ReFueling the Future

This Mastery Project introduces sustainable energy systems using science.

For high school students

This project was made possible through the support of:

Greenbacker

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ReFueling the Future is the first project in the ReImagining the Future series launched by Greenbacker Capital and Global Citizenship Experience Lab School.

Quality education will fuel future generations to lead and succeed in our rapidly changing, global workforce. We need more public-private partnerships to ensure that ALL students have access to courses that inspire curiosity in growth industries and provide pathways for existing and emerging careers.

Projects in the Imagining a Sustainable Future series:

ReFueling the Future: a science course that introduces the state of our energy supply system

ReDesigning the Future: a design and engineering course focused on systems thinking

ReMobilizing the Future: a civics and policy course about changing mindsets

A very special thank you to Greenbacker Capital, who is passionately committed to sustainability, to increasing the collective capacity of renewable energy, and to increasing the awareness of the economic benefits of sustainable infrastructure. Greenbacker is also committed to playing our part in the business ecosystem as a socially responsible and transparently governed organization that is a great place to work.
This Mastery Project is structured with three core stages:

### Internal Investigation

**Learning Foundational Skills & Concepts**

**Lessons 1-4**

**Why?**

The purpose of this investigation is to understand our current energy supply system and how it has developed since the Industrial Revolution.

**How?**

By the end of this investigation, you will have:

- Watched a video to put Earth’s resources into perspective
- Examined the history of human energy production and consumption
- Analyzed links between the rise in fossil fuel use and carbon dioxide in Earth’s atmosphere

### External Investigation

**Exploring World Context & Testing Credibility**

**Lesson 5–6**

**Why?**

The purpose of this investigation is to understand your energy impact and role in reducing energy consumption.

**How?**

By the end of this investigation, you will have:

- Calculated your carbon footprint
- Learned how to read an energy bill
- Made personal commitments to reduce your carbon footprint

### Action Project

**Demonstrating Mastery of Concepts & Skills**

**Lesson 7–8**

**Why?**

The purpose of this project is to synthesize everything you have learned so far to build an argument for a renewable energy future.

**How?**

By the end of this Action Project, you will have:

- Summarized major concepts from this project
- Conducted additional research into viable options for the future of our energy supply system
- Written a script for a video that outlines your argument and makes a pitch for support
- Created a video of your pitch
How will we fuel our future?

Why?

The purpose of this project is to get acquainted with the current state of our energy supply system, understand how it works, and evaluate options for transforming it.

How?

Here are the unit guiding questions you will pursue:

- What is the state of our energy supply system?
- How does Earth produce and consume energy?
- How do humans produce and consume energy?
- What are the alternatives to our energy supply system?
Lesson 1: Assess

Guiding Question:
What is the state of our energy supply system?
Even though you have probably seen many pictures of Earth before, the ability to view our planet from space is relatively recent. Do you remember what it was like to see a picture of Earth for the first time? Have you ever imagined what it would be like to experience that view from space?

To help you envision this experience, watch the first 7 minutes of this "Overview" video, by Planetary Collective. As you watch the clip from 0:00-7:10, take notes on images and quotes that stand out to you (of course you may also watch the whole 19-minute video if you would like).

"Overview" Video Questions

1. What is one word you would use to describe the images of Earth in this video?

2. Why do you think astronauts describe the moment of seeing the Earth from space as being so significant? How is it different from seeing Earth from the ground?

3. Would you say Earth is fragile or resilient? Explain.

4. In the video, lunar module pilot Edgar Mitchell describes the realization that the molecules in his body “had been prototyped in some ancient generation of stars,” then concludes, “we’re stardust.” What is your reaction to these statements? What does he mean, and how do you feel about him saying that we are all stardust?

5. Why do you think this video is being used to introduce a project about energy?
No matter how you get your news, you have probably heard reports that planet Earth is changing, and what life on our planet will look like in the next 50-100 years is uncertain. A major topic that arises in relation to these discussions is our current energy supply system: how we extract, transmit, generate, distribute, and store the fuels we use to power society.

When discussing our energy supply system, questions have been raised regarding its sustainability and impact on people and the planet. How well informed do you feel about our current energy system, and what questions do you have? What do you already know, and what do you hope to learn by the end of this project?

Before moving on to the next step, complete a simple KWL Chart:

- What do you already Know about our energy supply system and its related impacts?
- What do you Want to learn by the end of this project?
- Keep track of this chart, and at the end of each lesson, you will revise the third column: what you Learned.
To begin exploring our energy supply system, examine the graph below, then answer the prompts that follow. Save your answers so you may return to them throughout the course.

**History of Global Energy Consumption**

1. What does the graph show? Explain what you are looking at.
2. What trends do you notice by examining the graph?
3. The graph shows data up until 2010. What do you think the graph would look like if it showed data until 2030? 2050? 2100?

David Bice. History of Global Energy Consumption. Online: [Penn State University](http://www.psu.edu).
In the previous Step, you analyzed a graph showing the history of global energy consumption. You observed how it has increased since 1800, with a sharp rise starting around 1950. Why is that the case, and why and how do humans produce and consume so much energy?

To get a sense of our historical energy usage, watch the video below for an introduction to humans and energy, then answer the prompts that follow.

Humans and Energy: Crash Course 207

1. What primary sources did humans use for energy prior to industrialization?
2. How are fossil fuels originally from the sun?
3. How have fossil fuels shaped today’s political landscape?
4. Explain this statement in your own words: “From an energy use perspective, the world since 1900 is a totally new era in human history.”
5. How has Americans’ energy consumption changed since 1950?
6. The video states that significantly reducing our energy consumption “seems unlikely, especially since it would seem like a historical step backward.” Do you agree or disagree with this statement? Explain your position.
As you learned in the video from Step 4, “Humanity’s primary energy use has increased twenty times over since 1850 and nearly five times over since 1950.” Known as the **Great Acceleration**, this period is unprecedented in Earth’s history, and represents major shifts in socio-economic and earth system trends since 1750.

The effects of the Great Acceleration are beginning to impact Earth’s natural systems and cycles. To learn how, read this article from NASA, then answer the prompts that follow (click [here](#) to view the graphic in more detail). If you would like to learn more about how the data for this graph was collected, watch [this supplemental video](#) about CO₂ in the ice core.

### The Relentless Rise of Carbon Dioxide

The Relentless Rise of Carbon Dioxide

1. What does the graphic in the article show?
2. What does the dotted line on the graphic represent?
3. How was the data represented in this graph collected?
4. What does the measurement “ppm” mean?
5. During warmer interglacial periods, what was Earth’s ppm?
6. What was Earth’s ppm in 2013?
7. What is the “Anthropocene” and what do you think the name means?
8. If we exhaust all our fossil fuel reserves, how high might the ppm rise?
9. The article states, “This recent relentless rise in CO₂ shows a remarkably constant relationship with fossil-fuel burning, and can be well accounted for based on the simple premise that about 60 percent of fossil-fuel emissions stay in the air.” Comparing the graphic in this article with the graph in Step 2, does this statement seem consistent? Explain your answer.
Lesson 1  Step 6: Reflect

The guiding question for this lesson was: What is the state of our energy supply system? Based on what you have learned in this Lesson, write a one-paragraph response to this question. In your answer, consider the following:

- In your own words, what is the current state of the world’s energy supply system?
- What is one fact, statistic, or image from this Lesson that supports your assessment?
- In Step 2, you analyzed the History of Global Energy Consumption graph and made predictions about what the graph might look like in 2030, 2050, and 2100. Based on the information from this Lesson, would you revise your answers? Why or why not?
- Recall the Overview video you watched at the beginning of this Lesson. Why, do you think, that video was used to introduce this lesson? Do you see Earth any differently after completing this lesson?

After writing this reflection, revisit your KWL chart from Step 2 and make any necessary additions. You may need to add information to the “L” column - but you also might find this lesson raised more questions, and you need to update the “W” column as well.
Lesson 2: Understand

Guiding Question:
How does Earth produce and consume energy?
In Lesson 1, you explored the current state of our energy supply system and learned that fossil fuels are really just stored energy from the sun. What exactly does that mean, and how does the sun power the earth? If our energy, including fossil fuels, just comes from the sun, then what’s the harm in burning it?

To begin your exploration, watch the video below, then answer the questions that follow.

A guide to the energy of the Earth

1. What are Earth's four physical systems?
2. What are Earth's internal sources of energy?
3. How does the sun drive our weather and climate?
4. How does energy move through the biosphere, and which organisms are most efficient?
5. Why is carbon released when fossil fuels are burned?
6. How does electricity work, and what are different ways it can be generated?
7. What are some examples of energy decisions you make every day?
As you learned in the video from Step 1, Earth has four physical systems: the atmosphere, hydrosphere, biosphere, and geosphere. Energy is transferred within these spheres in the following ways:

**Atmosphere:** Solar radiation heats the Earth’s surface unevenly, depending on where it hits. For example, a glacier reflects more radiation, while water in the ocean absorbs more. Cold and warm air have different densities, so the uneven heating causes air to move in the atmosphere. When the air moves, it distributes energy, mostly in the form of heat, a process known as **convection**.

**Hydrosphere:** Solar radiation also heats water unevenly, based on depth and latitude. Differences in temperature and salinity mean differences in density. Like with air, this difference in density causes water to move, creating **convection currents**, which distribute energy in the ocean.

**Biosphere:** Energy also arrives in the biosphere via solar radiation, which is changed into chemical energy during photosynthesis. This energy is then transferred to primary consumers that eat plants, which in turn pass energy on to secondary consumers when they are eaten. When an organism dies, it is consumed by decomposers that break the remains into simple materials such as carbon dioxide—and then the cycle begins again, as plants use the carbon dioxide during photosynthesis.

**Geosphere:** Internally, convection also takes place in the geosphere, as rock in the earth’s mantle is heated and this, combined with the high pressure environment, causes rock to flow, losing density and rising towards the earth's crust. As cooler rock sinks, convection currents cause tectonic plates to move.

Energy is also transferred between spheres through **conduction**, or direct contact. For example, when air comes in direct contact with the earth’s surface, energy is passed back and forth, with the direction of the transfer depending on which is warmer.

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**Earth's Systems Diagram**

Based on the information in this Step, draw a diagram of how energy cycles through the four spheres. Do not look up a diagram; instead, draw your understanding based on the descriptions above. Your diagram should include all the terms from this Step written in **bold**, and they should be labeled.
Now that you understand how energy is transferred from one system to another, let’s focus on the biosphere and how energy flows through it. The biosphere includes all living things and their environments on Earth. Energy enters the biosphere through solar radiation, which is converted by producers or autotrophs—organisms that can produce their own food by transforming the radiant energy and simple molecules like carbon dioxide through the process of photosynthesis. They serve as the foundation for an ecosystem, because they are the entry point for energy, which they convert into a usable form for other organisms in the food web.

These primary producers are then consumed by primary consumers, which are in turn eaten by secondary consumers—and so on. We call each step in a food chain a trophic level, which describes how many transfers of energy and nutrients separate an organism from the chain's original energy source. Remember as you learned from the video in Step 1, energy is lost between each trophic level in the form of heat, so only about 10 percent of energy is transferred to the next level. So it is important to remember that energy flows in one direction through the biosphere — yet the heat produced as a byproduct is released back into the other spheres.

Ecological Pyramid. Online: Khan Academy.
In Step 3, you learned how energy flows through the biosphere. As energy is transferred from one living organism to the next, so are essential nutrients, such as carbon, phosphorus, and nitrogen. The living organisms in an ecosystem are referred to as biotic, while the non-living elements are known as abiotic factors, and biogeochemical cycles describe how nutrient material is exchanged between biotic and abiotic elements of an ecosystem. It is important to remember that energy flows in one direction through the biosphere, but matter, such as chemical compounds, are recycled and move cyclically.

In this Step, let’s focus on carbon and how it cycles through the biosphere, as it informs our understanding of the energy supply system. To begin, watch this video and answer the prompts that follow on the next slide.
A guide to the energy of the Earth

1. What are greenhouse gases?
2. How did the evolution of plants change the earth’s atmosphere?
3. Describe how carbon fixation works in your own words.
4. How much of Earth’s carbon is locked up in rocks?
5. How much of Earth’s carbon is in fossil fuels?
6. About how much of the 30 gigatons of $\text{CO}_2$ produced annually by humans is reabsorbed by the environment?
In the video from Step 4, you learned that the environment is only able to reabsorb about 40 percent of the CO$_2$ produced by humans each year. To understand why, open this slideshow and examine the diagrams featured.

The carbon cycle has both “fast” and “slow” components. Diagram 1 in the slideshow shows the fast carbon cycle, while Diagram 2 shows both the fast and slow carbon cycles. In the slow cycle, carbon moves through Earth’s spheres over millions of years, while the fast cycle mostly represents how carbon is exchanged between trophic levels or moves from the biosphere and atmosphere via photosynthesis. We can observe this exchange across seasons:

In the Northern Hemisphere winter, when few land plants are growing and many are decaying, atmospheric carbon dioxide concentrations climb. During the spring, when plants begin growing again, concentrations drop. It is as if the Earth is breathing. The ebb and flow of the fast carbon cycle is visible in the changing seasons. As the large land masses of Northern Hemisphere green in the spring and summer, they draw carbon out of the atmosphere (US Carbon Cycle Science Program).

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**Fast and Slow Carbon Cycles**

Presentation. Images and text from UCAR Center for Science Education.

1. What do the white, yellow, and red text represent in the diagrams?

2. Focus on the red text. About how much carbon is released due to human activity, which cannot be absorbed through natural processes?

3. Based on what you have learned about the fast and slow carbon cycles, what could be done about the excess carbon released due to human activity?
As you learned from the diagrams in Step 5, oceans and forests naturally absorb and store carbon from the atmosphere. For this reason, they are known as **carbon sinks** — natural reservoirs that store carbon. Learn more about carbon sinks by reading this site and watching the video embedded in the page.

As we simultaneously emit more carbon and cut forests for industry and farmland, we make the carbon imbalance greater because we are shrinking the sinks that have traditionally stored carbon and kept it from being released into the atmosphere.

**What are Carbon Sinks?**

There are three types of carbon sinks mentioned in the resource. List each of the three, explain how it works, and summarize its limitations.
Refer back to the Overview video you watched at the beginning of Lesson 1. You were asked to answer this prompt: Would you say Earth is fragile or resilient? Has your answer changed at all? Reflect on your initial response and revise if necessary.
Lesson 3: Compare

Guiding Question:

How do humans produce and consume energy?
In the first two lessons, you have learned about the crisis posed by our current energy supply system, and learned how Earth’s natural systems exchange energy through a continuous cycle. In this Lesson, you will explore exactly what energy is, and how we as humans currently harness it to power our lifestyles. Begin by watching this video.

As you learned in the video, the total amount of energy in the universe is always the same. Much of this energy is stored in chemical bonds (potential energy) that is released when those bonds are broken (kinetic energy).

**All of the Energy in the World Is...**

1. How are temperature and energy related?
2. Explain the process of cooking food using the concept of kinetic energy.
3. Why does the video describe energy as a “chameleon phoenix?”
In Step 1, you learned about potential energy and kinetic energy. Yet these are not the only types of energy. Read this site to learn about the different types of energy.

**Types of Energy**

1. In your own words, what is kinetic energy? Provide an example not mentioned on the site.
2. In your own words, what is potential energy? Provide an example not mentioned on the site.
3. How do we use energy to do work?

Anne Marie Helmenstine, Ph.D. (May 31, 2019). Online: ThoughtCo.
As you learned in Step 2, there are different types of energy, and also different sources of energy humans can harness to power our lives.

Explore these pages from the U.S. Energy Information Administration, then answer the prompts that follow.

- Renewable and nonrenewable sources of energy
- U.S. energy consumption and production

Sources of Energy

Select one renewable and one nonrenewable source of energy to research more in-depth, then complete the following:

- Summarize what the resources are and how they work, as if you were explaining it to a 5-year-old.
- Create a list of pros and cons for each of the two sources you researched.
- Write an analysis of each source and whether you believe we should invest in increasing or decreasing its use, and why.
Now watch the video below about energy production from 0:00-2:45 and answer the prompts that follow:

**How Energy is Produced**

1. What are four different ways a power plant generator can be powered?
2. What is one way, aside from using generators, that electricity can be generated?
3. How does electricity get from a power plant to a home? List at four different stops.
4. What is the electrical grid?
Now you know where energy comes from and how it is converted to power we can use to fuel our lifestyles. Yet our challenge is bigger than just transitioning our existing energy sources from non-renewable to renewable sources — we also must find ways to provide energy to those who are currently underserved. In fact, the United Nations has identified this as a top global priority, as outlined in its 17 Sustainable Development Goals.

Goal 7 aims to provide affordable, reliable, sustainable and modern energy for all by 2030. Do you believe this is possible, and if so, how might we achieve it? Before answering, watch this video, then use what you have learned from the video and other resources in this lesson to answer the prompts on the next slide.
How Energy is Produced

1. On a global scale, about what percent of our energy production comes from renewable sources?
2. About how many people worldwide do not have access to clean energy sources?
3. What will be the effects of 3 billion more people moving from rural to urban areas?
4. What would happen if everyone on Earth used the same amount of energy as North Americans?
5. Our challenge is to increase energy production so we can both meet current demands and provide access to those who do not currently have it, all while reducing CO$_2$ emissions. With this reality facing humanity, what are your initial thoughts on how to address the issue? Would you be willing to make any personal sacrifices, or do you have other proposed solutions?
Lesson 4: Transition

Guiding Question:
What are the alternatives to our current energy supply system?
From the information provided so far in this project, what does the evidence tell us about the future of our energy supply system?

In Lesson 3, you selected a renewable energy source and conducted some research on its pros and cons. What is standing in the way of scaling up various sustainable power sources? Watch the video below and answer the prompts that follow.

Can We Run on 100% Renewables?

1. When is it estimated we will run out of oil, gas and coal?

2. What are the opportunities and challenges posed by using solar power to fuel the world?

3. How efficient are our current power lines?

4. What are some of the challenges posed by replacing our liquid fuels?

5. What is a superconductor? Conduct additional research if necessary to answer this question.

6. What are some fields that must work together to achieve a transition to renewable energy?
What can be done in the meantime, as we wait for the technological advancements needed to scale up solar, wind, hydro, and other forms of renewable energy? Some companies are already working to make renewables more efficient, accessible, and attractive to consumers and investors.

For example, Greenbacker Renewable Energy Company is leading the transition to a clean-energy economy by investing in and operating a diversified national portfolio of income-producing renewable energy power plants, energy efficiency projects, and other sustainable investments. They are not an emerging technology or clean technology investor; instead, they buy renewable energy assets and other long-term contracted income producing assets with the goal of professionally managing them to increase energy production and investor return. Today, these assets make up a $450+ million portfolio that generally offers investors predictable, safe, and reliable financial returns.

Greenbacker is not only committed passionately to sustainability, to increasing the collective capacity of renewable energy, and to increasing investor awareness of the economic benefits of sustainable infrastructure; the company is also committed to playing their part in the business ecosystem as a socially responsible and transparently-governed organization.
Greenbacker is also working to achieve the UN Sustainable Development Goals and using them to help measure the firm's impact. As sustainability issues have a more direct impact on a company’s reputation and financial standing, developing strategies and modes of operation that coincide with the SDGs will allow us to benchmark our progress in sustainability and show our commitment to a community that is dedicated to a better future.

Learn more about Greenbacker’s investments by reading the following case study and answering the prompts that follow.

Beyond Energy Generation

1. What is biomass? Conduct outside research if needed to answer this question.

2. How many homes can be powered by the Eagle Valley Clean Energy Biomass Plant?

3. How many local residents are employed by the Plant?

4. What are three ways the Plant benefits the local community and environment?

Beyond Energy Generation

Greenbacker Impact Report Q1Q2 2019
Let us never forget that everything that is required to make America’s economy cleaner, greener and more resilient is a career pathway for someone. Or a business contract. Or an entrepreneurial opportunity... We can create millions of jobs that will make our people wealthier and the Earth healthier.

— Van Jones, President, Green for All

In your examination of the Eagle Valley Clean Energy Biomass Plant, you learned that 43 people are employed there. What kinds of jobs are included in that number, and what career possibilities are there for working in renewable energy and sustainability? Review the following information about how Greenbacker is impacting green jobs.

**Impacting Green Jobs**

1. What are the five job types that Greenbacker supports?

2. How many jobs does Greenbacker support in comparison to a natural gas company of similar size?

3. The five job categories include “Other.” What kinds of jobs do you think might fall under this category?

4. What opportunities do you see for yourself for working in renewable energy?
In the previous Step, you identified some opportunities for yourself to work in renewable energy. Do the jobs in this field require you to be good at math or science? What if you don’t want to work in engineering or construction — are there still opportunities for you in sustainability? Explore the resources below to get a better understanding of what types of jobs are needed in each industry.

**Career Maps in Renewable Energy**

- Careers in [Bioenergy](#)
- Careers in [Solar](#)
- Careers in [Wind](#)
- [Renewable Energy Competency Model](#)

1. What is one entry level position that aligns with your interests and career goals?
2. What is one advanced level position that aligns with your interests and career goals?
3. What might your career path look like to get a job in renewable energy? What are the competencies you would need to develop?
4. What are some careers you imagine in sustainability that are not listed in these resources, which might be of interest to you?
Revisit your KWL chart from Lesson 1 and make any updates based on what you have learned in this Internal Investigation.
Lesson 5: Research

Guiding Question:

Where does your energy come from?

So far, you have investigated national and global statistics on energy consumption. In this External Investigation, you will explore energy on a more local scale, from your state to your home. To begin, explore this site by finding your state and learning how energy production changed between 2001-2017.

**How Does Your State Make Electricity?**

How the United States generated electricity from 2001 to 2017
Now that you have an idea of the energy mix used in your state, how is that energy used? Where does it go, and how much of it do you use? If you wanted to make an energy-saving impact in your home, where would you begin? What is the difference in energy consumption between hanging your clothes to dry and using a dryer? How much energy do you save by unplugging your computer at night? Examine this infographic from VisualCapitalist for an initial understanding of which items use the most energy in the average home.

Now visit the full page, What Uses the Most Energy in Your Home? and answer the questions that follow.

**What Uses the Most Energy in Your Home?**

1. What percent of power used at home is wasted?

2. What “vampire” appliances, and what can you do about them?

3. After visiting this site, what is one thing you can do to save energy at home?
According to the Environmental and Energy Study Institute:

“residential and commercial buildings are responsible for almost 40 percent of U.S. carbon dioxide emissions. From houses and hotels to schools and skyscrapers, buildings in the United States use about 40 percent of the country’s energy for lighting, heating, cooling, and appliance operation... About 30 percent of the electricity buildings use is generated from coal-burning power plants, which release greenhouse gases, causing climate change.”

With this information, how might you play a role in reducing carbon emissions from your own home? Take a look at this carbon footprint calculator to learn what your impact is, see how to reduce your footprint, and make commitments to selected lifestyle changes.

Cool Climate Network

Carbon Footprint Calculator

1. The bar graph on the right compares your carbon footprint to similar households in the United States. How are you doing in comparison, and in what categories could you improve?

2. Why do food choices appear on a carbon footprint calculator? How is food production related to carbon emissions?

3. The “Take Action” tab offers opportunities to reduce your impact. What are at least 3 commitments you can make, starting today?
You just made at least three commitments to reduce your carbon footprint. For more information on the industries that contribute to your footprint, read this factsheet from the University of Michigan.

Carbon Footprint Factsheet


After reading the factsheet, identify at least two more areas where you could commit to reducing your carbon footprint, or encourage family and friends to join your pledge.
Lesson 6: Analyze

Guiding Question:

How much energy do you consume?

You just calculated your carbon footprint, but this is just an estimate. You have made some pledges to reduce your energy consumption — but how do you know if your actions are having any impact? For this External Investigation, you will determine how much energy you actually use in your own home.

Energy bills look different depending on the provider, but take a look at this sample to see an example and understand the information included on a typical bill and what it means. Using the sample bill as a reference, answer these questions:

**Sample Energy Bill**

1. How is energy measured on the bill? What units are used?
2. Examine the 7-month usage for this bill. What does it mean, and why is each month different?
3. This sample bill is for $99, which covers 33 days of energy service. What is the breakdown of that $99? How much of it is for energy?
4. Do you think $99 is a fair charge for the energy used and the service provided? Why or why not?
As you learned in the previous step, your energy consumption shows up on your bill as kWh, or kilowatt hours. To learn what this means, watch the video below.

What is a kilowatt hour?

Explain kilowatt hours in your own words.
Each month, you receive a bill for the energy you use. If possible, locate the bill for where you live. If you are unable to locate your home energy bill, you may use this sample. Using your bill, answer these questions.

**Sample Energy Bill**

1. How much energy did you use (in kWh) over the billing period?

2. How has your energy usage fluctuated over the last 7-12 months?

3. Locate the months with the highest and lowest usage. Why are these the months with the highest and lowest energy consumption? Think of weather or other patterns that might affect your monthly consumption.
Most energy companies offer an option to buy or support renewable energy. Read the following article to learn more about what these options are, and what they mean.

**Buying Clean Energy**

How to buy clean energy. Energy.gov.

Now contact your energy supplier, and inquire about options for supporting renewable energy. If your home is not already purchasing renewable energy, speak with family members to see if the investment is feasible, as many energy providers include an additional charge for renewable energy. If supporting renewables is not possible, work with family members to identify areas where energy consumption can be reduced in your home. Being mindful about energy usage will not just reduce the amount of kilowatts you use, it will also reduce your monthly bill!
Lesson 7: Plan

Guiding Question:

What is the future of our energy supply system?

Please review the Action Project worksheet, rubric, and example of excellence below:

ReFueling the Future Action Project Worksheet
ReFueling the Future Action Project Rubric
ReFueling the Future Sample Project
As you have already learned in this project, we are at a critical time in human history. The quality of life we experience in the future will depend on the decisions we make in the next few years. Transitioning to renewable sources of energy will be a challenge, but with the help of technological advancements, this switch may be possible in the coming decades. Before diving into your own project, watch this video, which provides an overview of renewable energy and the possibilities offered by each.

### Renewables Roundup

1. About how much energy do we consume each day?
2. According to the video, what are the pros and cons of solar energy?
3. According to the video, what are the pros and cons of hydropower?
4. According to the video, what are the pros and cons of biofuels?
5. According to the video, what are the pros and cons of geothermal power?
In Lesson 3, you conducted some initial research into a selected renewable and nonrenewable energy source. For this project, you will be asked to make a pitch for one renewable energy source and attempt to convince your audience or client that your chosen source is a worthy investment in the long-run.

Revisit this site on renewable and nonrenewable sources of energy, and select one renewable source to pitch. This could be the same one you researched in Lesson 3, or you may choose a different one. Whatever you decide, select one that will hold your interest for the duration of the Action Project. The resources you will find the most information on include:

- Hydro
- Biomass
- Biofuels
- Wind
- Geothermal
- Solar
Once you have selected your renewable energy type, you may begin conducting research for your pitch. Use this Action Project Prep Worksheet to record your ideas and research. Save this worksheet for the duration of the project, as you will continue to add to it and refer to it as you make your video.

To begin, make a copy of the worksheet, rename it with your initials, and complete prompts 1-4. As you conduct your research, be sure the sources you use are credible. If you are unsure about the credibility of a source, visit a site like OWL at Purdue, which will help you evaluate questionable sources.

🔗 ReFueling the Future Action Project Prep Worksheet
Now that you have conducted your initial research, build an argument in support of increasing the use of your chosen renewable energy source. Use questions 5-7 on the Prep Worksheet to guide your work.

ReFueling the Future Action Project Prep Worksheet
Summarize your argument and outline a final pitch that will leave a lasting, impactful impression on your audience.
Lesson 8: Create

Guiding Question:

How do you make an argument for renewable energy?
Now that you have completed your research and organized your main points on the Prep Worksheet, begin to draft a script that can be used to narrate your video. Consider both the narration and the images you will use. Will you make a slideshow and record narration? Will you film your pitch and edit the clips together? Whichever approach you take, be sure it includes all the elements required on the Action Project Rubric.
Create any visuals you will use in your video. If you need to make a slideshow, now is the time to do it. If you will be filming a video, consider how you will incorporate the required visuals into your final cut.
Once you have completed your script and slideshow or plan for visuals, rehearse several times. Be sure you know how to pronounce any new vocabulary confidently, and try playing with your voice inflection so your narration is engaging, convincing, and memorable. Remember you want people to be convinced by your argument, and enthusiasm can be as important as good research!
If you are making a video, here are some suggestions for capturing high-quality footage:

**Devices & Accessories**

**Cameras:** Most smartphones have cameras that capture high-quality images and videos. The quality of video and audio capture are highly dependent on the type of camera, but any camera that records video will work.

**Microphones:** A big component of a successful video is not only quality footage but also quality audio. Test how well your camera captures audio. If the audio does not sound great, it is worth supplementing your camera with an external microphone. The microphone on most smartphones work well.

**Tripod:** It is extremely helpful to have a tripod to keep your camera steady and leveled throughout your recordings.

Watch the video for some easy-to-make desktop tripods for any smartphone.
Tips for Recording

You may not have full control over the quality of your recording devices, the surroundings in which you are recording, or the volume or movements of your subject; but you can do your best to ensure good-quality video and audio. Follow the tips below:

- Find a quiet spot to record. Tips for recording quality audio:
  - Find a quiet space. If you can hear it, your microphone will likely pick it up. Try to find a space that has no background noises.
  - Find a space with as little echo as possible. A large room with bare walls will create echoing which will make your audio sound far away and hollow. Find a room with carpet and curtains to make your audio sound fuller and richer. Bedrooms and bathrooms can be good options depending on the space.
  - Speak into the microphone. Always point the microphone at the person that is speaking.
  - Trial and error. There are so many factors that play into recording quality audio. The best first step is to experiment with the spaces and recording devices that are available to you.

- Find interesting and relevant backgrounds. If you are recording an interview, set up your subject in front of an interesting background and if possible, create an environment that reflects what your video is about. For instance, if I am recording an interview about education, I would find a chalkboard or a bookshelf to record in front of. Make sure that there is not too much movement behind your subject; the background should enhance, not distract.

- Go horizontal. To avoid the black bars that appear on the sides of videos, always orient your camera to capture footage and images horizontally. This ensures all visuals fill up the screen.

- Keep it steady. Use a tripod whenever possible to make sure that your recordings are steady. But since setting up a tripod is not always an option, try your best to keep your hands as steady as possible. If possible move your wrists, and not your body to capture movement.

- Keep it calm. Try your best not to verbally react to what you are recording, unless your reaction or narration is a part of the video. Remember you're closest to the camera, so whatever you say will be clearly recorded.

- Trial and error. There are so many factors that play into recording quality video. The best first step is to experiment with the spaces and recording devices that are available to you. There are always surprises when recording video, so go with the flow.
If you need to edit your video footage, you may find the following advice and resources useful.

The video editor on YouTube is a sufficient tool if you want to add transitions and text to a video that requires minimal editing. A major downfall to the YouTube editor is that you cannot upload your own audio. WeVideo is a free online editing app that allows for basic editing and does give you the option of uploading your own audio.

You may already have programs on your computers such as iMovie or MovieMaker. Both of these programs allow for more detailed editing.

There are also a number of free or very affordable apps you can download to your phone or computer.

Use what you are comfortable with.
Let's publish your work! Before you can share your video project on your blog, you must publish it on a video hosting site. Youtube is the most popular site, but there are other options out there. If your video is less than 60 seconds long, Instagram is another great option. Uploading and sharing a video through Instagram is just as simple as uploading and sharing a photo. Vimeo is a great-looking and ad-free video hosting site.

Follow the instructions on the website to create your own Vimeo account. Once you've done that submit the link to your profile.
Sustainable Development Goals

**SDG 7:** Affordable and Clean Energy

7.2 increase substantially the share of renewable energy in the global energy mix by 2030

7.3 double the global rate of improvement in energy efficiency by 2030

NextGen Science Standards

**HS-LS2-2:** Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

**HS-LS2-4:** Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.

**HS-ESS2-2:** Analyze science data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.

**HS-ESS2-6:** Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
CITE THIS RESOURCE:


* We thank Jessie Stenftenagel & Will Johnson for reviewing this course.

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