



Be Aware of our Air

Grade/Subject: 5th grade

Strand/Standard 5.3.4 Evaluate **design solutions** whose primary function is to conserve Earth's environments and resources. *Define the problem, identify criteria and constraints, analyze available data on proposed solutions, and determine an optimal solution.* Emphasize how humans can balance everyday needs (agriculture, industry, and energy) while conserving Earth's environments and resources. (ESS3.A, ESS3.C, ETS1.A, ETS1.C)

Lesson Performance Expectations (description):

Students will recognize that air is a natural resource. Students will create a solution to minimize their effect on the air through the conservation of energy.

Materials:

- Rigid water bottle with a small hole in the bottom $\frac{1}{8}$
- #4 stopper with a hole
- Eyedropper
- Bulb syringe
- Lighter or match
- Water
- Internet

Time: Two 50 minute periods plus time either before or after school for data gathering.

Teacher Background Information:

- [Video](#) of demonstration - Smoke in a Bottle (3:21 min)
- [Video](#) - Know When to Burn (1:41 min), Breathe Utah
- [Video](#) Combustion (3:38 min), OED
- We use energy, minerals, and other natural resources every day. The energy powering our daily lives comes from natural resources like water, wind, coal, wood, oil, natural gas, and the sun. Another natural resource is our air. Modern forms of energy have standardized many basic comforts, such as heat in the winter and cool air for the summer. Our high quality of life requires the use of **natural resources**, which come in the forms of both renewable and nonrenewable, or conventional energy resources such as fossil fuels. The use of energy resources can have environmental effects that impact our **quality of life**.
- Burning fossil fuels to produce energy also produces emissions. These emissions contribute to poor air quality. The three main contributors to air emissions include transportation at 48%, buildings at 39%, and point sources or industry (e.g., industrial facilities, power plants, and refineries) at 13% ([DEQ](#)).

- Utah's unique geography of valleys with mountains surrounding our urban areas along the Wasatch Front creates a bowl-like landform. In the colder months, a natural phenomenon called an inversion occurs, trapping cooler air below a layer of warm air, negatively impacting the air quality. It takes strong winds or storms to stir up the air and lift the "lid" of warm air enabling the emissions to escape.
- [YouTube Causes of Inversion](#)
- We can't change our geography or population centers, but we can work to improve air quality. We have increased our use of natural gas, which has fewer emissions than other conventional fossil fuels. The development of alternative energy sources like biogas, wind, solar and geothermal energy have begun to help power our modern society with lower emissions. Tier 3 fuels, when fully implemented, will reduce directly emitted particulate matter (PM) of the average new passenger vehicle by 70 percent less than current Tier 2 standards ([DEQ](#)). All these advancements in energy have contributed to cleaner air and increased access to reliable, affordable energy.
- Energy efficiency plays an integral role in meeting the demands of our thriving economy and growing population. Energy efficiency is using less energy to do the same thing. This can be achieved through the use of efficient technologies and energy-wise conservation behaviors. Technologies such as programmable thermostats, insulation, low flow water devices, Energy Star® certified appliances, LED lighting, smart power strips, as well as advancements in the smart grid help, increase energy efficiency. Our behaviors can reduce energy use, save money and preserve the environment. Taking shorter showers, turning off the lights, reducing **phantom loads**, and setting thermostats to 68 F in the winter and 78 F in the summer are all examples of energy-wise behavior to conserve energy ([OED](#)).
- Check out [Utah's Energy Efficiency and Conservation Plan](#) to see how Utah is committed to improving air quality through Energy Efficiency
- Watch OED's [4 part video series on energy efficiency](#) and your home
- Check out OED's [Renters Guide to Energy Efficiency](#) for more tips on how to save energy at home
- See how Utah is improving the transportation sectors contribution to Air Quality [here](#).
- Visit [cleartheairchallenge.org](#) to see what a difference we can make when we all work together.
- Find which Utah municipalities have pledged to be [Idle Free](#).

Student Background Knowledge:

Students should know what is considered a natural resource and that air is made up of different gases.

Teacher Step by Step: A 3D lesson should insist students think. Provide time and space for the students to experience the phenomenon and ask questions. The student sheet provided below provides guidance but is only an example of how students might respond.

1. **Introduce Phenomenon:** Show students the demonstration of Smoke in a bottle. Put tape over the hole and fill the bottle with water. Then roll a small piece of paper and insert it into the dropper. Put the dropper in the stopper and the stopper into the bottle. Light the paper on fire and pull off the tape. As the water drains out, the smoke will be drawn into the bottle. Take off the stopper, cover the opening with multiple layers of paper towel and secure with a rubber band. Use the bulb syringe to push the air out of the bottle from the hole at the bottle. The soot will accumulate on the inside of the paper towel. Pass around the paper towel with a hand lens to see the soot.
2. Have students write down questions they have about the phenomenon. Allow some of the students to ask their questions. (do not answer them)
3. Show the video *Know when to Burn*. ([Link](#) 1:41 min)
4. Utah is rich in natural resources. Use the [map](#) to identify some of them and which ones we burn for energy.
5. Discuss with the students that air is a natural resource that can be affected by emissions.
6. How can we conserve these resources?

7. Idling engines contribute significantly (and unnecessarily) to air pollution. Exhaust from idling vehicles contains particulate matter and other pollutants known to cause serious health problems ([DAQ 2018](#)). Transportation makes up 42% of all vehicle emissions, and unnecessary idling contributes a significant amount of emissions into our air shed each day ([Utah Clean Cities](#)). In 2006, the Idle Free Governor's Declaration in Utah was first signed as the nation's first Idle Free campaign. Since then, the Idle Free campaign in Utah has grown to include over seventy mayors representing the majority of Utah's population.



- 8.
9. Ask students to estimate how much time vehicles spend idling at the school. Record responses.
10. Have students use the worksheet to gather data on how much time vehicles at their school are idling. (Make a plan with your administration to keep the students safe during this process. This could be a small team of students that gather the data to share with the class.)
11. You can count the vehicles and the minutes or use the full worksheet to calculate the time, gallons of gas, and the amount of CO₂ put into the air.
12. The students will design a plan to reduce the amount of time spent idling at the school.
13. As a class, establish the plan's criteria and constraints (for example, reduce idling by X%, cost less than \$Y, be implementable on a school-wide level within Z time, outcomes must be measurable, must be teacher and administrator approved, etc.)
14. As a class, create a rubric using the criteria and constraints that will be used to assess the plan.
15. Divide into groups of 3-4. Have each group appoint a discussion leader and a scribe. The discussion leader will keep the group on task, and the scribe will record their decisions.
16. Instruct each group to create a plan to reduce the amount of time spent idling that fits the criteria and constraints. The scribe should write the group's plan on a piece of poster paper. This step could take 10 minutes or two days. There is a wealth of information on the Internet (see Teacher Background) the students could explore if there is time available.
17. Alternative Activity: Use the worksheet to identify what energy each student is using and have them develop a personal plan to commit to using less energy.

Assessment of Student Learning.

The table below shows the results from a study performed by students at their schools. Students measured the total number of minutes drivers spent idling their cars after school. The schools had similar numbers of students and drivers.

Week	School 1 (min.)	School 2 (min.)	School 3 (min.)
Sept. 1-5	110	99	130
Sept. 8-12	105	90	125
Sept. 15-19	100	55	120
Sept. 22-26	99	40	121

- School 1 presented lessons to students about idling and asked them to talk to their parents. How effective does this solution appear to be?
 - Very effective
 - Somewhat effective*
 - Slightly effective*
 - Least effective
- School 2 also presented lessons to students about idling and asked them to talk to their parents. They also put up “no idling” signs in the parking lot and handed out “thumbs up” stickers to cars that were not idling. How effective does this solution appear to be?
 - Very effective*
 - Somewhat effective
 - Slightly effective
 - Least effective
- School 3 did not present lessons to students about idling. They put up “no idling” signs in the parking lot. How effective does this solution appear to be?
 - Very effective
 - Somewhat effective
 - Slightly effective*
 - Least effective*
- Which of the following affects peoples’ respiratory systems and is produced by idling engines?
 - Carbon dioxide
 - Oxygen
 - Particulates*
 - Water vapor

Extension of lesson: Have students research the existing Utah regulations on wood-burning and other human activities that impact air quality. For example, fireworks, gas vs. electric appliances, semi-truck engines (diesel, hybrid, electric, hydraulic, natural gas). Have students write a bill addressing these issues. Have students write an argument for or against the use of fines as a tool for improving air quality. Possible source [link](#).

Career Connections: Potential careers related to this activity are Meteorologist, Environmental Engineer, Atmospheric and Space Scientist

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Name _____

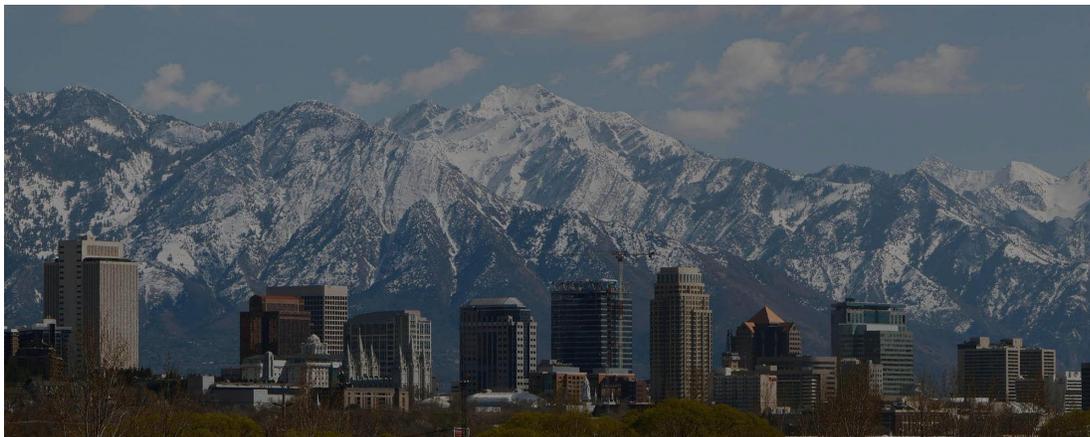
Phenomenon: Watch the phenomenon of the Smoke in a Bottle. Ask three questions about what you see.

- 1.
- 2.
- 3.

Utah has many natural resources that we use for energy. Visit [this](#) website and list these natural energy resources. ([Arc GIS Utah Energy Resources and Infrastructure](#))

Which of these sources are combusted (or burned) for energy?

In the picture below, label where the particles from burning fuel go.



V	T			Y	N			
V	T			Y	N			
V	T			Y	N			

TOTAL minutes V (passenger cars) spent idling _____

TOTAL minutes T (trucks, SUV, minivans) idled _____

ANALYZING IDLING OBSERVATION DATA

Here is the approximate rate of fuel used during idling

Vehicle Type (Engine Size in Liters)	Idling Fuel Use (with no car accessories, like AC or radio, running)
Vehicle (passenger car)	0.0053 gal/min (or 0.32 gal/hr.)
Truck, SUV, minivan	0.0118 gal/min (or 0.71 gal/hr.)

[Source](#)

1. Add the total minutes of idling of each type of auto and fill in the chart below.

Automobiles	Total minutes idling
V (passenger cars)	V
T (trucks, SUVs, minivans)	T

2. To calculate the gas wasted by passenger cars multiply V total minutes idling by .0053

_____ V total minutes idling x .0053 gal/min = _____ gallons of gas

3. To calculate the gas wasted by trucks, SUVs, and minivans, multiply T total minutes idling by .0118

_____ V total minutes idling x .0118 gal/min = _____ gallons of gas

4. Find the total gallons of gas wasted.

_____ gal gas (passenger) + _____ gal gas (trucks, SUV, minivans) = _____ TOTAL gallons gas used idling

5. Find the amount of money wasted by idling

_____ Total gal gas x _____ (current price per gal) = _____ TOTAL cost

6. Find the amount of carbon dioxide (CO2) emitted

_____ Total gal of gas x 19.64 lbs. CO2/gal gas = _____ TOTAL CO2 emitted

7. Compare your findings with others in the class and fill in the chart below

TOTALS	Mine	Class
Gallons of gas used idling		
Cost		
CO2 emitted		

8. Analyze the data and write a conclusion in the space below.