**Subject area/course**: Science/Environmental Science

**Grade level/band**: 9-12

**Task source**: Stanford Center for Assessment, Learning, and Equity (SCALE); author: Susan Schultz

**Renewable Resources**

**TEACHER'S GUIDE**

1. **Task overview**:

For this task, students will work in teams to examine a specific type of renewable energy source. Student groups will research one renewable energy resource (such as solar energy, wind energy, biomass, geothermal energy, hydrogen fuel, nuclear power, and hydroelectric power) and determine the current use of the renewable resource within a local context.

Students will then analyze the feasibility of significantly expanding the use of this type of energy source and prepare an argument based on evidence from their research and their analysis. As a group, they will prepare a logical and convincing argument with evidence about why this is a feasible alternative energy source for your location. To fully develop their argument, they must justify why their renewable resource is the “best” for their location providing multiple credible sources of evidence to support their claim. They must also explain and refute any alternative renewable resources using evidence, and identify the limitations of their argument. Groups will then create a multimedia public awareness campaign (e.g., a infomercial, commercial, video, song, billboard, etc.) to inform the public and generate support for the use of renewable energy. Individually, they will write a reflective essay sharing what they learned from this project.

NOTE: The individual essay is intended to provide you with evidence of what each individual student learned and to assess his/her ability to construct and justify an argument using evidence. This can be assigned as a homework assignment instead of using class time.

1. **Aligned standards:**
2. **Common Core State Standards**

CCSS.ELA-Literacy.RST.9-10.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

CCSS.ELA-Literacy.RST.9-10.2 Determine the central ideas or conclusions of a text; trace the text’s explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

CCSS.ELA-Literacy.RST.9-10.7 Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

CCSS.ELA-Literacy.WHST.9-10.1a Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.

CCSS.ELA-Literacy.WHST.9-10.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

CCSS.ELA-Literacy.WHST.9-10.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

1. **Critical abilities**

Research: Conduct sustained research projects to answer a question (including a self-generated question) or solve a problem, narrow or broaden the inquiry when appropriate, and demonstrate understanding of the subject under investigation. Gather relevant information from multiple authoritative print and digital sources, use advanced searches effectively, and assess the strengths and limitations of each source in terms of the specific task, purpose, and audience.

Analysis of Information: Integrate and synthesize multiple sources of information (e.g., texts, experiments, simulations) presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to address a question, make informed decisions, understand a process, phenomenon, or concept, and solve problems while evaluating the credibility and accuracy of each source and noting any discrepancies among the data.

Interpersonal Interaction and Collaboration: Develop a range of interpersonal skills, including the ability to work with others, to participate effectively in a range of conversations and collaborations.

Communication in Many Forms: Use oral and written communication skills to learn, evaluate, and express ideas for a range of tasks, purposes, and audiences. Develop and strengthen writing as needed by planning, revising, editing, and rewriting while considering the audience.

1. **Next Generation Science Standards**

*Disciplinary Core Ideas*

HS-ESS3-2. All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors.

Secondary to HS-ESS3-2 When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. HS-ETS1-3

HS-ESS3-3.The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.

HS-ESS3-4. Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.

HS-PS2-6. Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).

*Science and Engineering Practices*

Constructing Explanations and Designing Solutions

* Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students’ own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.
* Design or refine a solution to a complex real-world problem, based on scientific knowledge, student- generated sources of evidence, prioritized criteria, and tradeoff considerations.

*Engaging in Argument From Evidence*

* Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues.
* Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.
* Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge and student-generated evidence.
* Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and/or logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations)
1. **Time/schedule requirements:**

The following schedule is an estimate of the number of school days required for students to complete this task. Time requirements will vary based on grade level, schedule constraints, class size, class length, and academic readiness.

|  |  |  |
| --- | --- | --- |
| **Day** | **What Students Need To Do** | **Product** |
| Day 1 | Intro: Get familiar with the task requirements and expectations |  |
| Days 2-3 | Part 1: Use the Internet and other resources to explore various types of renewable resources; select and get approved to study a particular renewable resource | Multimedia production |
| Days 3-8 | Part 2: Research the current use of the renewable resource within the selected location |
| Part 3: Analyze the feasibility of significantly expanding this type of renewable resource in the location—the costs, benefits, and public sentiments |
| Part 4: Prepare your argument using evidence and address any counterclaims |
| Parts 5 & 6: Prepare an outline or storyboard of your public awareness campaign; get teacher and/or peer feedback and revise |
| Day 9 | Part 7: Present final public awareness campaign (presentation, video, song, etc.) |
| Day 10-11 | Part 8: Draft of individual reflection essay (This could be a homework assignment)  | Individual Reflection Essay |
| Day 12 | Individual reflection DUE |

1. **Materials/resources:**

Students will need:

* Access to the Internet for research
* Presentation, video, audio and/or other software
* *Criteria for Oral Presentations* document

Books and/or resources (optional):

* EIA Releases New Energy Education Resource for Teachers and Students, [www.eia.doe.gov/energyexplained](https://webmail.ccesc.org/owa/redir.aspx?C=e075c1c95c4b4ecabf265325f7b5c19c&URL=http%3a%2f%2fwww.eia.doe.gov%2fenergyexplained)
* Gale, Cengage Learning, [www.trials.gale.com](http://www.trials.gale.com)

Helpful links:

* [Centre For Energy](http://centreforenergy.com/AboutEnergy/) (Canada): <http://centreforenergy.com/AboutEnergy/>
* [National Renewable Energy Lab](http://www.nrel.gov/): <http://www.nrel.gov/>
* [How Stuff Works](http://science.howstuffworks.com/)-science site: <http://science.howstuffworks.com/>
* [The Future for Geothermal Energy](http://www1.eere.energy.gov/geothermal/future_geothermal.html): <http://www1.eere.energy.gov/geothermal/future_geothermal.html>
* [Green Econometrics](http://greeneconometrics.com/): <http://greeneconometrics.com/>
* [Science Daily News articles related to renewable energy](http://www.sciencedaily.com/news/earth_climate/renewable_energy/): <http://www.sciencedaily.com/news/earth_climate/renewable_energy/>
* [http://www.thecarblog.com/domestics/ford\_fusion\_hydrogen\_999\_showcases\_fords\_fuel\_cell\_technology.php](https://webmail.ccesc.org/owa/redir.aspx?C=e075c1c95c4b4ecabf265325f7b5c19c&URL=http%3a%2f%2fwww.thecarblog.com%2fdomestics%2fford_fusion_hydrogen_999_showcases_fords_fuel_cell_technology.php)
* [http://fuelcellsworks.com/news/2009/05/19/ohio-house-alternative-energy-committe-visits-unique-fuel-cell-demonstration-project/](https://webmail.ccesc.org/owa/redir.aspx?C=e075c1c95c4b4ecabf265325f7b5c19c&URL=http%3a%2f%2ffuelcellsworks.com%2fnews%2f2009%2f05%2f19%2fohio-house-alternative-energy-committe-visits-unique-fuel-cell-demonstration-project%2f)
1. **Prior knowledge:**

Students will need to know:

* The basics of energy production, use, and transfer.
* Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.
* At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy.
* All of the different manifestations of energy can be modeled as either motions of particles or energy stored in fields (which mediate interactions between particles).
* Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems.
1. **Connection to curriculum:**

This performance assessment can be used as a culminating project at the end of an Environmental Science unit on types of energy, energy production, and/or human impacts.

1. **Teacher instructions:**

Below is a comprehensive list of *suggested* ways to facilitate, organize, and scaffold student work. You will, of course, need to choose which ideas meet the needs of your students, their previous experience with open-ended projects, and practicalities of your classroom/school, and adapt them accordingly.

You will notice that throughout we have tried to provide students with opportunities to make choices and take the lead in decision-making to complete the task. In this same vein, we encourage the use of peer-review and revision.

Possible Engagement Activities (The Hook)

1. Pick one type of renewable energy (perhaps a type you won’t have any of the groups study) and have students consider reasons to increase our use of this type of energy (so we reduce our use of fossil fuels which may eventually run out and reduce carbon emissions). Then have them think of reasons against increasing our use of this particular type of renewable energy. Through the discussion address some possible misconceptions, such as:
* Not all renewable resources would be appropriate for use in the same location depending on economic, environmental, and cultural conditions.
* The financial cost of implementing a renewable resource is equivalent to what is being used today.
* Renewable resources have little or no environmental or human risks associated with them.
1. Another suggestion for introducing the task is to show the class an infomercial on an energy topic and ask them to identify the science content, the claims, evidence, counterclaims, and limitations presented in the infomercial. This will highlight some of the expectations for the final group product. One pilot teacher used this link with their students: <https://www.youtube.com/watch?v=qlTA3rnpgzU>. When you go to this site you also see numerous YouTube videos refuting their ideas.
2. Have students measure their own energy use/ecological footprint: <http://www.myfootprint.org>

Introduce the Task

* After the introductory activity, review the task description on page one and respond to any student questions.
* Suggest students design a template to be used to collect information and record references at the time data is being collected.
* Tell students that personal reflections should be written in a journal/log throughout the project.

Review Expectations

* Review the due dates/task timeline.
* Review expectations for working together in a group – the roles students should take on and the norms for behavior (for more details, see “Student Support” section).
* Allow students time to look at the rubric(s), clarify the Scientific Literacy Rubric and the *Criteria for Oral Presentations* document, and respond to student questions.
* Explain that, as they work in their groups, they will be responsible for gathering information and making their own decisions. As the teacher, you will provide help/resources only when everyone in the group agrees that they need help or if there is information they can’t find themselves.

Part 1: Explore various types of renewable resources (Team Activity)

* Ask students to select the location that they want to focus on for this project. We opened it up to any location to provide students with lots of choice. You can decide to narrow the scope of this project to any state in the U.S. or to regions within your own state.
* Have students use the Internet and other resources to understand the breadth of possible sources of renewable resources at the location they have selected.
* At the end of the period, each group should get approval on the location and type of renewable resource they wish to investigate in depth.

Part 2: Research the **current** use of ONE renewable resource within the state (Team Activity)

Students will need to collect information from a variety of sources and discuss any potential bias within the documents.

Before allowing students to conduct research, it will be necessary to discuss:

* Need for credible sources for obtaining research information– what does it mean to be a credible source?
* Review how to gather information from a source and properly cite the author’s statements.
* Explain to students the format that you want them to use to make within-text citations and references (bibliography).

The research should:

* Identify the locations or regions of the state that currently use this form of energy.
* Describe any specific features of the location that make it ideal for this form of energy (for example, being near a river is essential for hydropower).
* Explain the benefits and approximate costs of implementing and using this resource to produce energy.
* Discuss any geographic or climatic issues that might make this energy source difficult.
* Report the amount of electricity or other energy produced from this renewable resource.
* Synthesize the information and summarize the location’s current use of this renewable resource.

*Individual Task*: Provide students time at the end of class to summarize their research/findings, to record this information in their science notebook, and to reflect on the group and individual work in their notebooks (or a reflection log).

Part 3: Analyze the feasibility of significantly expanding this type of renewable resource as a major source of energy in the state (Team Activity)

Students are required to explore the possibility of using this renewable resource on a large scale. They will need to:

* Estimate the approximate costs associated with purchasing or harnessing this renewable resource and maintaining a consistent source of energy (i.e., manpower, equipment, construction, delivery system, etc.).
* Calculate the amount of increased production that needs to occur over the next 15 years.
* Discuss which obstacles, if any, need to be overcome to effectively use this resource.
* Examine possible safety hazards and how these safety issues might be addressed.
* Identify any potential environmental impacts and methods to reduce or minimize the impacts.
* Include any data that was gathered during their investigation.
* Organize the data into charts, tables, and/or graphs where appropriate, remembering to properly label everything and provide a key/legend when applicable.
* Describe and explain any patterns and/or trends that they notice when examining the information.

*Individual Task*: Provide students time at the end of class to summarize their research/findings, to record this information in their science notebook, and to reflect on the group and individual work in their notebooks (or a reflection log).

Part 4: Construct and justify an argument (Team Activity)

Students review their analysis and interpretations of the data and write up their argument. In this section they should:

* Make a claim about what they think will be the best renewable resource for their location.
* Provide and explain the data/evidence to support their argument
* Identify and evaluate other possible renewable resource options (counterclaims) for the location and whether it is supported and/or refuted by the research information they collected.
* Reflect and explain the limitations of their renewable resource and what additional information or data they would like to examine.

Depending upon how much previous experience your students have writing arguments, you might want to provide them with some sentence starters such as:

1. I think \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is the best renewable resource for our location because \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
2. I have many sources of evidence that supports my claim that \_\_\_\_\_\_\_\_\_ is the best renewable resource for this location. One pieces of evidence is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Another source of evidence is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
3. Others might think that \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is a better renewable resource because \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ but I disagree because \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
4. I think my \_\_\_\_\_\_\_\_ renewable resource is the strongest because \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
5. Although I have strong evidence to support my claim, there are limitations that may affect the accuracy of my claim such as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
6. I would want further information or tests such as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to be more confident in my claim.

*Individual Task*: Provide students time at the end of class to summarize their argument, to record this information in their science notebook, and to reflect on the group and individual work in their notebooks (or a reflection log).

Part 5: Prepare an outline or storyboard of a public awareness campaign (Team Activity)

Students will create a multimedia presentation that informs the public and generates support for increased use of their renewable source of energy. They may select a format and media of their choice (e.g., video, billboard, song, Prezi, etc.). When preparing their presentation they should refer to the *Criteria for Oral Presentations* document. The presentation should contain:

* Summary of what they learned about the renewable resource
* Explanation of the feasibility of using this renewable resource to meet the location’s energy needs
* Some concrete data in the form of tables, graphs, visuals or text
* Analysis and interpretations of using this renewable resource to supply energy
* Reasons why their renewable resource is a good source of energy for the location
* A list of recommendations that are supported by their research
* Check any written materials and visuals to ensure that they have used proper scientific convention and that they have cited all of their references using the appropriate format

*Individual Task*: Provide students time at the end of class to reflect on the group and individual work in their notebooks (or a reflection log).

Part 6: Get teacher and/or peer feedback on campaign

Part 7: Present final public awareness campaign

Presentation will be evaluated based on the SCALE Effective Communication Oral Presentation Rubric.

*Individual Task*: Provide students time at the end of class to reflect on the group and individual work in their notebooks (or a reflection log).

Part 8: Reflection essay (Individual Activity)

Students will write an individual reflection essay to share what they have learned.In the essay, each student will:

* Describe the renewable resource they researched
* Evaluate the feasibility of this renewable resource for the location
* Identify the potential costs and benefits
* Explain how adaptable this energy source is to their selected location
* Explain and justify their argument with evidence on the feasibility of this energy source as well as address why other renewable resources would not be the “best” fit
* Discuss the limitations of their argument
* Share their recommendations for ways to use this energy resource in the location

This essay will be assessed using the Scientific Literacy Rubric.

1. **Student support:**

Planning for Group Interaction

Grouping: Student grouping can vary, but a group size of 3 or 4 seems to work well. No matter what the team size, it is critical that each team keeps detailed records, and thus there must be at least one recorder for each team.

Suggested classroom norms to be used during the task:

1. You have the right to ask for help and ask questions
2. You have a duty to assist others
3. Share your ideas with others
4. Make a plan

Roles: It often helps group dynamics to assign students to specific roles (i.e., facilitator, researcher, presenter, recorder, etc.) in order to promote student learning or to utilize student skills.

* Facilitator – Timekeeper and task master (make sure group stays on task and that each assigned bullet is completed)
* Researcher – Computer searches
* Recorder – Note taker and collects pertinent information from the researchers
* Presenter – Presents group information for each part

Possible Accommodations for Students with Special Needs

You will be the best judge of your students’ abilities but here are some suggested ways to revise the task depending upon your students’ needs:

* Assign a specific energy source to each group instead of letting them select it on their own.
* Provide one or two research sources to the students to help them get started or provide students with abbreviated resource cards with the relevant information provided in text, graphs, diagrams, and other visuals.
* Provide a detailed graphic organizer to help student determine what information should be collected.
* Walk students through the analysis of the information and provide sentence stems to help them write up sections of the analysis.
* Show a video of a public awareness plan on a different topic so students have a concrete example of the product.
1. **Extensions or variations:**
* Students may design an experiment with one of the renewable resources such as wind or solar energy as practice for the larger task. This could be a more guided approach but would still provide an opportunity for students to prepare for the upcoming assessment task.
* Integrate this task within a school-wide program to reduce the school’s carbon emissions/footprint.
* Garbology Unit (kids study their own garbage, lunch garbage, etc.) Discuss landfills: <http://www.pastfoundation.org/>
* Climate change: The various types of renewable energy can be analyzed to determine the extent to which they may decrease carbon dioxide emissions and at what cost. Students can consider what is the best combination of renewable energies to reduce our carbon dioxide emissions to a level that will slow down, or stop the increasing global temperature.
* A company called Melink designs and sells products necessary for constructing alternative energy sources for homes and buildings such as solar panels, temperature sensitive exhaust systems, and wind turbines. The owner of Melink not only sells these products but also believes strongly that it is every person’s responsibility to reduce their dependency upon carbon-based energy sources. As an incentive for his employees to think about their own energy dependencies, Melink had a contest. Each employee was invited to submit his or her “Green Resume.” This resume describes how the individual used “green practices” in their daily lives such as recycling, modes of transportation, home energy saving practices, etc. All of the resumes were displayed in the lobby of the office building. The prize for the most Green Resume was $5,000.00.
	+ Ask students to write their own “Green Resume”.
	+ Have students share their resume in small groups to decide who has the best Green Resume.
	+ Have students reflect on how they can possibly improve upon their individual practices.
1. **Scoring:**

Student work can be scored using the SCALE Scientific Literacy Rubric and the SCALE Effective Communication Oral Presentation Rubric.