



Renewable Energy Learning Lab

Molly

Redwood Cooperative School, Middle School
Lexington, Kentucky
2023-2024



First Semester-*Learning* about Renewable Energy

After attending the TCI Educator's Retreat in Saco, Maine in 2023 with one of my co-teachers, Ashley Coning, we went home excited and inspired to incorporate what we had learned into a year-long study of energy. Students worked as a middle school (grades 6-8) to learn about different forms of energy, both renewable and non-renewable, and their effects on our world. They engaged in a variety of activities to explore this topic through three lenses: Environmental, Economic, & Cultural. The three middle school teachers collaborated throughout the year in science, math, ELA, social studies, and project study to present ideas from TCI's Learning Lab as well as other resources to help students better understand energy and its effects on the world around them.



Left: 2023-2024 Redwood Middle School students

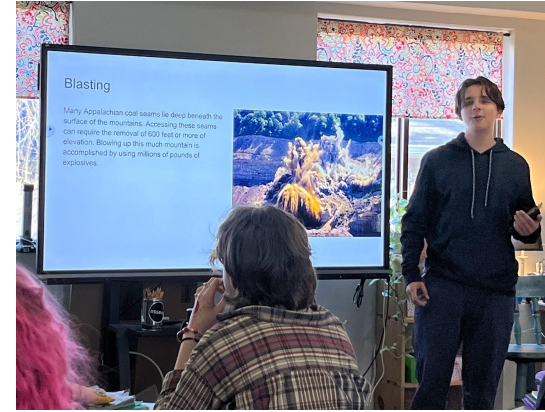
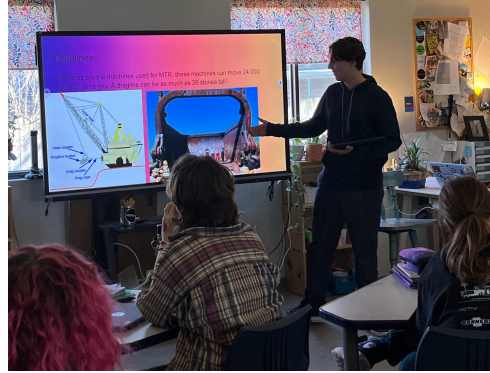


Above (left to right): Redwood Middle School teachers-Moira Dalibor (math, social studies), Molly Franklin (ELA, social studies), and Ashley Coning (science, social studies)

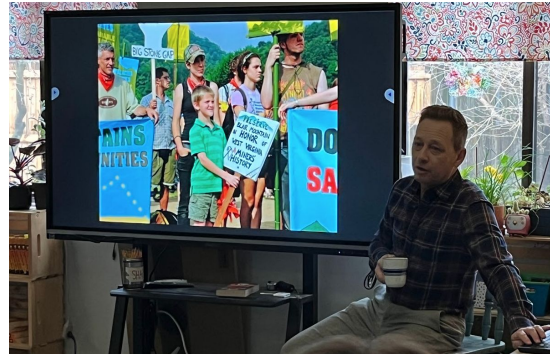
Class Novel-Same Sun Here

The novel, *Same Sun Here*, is an epistolary novel co-written by Neela Vaswani and Kentuckian Silas House. Neela writes from the perspective of a native Indian girl living in NYC while Silas writes from the perspective of a middle school boy, River, living in Southeastern Kentucky. River's life is greatly impacted by mountaintop removal, as is much of life in SE Kentucky.

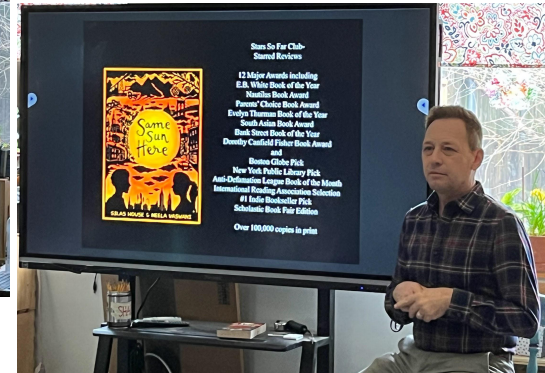
All middle school students read this novel and used it as a starting point for an in-depth study of coal, especially as it impacts Kentucky and Kentuckians. Examining this complex issue through three lenses was fascinating, especially with this being a local issue for us in Kentucky.



Independent research and presentations on issues presented in the novel.

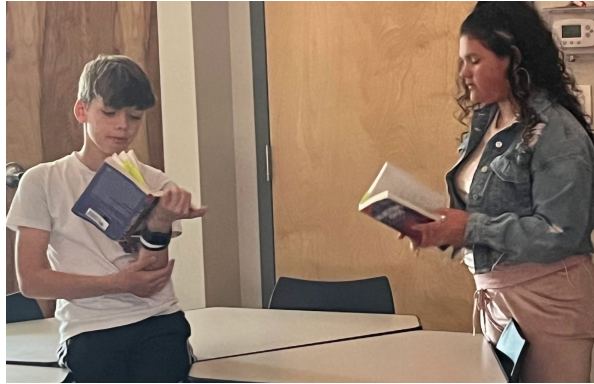


Silas House came to visit our middle school and talk about the topics and writing of the novel!



Other novels used to continue discussions on energy

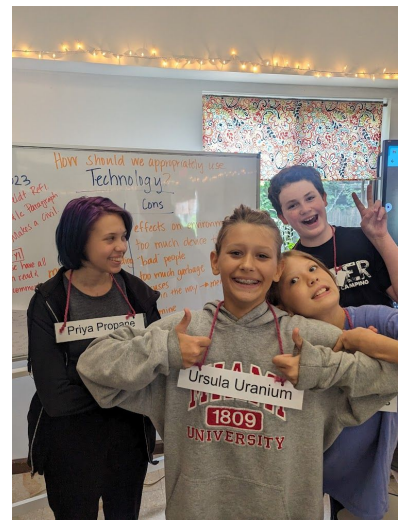
Blackbird Girls by Anne Blankman-historical fiction surrounding the events of the Chernobyl disaster which prompted a lot of research into nuclear energy.



Carl Hiaasen has written several YA novels, all touching on different environmental issues. Students self-selected groups for these novel studies: *Flush*, *Squirm*, *Scat*, & *Chomp*.

Energy Squares

We used a game from the NEED project (www.NEED.org) to “play” around with more energy ideas. This trivia-like game focused on energy sources and energy related topics. See the next two slides for the guidelines.





Energy Squares

Get Ready

Before class, make nine nametags for the celebrity energy guests. Next, make a copy of the game board found on page 40 to project for the class. Cut out X and O shapes from black construction paper or make sure interactive board markers are available. There are five questions provided for each guest. Most likely, only three or four questions will be needed, so choose the ones you feel are most important. You can also come up with alternative questions appropriate to the grade level of the students playing the game.

ENERGY NAMES

Pablo Petroleum	Naima Natural Gas	Colin Coal
Reba Renewable	Ursula Uranium	Christy Conserve
Priya Propane	Eli Electricity	Hector History

Get Set

•Choose nine students to act as energy guests for the game. Provide each guest with a nametag and stand them in front of the room. Another student acts as the game show host. Props and costumes may be used.

•Divide the remaining students into four teams. Each team must choose one spokesperson.

•Only two teams can participate at one time—decide which two teams will play in the first round and which two will play in the second round.

•Flip a coin to determine which first round team begins the game. The winner of the coin toss decides who goes first, and the losing team chooses either X or O as their symbol. Repeat this procedure with the second round teams.

Go

Give the students the following instructions for how to play the game:

•This game is similar to tic-tac-toe. The goal is to get three X's or O's in a row on the game board. The first two teams will play each other and then the remaining two teams will play. The winners will face off in the final championship round.

•The first team chooses a guest and his or her accompanying square on the game sheet. The guests' names correspond to the topic of the question they will be asked. The host asks the guest a question and the guest answers to the best of his knowledge and ability. It is now the team's responsibility to decide whether or not they agree with the answer given by the energy guest. If they answer correctly, the team's symbol is placed in the square. However, if they answer incorrectly, the other team's symbol is placed in the square. After each question, it is the other team's turn to choose a guest.

•When choosing guests, keep in mind that this game is played like tic-tac-toe. You are trying to get three of your symbols in a row while blocking your opponents from doing the same thing. Play continues in this manner until a team succeeds in getting three in a row or all squares are filled with either X's or O's. One final rule—when a team is going for the winning square to get three in a row, the team members must answer the question correctly. If the question is answered incorrectly, the other team does not place its symbol in that square. Again, this is only applicable when one of the teams is going for the winning square. In case neither team succeeds in getting three in a row, the team with the most symbols on the board wins.

Based on tic-tac-toe, *Energy Squares* reinforces students' knowledge of energy sources and energy-related topics.

Grade Levels

- Elementary, grades 3-5
- Intermediate, grades 6-8
- Secondary, grades 9-12

Preparation

- 10-15 minutes

Time

- 30 minutes

Pablo Petroleum	Naima Natural Gas	Colin Coal
Reba Renewable	Ursula Uranium	Christy Conserve
Priya Propane	Eli Electricity	Hector History



Energy Squares

QUESTIONS AND ANSWERS FOR PETROLEUM

1. What is the major use of petroleum in the U.S.? (*Transportation*)
2. What is the major product produced during petroleum refining? (*Gasoline*)
3. How many gallons of oil are in one barrel? (*42*)
4. True or false? Alaska is the nation's top oil producing state. (*False, Texas is*)
5. What approximate percentage of U.S. petroleum supply is imported—24%, 44%, 64%, or 74%? (*44%*)

QUESTIONS AND ANSWERS FOR NATURAL GAS

1. How is natural gas usually transported? (*By pipeline*)
2. True or false? Natural gas is a light yellow color. (*False, it's colorless*)
3. What is the major use of natural gas by a family? (*Home heating*)
4. What is the chemical name for natural gas? (*Methane*)
5. True or false? Natural gas is measured in, and sold by, gallons? (*False, by cubic feet*)

QUESTIONS AND ANSWERS FOR COAL

1. What is the major use of coal? (*Producing electricity*)
2. True or false? Canada is the world leader of known reserves of coal. (*False, The U.S. is*)
3. How is coal mainly transported? (*By railroad*)
4. On average, is coal typically older or younger than other fossil fuels? (*Younger*)
5. Most U.S. coal is produced from which type of mining, surface or underground? (*Surface*)

QUESTIONS AND ANSWERS FOR RENEWABLES

1. What type of solar cell produces electricity directly from sunlight? (*Photovoltaic cell*)
2. Renewables make up approximately what percentage of total U.S. energy demand—2%, 11%, 19%, or 45%? (*11%*)
3. Which renewable source of energy is NOT a result of the sun's energy striking the Earth? (*Geothermal*)
4. True or false? Wind is the result of uneven heating of the Earth's mantle. (*False, uneven heating of the Earth's surface*)
5. Which energy source gets its energy from garbage and agricultural wastes? (*Biomass*)

QUESTIONS AND ANSWERS FOR URANIUM

1. Where is nuclear waste stored? (*On-site in spent fuel pools and dry casks/vaults*)
2. True or false? The isotope of uranium that splits in nuclear reactors is U-238. (*False, it's U-235*)
3. What is the name of the subatomic particle that causes nuclear fission when it strikes U-235—an electron, a neutron, or a proton? (*A neutron*)
4. Plus or minus ten years, in what year did America's first nuclear power plant go into operation? (*1957 (accept 1947-1967)*)
5. In what part of a nuclear power plant does nuclear fission take place? (*The reactor*)

QUESTIONS AND ANSWERS FOR CONSERVATION

1. Which letter of the alphabet is used to measure the value of insulation? (*R value*)
2. True or false? Incandescent light bulbs provide the same amount of light that fluorescent bulbs do for one-fourth the energy. (*False, it's exactly the opposite*)
3. After home heating and cooling, what is the most energy-consuming job in the home? (*Water heating*)
4. What two items are used to seal cracks around windows and doors? (*Caulking and weatherstripping*)
5. As the energy efficiency rating of an appliance increases, the amount of energy it requires to operate: increases, decreases, or remains the same? (*Decreases*)

QUESTIONS AND ANSWERS FOR PROPANE

1. Is propane used mostly in metropolitan or rural areas? (*Rural*)
2. By what quantity is propane sold? (*By the gallon*)
3. What physical state does propane turn into when it's stored under moderate pressure or cooled to -45° Fahrenheit? (*A liquid*)
4. Propane comes from processing which fossil fuels? (*Natural gas and petroleum*)
5. Is the density of propane lower than, higher than, or equal to the density of air? (*Higher*)

QUESTIONS AND ANSWER FOR ELECTRICITY

1. How is electricity used, measured, and sold? (*By the kilowatt-hour*)
2. What is the average cost of a kilowatt-hour of electricity for consumers? (*13.0 cents (accept 11 to 15 cents)*)
3. Is electricity produced by rotating wires in a magnetic field in a turbine or a generator? (*A generator*)
4. In the summer, during what time period does the demand for electricity peak—6:00 a.m. to noon, noon to 6:00 p.m., or 6:00 p.m. to midnight? (*Noon to 6:00 p.m.*)
5. What is the leading energy source used to generate electricity? (*Natural Gas*)

QUESTIONS AND ANSWERS FOR HISTORY

1. Whose motorized vehicle created a great demand for gasoline? (*Henry Ford*)
2. Where was the world's first hydroelectric power plant built in 1882? (*Appleton, Wisconsin on the Fox River*)
3. Who invented the steamboat, Robert Fulton or Edwin Drake? (*Robert Fulton*)
4. Who invented the light bulb and other electrical devices? (*Thomas Edison*)
5. After World War II, this energy source replaced coal as the number one energy source consumed in the U.S. (*Petroleum*)

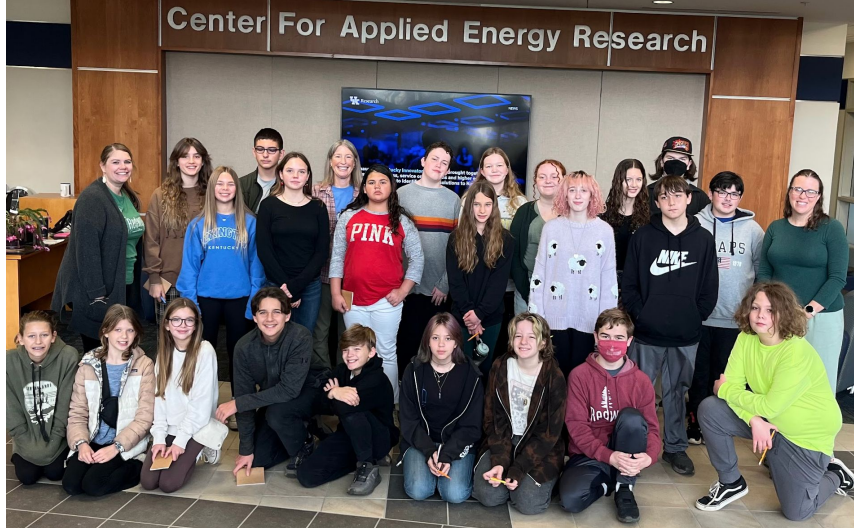
Tik Tok Videos



Students worked in groups to choose energy-related topics that they found interesting, write scripts, and record “Tik Tok style” videos.

University of Kentucky Center for Applied Energy Research (UK CAER)

Middle school students went on a field trip to the University of Kentucky's CAER facility to talk to researchers about different types of energy, recycling, research projects, and so much more. We met with UK faculty in a variety of departments and learned about topics such as biofuels, solar cells/power, using algae to collect carbon dioxide from power plants, carbon removal research from coal usage and cement production, and the process of recycling electronics.



Students learned about the challenges of recycling electronic materials.



Hearing from experts in a variety of different research fields.



UK CAER (cont'd)



Learning about Kentucky's dependence on coal-an extremely complex issue.



Students played a biofuels game together to see if they could find the best way to create fuel.

Students learned about the amount of energy required to make cement, then they got to make some of their own. Did you know that creating cement takes a HUGE amount of energy and releases CO₂? In this lab, scientists are working to create new cement that would have less of an environmental impact.



A post-hail storm solar panel...now what?



Learning about turning used cooking oil in fuel.



Four-day trip to Pine Mountain Settlement School

Redwood middle school students spent four days and three nights in Southeastern Kentucky making connections between many concepts from the school year. We attended a variety of classes, many touching on energy related topics.



Solar powered artwork.



Learning about wind power.



*Making diesel fuel
(and lighting it on
fire).*



Portal 31

One of the highlights of our trip to SE Kentucky was visiting and touring the coal mine, Portal 31, part of the Central Appalachian bituminous coalfield. Portal 31 first opened in 1917 as a subsidiary of U.S. Steel which operated the mine and built the nearby community of Lynch. At the time, Lynch was the world's largest coal camp. When it closed its doors in 1963, Portal 31 had produced more than 120 million tons of coal.

The mine reopened in 2009 as part of the Abandoned Mine Land Reclamation Program started by Congress in 1977. Roughly 5,000 visitors tour the mine each year. We had the opportunity to learn about the many effects of coal on Kentucky's land and people, up close and personal.



Argumentative Writing-Is Recycling Worth It?

Like many issues surrounding energy, recycling is a complicated issue. Sixth graders used resources through *thinkalong.org* to research the rules, regulations, and realities of recycling. All of the students ended up presenting arguments against the practicality of recycling citing people's inability to follow strict rules and the tremendous amounts of energy required in the many steps of the recycling process. The general consensus was that reusing is a much better practice. Following this conclusion, we watched the documentary *Landfill Harmonic* about a town in Paraguay that uses trash from the landfill to make musical instruments for local children.



"After you recycle, if it even does get recycled, the material is put in a truck. The truck releases fossil fuels which hurts the earth. But it's doing more good than evil, right? It balances out, right? No. After that it is sent to another car and then put in a ship and carried overseas, which is awful for the environment. But it's still not done! Next it is dropped off at another place and put in a car that drives to another place and THEN it gets dropped at its destination. Now it has to be over, right? Nope. I haven't talked about the fact that ANOTHER ship takes the recycled recycling and ships it out before that recycling gets recycled (if it even does). Then the whole cycle starts again ("Recycling is Broken," 2019).

-Aiden, sixth grader

Share what you know: Solar Power

Middle school students helped students in Redwood's second and third grade classes learn about solar power by building "houses" with working solar panels.



Share what you know: Wind Power

Middle school students visited the second and third grade classes to help them learn about wind power, then build wind turbines and test them in front of a fan.



Collaboration with Ghana

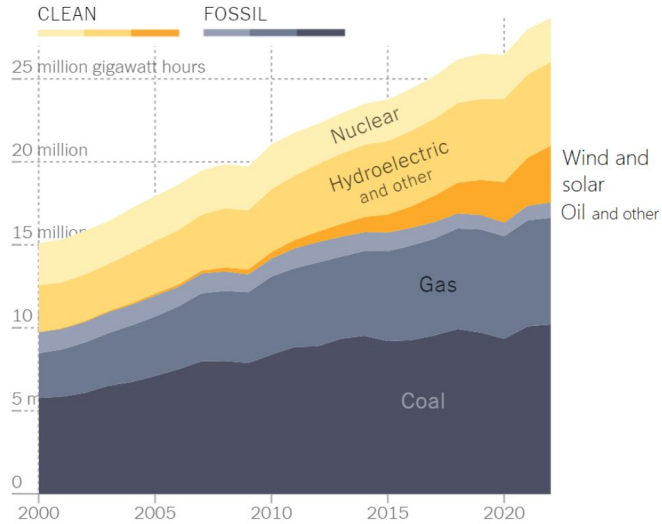
Redwood middle school students collaborated with a biology class at Savelugu Senior High School in the Northern Region of Ghana. In Ghana, production and sale of charcoal is resulting in mass deforestation but reducing the reliance on charcoal is very challenging as many people rely on this resource for income and energy. Students at SAVESS and students here at Redwood are answering the same set of questions about our local resource (our local resource begin Kentucky coal), how we use it for energy production, and the role it plays in our communities. They are sharing their answers through posters and videos.



Graphing

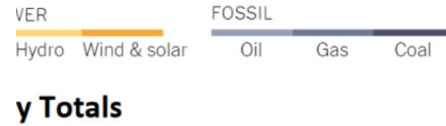
In addition to using the En-ROADS simulator to examine the impacts policy changes might have on climate, middle school students used a variety of graphs to better understand energy usage worldwide. We stress the importance of asking questions as learners, and this is a sampling of graphs used to help students stay curious about the world around them. Here are just a few samples used to illustrate global energy usage.

World electricity generation

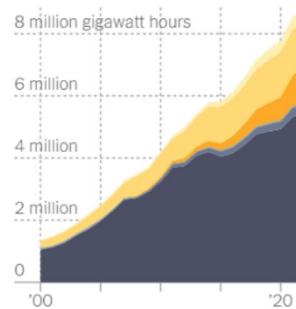


Students were asked to consider the following about these graphs:

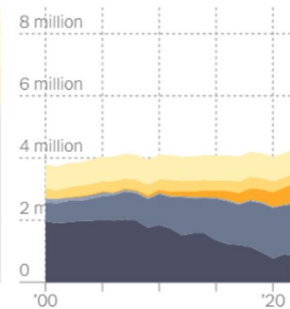
- What do you notice?
- What do you wonder?
- How might this impact you and your community?



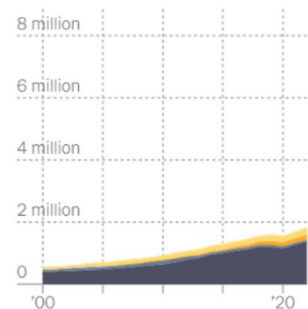
China



United States



India



Where Fossil-Fueled Power Is Still Growing Today

TREND OVER LAST DECADE

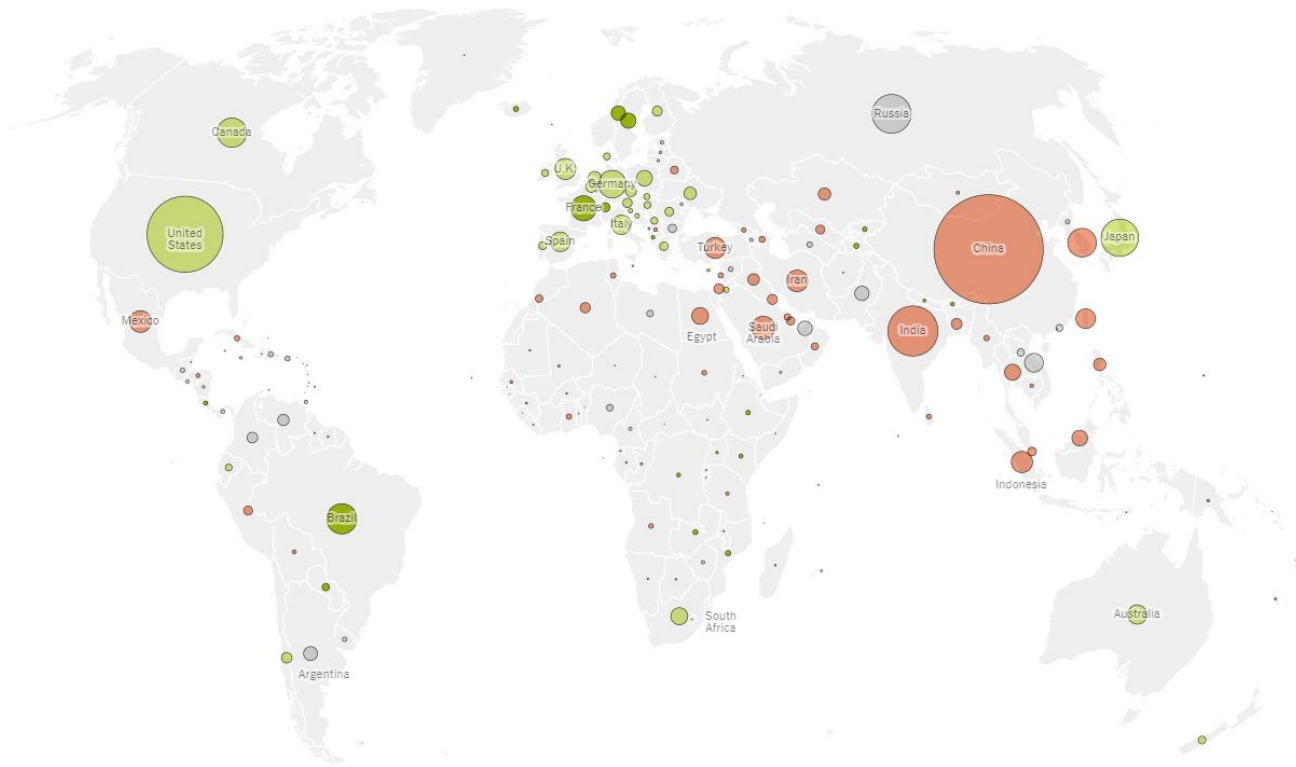
Mostly clean
already

Declining
fossil power

Plateau or
other trend

Rising
fossil power

Circles are sized by the amount of total power
generated by each country in 2021-22.

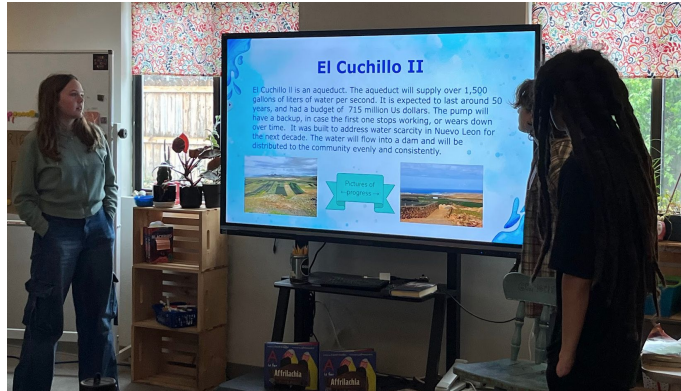
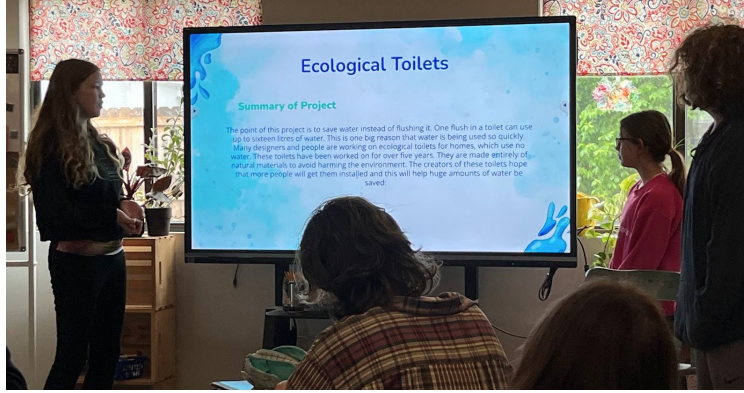


Note: Total generation data is shown through 2022 for the countries that have power generation data available through that year. For others, data is shown through 2021. More information on how the categories were determined can be found at the bottom of this page.

Questions for this chart:

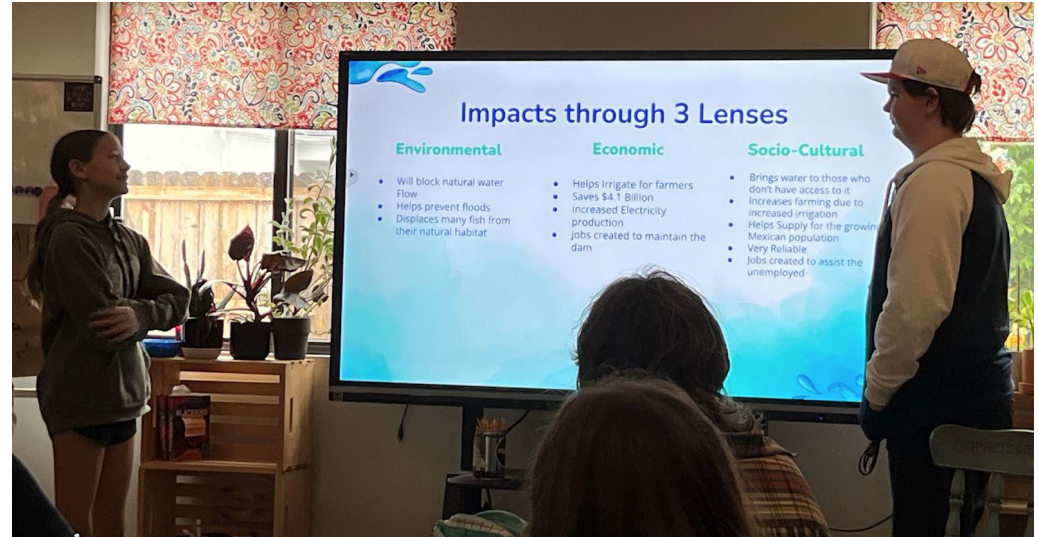
1. What are some countries that already have mostly green power?
2. What are some countries that are decreasing fossil fuels?
3. What are some countries that are increasing their use of fossil fuels?
4. What do the size of the circles tell us about the graph?

Applying the idea of the three lenses to other areas of study



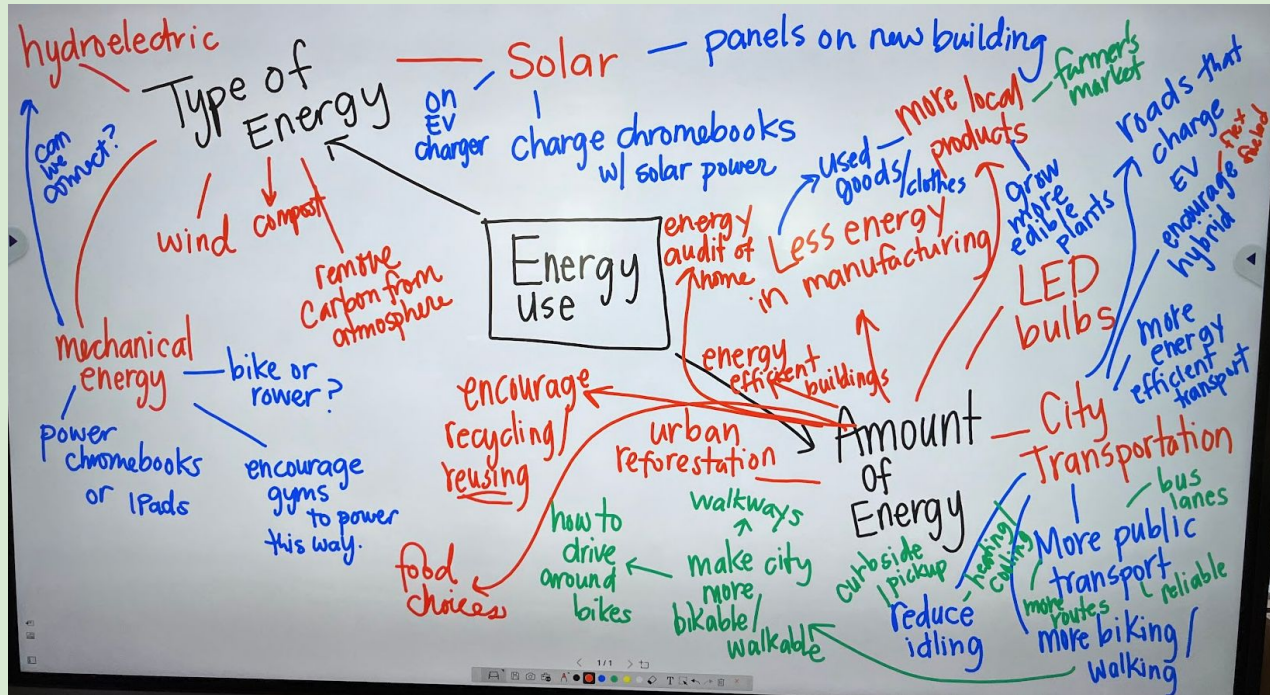
In social studies, students learned about the current water crisis affecting Mexico City. They worked in groups to examine different possible solutions, focusing on each solution's environmental, economic, and cultural implications before presenting their findings to the class. Click the link to see their slides.

Finding Water-Mexico City



Second Semester: Student Action Projects

After learning about energy for the first semester, students submitted topics for student action projects in January. Students brainstormed ideas for project topics.



The web was narrowed down to the following topics:

- Powering the Chromebook cart using solar power.
- Educate and encourage our school community about the benefits of eating locally grown food.
- Put solar panels on the new building and existing school buildings.
- Create a demonstration of how to reuse products.
- Host a used clothing drive.
- Create a "seed stand" to encourage growing your own food.
- Make a carbon capture device.
- Make an informational video (or series of videos) about energy use.
- Poster campaign to encourage bike riding.
- Start a program at Redwood that collects and redistributes used bikes to encourage more bike riding.
- Create an informational video about how to drive safely around bikes.
- Create a documentary showcasing ways local people and businesses are lowering energy use. Share with the community to inspire others.
- Plant trees in areas that need reforestation.
- Talk to city council about ways to encourage walking, biking, and using public transportation.
- Create a website promoting local businesses and opportunities to buy locally made products.

Students had to rate each project proposal based on the following criteria:

- This project is doable.
- This project would have a positive impact on our community.
- I would enjoy participating in this project.
- This idea would not be a good service learning project.

They then voted for their top choices. From that narrowed down list, they ranked the projects based on which one they'd like to do. We ended up with 4 groups:

- Powering the Chromebook cart using solar power.
- Educate and encourage our school community about the benefits of eating locally grown food.
- Host a used clothing drive.
- Make an informational video (or series of videos) about energy use.

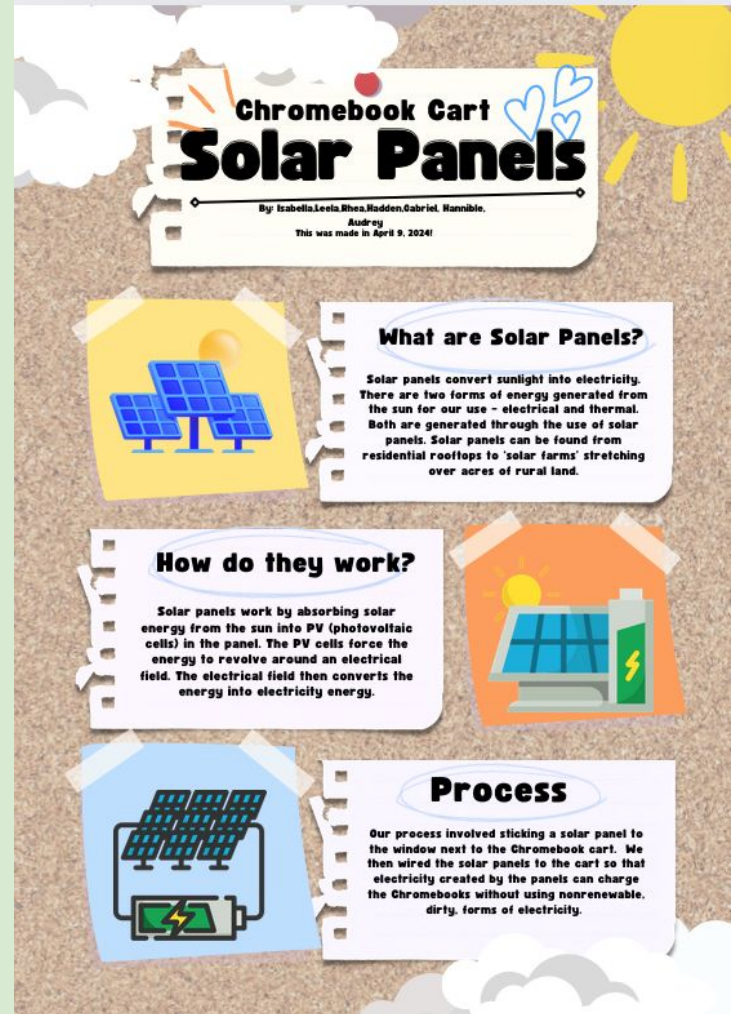
Students then researched their topic, made educational materials, and proposed a budget (solar panels) for their project. Each group then met with the Head of School to discuss their plan and ask for assistance as needed. Groups submitted project explanations that were sent out to the Redwood community in a newsletter.

On the following slides, the black text, websites, and graphics are student-written and designed, the turquoise text is my added notes.

Using solar panels to charge our Chromebook cart

Our Group had the mission of connecting our chromebook charging cart to solar power. We started by doing much research about what solar panels are, and how they work. After this research, we started looking into how to connect the solar panels to the chromebook cart. We started looking into what we would need, and what they would cost. After putting together our supply list, we proposed the budget, which came out to around \$1,450. With the solar panels, we put together a sign teaching the chromebook users how solar panels work, and how we did the project. Once our budget was approved, we got in touch with an electrician to help us with installation. The solar panels will be connected into the new building, charging our chromebooks. We will also reduce our carbon footprint by using clean sources of energy.

This group has submitted a budget to the Head of School, and the project is in the process of being funded/carried out in the new middle school building that will open August 2024.





Local Food

Our project, “S.E.E.D” (saving earth every day) is trying to address the issue of transportation, price, and land use of store bought food. Buying all of your fruits and vegetables from the supermarket isn't good for the earth, as the food has been transported long distances, thus putting out more carbon emissions. On top of this it also requires more land destruction of ecosystems killing many natural plants and animals. An alternative way to get your food is by growing it yourself which reduces the amount of carbon emission and destruction of land.

[S.E.E.D. website](https://sites.google.com/redwoodcoop.org/rewood-seed/home)

This group designed the website linked above as well as posters to the left which were printed and hung around school and along the car line route.

Fashion Footprint

Today we are going to discuss energy and fashion and how they connect with each other. In middle school, we have worked on our service learning unit this year, where we researched and picked a project to work on to help the community. This semester, we chose to host a clothing drive to educate students and families about the impact that fast fashion has on the environment.

We may not think about it but the clothes we wear everyday went through a long process of designing, dying, cutting, sewing, and shipping. All of which take up extremely large amounts of energy. Reusing older siblings' clothes, or buying second hand can help reduce the carbon footprint left by your fashion use. Carbon footprint is the amount of carbon dioxide released into the atmosphere. The more carbon there is in the atmosphere the hotter the global temperature gets.

This group spoke in each classroom (PreK-8) about the energy implications of fashion. They collected and organized clothes from the community and held a free clothing pop up in the front circle. Each class, as well as parents, were invited to attend.

Redwood coop clothing drive



Bring any unused or unwanted clothes to Middle school at Redwood Cooperative on

May 16th, 17th, 20th

2024



Come to our clothing drive on Tuesday May 21st to look at and take home other peoples donations! from 2:00pm-3:00pm

We do not except any under garments, damaged clothing, or any head wear. This includes holes, tears, stains, underwear, socks, headbands, hats, etc. Adult clothing is welcome!

We also ask that you please wash any donations you plan to bring in.



We would also love shoes, and back pack donations.



Thank you!



Speaking with 4th and 5th graders about the energy implications of fashion.



Organizing the free pop-up fashion boutique.



Videos

Starting in January, a group of middle school students began creating short videos to educate the Redwood community about energy. Students split into smaller groups and began creating the videos. Students researched, created outlines, created scripts, and then put together videos. All of these videos were made to educate people who see them about energy, how we use it, how we get it, and more.

This group of nine students began with the goal of working on three different series of videos. The individual topics were:

- Greenhouse gases and their negative effects on climate change & health
- How non renewable resources are eventually not renewable
- Process and problems of extraction of non-renewable resources (toxic waste, coal, oil spills)

While they began with the best of intentions, they had trouble actually producing videos. They got very caught up in the process instead of the product. They did a lot of research and learned a lot of things, then tried to make videos that were above their skill levels. In the end, the groups ran out of time and these videos are still in the production stages.

Reflection Survey

Students were asked to fill out a survey in May about the year-long study of energy, reflecting on the following questions:

- What was the most interesting thing you learned about energy this year?
- What is something that you learned that you will apply to your life?
- What is something from the energy project that inspired you?
- What is something you learned about energy from the environmental lens?
- What is something you learned about energy from the economic lens?
- What is something that you learned about energy from the socio-cultural lens?
- Are you more knowledgeable about energy than you were at the beginning of the year?
- Do you feel like you can make an impact on your community with regards to energy consumption, policy or conservation?

Here is a link to their responses:

[Response Spreadsheet](#)

We had a very positive experience using materials and ideas from the TCI Renewable Learning Lab, and building on the concepts presented. The variety of activities and resources provided in the learning lab was phenomenal. It provided so many great ideas for lessons, concepts, and approaches. Our students benefited from the experiences and we look forward to investigating another topic during the 2024-2025 school year with our next group of middle school students.

