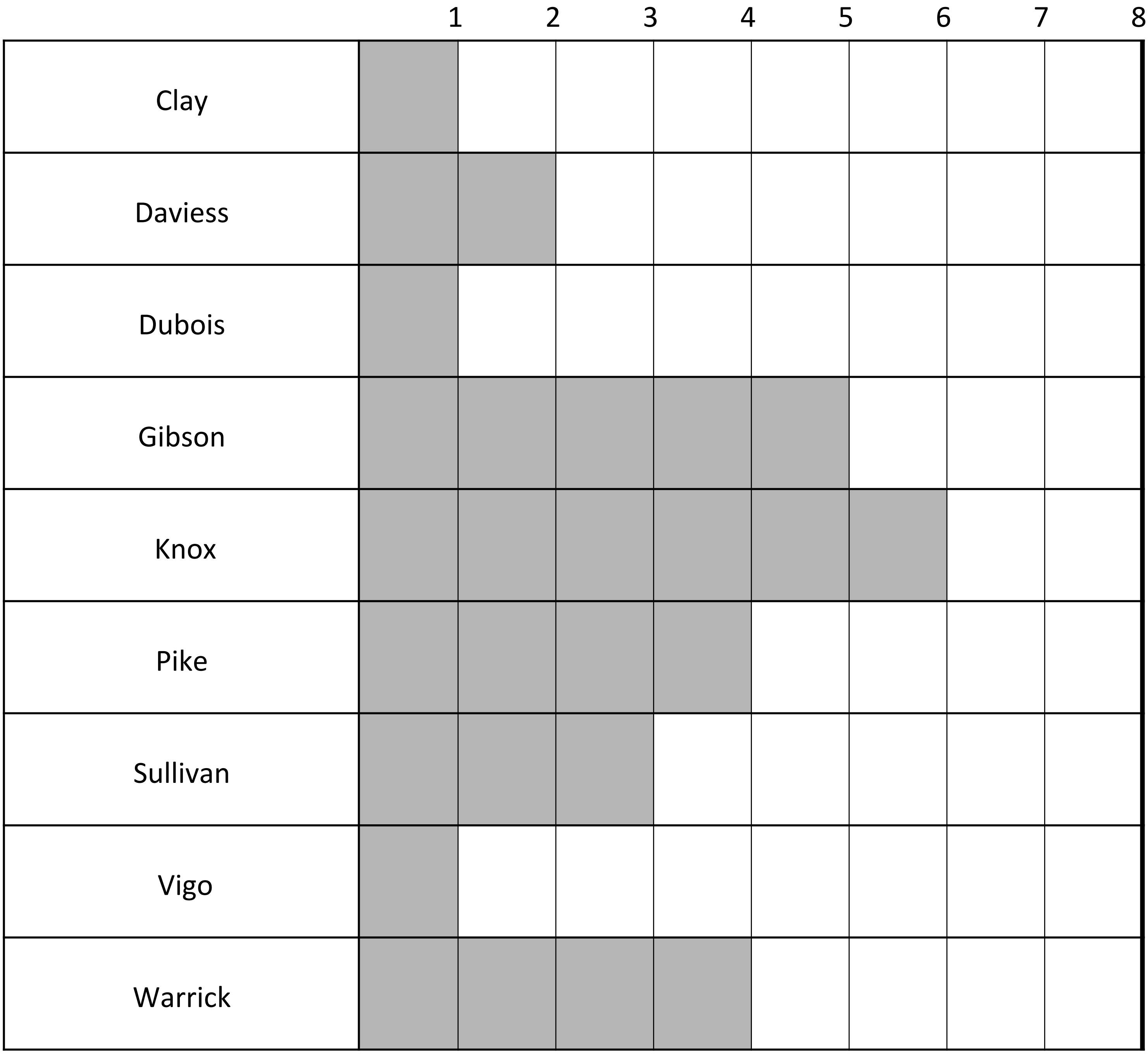
315

P 315—Student Sheet

There are coal mines in 9 counties in Indiana. The map below shows the number of coal mines those 9 counties have.



There are coal mines in 9 counties in Indiana. The table below shows the number of coal mines those 9 counties have.



Fill in the bar graph to show how many coal mines these counties have. The first bar on the graph is already done for you.

	1	2	3	4	5	6	7	8
Clay								
Daviess								
Dubois								
Gibson								
Knox								
Pike								
Sullivan								
Vigo								
Warrick								

1. What county has the highest number of coal mines?

____

2. How many coal mines does Gibson County have?

____

3. Use < , > or = to show which has more coal mines.

For example, Clay (>) Daviess

Vigo ( ) Dubois

Knox ( ) Warrick

Pike ( ) Gibson

Daviess ( ) Sullivan

1. What county has the highest number of coal mines?

2. How many coal mines does Indiana have in total?

3. What is the range of the data?

4. What is the mode of the data?

5. What is the median of the data?

6. What is the mean of the data?

Number and Operations

G3 G4 G5	Number comparison (3 digits)
G3 G4 G5	Place value
G3 G4 G5	Rounding

Data Analysis

G4 G5	Bar graphs (2-3 digits)

WHAT STATE PRODUCES THE MOST COAL?

PURPOSE

Through this activity, **3rd grade** students will

- Add and subtract 3-digit numbers—**PROBLEM A**
- Compare and order eight 3-digit numbers—**PROBLEM B**
- Round to the nearest 10**—PROBLEM C**
- Understand that Indiana is one of the largest states of coal production
- Develop awareness of coal production

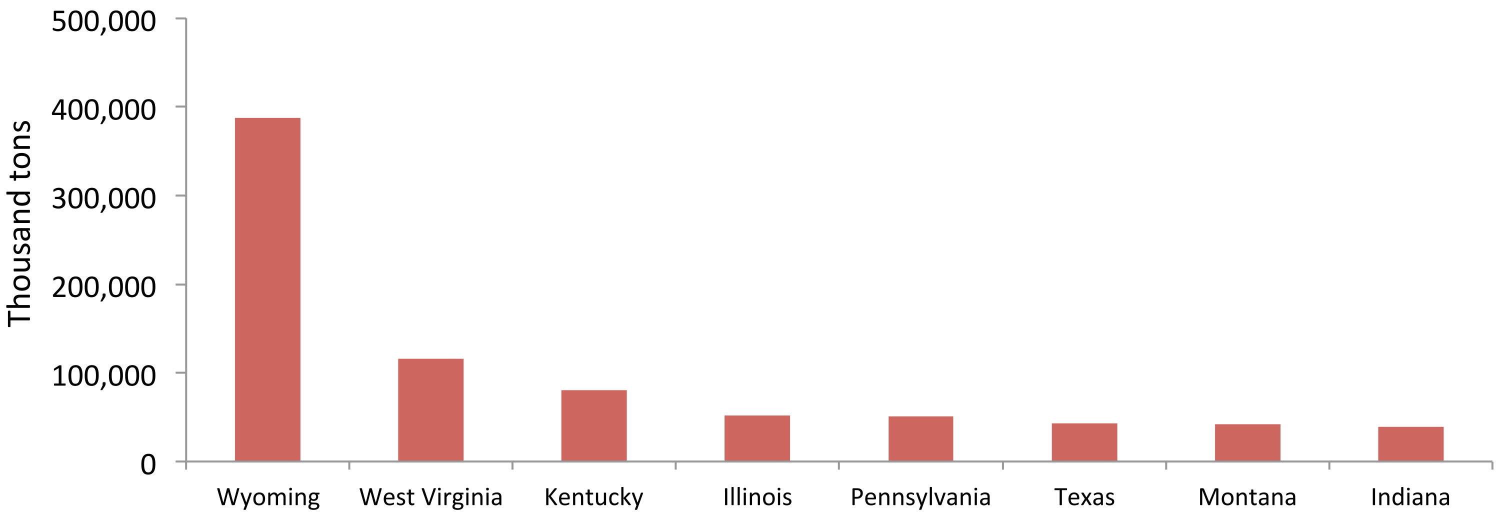
Through this activity, **4th – 5th grade** students will

- Add and subtract large (6-digit) numbers—**PROBLEM D**
- Compare and order eight 3-digit numbers—**PROBLEM E**
- Round to the nearest thousand**—PROBLEM F**
- Interpret bar graphs (2-3 digits)**—PROBLEM G**
- Understand that Indiana is one of the largest states of coal production
- Develop awareness of coal production

BACKGROUND FOR THE TEACHER

Indiana has the 8th largest coal-producing capacity in the United States, producing 39 million tons of coal in 2013. There are 27 coal mines in 9 counties in Indiana, and 19 of which are located in Southwest Indiana.

Coal mining involves the displacement of large volumes of soil and rock and severely alters the environment as a result. This results in a number of environmental problems, including soil erosion, destabilization of land, water pollution, and destruction of local ecosystems. Coal-powered electricity generation is also associated with air pollution and climate change.



8 largest coal producing states in the United States

(Source: U.S. Energy Information Administration)

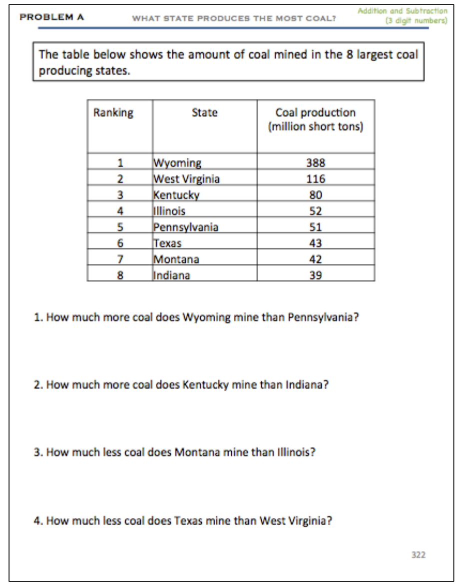
TEACHER GUIDE

The purpose of this activity is to enhance students' skills in number and operations that include number arrangement, expanded notation, place value, and rounding (from PROBLEM A to F). PROBLEM G provides questions to strengthen students' skills in interpreting a bar graph. This activity uses the amount of coal production in the 8 largest coal producing states in this country. Data was obtained from the U.S. Energy information Administration.

PROBLEM A

- *Addition & Subtraction (3 digits)*

Using the table that shows the amount of coal production in the 8 largest coal producing states in 2013, students are asked to add or subtract 3-digit numbers.



PROBLEM A WHAT STATE PRODUCES THE MOST COAL? Addition and Subtraction (3 digit numbers)

The table below shows the amount of coal mined in the 8 largest coal producing states.

Ranking	State	Coal production (million short tons)
1	Wyoming	388
2	West Virginia	116
3	Kentucky	80
4	Illinois	52
5	Pennsylvania	51
6	Texas	43
7	Montana	42
8	Indiana	39

1. How much more coal does Wyoming mine than Pennsylvania?
2. How much more coal does Kentucky mine than Indiana?
3. How much less coal does Montana mine than Illinois?
4. How much less coal does Texas mine than West Virginia?

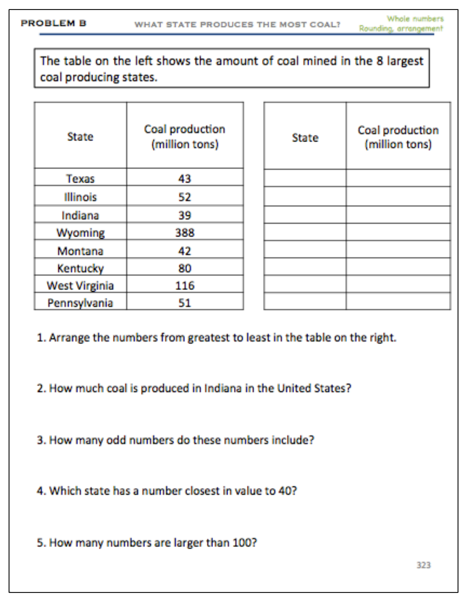
322

P 322—Student Sheet

PROBLEM B

- *Comparing and ordering 3-digit numbers*

Using the table that shows the amount of coal production in the 8 largest coal producing states in 2013, students are asked to complete questions related to number and operations, including comparing and ordering eight 3-digit numbers.



PROBLEM B WHAT STATE PRODUCES THE MOST COAL? Whole numbers Rounding, arrangement

The table on the left shows the amount of coal mined in the 8 largest coal producing states.

State	Coal production (million tons)	State	Coal production (million tons)
Texas	43		
Illinois	52		
Indiana	39		
Wyoming	388		
Montana	42		
Kentucky	80		
West Virginia	116		
Pennsylvania	51		

1. Arrange the numbers from greatest to least in the table on the right.
2. How much coal is produced in Indiana in the United States?
3. How many odd numbers do these numbers include?
4. Which state has a number closest in value to 40?
5. How many numbers are larger than 100?

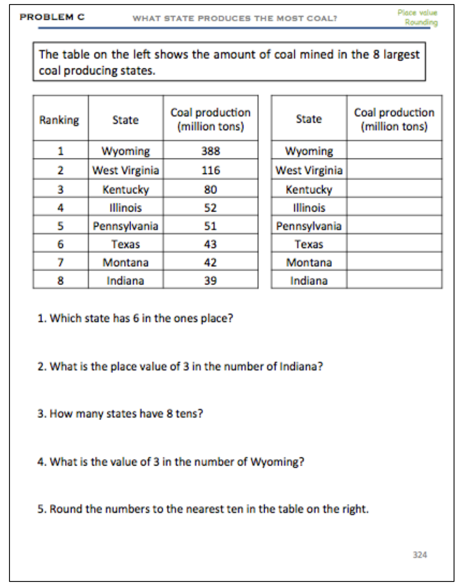
323

P 323—Student Sheet

PROBLEM C

- *Place value*
- *Rounding*

Using the table that shows the amount of coal production in the 8 largest coal producing states in 2013, students are asked to complete questions related to number and operations, including finding place values and rounding 3-digit numbers.



PROBLEM C WHAT STATE PRODUCES THE MOST COAL? Place value Rounding

The table on the left shows the amount of coal mined in the 8 largest coal producing states.

Ranking	State	Coal production (million tons)	State	Coal production (million tons)
1	Wyoming	388	Wyoming	
2	West Virginia	116	West Virginia	
3	Kentucky	80	Kentucky	
4	Illinois	52	Illinois	
5	Pennsylvania	51	Pennsylvania	
6	Texas	43	Texas	
7	Montana	42	Montana	
8	Indiana	39	Indiana	

1. Which state has 6 in the ones place?
2. What is the place value of 3 in the number of Indiana?
3. How many states have 8 tens?
4. What is the value of 3 in the number of Wyoming?
5. Round the numbers to the nearest ten in the table on the right.

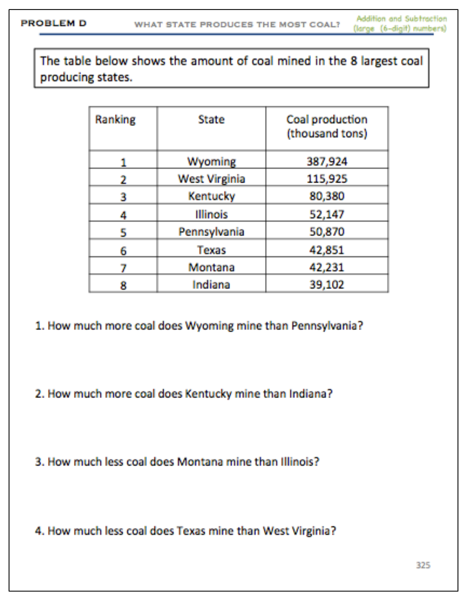
324

P 324—Student Sheet

PROBLEM D

- *Addition & Subtraction (3 digits)*

Using the table that shows the amount of coal production in the 8 largest coal producing states in 2013, students are asked to add or subtract large (6-digit) numbers



PROBLEM D WHAT STATE PRODUCES THE MOST COAL? Addition and Subtraction (large (6-digit) numbers)

The table below shows the amount of coal mined in the 8 largest coal producing states.

Ranking	State	Coal production (thousand tons)
1	Wyoming	387,924
2	West Virginia	115,925
3	Kentucky	80,380
4	Illinois	52,147
5	Pennsylvania	50,870
6	Texas	42,851
7	Montana	42,231
8	Indiana	39,102

1. How much more coal does Wyoming mine than Pennsylvania?
2. How much more coal does Kentucky mine than Indiana?
3. How much less coal does Montana mine than Illinois?
4. How much less coal does Texas mine than West Virginia?

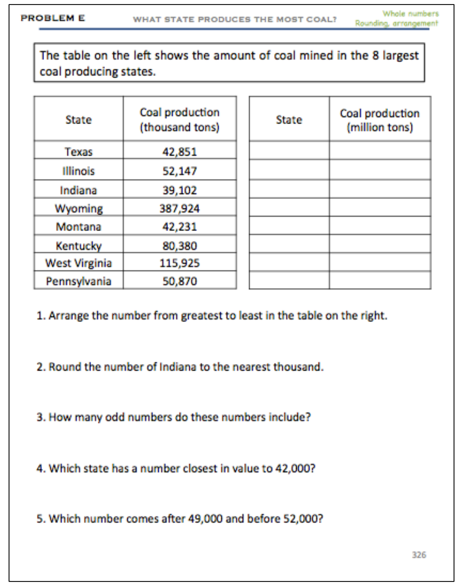
325

P 325—Student Sheet

PROBLEM E

- *Comparing and ordering 6-digit numbers*

Using the table that shows the amount of coal production in the 8 largest coal producing states in 2013, students are asked to complete questions related to number and operations, including comparing and ordering eight 6-digit numbers.



PROBLEM E WHAT STATE PRODUCES THE MOST COAL? Whole numbers Rounding, arrangement

The table on the left shows the amount of coal mined in the 8 largest coal producing states.

State	Coal production (thousand tons)
Texas	42,851
Illinois	52,147
Indiana	39,102
Wyoming	387,924
Montana	42,231
Kentucky	80,380
West Virginia	115,925
Pennsylvania	50,870

State	Coal production (million tons)

1. Arrange the number from greatest to least in the table on the right.
2. Round the number of Indiana to the nearest thousand.
3. How many odd numbers do these numbers include?
4. Which state has a number closest in value to 42,000?
5. Which number comes after 49,000 and before 52,000?

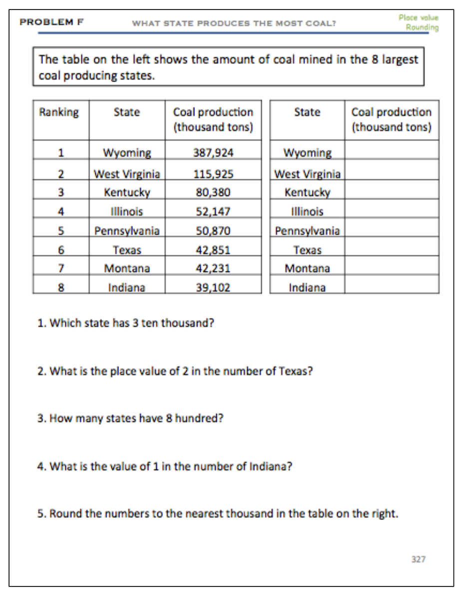
326

P 326—Student Sheet

PROBLEM F

- *Place value*
- *Rounding*

Using the table that shows the amount of coal production in the 8 largest coal producing states in 2013, students are asked to complete questions related to number and operations, including finding place values and rounding 6-digit numbers.



PROBLEM F WHAT STATE PRODUCES THE MOST COAL? Place value Rounding

The table on the left shows the amount of coal mined in the 8 largest coal producing states.

Ranking	State	Coal production (thousand tons)
1	Wyoming	387,924
2	West Virginia	115,925
3	Kentucky	80,380
4	Illinois	52,147
5	Pennsylvania	50,870
6	Texas	42,851
7	Montana	42,231
8	Indiana	39,102

State	Coal production (thousand tons)
Wyoming	
West Virginia	
Kentucky	
Illinois	
Pennsylvania	
Texas	
Montana	
Indiana	

1. Which state has 3 ten thousand?
2. What is the place value of 2 in the number of Texas?
3. How many states have 8 hundred?
4. What is the value of 1 in the number of Indiana?
5. Round the numbers to the nearest thousand in the table on the right.

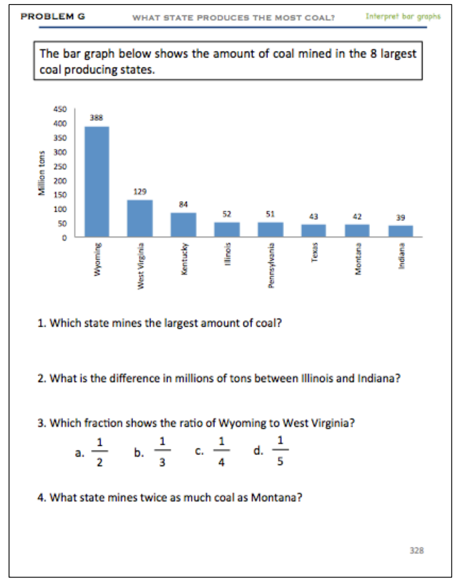
327

P 327—Student Sheet

PROBLEM G

- *Interpret bar graphs*

Using the table that shows the amount of coal production in the 8 largest coal producing states in 2013, students are asked to read the graph. Questions include "What state mines twice as much coal as Montana?"


PROBLEM G WHAT STATE PRODUCES THE MOST COAL? Interpret bar graphs

The bar graph below shows the amount of coal mined in the 8 largest coal producing states.

1. Which state mines the largest amount of coal?

2. What is the difference in millions of tons between Illinois and Indiana?

3. Which fraction shows the ratio of Wyoming to West Virginia?

a. $\frac{1}{2}$ b. $\frac{1}{3}$ c. $\frac{1}{4}$ d. $\frac{1}{5}$

4. What state mines twice as much coal as Montana?

328

P 328—Student Sheet

Coal mining in eastern Kentucky (photo: Art Basel Miami)

The table below shows the amount of coal mined in the 8 largest coal producing states.

Ranking	State	Coal production (million short tons)
1	Wyoming	388
2	West Virginia	116
3	Kentucky	80
4	Illinois	52
5	Pennsylvania	51
6	Texas	43
7	Montana	42
8	Indiana	39

1. How much more coal does Wyoming mine than Pennsylvania?

2. How much more coal does Kentucky mine than Indiana?

3. How much less coal does Montana mine than Illinois?

4. How much less coal does Texas mine than West Virginia?

The table on the left shows the amount of coal mined in the 8 largest coal producing states.

State	Coal production (million tons)
Texas	43
Illinois	52
Indiana	39
Wyoming	388
Montana	42
Kentucky	80
West Virginia	116
Pennsylvania	51

State	Coal production (million tons)

1. Arrange the numbers from greatest to least in the table on the right.

2. How much coal is produced in Indiana in the United States?

3. How many odd numbers do these numbers include?

4. Which state has a number closest in value to 40?

5. How many numbers are larger than 100?

The table on the left shows the amount of coal mined in the 8 largest coal producing states.

Ranking	State	Coal production (million tons)
1	Wyoming	388
2	West Virginia	116
3	Kentucky	80
4	Illinois	52
5	Pennsylvania	51
6	Texas	43
7	Montana	42
8	Indiana	39

State	Coal production (million tons)
Wyoming	
West Virginia	
Kentucky	
Illinois	
Pennsylvania	
Texas	
Montana	
Indiana	

1. Which state has 6 in the ones place?

2. What is the place value of 3 in the number of Indiana?

3. How many states have 8 tens?

4. What is the value of 3 in the number of Wyoming?

5. Round the numbers to the nearest ten in the table on the right.

The table below shows the amount of coal mined in the 8 largest coal producing states.

Ranking	State	Coal production (thousand tons)
1	Wyoming	387,924
2	West Virginia	115,925
3	Kentucky	80,380
4	Illinois	52,147
5	Pennsylvania	50,870
6	Texas	42,851
7	Montana	42,231
8	Indiana	39,102

1. How much more coal does Wyoming mine than Pennsylvania?

2. How much more coal does Kentucky mine than Indiana?

3. How much less coal does Montana mine than Illinois?

4. How much less coal does Texas mine than West Virginia?

The table on the left shows the amount of coal mined in the 8 largest coal producing states.

State	Coal production (thousand tons)
Texas	42,851
Illinois	52,147
Indiana	39,102
Wyoming	387,924
Montana	42,231
Kentucky	80,380
West Virginia	115,925
Pennsylvania	50,870

State	Coal production (million tons)

1. Arrange the number from greatest to least in the table on the right.

2. Round the number of Indiana to the nearest thousand.

3. How many odd numbers do these numbers include?

4. Which state has a number closest in value to 42,000?

5. Which number comes after 49,000 and before 52,000?

The table on the left shows the amount of coal mined in the 8 largest coal producing states.

Ranking	State	Coal production (thousand tons)
1	Wyoming	387,924
2	West Virginia	115,925
3	Kentucky	80,380
4	Illinois	52,147
5	Pennsylvania	50,870
6	Texas	42,851
7	Montana	42,231
8	Indiana	39,102

State	Coal production (thousand tons)
Wyoming	
West Virginia	
Kentucky	
Illinois	
Pennsylvania	
Texas	
Montana	
Indiana	

1. Which state has 3 ten thousand?

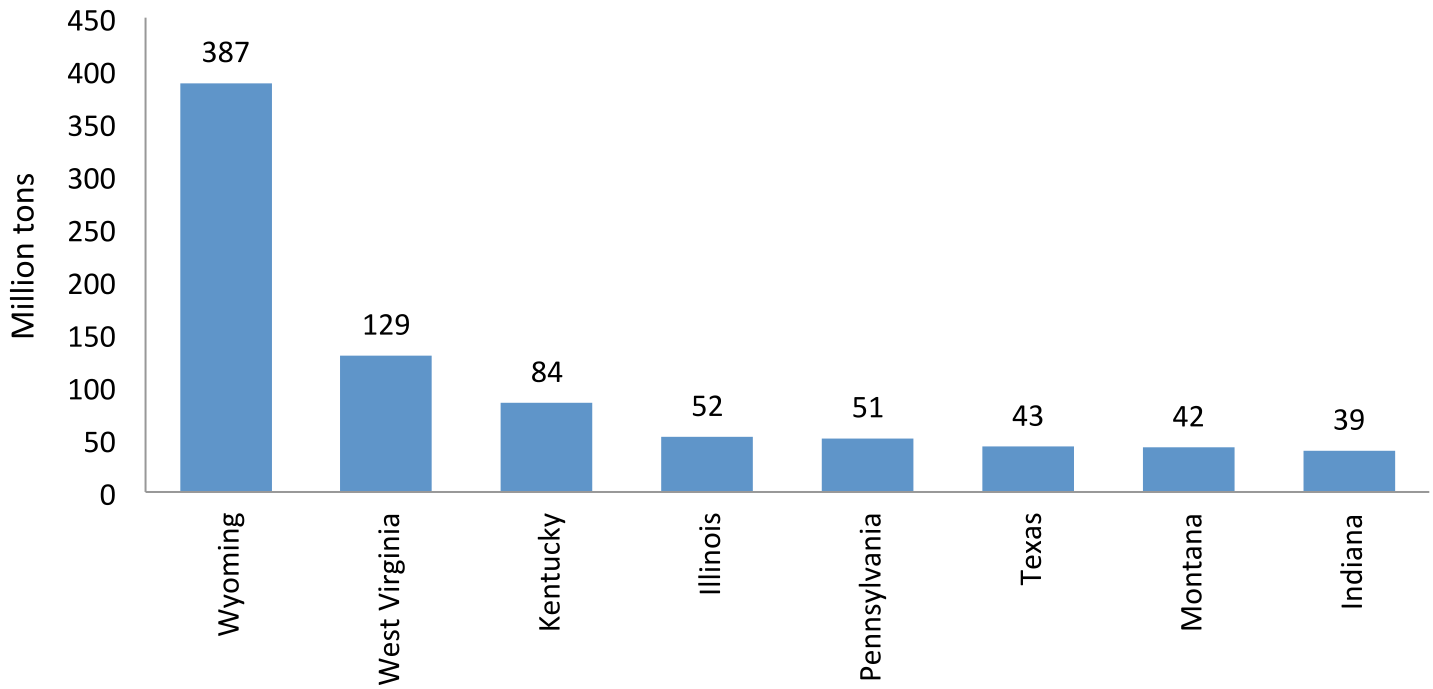
2. What is the place value of 2 in the number of Texas?

3. How many states have 8 hundred?

4. What is the value of 1 in the number of Indiana?

5. Round the numbers to the nearest thousand in the table on the right.

The bar graph below shows the amount of coal mined in the 8 largest coal producing states.



1. Which state mines the largest amount of coal?

2. What is the difference in millions of tons between Illinois and Indiana?

3. Which fraction shows the ratio of Wyoming to West Virginia?

a. $\frac{1}{2}$ b. $\frac{1}{3}$ c. $\frac{1}{4}$ d. $\frac{1}{5}$

4. What state mines twice as much coal as Montana?

PROBLEM 47

Data Analysis

G2
G3
G4
G5

Circle graphs

ENERGY SOURCES IN OUR STATE

PURPOSE

Through this activity, **2nd – 3rd grade** students will

- Interpret circle graphs—**PROBLEM A**
- Compare portions (percent)—**PROBLEM A**
- Understand primary energy sources in our state
- Develop awareness of our energy use

Through this activity, **4th – 5th grade** students will

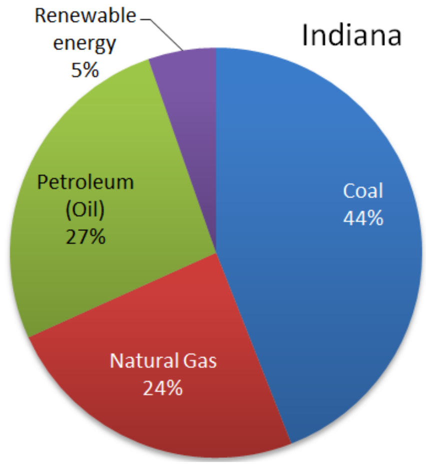
- Interpret circle graphs—**PROBLEM B**
- Convert from percents to fractions—**PROBLEM B**
- Compare two circle graphs—**PROBLEM C**
- Understand primary energy sources in our state
- Develop awareness of our energy use

BACKGROUND FOR THE TEACHER

Our states produces 8th largest amount of coal in this country. Accordingly, the share of coal in total energy consumption is large. Almost half of our energy comes from coal in Indiana.

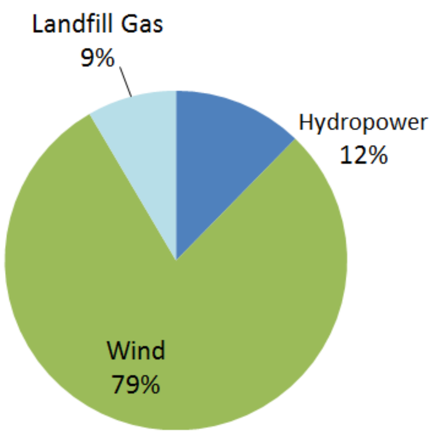
About 95% of our energy comes from fossil fuels, including petroleum, natural gas, and coal. The share of renewable energy is 5%. Of renewable energy, about 80% is produced from wind.

The energy consumption pattern in our state is significantly different from that in California, which has little or no coal reserves. Almost half of total energy consumption is supported by petroleum in California. The share of fossil fuels is 85% and renewable energy consists of 12% of total energy consumption in California.



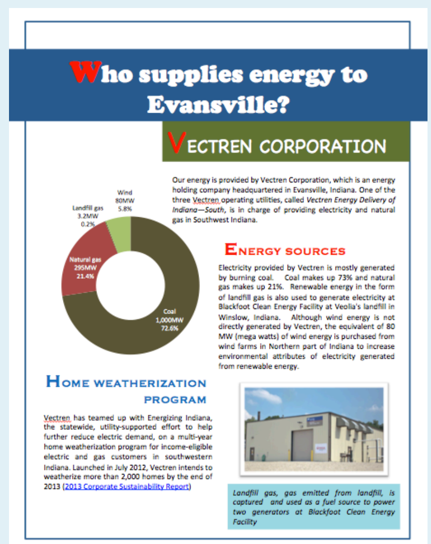
Primary energy consumption by source in Indiana in 2012

Source: U.S. EIA



Sources of Renewable Electricity in Indiana in 2012

Source: U.S. EIA



Who supplies energy to Evansville?

VECTREN CORPORATION

Our energy is provided by Vectren Corporation, which is an energy holding company headquartered in Evansville, Indiana. One of the three Vectren operating utilities, called *Vectren Energy Delivery of Indiana—South*, is in charge of providing electricity and natural gas in Southwest Indiana.

Wind 80MW 5.8%
Landfill gas 3.2MW 0.2%
Natural gas 295MW 21.4%
Coal 1,000MW 72.6%

ENERGY SOURCES

Electricity provided by Vectren is mostly generated by burning coal. Coal makes up 73% and natural gas makes up 21%. Renewable energy in the form of landfill gas is also used to generate electricity at Blackfoot Clean Energy Facility at Veolia's landfill in Winslow, Indiana. Although wind energy is not directly generated by Vectren, the equivalent of 80 MW (mega watts) of wind energy is purchased from wind farms in Northern part of Indiana to increase environmental attributes of electricity generated from renewable energy.

HOME WEATHERIZATION PROGRAM

Vectren has teamed up with Energizing Indiana, the statewide, utility-supported effort to help further reduce electric demand, on a multi-year home weatherization program for income-eligible electric and gas customers in southwestern Indiana. Launched in July 2012, Vectren intends to weatherize more than 2,000 homes by the end of 2013 (2013 Corporate Sustainability Report)

Landfill gas, gas emitted from landfill, is captured and used as a fuel source to power two generators at Blackfoot Clean Energy Facility

Electricity production in Evansville is explained in page 281.

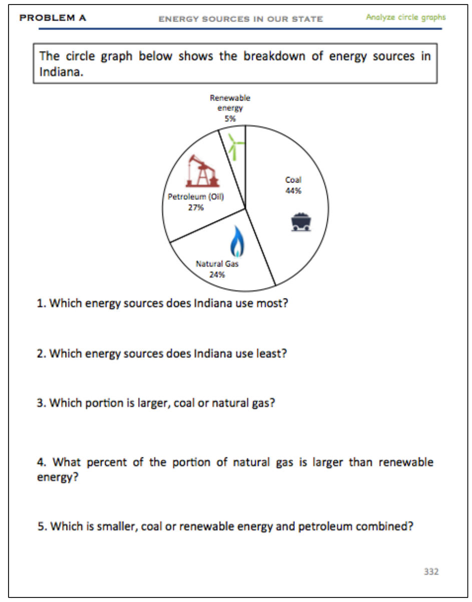
TEACHER GUIDE

The purpose of this activity is to enhance students' skills in interpreting circle graphs. Using the information on how much of our energy comes from which energy source in our state, this activity provides 3 worksheets depending on students' understanding levels. The circle graph used in this activity was created based on data obtained from the US Energy Information Administration.

PROBLEM A

- *Interpreting circle graphs*
- *Comparing numbers*

Using a circle graph on primary energy consumption by source in Indiana, students are asked to find out which portion is largest/ smallest. The graph uses percentage to show the size of each portion. They are also asked to compare numbers to answer questions that ask which portion is larger/smaller.


PROBLEM A ENERGY SOURCES IN OUR STATE Analyze circle graphs

The circle graph below shows the breakdown of energy sources in Indiana.

1. Which energy sources does Indiana use most?

2. Which energy sources does Indiana use least?

3. Which portion is larger, coal or natural gas?

4. What percent of the portion of natural gas is larger than renewable energy?

5. Which is smaller, coal or renewable energy and petroleum combined?

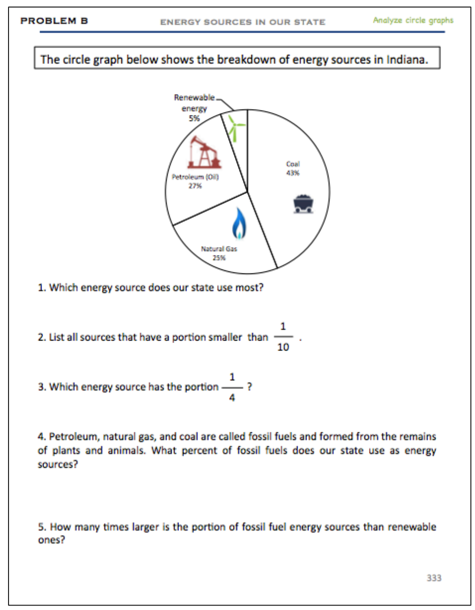
332

P 332—Student Sheet

PROBLEM B

- *Interpreting circle graphs*
- *Converting percents to fractions*

Using a circle graph on primary energy consumption by source in Indiana, students are asked to use skills in both percents and fractions. The graph uses percentage to show the size of each portion. Questions include, “Which energy source has the portion of 1/4?”


PROBLEM B ENERGY SOURCES IN OUR STATE Analyze circle graphs

The circle graph below shows the breakdown of energy sources in Indiana.

1. Which energy source does our state use most?

2. List all sources that have a portion smaller than $\frac{1}{10}$.

3. Which energy source has the portion $\frac{1}{4}$?

4. Petroleum, natural gas, and coal are called fossil fuels and formed from the remains of plants and animals. What percent of fossil fuels does our state use as energy sources?

5. How many times larger is the portion of fossil fuel energy sources than renewable ones?

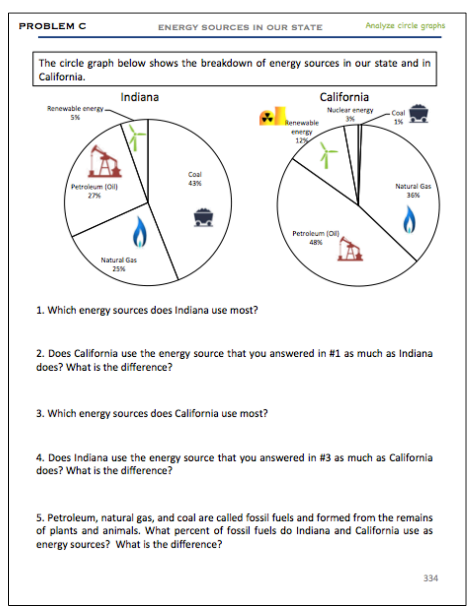
333

P 333—Student Sheet

PROBLEM C

- *Interpreting circle graphs*
- *Comparing numbers*

The energy consumption pattern in California is significantly different from that in Indiana. Using circle graphs on primary energy consumption by source in Indiana and California, students are asked to compare those two graphs. Questions include, “Does California use as much of the energy source that you answered in #1 (which is coal) as Indiana does? What is the difference?”


PROBLEM C ENERGY SOURCES IN OUR STATE Analyze circle graphs

The circle graph below shows the breakdown of energy sources in our state and in California.

1. Which energy sources does Indiana use most?

2. Does California use the energy source that you answered in #1 as much as Indiana does? What is the difference?

3. Which energy sources does California use most?

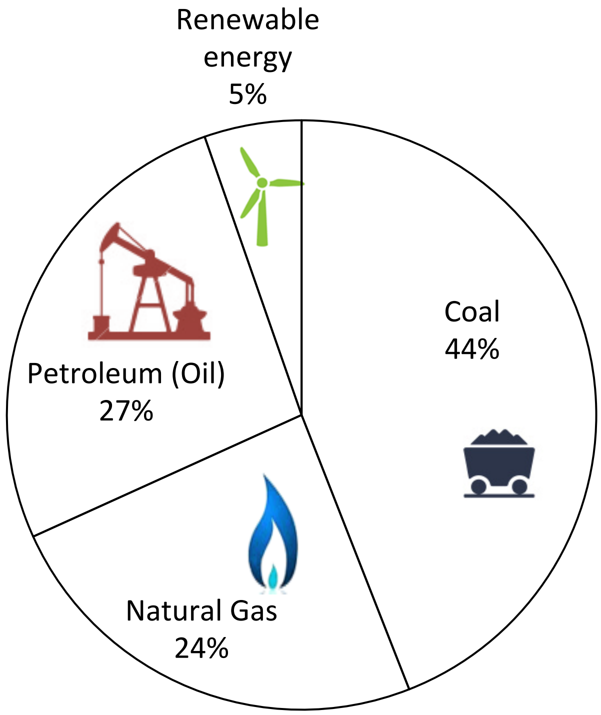
4. Does Indiana use the energy source that you answered in #3 as much as California does? What is the difference?

5. Petroleum, natural gas, and coal are called fossil fuels and formed from the remains of plants and animals. What percent of fossil fuels do Indiana and California use as energy sources? What is the difference?

334

P 334—Student Sheet

The circle graph below shows the breakdown of energy sources in Indiana.



1. Which energy sources does Indiana use most?

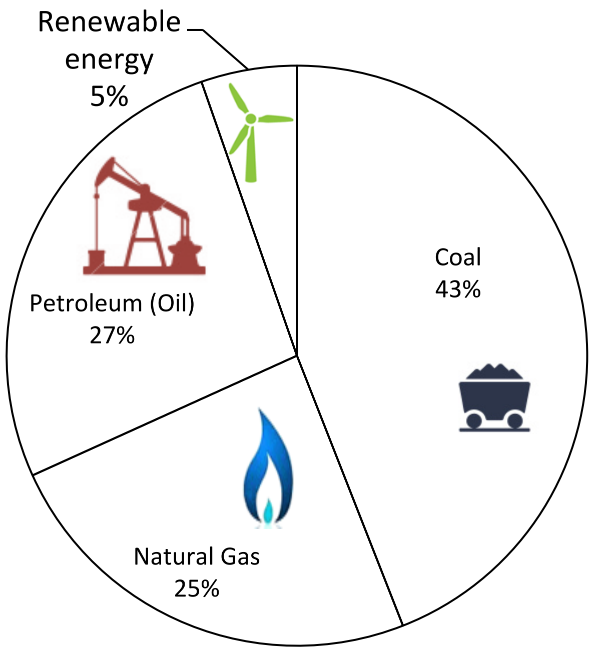
2. Which energy sources does Indiana use least?

3. Which portion is larger, coal or natural gas?

4. What percent of the portion of natural gas is larger than renewable energy?

5. Which is smaller, coal or renewable energy and petroleum combined?

The circle graph below shows the breakdown of energy sources in Indiana.



1. Which energy source does our state use most?

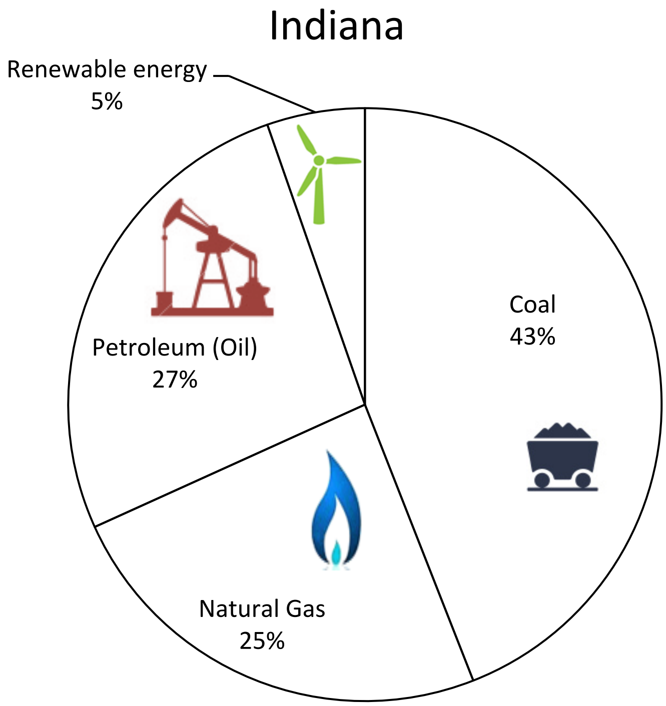
2. List all sources that have a portion smaller than $\frac{1}{10}$.

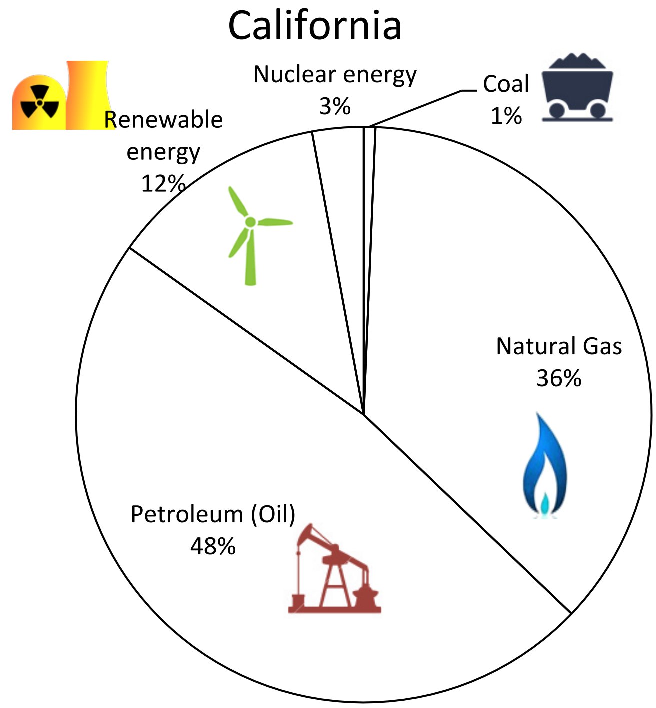
3. Which energy source has the portion $\frac{1}{4}$?

4. Petroleum, natural gas, and coal are called fossil fuels and formed from the remains of plants and animals. What percent of fossil fuels does our state use as energy sources?

5. How many times larger is the portion of fossil fuel energy sources than renewable ones?

The circle graph below shows the breakdown of energy sources in our state and in California.





1. Which energy sources does Indiana use most?

2. Does California use the energy source that you answered in #1 as much as Indiana does? What is the difference?

3. Which energy sources does California use most?

4. Does Indiana use the energy source that you answered in #3 as much as California does? What is the difference?

5. Petroleum, natural gas, and coal are called fossil fuels and formed from the remains of plants and animals. What percent of fossil fuels do Indiana and California use as energy sources? What is the difference?

PROBLEM 48

Number and Operations

G4 G5	Number comparison (decimals)
G4 G5	Using > or < (decimals)
G4 G5	Subtraction (decimals)

OUR ELECTRICITY PRICE – HIGH OR LOW?

PURPOSE

Through this activity, **4th – 5th grade** students will

- Compare decimal numbers—**PROBLEM A**
- Use < or > to compare two decimal numbers—**PROBLEM A**
- Subtract decimal numbers**—PROBLEM B**
- Develop awareness of electricity consumption

BACKGROUND FOR THE TEACHER

The price of electricity in our country varies by state. The state with the highest electricity price was Hawaii, at 34.59 cents/kwh, as of December 2014. The state with the lowest electricity price, on the other hand, is Washington, at 8.22 cents/kwh.

The electricity price in Indiana was 11.2 cents/kwh and ranked 30th in the country. The monthly electricity consumption for an average household in Indiana was 1,004 kWh, which was larger than the national average—909 kWh—as of 2013 (EIA).

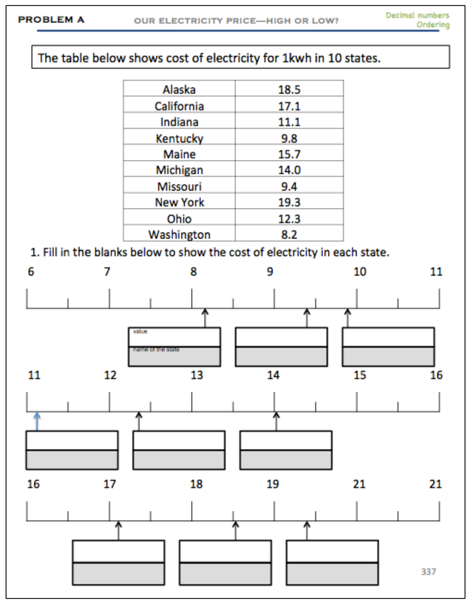
TEACHER GUIDE

The purpose of this activity is to enhance students' skills in decimal numbers, including ordering, number comparison, and addition and subtraction of decimal numbers. This activity uses the prices of electricity in 10 selected states, including Indiana, in 2014. Data was obtained from the U.S. Energy Information Administration.

PROBLEM A

- *Ordering decimal numbers*
- *Using < or >*

Using the electricity prices in 10 states, including Indiana, students are asked to order decimal numbers on page 337 and compare two decimal numbers by using < or > symbols in page 338.


PROBLEM A OUR ELECTRICITY PRICE—HIGH OR LOW? Decimal numbers Ordering

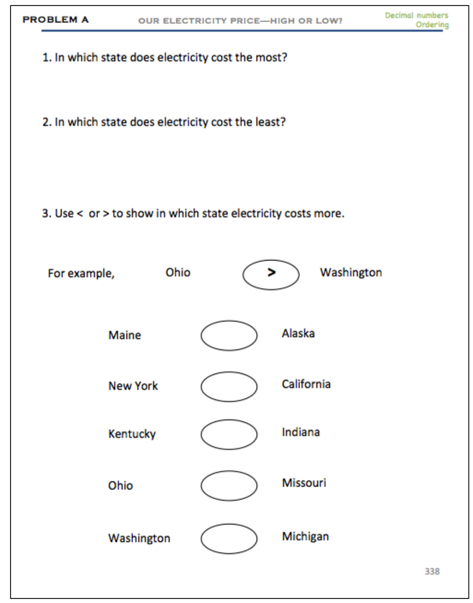
The table below shows cost of electricity for 1kwh in 10 states.

Alaska	18.5
California	17.1
Indiana	11.1
Kentucky	9.8
Maine	15.7
Michigan	14.0
Missouri	9.4
New York	19.3
Ohio	12.3
Washington	8.2

1. Fill in the blanks below to show the cost of electricity in each state.

337

P 337—Student Sheet


PROBLEM A OUR ELECTRICITY PRICE—HIGH OR LOW? Decimal numbers Ordering

1. In which state does electricity cost the most?

2. In which state does electricity cost the least?

3. Use < or > to show in which state electricity costs more.

For example, Ohio > Washington

Maine ◯ Alaska

New York ◯ California

Kentucky ◯ Indiana

Ohio ◯ Missouri

Washington ◯ Michigan

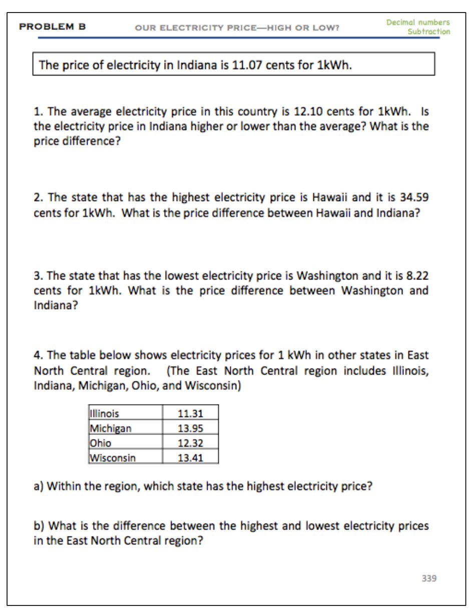
338

P 338—Student Sheet

PROBLEM B

- *Subtraction (decimal numbers)*

Using electricity prices in several states, including Indiana, students are asked to add and subtract decimal numbers.


PROBLEM B OUR ELECTRICITY PRICE—HIGH OR LOW? Decimal numbers Subtraction

The price of electricity in Indiana is 11.07 cents for 1kWh.

1. The average electricity price in this country is 12.10 cents for 1kWh. Is the electricity price in Indiana higher or lower than the average? What is the price difference?

2. The state that has the highest electricity price is Hawaii and it is 34.59 cents for 1kWh. What is the price difference between Hawaii and Indiana?

3. The state that has the lowest electricity price is Washington and it is 8.22 cents for 1kWh. What is the price difference between Washington and Indiana?

4. The table below shows electricity prices for 1 kWh in other states in East North Central region. (The East North Central region includes Illinois, Indiana, Michigan, Ohio, and Wisconsin)

Illinois	11.31
Michigan	13.95
Ohio	12.32
Wisconsin	13.41

a) Within the region, which state has the highest electricity price?

b) What is the difference between the highest and lowest electricity prices in the East North Central region?

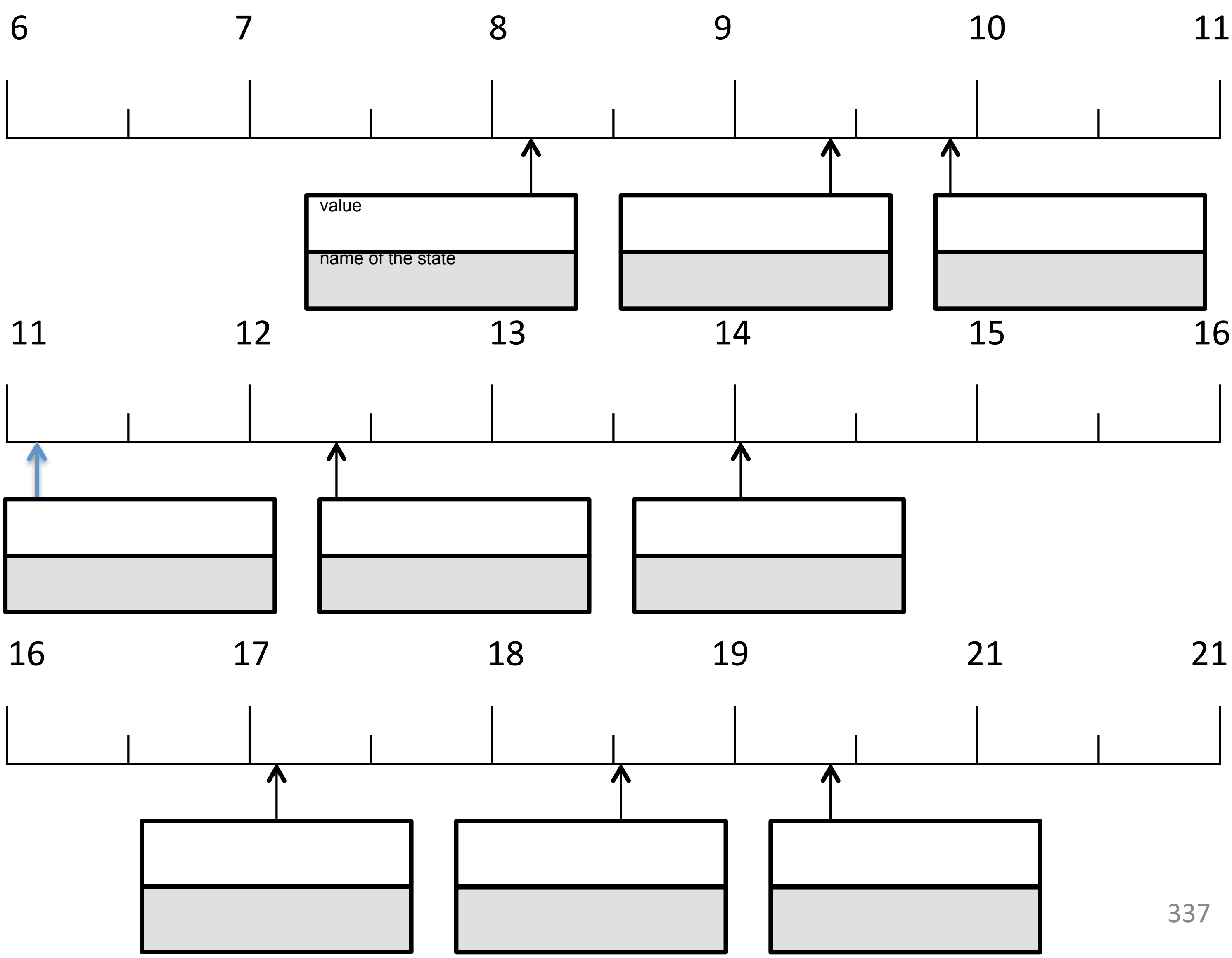
339

P 339—Student Sheet

The table below shows cost of electricity for 1kwh in 10 states.

Alaska	18.5
California	17.1
Indiana	11.1
Kentucky	9.8
Maine	15.7
Michigan	14.0
Missouri	9.4
New York	19.3
Ohio	12.3
Washington	8.2

1. Fill in the blanks below to show the cost of electricity in each state.



1. In which state does electricity cost the most?

2. In which state does electricity cost the least?

3. Use < or > to show in which state electricity costs more.

For example,	Ohio	>	Washington
	Maine		Alaska
	New York		California
	Kentucky		Indiana
	Ohio		Missouri
	Washington		Michigan

The price of electricity in Indiana is 11.07 cents for 1kWh.

1. The average electricity price in this country is 12.10 cents for 1kWh. Is the electricity price in Indiana higher or lower than the average? What is the price difference?

2. The state that has the highest electricity price is Hawaii and it is 34.59 cents for 1kWh. What is the price difference between Hawaii and Indiana?

3. The state that has the lowest electricity price is Washington and it is 8.22 cents for 1kWh. What is the price difference between Washington and Indiana?

4. The table below shows electricity prices for 1 kWh in other states in East North Central region. (The East North Central region includes Illinois, Indiana, Michigan, Ohio, and Wisconsin)

Illinois	11.31
Michigan	13.95
Ohio	12.32
Wisconsin	13.41

a) Within the region, which state has the highest electricity price?

b) What is the difference between the highest and lowest electricity prices in the East North Central region?

PROBLEM 49

Number and Operations

G4 G5	Expanded notation (decimals)
G4 G5	Rounding (decimals)
G4 G5	Addition and subtraction (decimals)

Data Analysis

G4 G5	Bar graphs (up to 4 digits)

SOLAR ENERGY IN OUR COUNTRY

PURPOSE

Through this activity, **4th – 5th grade** students will

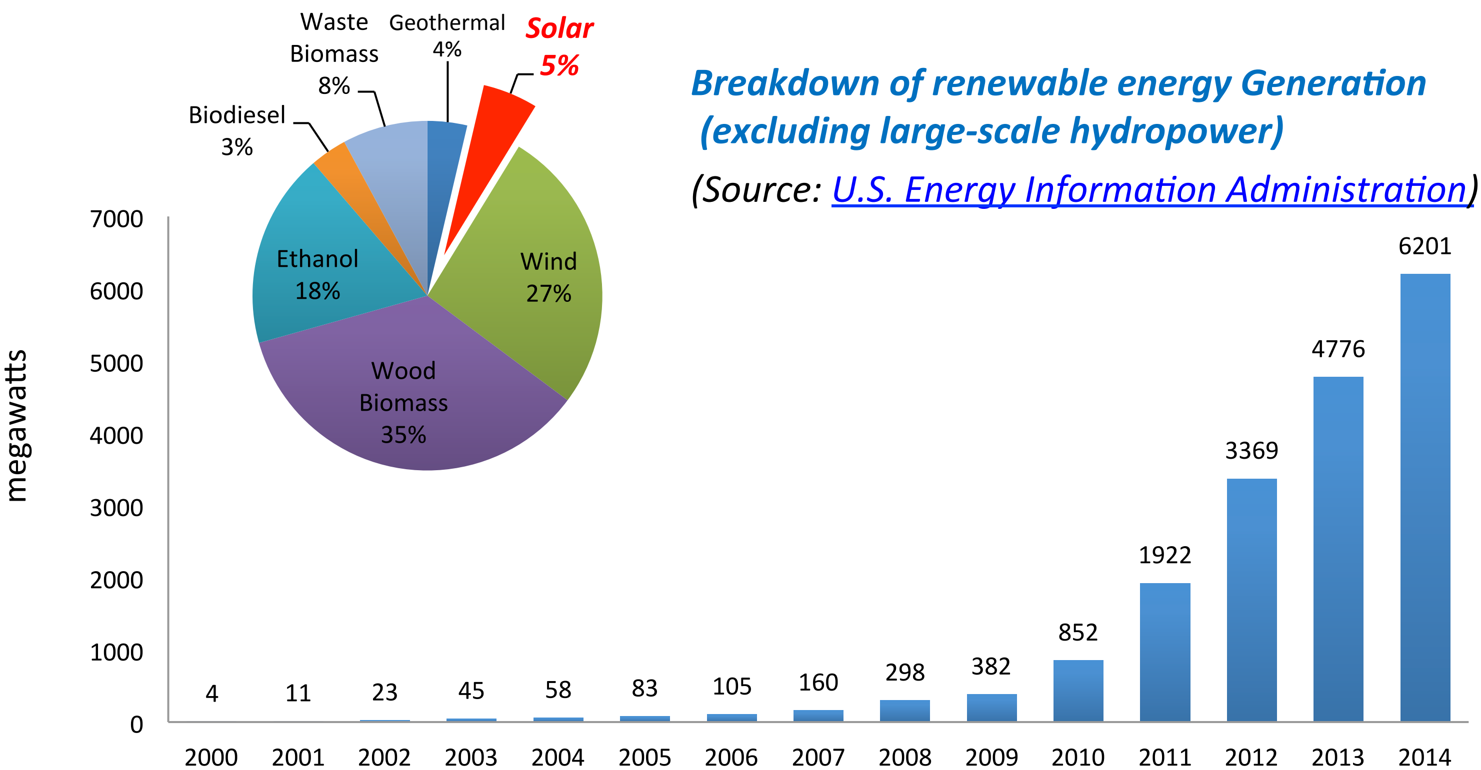
- Name decimal numbers—**PROBLEM A**
- Round decimal numbers—**PROBLEM B**
- Add and subtract decimal numbers**—PROBLEM C**
- Interpret bar graphs**—PROBLEM D**
- Understand renewable power generation in the United States
- Develop awareness of solar power generation

8.4 kW Solar system on C.K. Newsome Community Center, Evansville

BACKGROUND FOR THE TEACHER

The United States has the world's third largest generation capacity from solar PV panels, only after Germany and Italy, as of 2013. Its capacity has increased significantly over the last 5 years. Solar energy makes up 5% of total renewable energy generation (excluding large hydropower).

Solar power has become more affordable due to technological development and economies of scale. The national average price for a PV installed system went down to $2.71 per watt, as of Q3, 2014 (Solar Energy Industries Association).

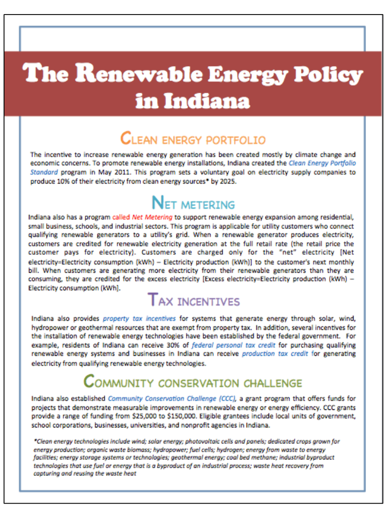


Breakdown of renewable energy Generation (excluding large-scale hydropower)

(Source: U.S. Energy Information Administration)

Increase in solar energy generation since 2000

(Source: Solar Energy Industries Association)



The Renewable Energy Policy in Indiana

Clean energy portfolio

The incentive to increase renewable energy generation has been created mostly by climate change and economic concerns. To promote renewable energy installations, Indiana created the *Clean Energy Portfolio Standard* program in May 2011. This program sets a voluntary goal on electricity supply companies to produce 10% of their electricity from clean energy sources* by 2025.

Net metering

Indiana also has a program called *Net Metering* to support renewable energy expansion among residential, small business, schools, and industrial sectors. This program is applicable for utility customers who connect qualifying renewable generators to a utility's grid. When a renewable generator produces electricity, customers are credited for renewable electricity generation at the full retail rate (the retail price the customer pays for electricity). Customers are charged only for the "net" electricity [Net electricity=Electricity consumption (kWh) – Electricity production (kWh)] to the customer's next monthly bill. When customers are generating more electricity from their renewable generators than they are consuming, they are credited for the excess electricity [Excess electricity=Electricity production (kWh) – Electricity consumption (kWh)].

Tax incentives

Indiana also provides *property tax incentives* for systems that generate energy through solar, wind, hydropower or geothermal resources that are exempt from property tax. In addition, several incentives for the installation of renewable energy technologies have been established by the federal government. For example, residents of Indiana can receive 30% of *federal personal tax credit* for purchasing qualifying renewable energy systems and businesses in Indiana can receive *production tax credit* for generating electricity from qualifying renewable energy technologies.

Community conservation challenge

Indiana also established *Community Conservation Challenge (CCC)*, a grant program that offers funds for projects that demonstrate measurable improvements in renewable energy or energy efficiency. CCC grants provide a range of funding from $25,000 to $150,000. Eligible grantees include local units of government, school corporations, businesses, universities, and nonprofit agencies in Indiana.

**Clean energy technologies include wind; solar energy; photovoltaic cells and panels; dedicated crops grown for energy production; organic waste biomass; hydropower; fuel cells; hydrogen; energy from waste to energy facilities; energy storage systems or technologies; geothermal energy; coal bed methane; industrial byproduct technologies that use fuel or energy that is a byproduct of an industrial process; waste heat recovery from capturing and reusing the waste heat*

The renewable energy policy and incentives in Indiana is explained in page X.

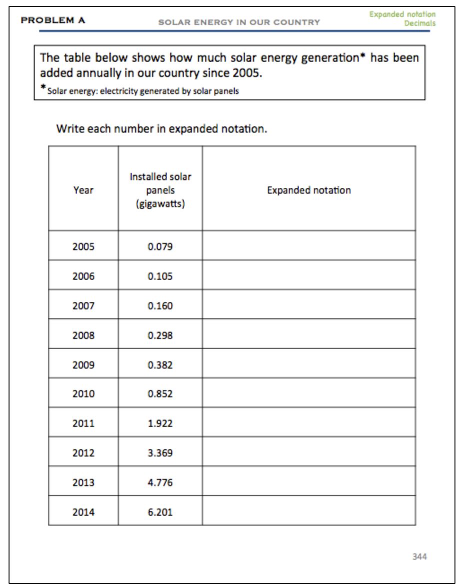
TEACHER GUIDE

The purpose of this activity is to enhance students' skills in decimal numbers, including naming, rounding, and addition and subtraction of decimal numbers (PROBLEMS A to C). PROBLEM D provides questions to strengthen students' skills in interpreting a bar graph. This activity uses information on how much solar PV capacity was added since 2000. Data was obtained from the US Energy information Administration and the Solar Energy Industries Association.

PROBLEM A

- *Expanded notation (decimal numbers)*

Using the numbers of how much solar PV capacity was added over the last ten years, students are asked to write expanded notation of each number.



PROBLEM A SOLAR ENERGY IN OUR COUNTRY Expanded notation Decimals

The table below shows how much solar energy generation* has been added annually in our country since 2005.
* Solar energy: electricity generated by solar panels

Write each number in expanded notation.

Year	Installed solar panels (gigawatts)	Expanded notation
2005	0.079	
2006	0.105	
2007	0.160	
2008	0.298	
2009	0.382	
2010	0.852	
2011	1.922	
2012	3.369	
2013	4.776	
2014	6.201	

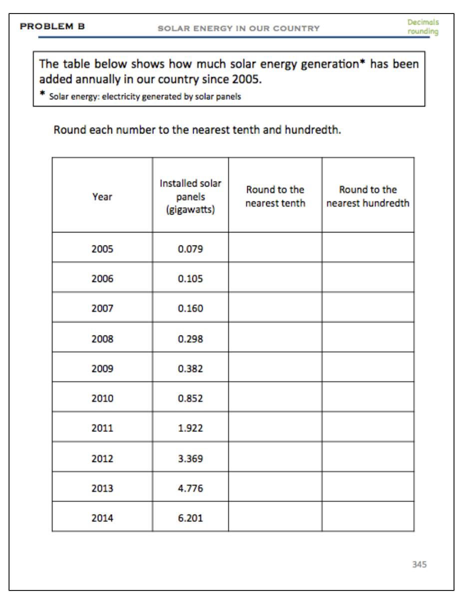
344

P 344—Student Sheet

PROBLEM B

- *Rounding (decimal numbers)*

Using the numbers of how much solar PV capacity was added over the last ten years, students are asked to round to the nearest tenth and hundredth.



PROBLEM B SOLAR ENERGY IN OUR COUNTRY Decimals rounding

The table below shows how much solar energy generation* has been added annually in our country since 2005.
* Solar energy: electricity generated by solar panels

Round each number to the nearest tenth and hundredth.

Year	Installed solar panels (gigawatts)	Round to the nearest tenth	Round to the nearest hundredth
2005	0.079		
2006	0.105		
2007	0.160		
2008	0.298		
2009	0.382		
2010	0.852		
2011	1.922		
2012	3.369		
2013	4.776		
2014	6.201		

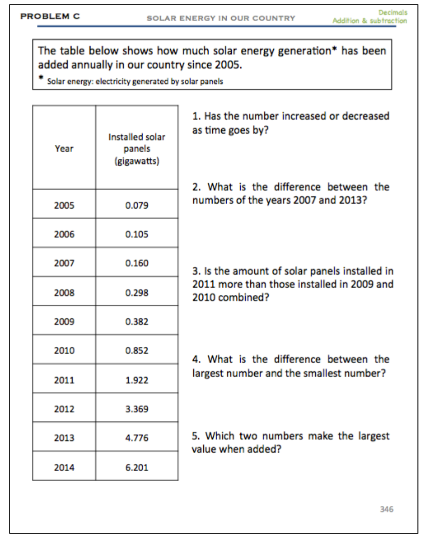
345

P 345—Student Sheet

PROBLEM C

- *Addition and subtraction (decimal numbers)*

Using the numbers of of how much solar PV capacity was added over the last ten years, students are asked to add and subtract decimal numbers.



PROBLEM C SOLAR ENERGY IN OUR COUNTRY Decimals Addition & subtraction

The table below shows how much solar energy generation* has been added annually in our country since 2005.
* Solar energy: electricity generated by solar panels

Year	Installed solar panels (gigawatts)
2005	0.079
2006	0.105
2007	0.160
2008	0.298
2009	0.382
2010	0.852
2011	1.922
2012	3.369
2013	4.776
2014	6.201

1. Has the number increased or decreased as time goes by?
2. What is the difference between the numbers of the years 2007 and 2013?
3. Is the amount of solar panels installed in 2011 more than those installed in 2009 and 2010 combined?
4. What is the difference between the largest number and the smallest number?
5. Which two numbers make the largest value when added?

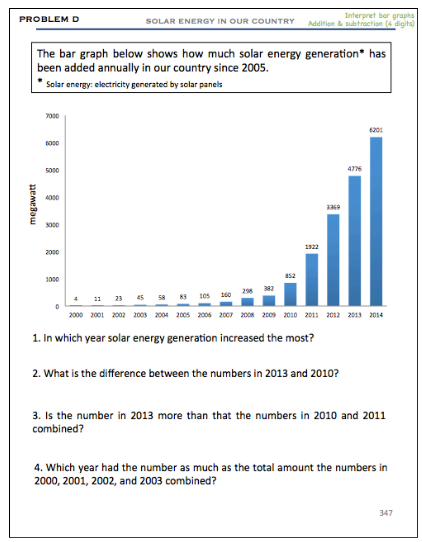
346

P 346—Student Sheet

PROBLEM D

- *Interpreting bar graphs*

Using the numbers of of how much solar PV capacity was added over the last ten years. Questions include, “ How much more solar energy were added in 2013 than in 2010?”



PROBLEM D SOLAR ENERGY IN OUR COUNTRY Interpret bar graphs Addition & subtraction (4 digits)

The bar graph below shows how much solar energy generation* has been added annually in our country since 2005.
* Solar energy: electricity generated by solar panels

1. In which year solar energy generation increased the most?
2. What is the difference between the numbers in 2013 and 2010?
3. Is the number in 2013 more than that the numbers in 2010 and 2011 combined?
4. Which year had the number as much as the total amount the numbers in 2000, 2001, 2002, and 2003 combined?

347

P 347—Student Sheet

The table below shows how much solar energy generation* has been added annually in our country since 2005.

* Solar energy: electricity generated by solar panels

Write each number in expanded notation.

Year	Installed solar panels (gigawatts)	Expanded notation
2005	0.079	
2006	0.105	
2007	0.160	
2008	0.298	
2009	0.382	
2010	0.852	
2011	1.922	
2012	3.369	
2013	4.776	
2014	6.201	

The table below shows how much solar energy generation* has been added annually in our country since 2005.

* Solar energy: electricity generated by solar panels

Round each number to the nearest tenth and hundredth.

Year	Installed solar panels (gigawatts)	Round to the nearest tenth	Round to the nearest hundredth
2005	0.079		
2006	0.105		
2007	0.160		
2008	0.298		
2009	0.382		
2010	0.852		
2011	1.922		
2012	3.369		
2013	4.776		
2014	6.201		

The table below shows how much solar energy generation* has been added annually in our country since 2005.

* Solar energy: electricity generated by solar panels

Year	Installed solar panels (gigawatts)
2005	0.079
2006	0.105
2007	0.160
2008	0.298
2009	0.382
2010	0.852
2011	1.922
2012	3.369
2013	4.776
2014	6.201

1. Has the number increased or decreased as time goes by?

2. What is the difference between the numbers of the years 2007 and 2013?

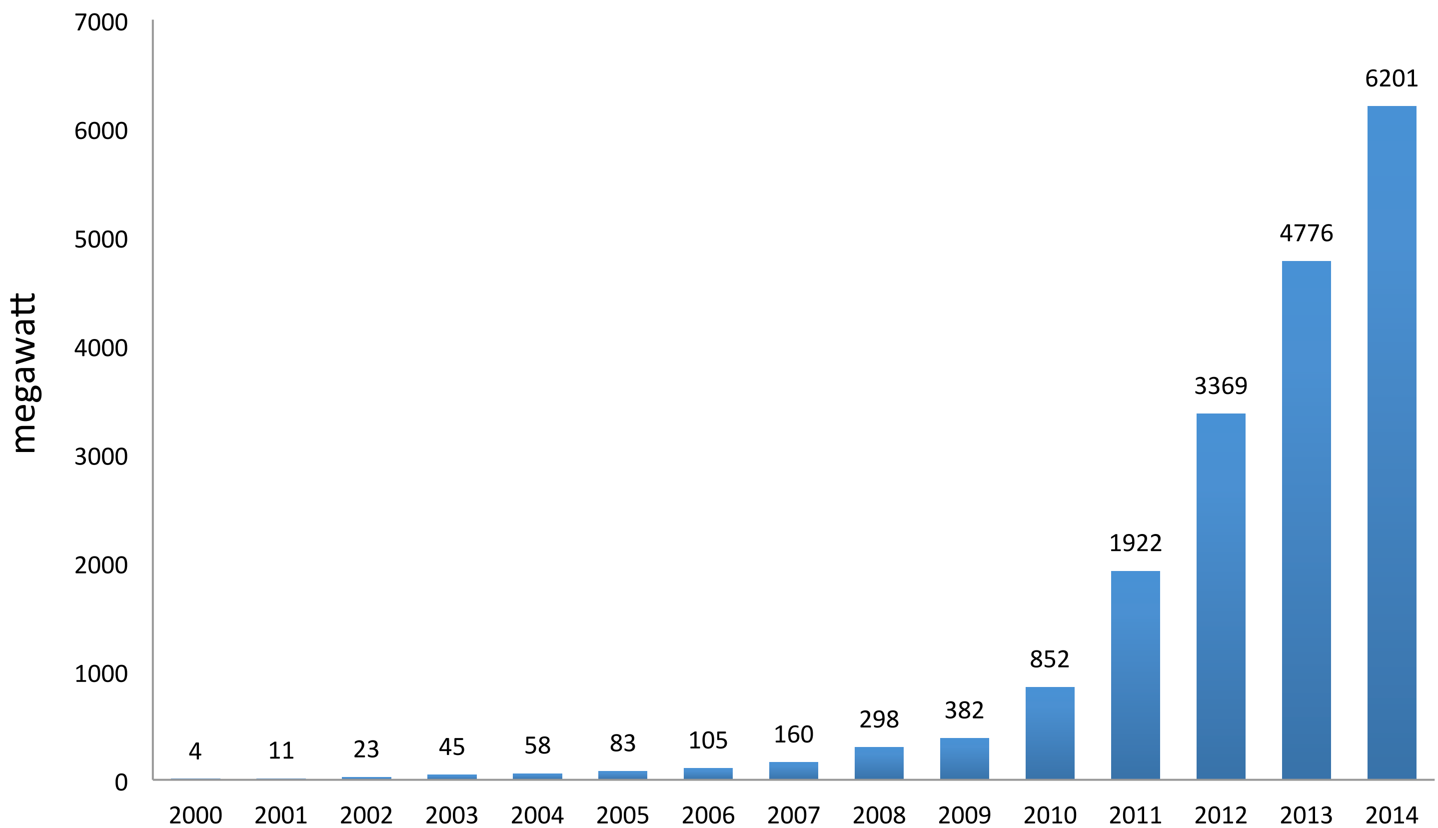
3. Is the amount of solar panels installed in 2011 more than those installed in 2009 and 2010 combined?

4. What is the difference between the largest number and the smallest number?

5. Which two numbers make the largest value when added?

The bar graph below shows how much solar energy generation* has been added annually in our country since 2005.

* Solar energy: electricity generated by solar panels



1. In which year solar energy generation increased the most?

2. What is the difference between the numbers in 2013 and 2010?

3. Is the number in 2013 more than that the numbers in 2010 and 2011 combined?

4. Which year had the number as much as the total amount the numbers in 2000, 2001, 2002, and 2003 combined?

PROBLEM 50

Number and Operations

G4 G5	Multiplication (2 digits x 2 digits)
G4 G5	Division (2 digits / 2 digits)

SOLAR POWER ON SWONDER

PURPOSE

Through this activity, **4th – 5th grade** students will

- Multiply 2-digit numbers—**PROBLEM A**
- Divide 2-digit numbers—**PROBLEM A**
- Understand renewable energy generation in Southwest Indiana
- Develop awareness of solar power generation

BACKGROUND FOR THE TEACHER

The Evansville Department of Sustainability, Energy & Environmental Quality (SEEQ) installed the first municipal renewable energy project in Evansville, installing solar photovoltaic (PV) panels on the roofs of the *Swonder Ice Arena (16.8kW) in 2012.* The Swonder solar panels are the largest array in the city and provide approximately *21,312 kWh of* electricity annually.

16.8 kW Solar system on Swonder Ice Arena, Evansville

More solar systems in the area of Evansville

5.6 kW Solar System at Ohio Township Public Library, Newburgh
(Installed by Morton Solar and Wind, LLC)

Solar system at Howell Wetlands
(Installed by USI students in 2009, Morton Solar and Wind, LLC, and Energy Systems Group partnered) Photo: Morton Solar and Wind, LLC

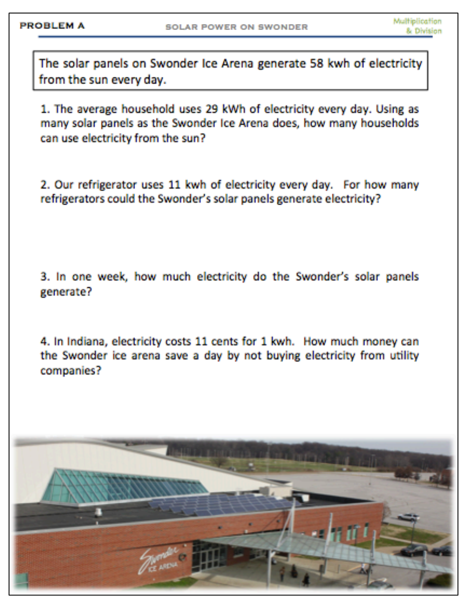
TEACHER GUIDE

The purpose of this activity is to enhance students' skills in multiplication and division. This activity uses the actual amount of solar electricity generation of Swonder Ice Arena. Data was obtained from the Evansville Department of Sustainability, Energy and Environmental Quality.

PROBLEM A

- *Multiplication (2-digit numbers)*
- *Division (2-digit numbers)*

Using the actual amount of electricity generation from solar panels on Swonder Ice Arena, students are asked to multiply and divide 2-digit numbers. Questions include, "Average household uses 29 kWh of electricity everyday. With the solar panels, how many households can use electricity from the sun? "



PROBLEM A SOLAR POWER ON SWONDER Multiplication & Division

The solar panels on Swonder Ice Arena generate 58 kwh of electricity from the sun every day.

1. The average household uses 29 kWh of electricity every day. Using as many solar panels as the Swonder Ice Arena does, how many households can use electricity from the sun?

2. Our refrigerator uses 11 kwh of electricity every day. For how many refrigerators could the Swonder's solar panels generate electricity?

3. In one week, how much electricity do the Swonder's solar panels generate?

4. In Indiana, electricity costs 11 cents for 1 kwh. How much money can the Swonder ice arena save a day by not buying electricity from utility companies?

P 350—Student Sheet

The solar panels on Swonder Ice Arena generate 58 kwh of electricity from the sun every day.

1. The average household uses 29 kWh of electricity every day. Using as many solar panels as the Swonder Ice Arena does, how many households can use electricity from the sun?

2. Our refrigerator uses 11 kwh of electricity every day. For how many refrigerators could the Swonder's solar panels generate electricity?

3. In one week, how much electricity do the Swonder's solar panels generate?

4. In Indiana, electricity costs 11 cents for 1 kwh. How much money can the Swonder ice arena save a day by not buying electricity from utility companies?

PROBLEM 51

Data Analysis

G3 G4 G5

Bar graphs (up to 1,500)

Comparing 2 bar graphs

SOLAR POWER AT VANDERBURGH PUBLIC LIBRARY

PURPOSE

Through this activity, **3rd – 5th grade** students will

- Interpret bar graphs (up to 1,500)—**PROBLEM A**
- Compare 2 bar graphs—**PROBLEM B**
- Develop awareness of solar power generation

BACKGROUND FOR THE TEACHER

A 10 kilowatt solar photovoltaic (PV) system was installed on the roof of the Vanderburgh Central Library in 2010. The purchase and installation of the system was funded, in part, by a matching grant of nearly $43,000 from Indiana's Office of Energy Development. The library was the recipient of one of 12 alternative power and energy grants totaling nearly $389,000 statewide to promote renewable energy. The awards were part of a competitive grant program offered in late 2009.

10 kW Solar system on Evansville Vanderburgh Public Library, Evansville

The installation of the 60 PV panels has not only reduced energy costs by about $1,300 but also has reduced the amount of greenhouse gas emissions. The amount of carbon offset is the equivalent of about 185 trees planted.

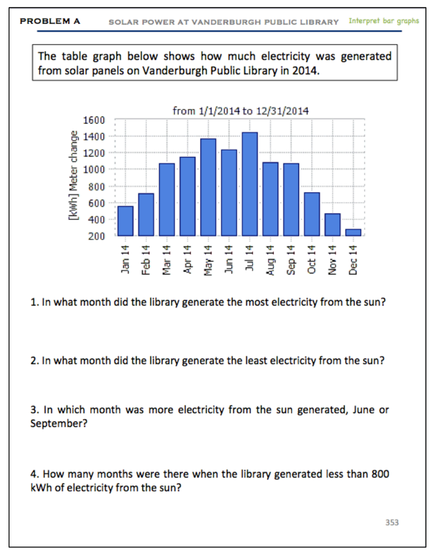
TEACHER GUIDE

The purpose of this activity is to enhance students' skills in reading a bar graph (PROBLEM A) and comparing two bar graphs (PROBLEM B). This activity uses the actual amount of solar electricity generation of the Evansville Vanderburgh Public Library in 2012 and 2014. The data was obtained from the site operational data prepared by Sunny Portal.

PROBLEM A

- *Interpreting bar graphs*

Using a bar graph on solar electricity generation from the Evansville Vanderburgh Public Library in 2014, students are asked to read the graph Questions include, "In which month was more electricity generated from the sun, June or September?"


PROBLEM A SOLAR POWER AT VANDERBURGH PUBLIC LIBRARY Interpret bar graphs

The table graph below shows how much electricity was generated from solar panels on Vanderburgh Public Library in 2014.

1. In what month did the library generate the most electricity from the sun?

2. In what month did the library generate the least electricity from the sun?

3. In which month was more electricity from the sun generated, June or September?

4. How many months were there when the library generated less than 800 kWh of electricity from the sun?

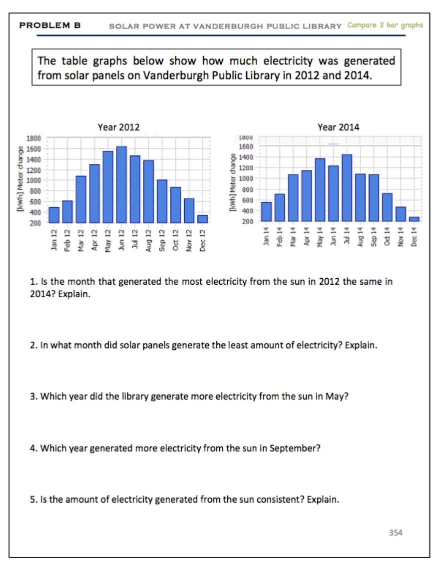
353

P 353—Student Sheet

PROBLEM B

- *Comparing 2 bar graphs*

Using 2 bar graphs on solar electricity generation from the Evansville Vanderburgh Public Library in 2012 and 2014, students are asked to compare the graphs. Questions include, "During which year was more electricity generated from the sun in September?"


PROBLEM B SOLAR POWER AT VANDERBURGH PUBLIC LIBRARY Compare 2 bar graphs

The table graphs below show how much electricity was generated from solar panels on Vanderburgh Public Library in 2012 and 2014.

1. Is the month that generated the most electricity from the sun in 2012 the same in 2014? Explain.

2. In what month did solar panels generate the least amount of electricity? Explain.

3. Which year did the library generate more electricity from the sun in May?

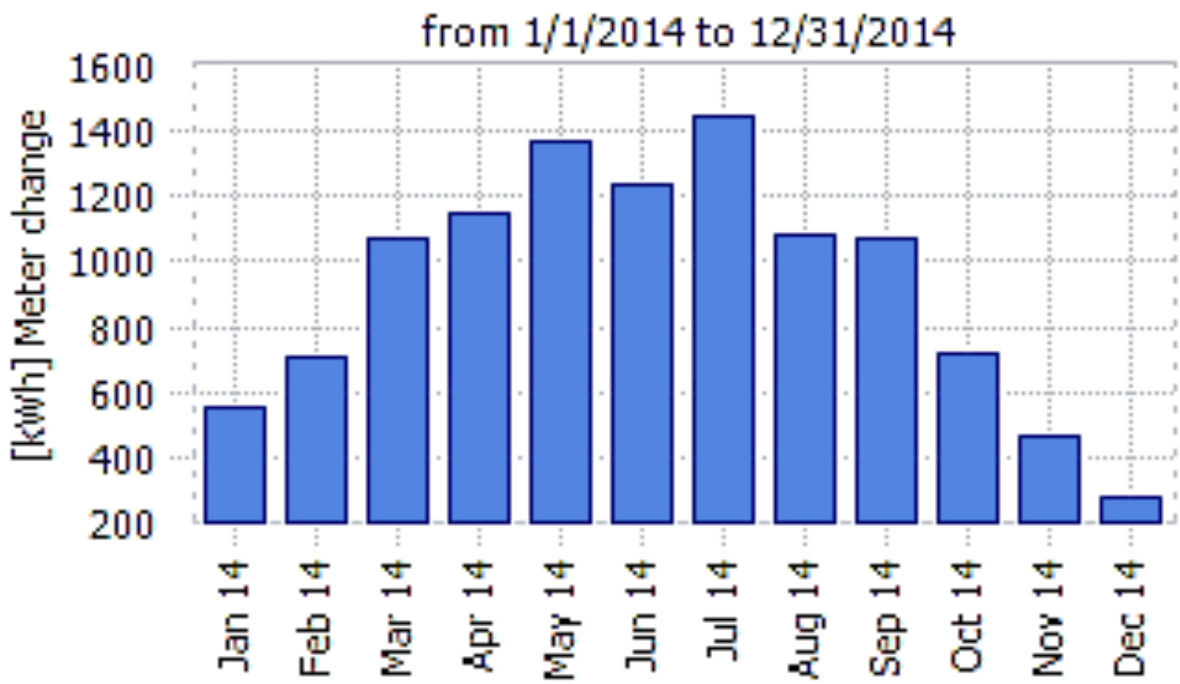
4. Which year generated more electricity from the sun in September?

5. Is the amount of electricity generated from the sun consistent? Explain.

354

P 354—Student Sheet

The table graph below shows how much electricity was generated from solar panels on Vanderburgh Public Library in 2014.



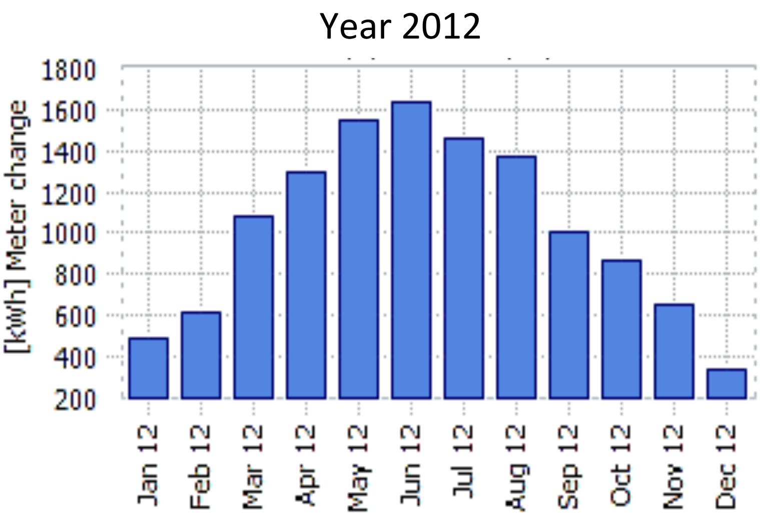
1. In what month did the library generate the most electricity from the sun?

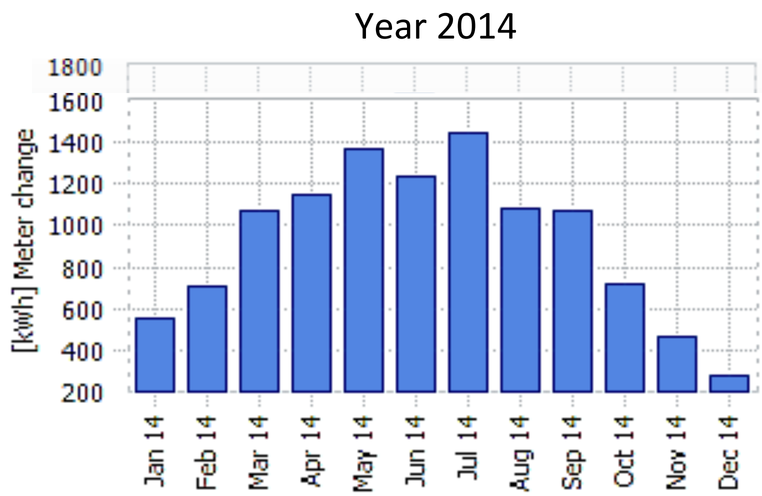
2. In what month did the library generate the least electricity from the sun?

3. In which month was more electricity from the sun generated, June or September?

4. How many months were there when the library generated less than 800 kWh of electricity from the sun?

The table graphs below show how much electricity was generated from solar panels on Vanderburgh Public Library in 2012 and 2014.





1. Is the month that generated the most electricity from the sun in 2012 the same in 2014? Explain.

2. In what month did solar panels generate the least amount of electricity? Explain.

3. Which year did the library generate more electricity from the sun in May?

4. Which year generated more electricity from the sun in September?

5. Is the amount of electricity generated from the sun consistent? Explain.

PROBLEM 52

Number and Operations

G4-5	Addition (3digits)
G4-5	Subtraction (4 digits)

Data Analysis

G4-5	Line graphs (4 digits)
G4-5	Bar graphs (3 digits)

OUR WIND POWER

PURPOSE

Through this activity, **4th – 5th grade** students will

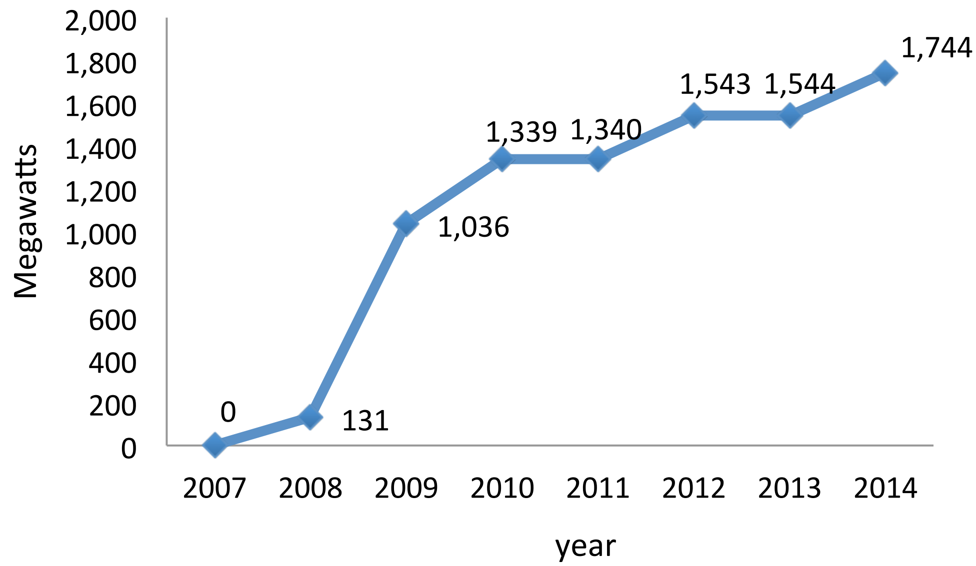
- Interpret line graphs (4 digits)—**PROBLEM A**
- Interpret bar graphs (3 digits)**—PROBLEM C**
- Subtract 4-digit numbers—**PROBLEM B**
- Add 3-digit numbers**—PROBLEM C**
- Develop awareness of wind power generation in Indiana

BACKGROUND FOR THE TEACHER

Wind power in the Unites States has developed quickly over the last decade and has led the world in power generation capacity along with China. Wind power generation in Indiana started in 2008 with construction of Indiana's first utility-scale wind power facility called Goodland. Capacity increased eightfold in 2009, with the construction of three more wind farms, Fowler Ridge, Meadow Lake, and Hoosier. Fowler Ridge is the largest wind farm in the Midwest and one of the largest farms in the world. These additions supported 3,000 to 4,000 jobs in Indiana.


Fowler Ridge wind farm, IN

Indiana ranks 12th in the United States in wind power generation and has the 5th highest density of wind generation capacity in the United States. Most of the suitable sites to develop wind power are located in the northern part of Indiana.



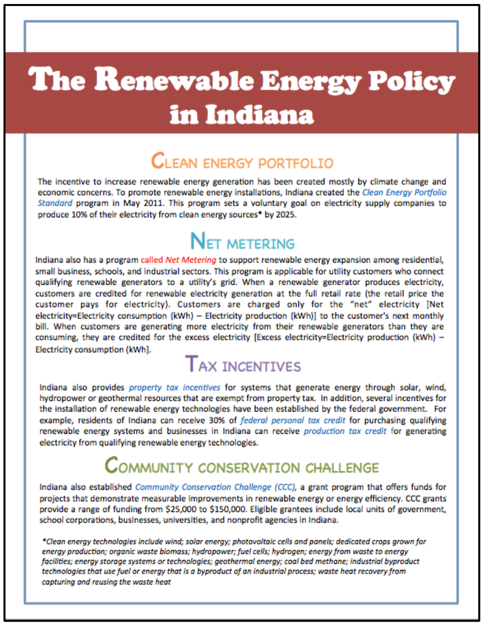
Total wind power capacity in Indiana
(Source: U.S. Department of Energy)

Haubstadt Community Wind Turbine Project, Gibson County

In 2008-2009, Mrs. Donya Bengert's 3rd grade class was studying renewable and nonrenewable energy sources. The students had an idea to purchase and install a wind turbine at Haubstadt School in Gibson County. The intent of their project was not only to generate electricity for the school, but also to raise awareness within the school and community about alternative energy sources.

The class took their idea to the Superintendent and the School Board for approval. They designed and gave a presentation to the South Gibson School Board in January 2009. The class worked hard, raising money by holding a school-wide student campaign and asking for donations from local businesses. They received a $10,000 grant from Toyota Motors Manufacturing, $1,500 from Alcoa, and an additional $12,500 from the Indiana Office of Energy Development.

In May, 2010 the wind turbine was installed and is currently fully operational. It has a monitoring system linked to the classroom so that students can track wind speed and energy generated on a daily basis. The turbine and its monitoring system are used to teach math, social studies and science topics.



The Renewable Energy Policy in Indiana

Clean energy portfolio

The incentive to increase renewable energy generation has been created mostly by climate change and economic concerns. To promote renewable energy installations, Indiana created the *Clean Energy Portfolio Standard* program in May 2011. This program sets a voluntary goal on electricity supply companies to produce 10% of their electricity from clean energy sources* by 2025.

Net metering

Indiana also has a program called *Net Metering* to support renewable energy expansion among residential, small business, schools, and industrial sectors. This program is applicable for utility customers who connect qualifying renewable generators to a utility's grid. When a renewable generator produces electricity, customers are credited for renewable electricity generation at the full retail rate (the retail price the customer pays for electricity). Customers are charged only for the "net" electricity [Net electricity=Electricity consumption (kWh) – Electricity production (kWh)] to the customer's next monthly bill. When customers are generating more electricity from their renewable generators than they are consuming, they are credited for the excess electricity [Excess electricity=Electricity production (kWh) – Electricity consumption (kWh)].

Tax incentives

Indiana also provides *property tax incentives* for systems that generate energy through solar, wind, hydropower or geothermal resources that are exempt from property tax. In addition, several incentives for the installation of renewable energy technologies have been established by the federal government. For example, residents of Indiana can receive 30% of *federal personal tax credit* for purchasing qualifying renewable energy systems and businesses in Indiana can receive *production tax credit* for generating electricity from qualifying renewable energy technologies.

Community conservation challenge

Indiana also established *Community Conservation Challenge (CCC)*, a grant program that offers funds for projects that demonstrate measurable improvements in renewable energy or energy efficiency. CCC grants provide a range of funding from $25,000 to $150,000. Eligible grantees include local units of government, school corporations, businesses, universities, and nonprofit agencies in Indiana.

**Clean energy technologies include wind; solar energy; photovoltaic cells and panels; dedicated crops grown for energy production; organic waste biomass; hydropower; fuel cells; hydrogen; energy from waste to energy facilities; energy storage systems or technologies; geothermal energy; coal bed methane; industrial byproduct technologies that use fuel or energy that is a byproduct of an industrial process; waste heat recovery from capturing and reusing the waste heat*

Renewable energy policy and incentives in Indiana are explained in page 281.

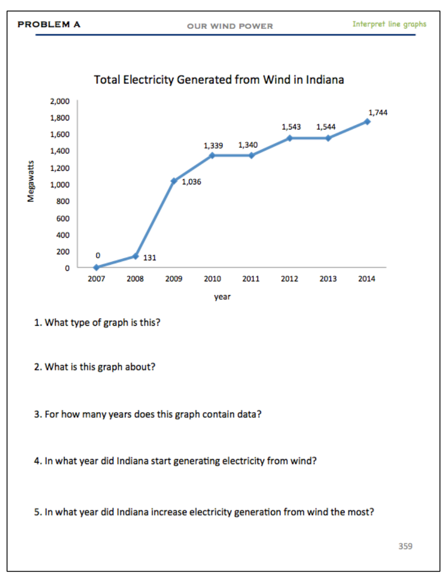
TEACHER GUIDE

The purpose of this activity is to enhance students' skills in reading line graphs with 4-digit numbers (PROBLEMS A & B) and bar graphs with 3-digit numbers (PROBLEM C). This activity uses the actual amount of wind power capacity in Indiana since 2007. The data was obtained from the [U.S. Department of Energy].

PROBLEM A

- *Interpreting line graphs*

Using a line graph that shows total wind power capacity in Indiana between 2007 and 2014, students are asked to find out what the graph is trying to show. Questions include, "In what year did Indiana increase electricity generation from wind the most?"



1. What type of graph is this?
2. What is this graph about?
3. For how many years does this graph contain data?
4. In what year did Indiana start generating electricity from wind?
5. In what year did Indiana increase electricity generation from wind the most?

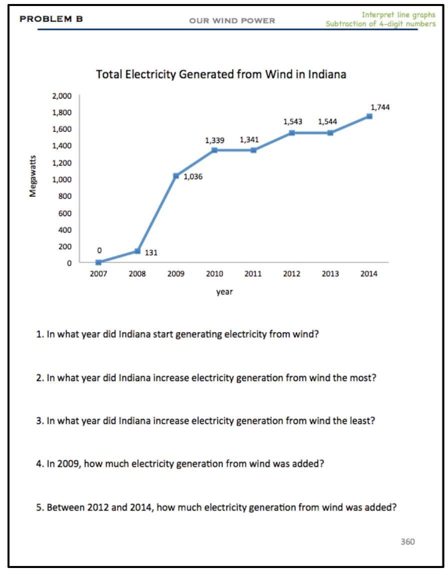
359

P 359—Student Sheet

PROBLEM B

- *Interpreting line graphs*
- *Subtraction (4-digit numbers)*

Using a line graph that shows the total wind power capacity in Indiana between 2007 and 2014, students are asked to find out what the graph is trying to show. Questions include, “Between 2012 and 2014, how much electricity generation from wind was added?”

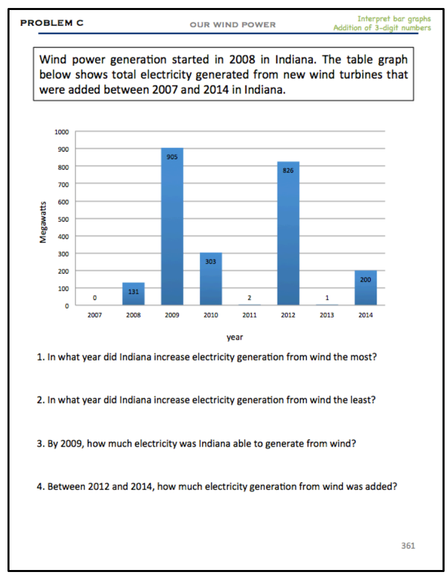


P 360—Student Sheet

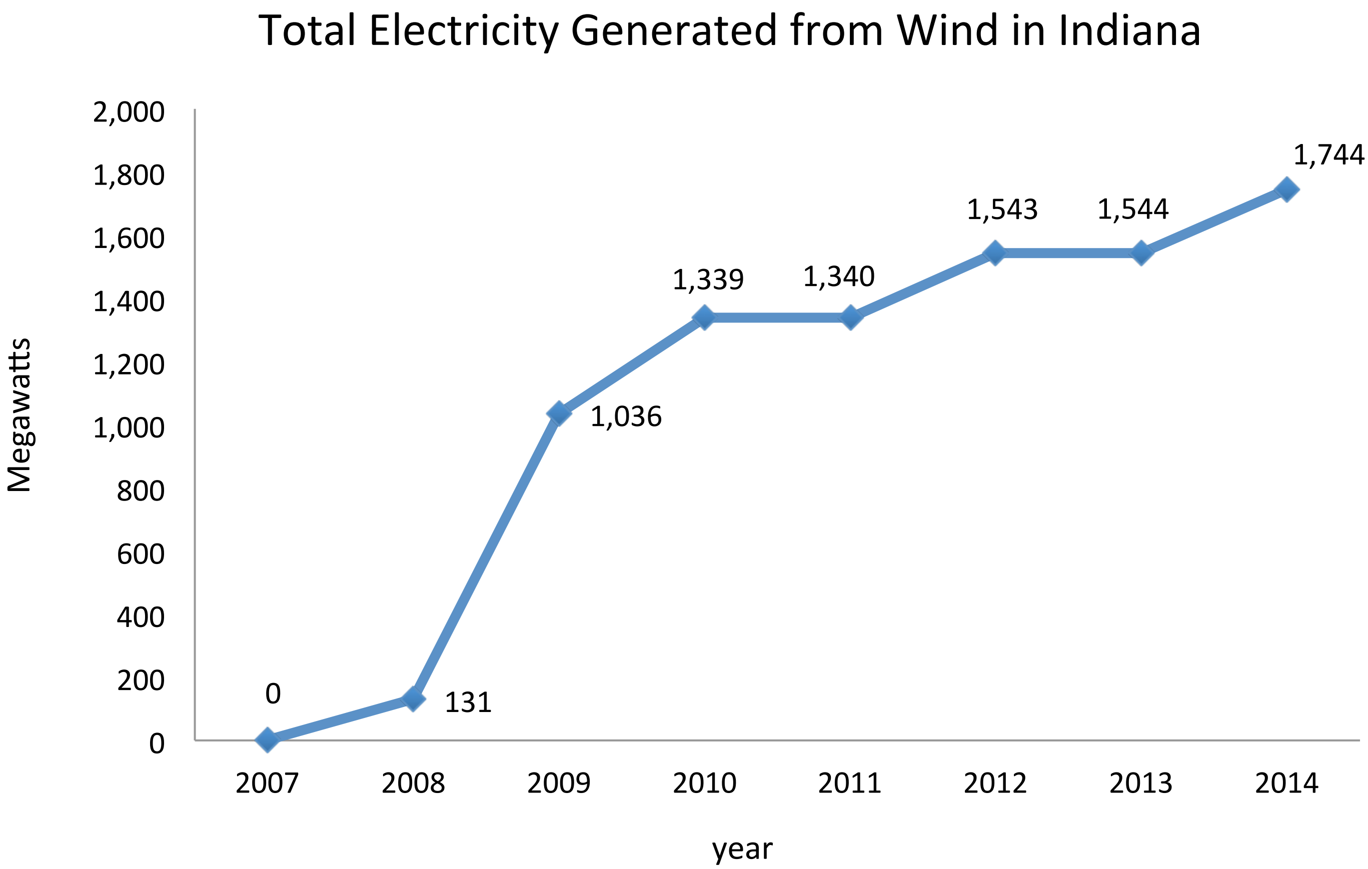
PROBLEM C

- *Interpreting bar graphs*
- *Addition(3-digit numbers)*

Using a bar graph that shows total wind power capacity in Indiana between 2007 and 2014, students are asked to read the graph. Questions include “By 2009, how much electricity was Indiana able to generate from wind?”



P 361—Student Sheet



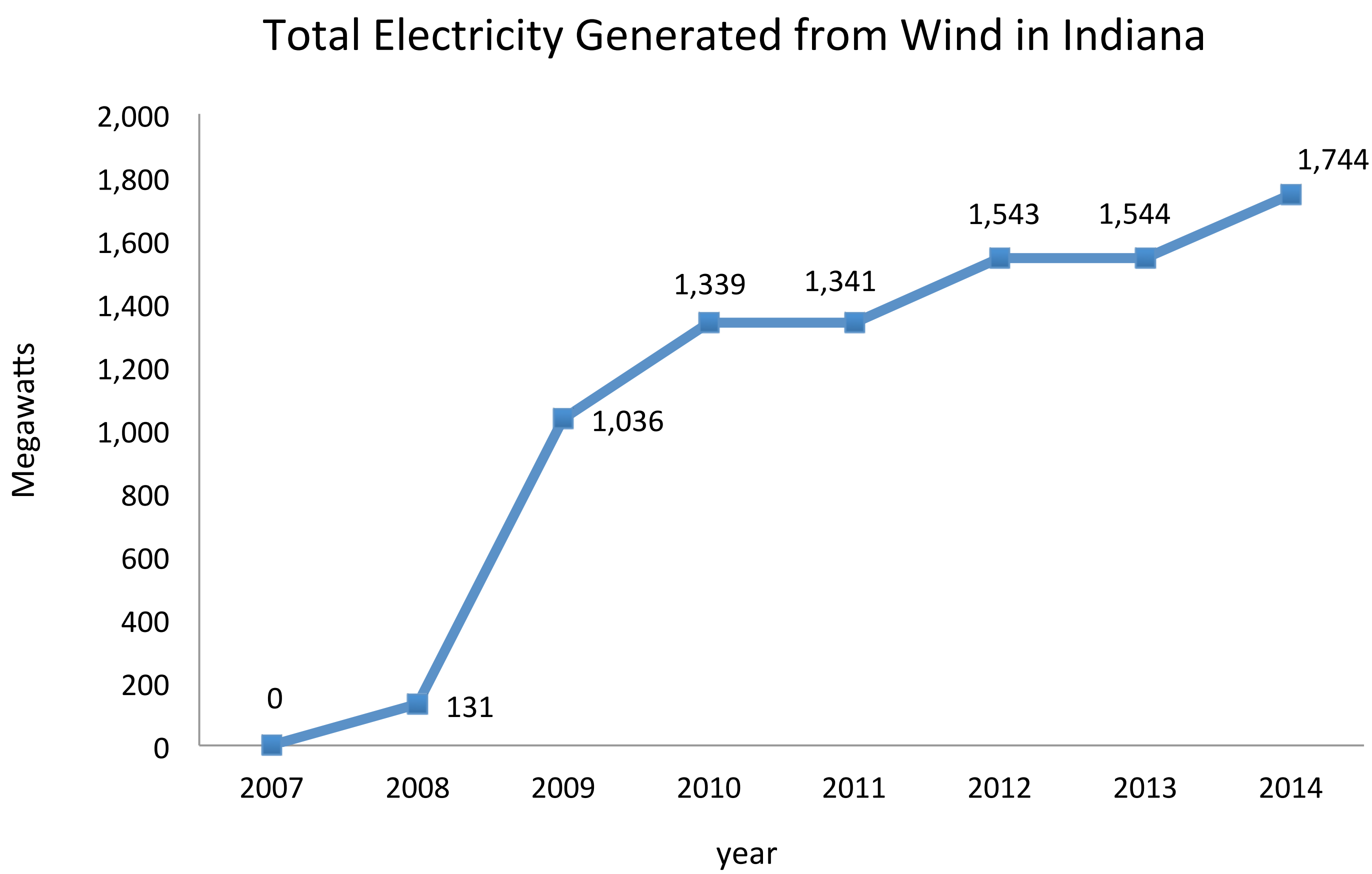
1. What type of graph is this?

2. What is this graph about?

3. For how many years does this graph contain data?

4. In what year did Indiana start generating electricity from wind?

5. In what year did Indiana increase electricity generation from wind the most?



1. In what year did Indiana start generating electricity from wind?

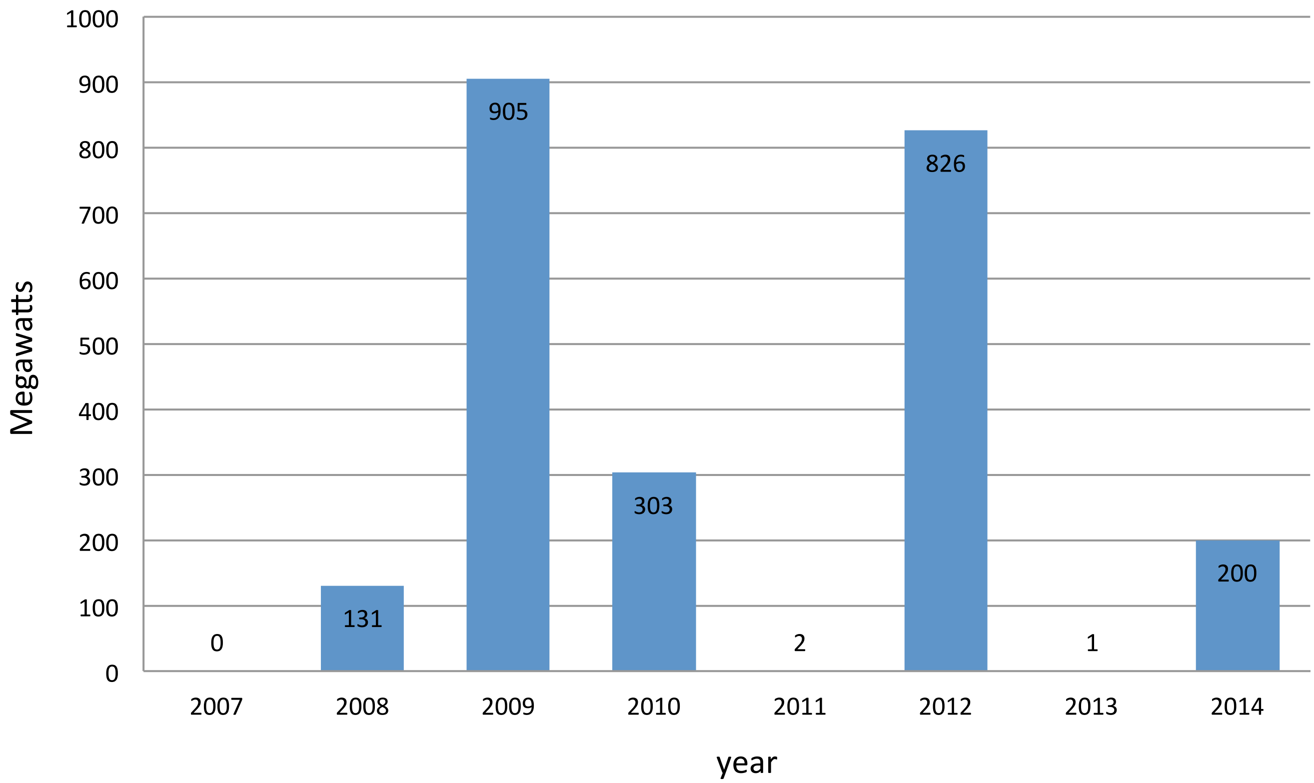
2. In what year did Indiana increase electricity generation from wind the most?

3. In what year did Indiana increase electricity generation from wind the least?

4. In 2009, how much electricity generation from wind was added?

5. Between 2012 and 2014, how much electricity generation from wind was added?

Wind power generation started in 2008 in Indiana. The table graph below shows total electricity generated from new wind turbines that were added between 2007 and 2014 in Indiana.



1. In what year did Indiana increase electricity generation from wind the most?

2. In what year did Indiana increase electricity generation from wind the least?

3. By 2009, how much electricity was Indiana able to generate from wind?

4. Between 2012 and 2014, how much electricity generation from wind was added?

Data Analysis

G4
G5

Line graphs with 2 series

WIND RACE: U.S. vs. CHINA

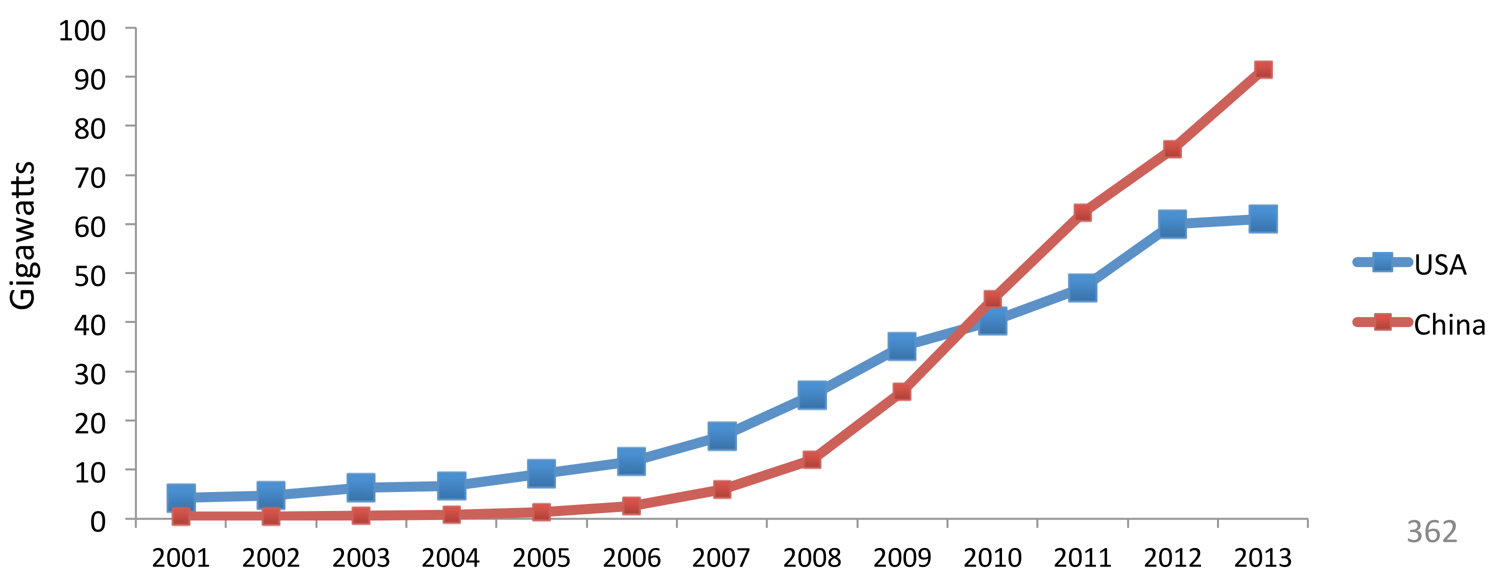
PURPOSE

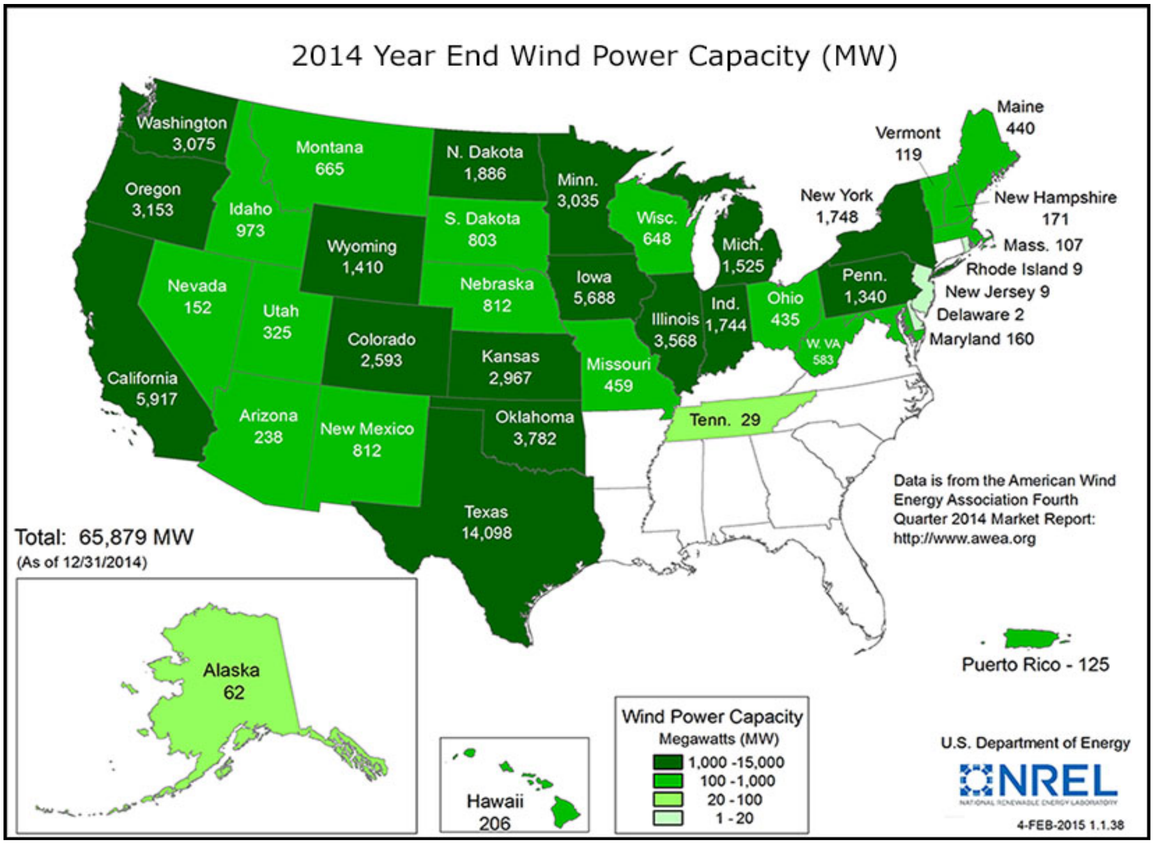
Through this activity, **4th– 5th grade** students will

- Interpret line graphs with 2 series—**PROBLEM A**
- Develop awareness of wind power generation in our country

BACKGROUND FOR THE TEACHER

The United States and China are the two countries with the largest wind power generation capacity in the world. Our nation had the world's largest wind power capacity in the 2000s. However, its capacity was surpassed by China in 2010. Together, our country and China produce nearly half of the world's wind energy.





Source: [*U.S. Department of Energy*]()

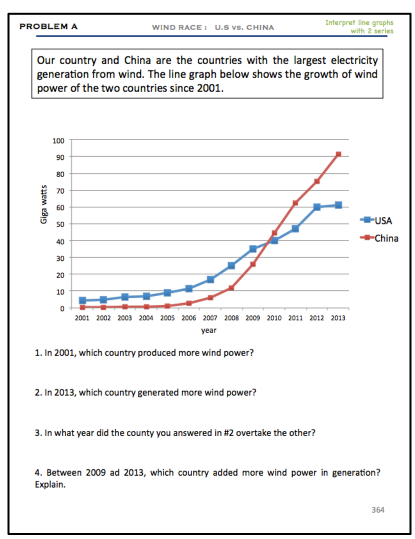
TEACHER GUIDE

The purpose of this activity is to enhance students' skills in interpreting line graphs with 2 series. The graph compares wind power capacity in our country and China between 2001 and 2013. The data was obtained from the *Global Wind Report 2013* prepared by the [Global Wind Energy Council]() and [U.S. Department of Energy]().

PROBLEM A

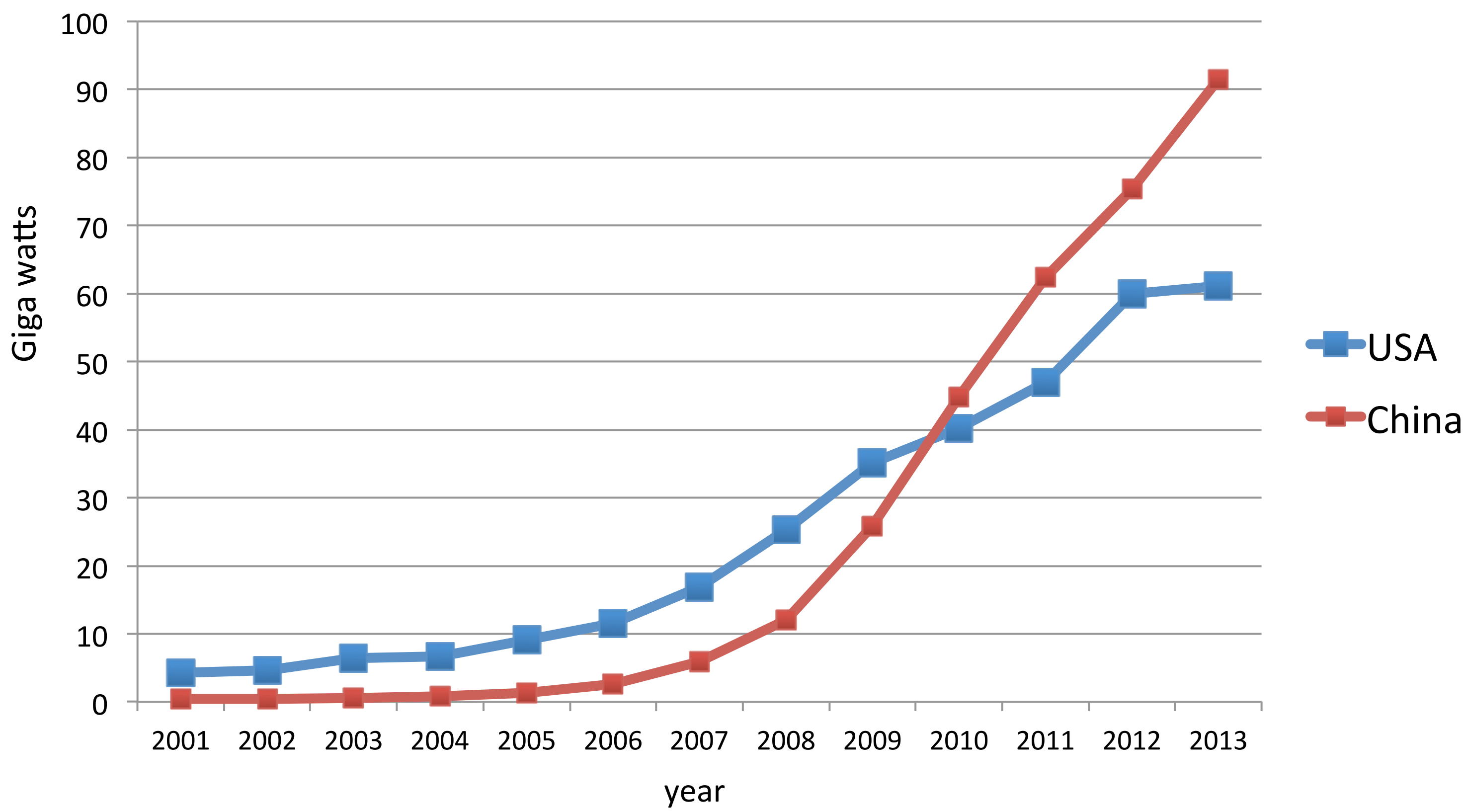
- *Interpreting line graphs with 2 series*

Using a line graph that shows total wind power capacity in Indiana between 2007 and 2014, students are asked to find out what the graph is trying to show. Questions include, "In what year did Indiana increase electricity generation from wind the most?"



P 364—Student Sheet

Our country and China are the countries with the largest electricity generation from wind. The line graph below shows the growth of wind power of the two countries since 2001.



1. In 2001, which country produced more wind power?

2. In 2013, which country generated more wind power?

3. In what year did the county you answered in #2 overtake the other?

4. Between 2009 ad 2013, which country added more wind power in generation? Explain.

Number & Operations

G3 G4	Number comparison (up to 1,000)
G3 G4	Addition and subtraction (up to 1,000)
G5	Multiplication and division (large numbers)

WHAT IS THE BIGGEST ELECTRICITY EATER IN YOUR HOUSE?

PURPOSE

Through this activity, **3rd – 4th grade** students will

- Compare large numbers (up to 1,000)—**PROBLEM A**
- Add and subtract large numbers (up to 1,000)—**PROBLEM B**
- Understand the electricity consumption of household appliances
- Develop awareness of our energy use

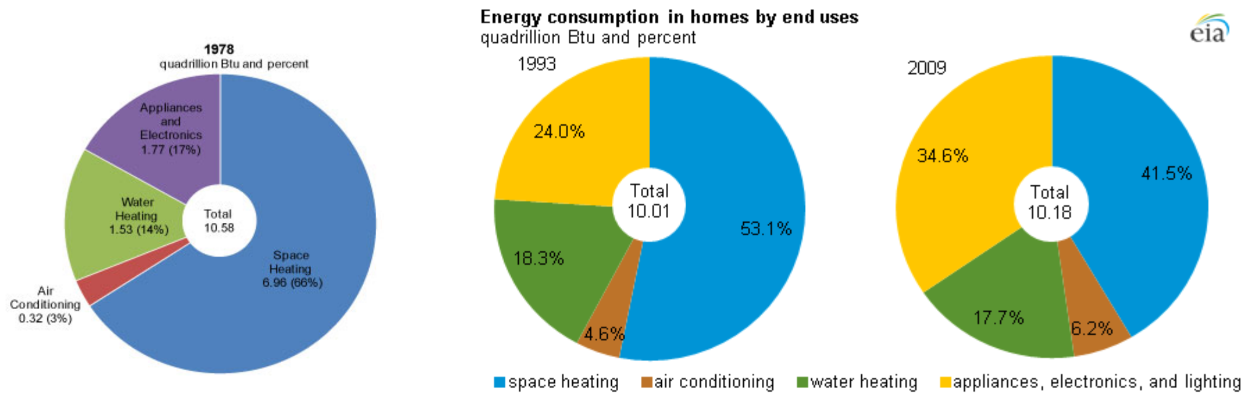
Through this activity, **5th grade** students will

- Multiply and divide large numbers—**PROBLEM C**
- Understand the electricity consumption of household appliances
- Develop awareness of our energy use

BACKGROUND FOR THE TEACHER

About half of total energy consumed at home is used for space heating and air conditioning, while about one-third of energy is used for running household appliances. Due to efficiency improvements in heating homes, electricity use for space heating has significantly declined over the last 30 years.

On the other hand, electricity use for appliances has expanded, increasing by about 18%, during the same period. This comes from the fact that people have started using more electronics, such as personal computers, TV, and related devices, at home. The efficiency of most home appliances has improved; however, increased use of electronics has resulted in offsetting the efficiency gains of household appliances (US [EIA](EIA)).



Trends of household electricity consumption by end uses
Source: U.S. Energy Information Administration

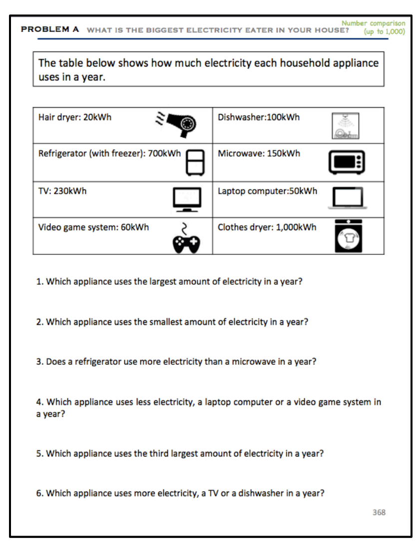
TEACHER GUIDE

The purpose of this activity is to enhance students' skills in number comparison (PROBLEM A), addition/subtraction (PROBLEM B), and multiplication and division (PROBLEM C) of large numbers. This activity uses typical amounts of electricity usage of household appliances in a year. The data was obtained from the Office of Sustainability, Indiana University.

PROBLEM A

- *Number comparison (up to 1,000)*

Using typical amounts of electricity usage of household appliances in a year, students are asked to compare two large numbers (ranging from 20 to 1,000). Questions include, "Which appliance uses less electricity, a laptop computer or a video game system in a year?"



PROBLEM A WHAT IS THE BIGGEST ELECTRICITY EATER IN YOUR HOUSE? Number comparison (up to 1,000)

The table below shows how much electricity each household appliance uses in a year.

Hair dryer: 20kWh	Dishwasher:100kWh
Refrigerator (with freezer): 700kWh	Microwave: 150kWh
TV: 230kWh	Laptop computer:50kWh
Video game system: 60kWh	Clothes dryer: 1,000kWh

1. Which appliance uses the largest amount of electricity in a year?
2. Which appliance uses the smallest amount of electricity in a year?
3. Does a refrigerator use more electricity than a microwave in a year?
4. Which appliance uses less electricity, a laptop computer or a video game system in a year?
5. Which appliance uses the third largest amount of electricity in a year?
6. Which appliance uses more electricity, a TV or a dishwasher in a year?

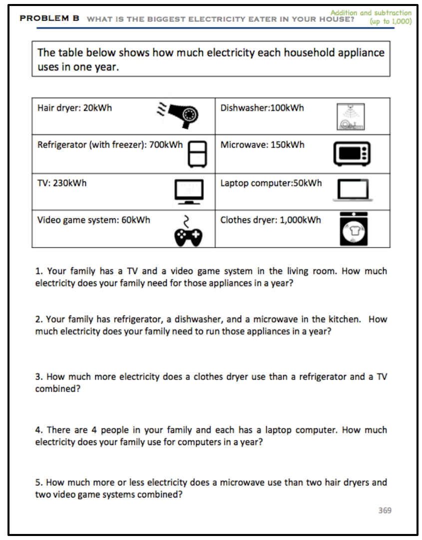
368

P 368—Student Sheet

PROBLEM B

- *Addition and subtraction (up to 1,000)*

Using typical amounts of electricity usage by household appliances in a year, students are asked to find the electricity usage of 2-3 appliances combined and the difference between 2 appliances' electricity use. Questions include, "Your family has a TV and a video game system in the living room. How much electricity does your family need for those appliances in a year?"



PROBLEM B WHAT IS THE BIGGEST ELECTRICITY EATER IN YOUR HOUSE? Addition and subtraction (up to 1,000)

The table below shows how much electricity each household appliance uses in one year.

Hair dryer: 20kWh	Dishwasher:100kWh
Refrigerator (with freezer): 700kWh	Microwave: 150kWh
TV: 230kWh	Laptop computer:50kWh
Video game system: 60kWh	Clothes dryer: 1,000kWh

1. Your family has a TV and a video game system in the living room. How much electricity does your family need for those appliances in a year?

2. Your family has refrigerator, a dishwasher, and a microwave in the kitchen. How much electricity does your family need to run those appliances in a year?

3. How much more electricity does a clothes dryer use than a refrigerator and a TV combined?

4. There are 4 people in your family and each has a laptop computer. How much electricity does your family use for computers in a year?

5. How much more or less electricity does a microwave use than two hair dryers and two video game systems combined?

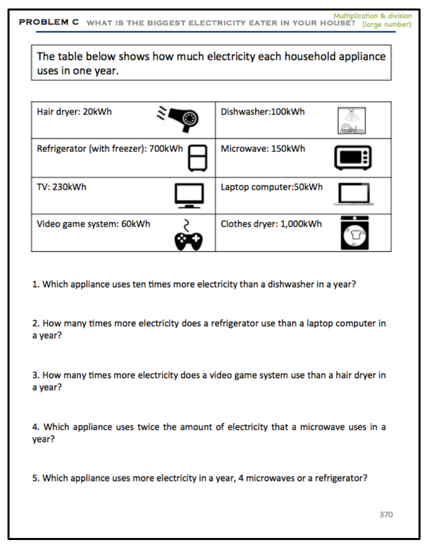
369

P 369—Student Sheet

PROBLEM C

- *Multiplication and division (large numbers)*

Using typical amounts of electricity usage by household appliances in a year, students are asked to find out how many times more electricity one appliance uses than the other. Questions include, "How many times more electricity does a refrigerator (with freezer) use than a laptop computer in a year?"



PROBLEM C WHAT IS THE BIGGEST ELECTRICITY EATER IN YOUR HOUSE? Multiplication & division (large number)

The table below shows how much electricity each household appliance uses in one year.

Hair dryer: 20kWh	Dishwasher:100kWh
Refrigerator (with freezer): 700kWh	Microwave: 150kWh
TV: 230kWh	Laptop computer:50kWh
Video game system: 60kWh	Clothes dryer: 1,000kWh

1. Which appliance uses ten times more electricity than a dishwasher in a year?

2. How many times more electricity does a refrigerator use than a laptop computer in a year?

3. How many times more electricity does a video game system use than a hair dryer in a year?

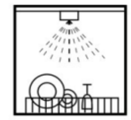
4. Which appliance uses twice the amount of electricity that a microwave uses in a year?

5. Which appliance uses more electricity in a year, 4 microwaves or a refrigerator?

370

P 370—Student Sheet

The table below shows how much electricity each household appliance uses in a year.

Hair dryer: 20kWh 	Dishwasher:100kWh 
Refrigerator (with freezer): 700kWh 	Microwave: 150kWh 
TV: 230kWh 	Laptop computer:50kWh 
Video game system: 60kWh 	Clothes dryer: 1,000kWh 

1. Which appliance uses the largest amount of electricity in a year?

2. Which appliance uses the smallest amount of electricity in a year?

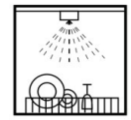
3. Does a refrigerator use more electricity than a microwave in a year?

4. Which appliance uses less electricity, a laptop computer or a video game system in a year?

5. Which appliance uses the third largest amount of electricity in a year?

6. Which appliance uses more electricity, a TV or a dishwasher in a year?

The table below shows how much electricity each household appliance uses in one year.

Hair dryer: 20kWh 	Dishwasher:100kWh 
Refrigerator (with freezer): 700kWh 	Microwave: 150kWh 
TV: 230kWh 	Laptop computer:50kWh 
Video game system: 60kWh 	Clothes dryer: 1,000kWh 

1. Your family has a TV and a video game system in the living room. How much electricity does your family need for those appliances in a year?

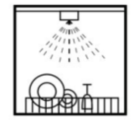
2. Your family has refrigerator, a dishwasher, and a microwave in the kitchen. How much electricity does your family need to run those appliances in a year?

3. How much more electricity does a clothes dryer use than a refrigerator and a TV combined?

4. There are 4 people in your family and each has a laptop computer. How much electricity does your family use for computers in a year?

5. How much more or less electricity does a microwave use than two hair dryers and two video game systems combined?

The table below shows how much electricity each household appliance uses in one year.

Hair dryer: 20kWh 	Dishwasher:100kWh 
Refrigerator (with freezer): 700kWh 	Microwave: 150kWh 
TV: 230kWh 	Laptop computer:50kWh 
Video game system: 60kWh 	Clothes dryer: 1,000kWh 

1. Which appliance uses ten times more electricity than a dishwasher in a year?

2. How many times more electricity does a refrigerator use than a laptop computer in a year?

3. How many times more electricity does a video game system use than a hair dryer in a year?

4. Which appliance uses twice the amount of electricity that a microwave uses in a year?

5. Which uses more electricity in a year, 4 microwaves or a refrigerator?

PROBLEM 55

Number & Operations

G4 Multiplication
G5 (large numbers)

HOW MUCH ENERGY & MONEY DO NEW LIGHT BULBS SAVE?

PURPOSE

Through this activity, **4th– 5th grade** students will

- Multiply large numbers —**PROBLEM A, B & C**
- Understand how much electricity and money they can save by changing light bulbs to energy saving ones
- Develop awareness of energy conservation

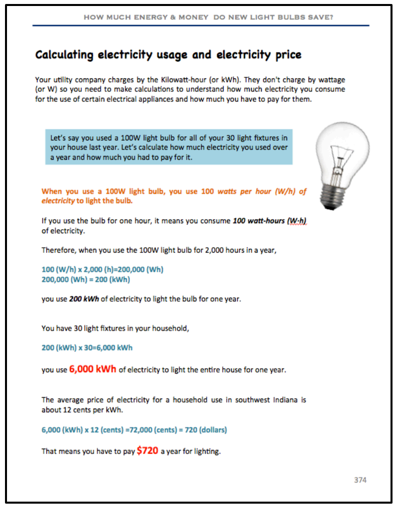
BACKGROUND FOR THE TEACHER

Replacing light bulbs from incandescent light bulbs to compact fluorescent bulbs is one of the easiest ways to reduce electricity use. Compact fluorescent light bulbs can convert electrical energy into useful light much more efficiently than incandescent bulbs and have several times the luminous efficacy of an incandescent bulb with comparable light output. Moreover, compact fluorescent light bulbs last 10 to 20 times as long as equivalent incandescent lamps.

The typical household has 30 light fixtures and uses lighting for 2,000 hours. When you replace all of the light fixtures from 100W incandescent bulbs to 30W compact fluorescent bulbs, you can save 4,200 kWh of electricity and $504 of money a year!

Note: The light output of a 100W incandescent bulb and 30W compact fluorescent bulb are both about 1,600 lumens.

A way of calculating savings in money and electricity by replacing light bulbs is shown on pages 374-5.


HOW MUCH ENERGY & MONEY DO NEW LIGHT BULBS SAVE?

Calculating electricity usage and electricity price

Your utility company charges by the Kilowatt-hour (or kWh). They don't charge by wattage (or W) so you need to make calculations to understand how much electricity you consume for the use of certain electrical appliances and how much you have to pay for them.

Let's say you used a 100W light bulb for all of your 30 light fixtures in your house last year. Let's calculate how much electricity you used over a year and how much you had to pay for it.

When you use a 100W light bulb, you use 100 *watts per hour (W/h) of electricity* to light the bulb.

If you use the bulb for one hour, it means you consume ***100 watt-hours (W·h)*** of electricity.

Therefore, when you use the 100W light bulb for 2,000 hours in a year,

100 (W/h) x 2,000 (h)=200,000 (Wh)
200,000 (Wh) = 200 (kWh)

you use ***200 kWh*** of electricity to light the bulb for one year.

You have 30 light fixtures in your household,

200 (kWh) x 30=6,000 kWh

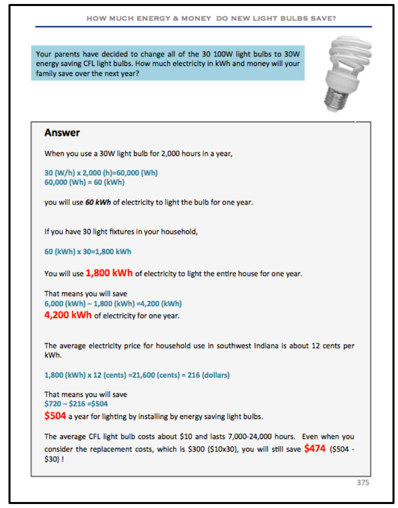
you use **6,000 kWh** of electricity to light the entire house for one year.

The average price of electricity for a household use in southwest Indiana is about 12 cents per kWh.

6,000 (kWh) x 12 (cents) =72,000 (cents) = 720 (dollars)

That means you have to pay **$720** a year for lighting.

374


HOW MUCH ENERGY & MONEY DO NEW LIGHT BULBS SAVE?

Your parents have decided to change all of the 30 100W light bulbs to 30W energy saving CFL light bulbs. How much electricity in kWh and money will your family save over the next year?

Answer

When you use a 30W light bulb for 2,000 hours in a year,

30 (W/h) x 2,000 (h)=60,000 (Wh)
60,000 (Wh) = 60 (kWh)

you will use ***60 kWh*** of electricity to light the bulb for one year.

If you have 30 light fixtures in your household,

60 (kWh) x 30=1,800 kWh

You will use **1,800 kWh** of electricity to light the entire house for one year.

That means you will save
6,000 (kWh) – 1,800 (kWh) =4,200 (kWh)
4,200 kWh of electricity for one year.

The average electricity price for household use in southwest Indiana is about 12 cents per kWh.

1,800 (kWh) x 12 (cents) =21,600 (cents) = 216 (dollars)

That means you will save
$720 – $216 =$504
$504 a year for lighting by installing by energy saving light bulbs.

The average CFL light bulb costs about $10 and lasts 7,000-24,000 hours. Even when you consider the replacement costs, which is $300 ($10x30), you will still save **$474** ($504 - $30) !

375

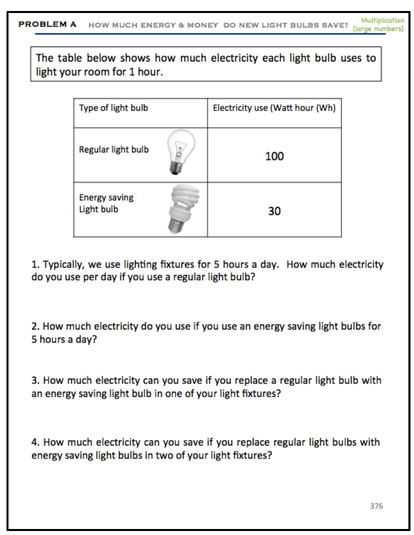
TEACHER GUIDE

The purpose of this activity is to enhance students' skills in multiplication. To find out how much electricity the two types of light bulbs use for a day (PROBLEM A) or a year (PROBLEMS B and C), students will use multiplication. In PROBLEM C, students will find out how much money they will save in a year.

PROBLEM A

- *Multiplication (large numbers)*

Using the amount of electricity usage of two types of light bulbs (regular light bulbs and energy saving light bulbs) for an hour, students are asked to find out how much electricity they can save a day if they replace a light bulb with an energy saving one. Questions include, "Typically, we use lighting fixtures for 5 hours a day. How much electricity do you use per day if you use a regular light bulb?"


PROBLEM A HOW MUCH ENERGY & MONEY DO NEW LIGHT BULBS SAVE? Multiplication (large numbers)

The table below shows how much electricity each light bulb uses to light your room for 1 hour.

Type of light bulb	Electricity use (Watt hour (Wh)
Regular light bulb	100
Energy saving Light bulb	30

1. Typically, we use lighting fixtures for 5 hours a day. How much electricity do you use per day if you use a regular light bulb?

2. How much electricity do you use if you use an energy saving light bulbs for 5 hours a day?

3. How much electricity can you save if you replace a regular light bulb with an energy saving light bulb in one of your light fixtures?

4. How much electricity can you save if you replace regular light bulbs with energy saving light bulbs in two of your light fixtures?

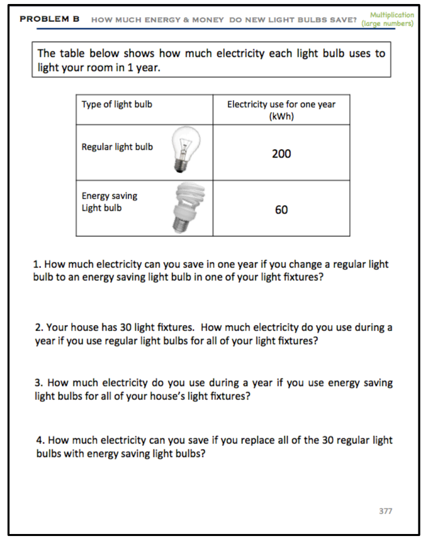
376

P 376—Student Sheet

PROBLEM B

- *Multiplication (large numbers)*

Using the amount of electricity usage of two types of light bulbs (regular light bulbs and energy saving light bulbs) for a year, students are asked to find out how much electricity they can save a year, if they replace all of the house's light bulbs with energy saving ones. Questions include, "Your house has 30 light fixtures. How much electricity do you use during a year if you use regular light bulbs for all of your light fixtures?"



PROBLEM B HOW MUCH ENERGY & MONEY DO NEW LIGHT BULBS SAVE? Multiplication (large numbers)

The table below shows how much electricity each light bulb uses to light your room in 1 year.

Type of light bulb	Electricity use for one year (kWh)
Regular light bulb	200
Energy saving Light bulb	60

1. How much electricity can you save in one year if you change a regular light bulb to an energy saving light bulb in one of your light fixtures?

2. Your house has 30 light fixtures. How much electricity do you use during a year if you use regular light bulbs for all of your light fixtures?

3. How much electricity do you use during a year if you use energy saving light bulbs for all of your house's light fixtures?

4. How much electricity can you save if you replace all of the 30 regular light bulbs with energy saving light bulbs?

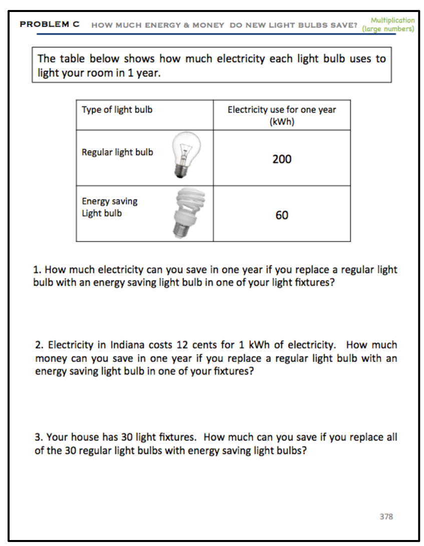
377

P 377—Student Sheet

PROBLEM C

- *Multiplication (large numbers)*

Using the amount of electricity usage of two types of light bulbs (regular light bulbs and energy saving light bulbs) for a year, students are asked to find out how much money they can save if they replace a light bulbs to an energy saving one. Questions include, "Electricity in Indiana costs 12 cents for 1 kWh of electricity. How much money can you save in one year if you exchange a regular light bulb with an energy saving light bulb?"



PROBLEM C HOW MUCH ENERGY & MONEY DO NEW LIGHT BULBS SAVE? Multiplication (large numbers)

The table below shows how much electricity each light bulb uses to light your room in 1 year.

Type of light bulb	Electricity use for one year (kWh)
Regular light bulb	200
Energy saving Light bulb	60

1. How much electricity can you save in one year if you replace a regular light bulb with an energy saving light bulb in one of your light fixtures?

2. Electricity in Indiana costs 12 cents for 1 kWh of electricity. How much money can you save in one year if you replace a regular light bulb with an energy saving light bulb in one of your fixtures?

3. Your house has 30 light fixtures. How much can you save if you replace all of the 30 regular light bulbs with energy saving light bulbs?

378

P 378—Student Sheet

Calculating electricity usage and electricity price

Your utility company charges by the Kilowatt-hour (or kWh). They don't charge by wattage (or W) so you need to make calculations to understand how much electricity you consume for the use of certain electrical appliances and how much you have to pay for them.

Let's say you used a 100W light bulb for all of your 30 light fixtures in your house last year. Let's calculate how much electricity you used over a year and how much you had to pay for it.

When you use a 100W light bulb, you use 100 *watts per hour (W/h) of electricity* to light the bulb.

If you use the bulb for one hour, it means you consume ***100 watt-hours (W·h)*** of electricity.

Therefore, when you use the 100W light bulb for 2,000 hours in a year,

100 (W/h) x 2,000 (h)=200,000 (Wh)
200,000 (Wh) = 200 (kWh)

you use ***200 kWh*** of electricity to light the bulb for one year.

You have 30 light fixtures in your household,

200 (kWh) x 30=6,000 kWh

you use **6,000 kWh** of electricity to light the entire house for one year.

The average price of electricity for a household use in southwest Indiana is about 12 cents per kWh.

6,000 (kWh) x 12 (cents) =72,000 (cents) = 720 (dollars)

That means you have to pay **$720** a year for lighting.

Your parents have decided to change all of the 30 100W light bulbs to 30W energy saving CFL light bulbs. How much electricity in kWh and money will your family save over the next year?

Answer

When you use a 30W light bulb for 2,000 hours in a year,

30 (W/h) x 2,000 (h)=60,000 (Wh)
60,000 (Wh) = 60 (kWh)

you will use ***60 kWh*** of electricity to light the bulb for one year.

If you have 30 light fixtures in your household,

60 (kWh) x 30=1,800 kWh

You will use **1,800 kWh** of electricity to light the entire house for one year.

That means you will save
6,000 (kWh) – 1,800 (kWh) =4,200 (kWh)
4,200 kWh of electricity for one year.

The average electricity price for household use in southwest Indiana is about 12 cents per kWh.

1,800 (kWh) x 12 (cents) =21,600 (cents) = 216 (dollars)

That means you will save
$720 – $216 =$504
$504 a year for lighting by installing by energy saving light bulbs.

The average CFL light bulb costs about $10 and lasts 7,000-24,000 hours. Even when you consider the replacement costs, which is $300 ($10x30), you will still save **$474** ($504 - $30) !

The table below shows how much electricity each light bulb uses to light your room for 1 hour.

Type of light bulb	Electricity use (Watt hour (Wh)
Regular light bulb 	100
Energy saving Light bulb 	30

1. Typically, we use lighting fixtures for 5 hours a day. How much electricity do you use per day if you use a regular light bulb?

2. How much electricity do you use if you use an energy saving light bulbs for 5 hours a day?

3. How much electricity can you save if you replace a regular light bulb with an energy saving light bulb in one of your light fixtures?

4. How much electricity can you save if you replace regular light bulbs with energy saving light bulbs in two of your light fixtures?

The table below shows how much electricity each light bulb uses to light your room in 1 year.

Type of light bulb	Electricity use for one year (kWh)
Regular light bulb 	200
Energy saving Light bulb 	60

1. How much electricity can you save in one year if you change a regular light bulb to an energy saving light bulb in one of your light fixtures?

2. Your house has 30 light fixtures. How much electricity do you use during a year if you use regular light bulbs for all of your light fixtures?

3. How much electricity do you use during a year if you use energy saving light bulbs for all of your house's light fixtures?

4. How much electricity can you save if you replace all of the 30 regular light bulbs with energy saving light bulbs?

The table below shows how much electricity each light bulb uses to light your room in 1 year.

Type of light bulb	Electricity use for one year (kWh)
Regular light bulb 	200
Energy saving Light bulb 	60

1. How much electricity can you save in one year if you replace a regular light bulb with an energy saving light bulb in one of your light fixtures?

2. Electricity in Indiana costs 12 cents for 1 kWh of electricity. How much money can you save in one year if you replace a regular light bulb with an energy saving light bulb in one of your fixtures?

3. Your house has 30 light fixtures. How much can you save if you replace all of the 30 regular light bulbs with energy saving light bulbs?

PROBLEM 56

Number and Operations

G4-5	Multiplication (3digits x 1 digit)
G4-5	Division (3 digits / 2 digits)

LOCAL ENERGY SAVING EFFORTS

PURPOSE

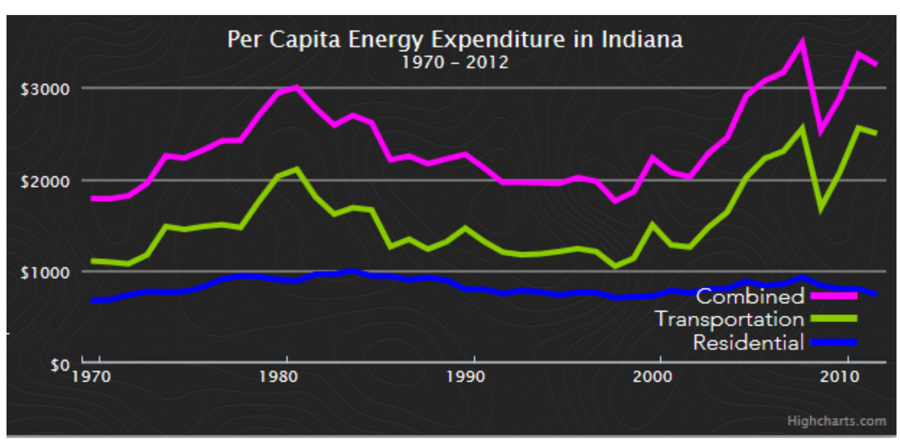
Through this activity, **4th – 5th grade** students will

- Multiply (3 digits x 1 digit)—**PROBLEM A**
- Divide (3 digits / 2 digits)—**PROBLEM A**
- Develop awareness of local energy saving efforts

BACKGROUND FOR THE TEACHER

Since scientists have found that our energy use is closely related to the increasing amount of carbon dioxide in the atmosphere and climate change, improvement of energy efficiency has become more critical than ever. Energy efficiency is now not just an isolated effort by many organizations to be cost efficient but also a social responsibility for society. In 2013, President Obama proposed to double the energy efficiency of the entire U.S. economy over the next 20 years.

Such efforts to boost energy efficiency have also been seen in many sectors in Evansville. Considering that per capita energy expenditures have increased over the last 10 years (see figure), energy efficiency improvement continues to be a vital issue for most of the organizations in Evansville.



Per capita energy expenditure in Indiana (1970-2012)
Source: U.S. Department of Energy

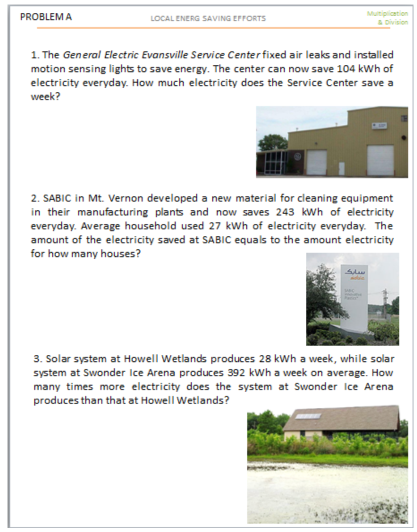
TEACHER GUIDE

The purpose of this activity is to enhance students' skills in multiplication and division. This activity uses the actual amount of electricity saving or solar electricity generation that some local organizations have achieved. The data was obtained from the Evansville Department of Sustainability, Energy and Environmental Quality.

PROBLEM A

- *Multiplication (3 digits x 1 digits)*
- *Division (3 digits / 2 digits)*

Using the actual amount of electricity saving or solar electricity generation that some of the local organizations have achieved, students are asked to multiply and divide 2 or 3-digit numbers. Questions include, "*SABIC* in Mt. Vernon developed a new material for cleaning equipment in their manufacturing plants and now saves 243 kWh of electricity everyday. The average household used 27 kWh of electricity every day. The amount of electricity saved at SABIC equals the amount electricity for how many houses?"


PROBLEM A LOCAL ENERG SAVING EFFORTS Multiplication & Division

1. The *General Electric Evansville Service Center* fixed air leaks and installed motion sensing lights to save energy. The center can now save 104 kWh of electricity everyday. How much electricity does the Service Center save a week?

2. SABIC in Mt. Vernon developed a new material for cleaning equipment in their manufacturing plants and now saves 243 kWh of electricity everyday. Average household used 27 kWh of electricity everyday. The amount of the electricity saved at SABIC equals to the amount electricity for how many houses?

3. Solar system at Howell Wetlands produces 28 kWh a week, while solar system at Swonder Ice Arena produces 392 kWh a week on average. How many times more electricity does the system at Swonder Ice Arena produces than that at Howell Wetlands?

P 383—Student Sheet

Energy Conservation Efforts in Evansville

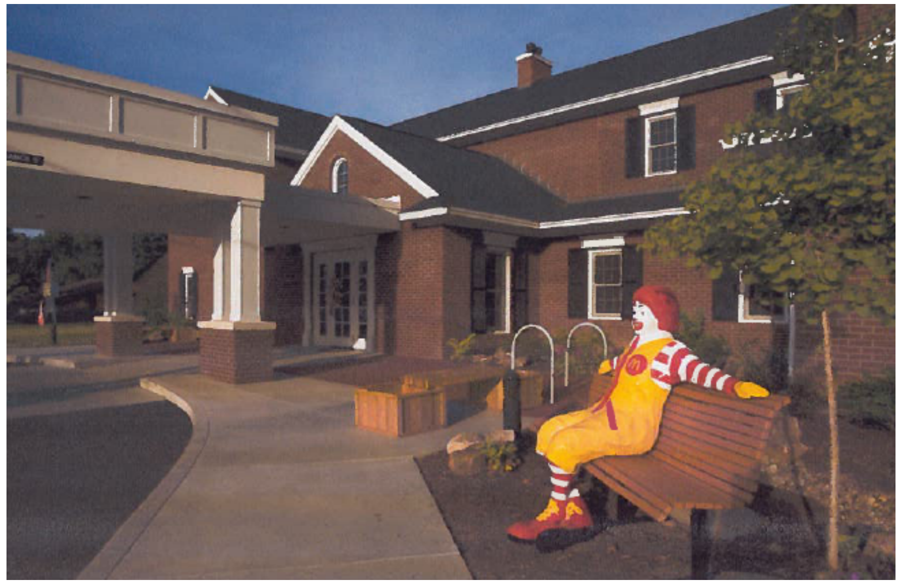
Deaconess Health System

Deaconess Health System updated its systems and spaces through the modernization and integration of multiple HVAC and Building Automation systems. The nearly 1,000,000 square foot Main Campus Facility was served by various HVAC and building automation systems. Some of these systems were about 25 years old. The project was expected to reduce operating expenses and energy consumption 5-10%.

Wesselman Woods Nature Center

Evansville' Ronald MacDonald House is a new facility built for the purpose of providing affordable temporary housing to families with children being treated for serious illness in local health care facilities. The new facility, completed in 2010, was designed to increase energy efficiency and conservation.

Energy savings of 36% were achieved through the use of the high-efficient geothermal heat pump system, building insulation, lighting and Heating, Ventilating and Air Conditioning (HVAC) controls. The control systems installed in the guest rooms automatically shut off lights and set-back the HVAC system when the room is not used. It received LEED® Silver Certification.

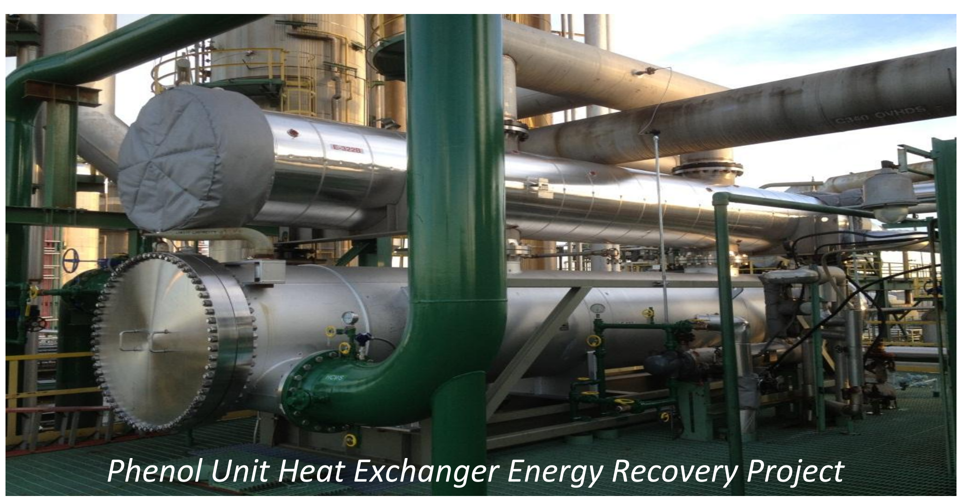


**LEED (Leadership in Energy and Environmental Design) is a set of rating systems for the design, construction, operation, and maintenance of green buildings, homes and neighborhoods.*

SABIC

SABIC, Mount Vernon, upgraded its facility to save energy by recovering more waste heat energy in Boiler House 2. A design to recover process waste heat using an existing builder fed water heat recovery flow loop was selected for this project. This new design modified the previous heat exchanger and added some piping to recover and send waste heat to Boiler House 2.

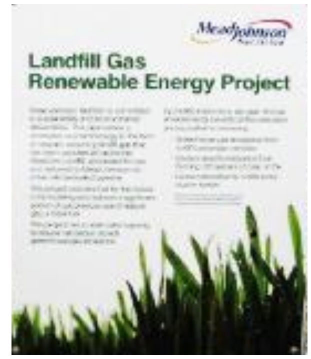
This project resulted in an energy usage reduction of 256,000 MMBTU per year. It also succeeded in a reduction of 14,978 tons of carbon dioxide emissions per year. This is equivalent to the carbon dioxide emissions from the annual combustion of 1.6 million gallons of gasoline.



Phenol Unit Heat Exchanger Energy Recovery Project

Mead Johnson Nutrition

Mead Johnson Nutrition, Evansville, completed a Landfill Gas Renewable Energy Project in May 2009. The goal of the project is to utilize landfill gas from the Laubscher Meadows Landfill (approximately five miles north of Mead Johnson Nutrition) to replace some of the company's natural gas use, reduce its dependence on fossil fuels, and help combat climate change.



About two-thirds of waste discarded at landfills is generally biodegradable and produces harmful gases called landfill gas as it rots and decomposes. Landfill gas is composed of about 50% methane, which is one of the greenhouse gases that contributes to global climate change. But, at the same time, methane is a renewable energy source that can be used for electricity generation.

Mead Johnson Nutrition invested in this project to capture and utilize all the landfill gas for their energy sources. The project has an estimated capacity to reduce net carbon dioxide emissions by 24,000 metric tons per year. It is equivalent to removing carbon dioxide emissions from 4,400 passenger cars or burning 125 railcars of coal.

Red Spot Paint & Varnish Co.

Red Spot Paint & Varnish Co., Inc. implemented an energy saving project in multiple buildings at its local campus located in Evansville. The energy saving project consisted of the replacement of more than 5,700 light bulbs with fewer, brighter, higher efficiency, and lower wattage bulbs. In addition, motion sensors were added to individual light fixtures where lights are only needed periodically.

This project was accomplished through a collaborative effort of Vectren Cooperation and their engineers and E&R Industrial who is a local distributor for Alumilight. The project resulted in reducing energy consumption by 673,000 kWh and greenhouse gas emissions by more than 1,150,000 pounds. This is equivalent to planting 11,340 trees.

1. The *General Electric Evansville Service Center* fixed air leaks and installed motion sensing lights to save energy. The center can now save 104 kWh of electricity every day. How much electricity does the Service Center save a week?

2. *SABIC* in Mt. Vernon developed a new material for cleaning equipment in their manufacturing plants and now saves 243 kWh of electricity everyday. The average household uses 27 kWh of electricity every day. The amount of electricity saved at SABIC equals the amount electricity for how many houses?

3. The solar system at Howell Wetlands produces 28 kWh a week, while the solar system at Swonder Ice Arena produces 392 kWh a week on average. How many times more electricity does the system at Swonder Ice Arena produce than that at Howell Wetlands?