

# THE CASE OF RARE EARTH ELEMENTS



## Instructor Manual

### Introduction

Science is at the center of the most important policy questions facing our country and our world today. The goal of *Science Matters: The Case of Rare Earth Elements* is to help students recognize how science is integral to their lives and how scientific knowledge can make them better-informed citizens.

This unit teaches students about the many benefits and pitfalls surrounding rare earth elements. These elements, which are ubiquitous in our lives, engender a great deal of passion and spirited debate among proponents and detractors. In this unit, students will study the historical and scientific context driving these deeply conflicting perspectives, and they will consider ways to reconcile the conflicts.

The role-playing game format allows students to explore many different points of view through their diverse personas, each of whom has a stake in the rare earths debate. As students assume their roles, they will participate in a debate in front of a Stewardship Council, arguing the pros and cons of the mining, production, and use of rare earth elements on a global scale. The ultimate goal is to create a Sustainability Seal. Producers and manufacturers who follow the Sustainability Seal guidelines would have their products certified as meeting ethical and sustainable standards. To gain approval for a final set of recommendations for the seal, students will have to reach a compromise with other groups.

The emphasis in this debate is on science, and most of the roles have a scientific background. But each role focuses on specific goals, which often exist in strong opposition to the goals of other roles. This project further emphasizes that while science does help us understand the world, it does not provide easy solutions to all problems.

The game is divided into six main stages:

1. In the Introduction students familiarize themselves with the issues and do research on their individual roles.
2. During the Summit Preparation students meet in their interest groups to prepare their arguments for the Summit.
3. In the Summit each group presents its arguments and answers questions from the Stewards.
4. In the Intersession students are reorganized into three new groups to develop proposals that represent compromises among the interest groups.
5. In the Debate students present their proposals, and the Stewards select a winner.



6. In the Reflection students discuss the issues and lessons of *The Case of Rare Earth Elements* from their personal point of view rather than from the perspective of their assigned role.

This manual provides a detailed outline of the game structure and what should occur at each stage. A day-by-day summary allows for easier tracking during game play. Timing recommendations are included for each stage, although they can be adjusted to meet the needs of individual classes. This manual also includes information on student roles, reading assignments, and evaluation suggestions.

## Intellectual Framework

This unit is designed to help students understand and appreciate multiple viewpoints in a complex argument and to demonstrate the importance of science and history in contemporary issues. The project has four specific learning objectives:

1. Students will be able to identify key scientific properties of rare earth elements and describe ways in which these elements permeate our society and day-to-day life.
2. Students will be able to develop coherent arguments regarding issues that affect their daily lives and to relate these arguments to public policy.
3. Students will be able to think critically about how the history of science and technology relates to contemporary life and provides perspective in decision making for current policy issues.
4. Students will be able to cultivate their ability to question simple narratives and to recognize and consider multiple viewpoints, especially with regard to the history of science and technology.

Assigned readings emphasize the historical and scientific context of debates about rare earth elements. By understanding the historical and scientific context of their positions, students will be better able to contextualize their arguments, to employ relevant examples, and to strengthen their positions.

## Game Setting

An international Stewardship Council has convened a Summit of experts in the field of rare earth elements. The goal of the Summit is to create a Sustainability Seal that outlines guiding values for the global production and processing of rare earth elements. A first draft of the proposed Sustainability Seal is provided by the Stewards of the council to form a starting point for discussion.

The experts represent all sides of the rare earth elements debate and were convened to provide comments, suggestions, and feedback. These experts are organized into four interest groups, which will allow them to strengthen their positions through coalitions.



Individuals within each interest group share common goals, and each group will prepare a list of recommendations for what the seal should include.

Students will take on the roles of the various group experts and the Stewards. During the Summit students in the roles of experts will answer questions from the Stewards. Students will subsequently develop formal proposals for the Sustainability Seal that they will present in the Debate. At the completion of the Debate, the Stewards will select the proposal they deem most effective as the basis for the final Sustainability Seal.

## Interest Groups and Roles

**Producers:** The demand for rare earth elements in the manufacturing of everything from smartphones to national defense weaponry has never been greater. However, with no international regulation the production of these elements varies widely in terms of cost and environmental impact. Producers are interested in sustainable and profitable production and in addressing illegal mining and shipping operations.

**Manufacturers:** Manufacturers rely on rare earth elements to make a variety of products, and although they prefer to source rare earths responsibly, their main concern is to limit restrictions that threaten a stable, consistent supply.

**Consumers:** Rare earth elements are an invisible but integral part of consumers' daily lives, but the ethical consumption of products that use rare earths can be tricky. With the rare earths debate now front and center, consumers want greater transparency in the mining and production process in order to aid the public and corporations in responsible decision making.

**Activists:** Activists are primarily focused on the people most affected by the mining and production of rare earths: for example, communities that are polluted by rare earths waste disposal or miners forced to work in unfair or unsafe conditions. Solutions that rely on recycling, responsible waste handling, and worker safety are essential to the activist agenda.

**Stewards:** The goal of the Stewardship Council is to create a Sustainability Seal for the mining, production, and use of rare earth elements. Experts in various fields have been invited to weigh in on what this seal should include. The council has released a draft set of guiding values for public comment and will now hear feedback from experts on all sides, listening to their arguments and selecting the proposal that is most practical and effective.

## Game Play

The game is divided into several sections, and the timing is flexible. The introductory sections of the game should be spread over several weeks and interspersed with other units, allowing students time outside of class to research their positions. Activities discussed in the pregame section give teachers options based on interests, classroom needs, and time.



The Summit, Intersession, and Debate stages should be scheduled with as short a break as possible between each section. However, they can be spaced as necessary. The opening Summit should take about 90 minutes of class time, while the Debate will last 45 minutes to an hour. The Intersession can last for several days, but some of the work can be done outside of class.

The game is designed to be run mostly by students. The teacher's role is to moderate and ensure that play runs smoothly. You should step in whenever students need clarification or redirection. To avoid disrupting the Debate, adopt the role of a fact-checker, which will allow you to interrupt and clarify when students stray from the goals of the game.

All student materials for the game are available on the *Case of Rare Earth Elements* website. Students should be introduced to the website and these materials at the same time they are introduced to the project. It will be their main resource for learning about their roles and conducting research.

### **Outcome**

The outcome of the game is based solely on the persuasiveness of the arguments made during the Debate. Each student will be given victory objectives to shape their argument and must work to ensure that those objectives are included in the final Sustainability Seal. The Stewards do not have victory objectives and cannot win the game. However, they determine the winner. Instructors may want to assign the Steward roles or ask for volunteers. Remaining roles can be randomly or strategically assigned to students as desired.

### **Scoring**

Students receive 10 points if the Stewards select their group's final proposal. Stewards also rank the interest groups based on how well the final Sustainability Seal reflects their interests. Students receive an additional 1 to 4 points based on their group's ranking. Students therefore win the game by proposing the best compromise proposal that also successfully advances the agenda of their group.

## **Stages**

### **Stage 1: Introduction**

*Timing: 1 to 2 weeks*

Begin several weeks before conducting the Summit. This segment contains a number of optional assignments and can involve as little or as much classroom time as available. However, students should have ample time to complete readings and research outside of class. You can continue with other material during this time.

*Classroom Activities*



## Day 1: Introduce Game

Briefly explain to students what the game is and how it will work. Emphasize that they will be taking on different roles and engaging in a debate to better understand not only rare earth elements but also the importance of science in their daily lives. Explain Assignment 1.

### Assignment 1: Rare Earth Elements in Our Lives

Review "The Case of Rare Earth Elements: Introduction," the "History and Future of Rare Earth Elements," the "Science of Rare Earth Elements," and "Instructions for Game Play."

Think about the many different ways that rare earth elements are incorporated into the products we use every day. For one day, between the time you leave this classroom until you return, record every item you touch that contains rare earths. List the items in your journal. (Record each item only once; you don't have to count each time you pick up the same cell phone.)

Of the items that you have listed, which three would be the most difficult to do without? Which three could you give up?

Review the list again. What items could easily be replaced with something that doesn't use rare earth elements?

Day 2: Review assignment results and discuss with students the importance of rare earth elements in their lives. Assign the readings below to all students to help them prepare for the upcoming debates.

### Reading:

- "The Case of Rare Earth Elements: Introduction"
- "Science of Rare Earth Elements"
- "History and Future of Rare Earth Elements"
- "Instructions for Game Play"

## Stage 2: Summit Preparation

### *Timing: 1 to 2 weeks*

This stage will require more classroom time than the Introduction, but the overall amount of time can be scheduled based on need. Students will require some class time to meet in their groups and prepare for the Summit. If there is time, you may also choose to do mini-lessons on debating and debate preparation depending on student experience. Again, ensure that students have sufficient time to read and prepare outside of class while continuing with other material in the classroom.

### *Classroom Activities*



### Review Game Structure:

Provide a concrete explanation about what will happen during the debates. Explain that students will be divided into five groups, each with a different position on rare earth elements. Review “Instructions for Game Play” that was assigned to students during the introduction period to ensure that all students understand the game setting and what is expected of them.

Each group wants the Stewards to select their proposal for the Sustainability Seal. That means each group must work to convince the Stewards that its position is the most effective and must be adopted. Whatever their personal beliefs, students must argue from the point of view of their role. During the next few weeks they will be preparing for the Summit and must learn as much as possible about their role, their role’s positions, and the positions of the other groups.

### Assign Roles:

These assignments may be completely random and done on the spot, or you may choose to group the students strategically in advance of the class meeting.

Roles are listed under “Student Roles” later in this manual, along with a ranking system to determine which roles to assign based on the number of students in the classroom. There should always be at least four Stewards, and each Steward should be assigned an interest group (Activists, Consumers, Manufacturers, or Producers). Stewards will attend the introductory meetings for their assigned group, and each Steward will become an expert on that group.

Once students have role assignments, they should choose a personal name for their role. This task can be done in or out of class but should take place within 24 hours. Encourage students to select props or costumes for their roles and to consider some sort of group prop or symbol to unify their interest group.

Allow students class time to explore the *Case of Rare Earth Elements* website and specifically the page associated with their group. From this page students can access a more thorough description of their roles along with their victory objectives, writing assignments, and reading assignments.

*Note: In this exercise many of the assigned roles represent individuals from many various nations and cultures. When assuming those personas, it is important for students to be aware of and to avoid stereotypes and implicit biases as they choose how to interpret the roles. Encourage students to practice empathy, remain respectful, and focus on the substance of the individual’s experience and arguments.*

### Summit Preparation:

Students will need several days in class to work with their groups and to prepare their arguments and answers to questions for the Summit. They will need to determine who will present their opening statement/argument; what their responses will be to each of the



questions posed by the Stewards (listed on each group's main page); and how they will respond to the other groups' main arguments.

Be very clear about expectations during these meetings, and emphasize the goals of your interest group. Depending on student comfort level with debating, this process can be as structured as necessary, but you should intercede as needed to ensure that students stay on task and topic. Consider providing a mini-lesson on debate preparation if students seem unsure how to proceed (see "Additional Classroom Activities" below).

The goal of the Summit is for the Stewards to get as much information as possible about each group's position, so having clear answers to each question is important for every group.

#### Stewards:

Members of this group will attend the preparation meetings of the interest group to which they were assigned. They will also each draft two questions to ask their group during the Summit. During the last preparation meeting the Stewards will meet together as a group. During this time they will elect a Chair, who will run the debates, and a Vice Chair, who will handle timekeeping.

*Note: You may at any time replace the Chair with the Vice Chair or another Steward if the Chair is not adequately facilitating the Debate. This change may be accomplished by sending a message that the Chair has been called to another meeting or had to leave owing to a personal emergency. Therefore, someone else must fulfill the role of presider.*

#### Reading

- Statement of Guiding Values
- Group Case Study (different for each group)
- Group and Individual Readings (assigned to each role)
- One additional article of the student's choice from the references list (click on the References tab on the website)

Assignments: Spaced across the pregame period as effective.

#### Role Name:

Students will need to choose a name for their persona. This task should be done within 24 hours of role assignments. Encourage students to get into their role through the use of props and costumes.

#### Role Reflection/Introduction:

Students will each write a brief position paper on rare earth elements from the point of view of their role. This paper will outline the individual role's opinions about rare earth elements and what that persona thinks should be done. Stewards will write a critical review of the interest group to which they have been assigned, considering the strong and weak points in that group's positions.



#### Interest Group Reflection:

Students will each write a paragraph or two that explains how their interest group fits into the wider history of rare earth elements.

#### Article Review:

Students should each write one or two paragraphs about the article they chose from the website's References section, indicating what the article taught them about rare earth elements and how they will use that information in the debate to support their argument. If your students are using note cards for the Summit, they should transfer the most important information from each article onto cards. These cards should clearly state the source of the information to help students use evidence to support their arguments.

#### Opposition Research:

Students should each write a brief reflection that considers one main argument they expect each of the other groups to make. They should then provide a counterargument for each to support their position over the others. They should also reflect on any common ground between their group and the other groups.

#### Additional Classroom Activities (Optional):

##### Summit Preparation:

Students may have different comfort levels researching topics and preparing for debates. Spend some classroom time reviewing general debating tips to help them prepare.

##### Use of Evidence:

Arguments must be backed up with evidence. Encourage the use of note cards to record particular points from the articles they read. They can then refer to these note cards during their presentations to back up their arguments. If the use of note cards is unfamiliar to students, review methods for preparing and using note cards.

##### Opposition Research:

Students should be familiar with not only their arguments but also those of the other groups. Emphasize the importance of developing counterarguments and recognizing common ground with the other groups.

##### Role Development:

Some students may find it difficult or uncomfortable to take on the role of another person, especially if that role's opinions do not align with their own. If time permits, engage students in thinking about their roles—what interests they hold, how they spend their time, why they hold the positions they do. For students who disagree with their role's position, engage them in an exercise of empathy, understanding someone else's point of view. Why does their role hold these opinions? What led to them believing these things? What is valuable about these positions?



### **Stage 3: Summit**

*Timing: Two 45-minute class periods, or one-and-a-half 60-minute periods*

The Summit can take longer than this if time permits, but it should be kept within reasonable time constraints to keep students on track.

#### *Classroom Activities*

##### **Setup:**

If possible, hold the Summit outside the classroom to help create a new atmosphere for the students. All students should have at least one prop associated with their role. Encourage them to consider dressing as a career professional might for this Summit.

Students should be seated so they can clearly see and address the Stewards, possibly by arranging the seats in a square or in a conference-room format with a head table facing the other groups. Students should sit with their interest groups, and all students should have a name card that identifies their role and group affiliation.

The Chair opens the Summit by briefly reminding everyone why they are there and explaining the way the Summit will proceed.

##### **Introductions:**

Each group will have 3 minutes to briefly introduce its members and present its main positions about rare earth elements and how they should be regulated. These presentations will provide the other groups with a sense of all the positions.

While other groups are presenting and answering questions, students should take notes using the Stewardship Council Tracking Sheet (available in Teacher Resources published with this manual). This task will ensure that students remain engaged, but it will also help them follow the other arguments and prepare their responses.

##### **Questions:**

The Stewards will now ask questions, beginning with those provided on the website. These questions are intended to foster conversation among the groups. Stewards should encourage dialogue, asking the groups to respond to each other or clarify their positions in relation to other groups' answers. Each group should be given the opportunity to answer first on one question. You should intercede to encourage discussion and debate as warranted.

After asking the questions provided to them, the Stewards will proceed with asking the questions they wrote during the Summit preparation. Stewards should have two questions apiece relating specifically to their assigned group. These questions will be directed to that



specific group, but the other groups will have a chance to respond after the targeted group has answered.

As many questions as possible should be asked in the time permitted, and Stewards should each have the chance to pose at least one question to their assigned group. However, interaction between groups is the goal of the Summit, so if the discussion is proceeding well, do not force students to stop and ask new questions.

End questioning approximately 10 minutes before the end of the Summit. The Stewards should each offer comments on what they have heard. They should say which arguments they found persuasive and give their thoughts about the final Sustainability Seal.

The Chair will then announce the following: "Now that all attendees have had the opportunity to share their opinions and recommendations, the Stewards would like to receive formal proposals for the Sustainability Seal. However, no one group seems to have all the answers. Therefore, all participants will be divided into three new groups. Each group must develop and agree to a formal set of recommendations for the Sustainability Seal. The panel will then reconvene to hear these proposals and will select one of the three."

*Note: In large classes it may be necessary to divide students into four or five groups. The announcement should reflect that decision.*

Winners:

There is no official winner of the Summit. However, at the end of the Summit the Stewards can rank the groups in order of performance and persuasion. This ranking will provide motivation and feedback and help students prepare for the next round.

## **Stage 4: Intersession**

*Timing: No more than one week*

If possible, the Intersession should occur in class within a few days of the Summit and be followed closely by the Debate. This timing will help students maintain momentum.

### *Classroom Activities*

Reassign Groups:

Divide the students into three new groups\*, with each new group having representation from each of the four original interest groups (excluding the Stewards). This process can be random, or you can strategically distribute the students. The goal is to encourage students to listen to the arguments and positions of other groups and to find common ground. The end result should be a Sustainability Seal with more moderate provisions than those proposed by the individual groups.

*\*Note: For large classes you may choose to divide students into four or five groups.*



Explain the new assignment to students. The goal has not changed: they still want a Sustainability Seal that emphasizes the aims of their interest group and role. But now to get their proposal chosen (and win the game), they must also compromise. The Stewards want a set of guiding values that incorporates ideas from different groups, so encourage students to compromise with the other members of their group where possible while still promoting their role's and their original group's concerns.

#### Group Proposals:

Students must draft a formal proposal for the Stewards. The proposal should consist of a list of recommendations for the Sustainability Seal (similar to those given to each interest group at the beginning of the game).

Review the procedures for completing the proposal before students begin work. The drafting of this proposal can be as structured as necessary depending on the class. Individual members of each group should propose provisions that must be voted on by all members. Only provisions with a majority of "yes" votes can be included. When completed, at least 80% of group members must vote to accept the proposal before it can be presented to the Stewards.

Students should vote for a version that meets as many of their victory objectives as possible, realizing that they may not be able to achieve everything they wish. Encourage them to think creatively about ways to address the problems of rare earth elements and to achieve their role's and original group's goals.

If the development and discussion of the new set of guiding values cannot be completed in the classroom, digital forums may also be used to encourage student interaction. Students may create Facebook groups and discuss changes to the proposal in that forum. If possible, it may also be helpful to create a wiki for the class or for each group, which would provide the students with another forum for discussion.

#### Stewards:

During the Intersession the Stewards will observe the new groups (perhaps individually or in pairs) while focusing on the upcoming vote. Allow time for them to sit in on the group meetings but also to meet together and discuss the arguments heard during the Summit.

It may be helpful to have the Stewards outline their thoughts on the Summit and the upcoming vote in writing. This task would serve as a counterpoint to the proposal-writing assignment of the other students and would force the Stewards to clarify their positions.

#### Additional Assignments:

##### Summit Reflection:

Have students write several paragraphs in which they reflect, from the viewpoint of their role, on how the Summit went for them and their group. They should explain where they thought their group made strong points, where they responded well to the other groups, and where their argument was weakest.



### Intersession Reflection:

During the process of rewriting the proposals, have the students reflect on the other members of their new groups. With which interest groups do they find it easiest to compromise? Which groups have positions that differ most from theirs? How has the arrangement of the group shaped the proposal they have created?

## **Stage 5: Debate**

*Timing: One 45-minute class period*

This stage can be extended if the class period is longer or if students are engaged in a productive debate that extends beyond the time. Large classes may also require more time.

### *Classroom Activities*

#### Setup:

Use the same setup as for the Summit, except students should be arranged in their new groups.

The Chair will once again call the session to order and remind the participants that they are meeting today to present their final versions of the Sustainability Seal. At the conclusion of today's session the Stewards will vote.

Each group will have 5 minutes to present its new version of the Sustainability Seal. (The Sustainability Seal drafts should be circulated in advance so students do not need to read them verbatim while presenting.) Students should highlight areas of compromise and explain how this new Sustainability Seal effectively addresses the problems of rare earth elements.

Each group will then have 2 minutes to respond to the proposals of the other groups. Responses should be directed to the Stewards and should refer to the specific points the groups are either supporting or challenging.

Finally, the Stewards will have several minutes to ask questions of each group. Questions can be addressed to specific groups, but all groups should be given the chance to respond to each question and to the responses of the other groups.

## **Final Vote and Winning the Game**

Stop the Debate 15 minutes before the end of class. The Stewards should adjourn to another room to select the final version of the Sustainability Seal. If the Debate runs over and there is not enough time in the class period, allow the vote to continue into the next class period.



Each Steward should have a chance to state which proposal they found the most persuasive and make a case for why it should be accepted.

A vote will be taken on each of the Sustainability Seal drafts. If there is no clear majority, the proposal with the fewest votes will be removed and a second vote will be taken.

After selecting the winning proposal Stewards must determine which interest groups most successfully advanced their goals in the Sustainability Seal. They will rank the interest groups in order of effectiveness based on their representation in the final Sustainability Seal.

When the vote is finished, the Stewards will return to the class, and the Chair will announce the decision on the final Sustainability Seal and the most successful interest group(s).

Stewards should then take the time to explain why they chose the proposal they did. This step is important because it allows the students who presented arguments to know what the Stewards found persuasive. It is also important that the Stewards reflect on their decision.

Stewards will also explain why they ranked the interest groups as they did, drawing on specific clauses from the proposal that they feel support each interest group.

Scoring:

Students receive 10 points if their proposal is accepted. Members of the winning interest group each receive 4 points. The second-ranked group will receive 3 points; the third, 2; and the lowest-ranked group will receive 1 point.

MVP Awards:

In the days after the game the teacher can give MVP awards for student performance during the game. These awards will allow you to recognize students who may not be in the winning group but who did an exceptional job in some aspect of the game.

## **Stage 6: Reflection**

*Timing: Closely following the completion of the game*

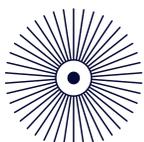
The final classroom discussion and the reflection assignment allow students the opportunity to reflect on what they have learned. The discussion should happen within a few days of the Debate.

*Classroom Activity*

Classroom Discussion:

Encourage students to discuss what they learned, share how their ideas about rare earth elements have changed, and listen to the opinions of their classmates. Questions for consideration include the following:

- What did you learn over the course of this project?



- How did your role influence the way you thought about the issues?
- Has your view or understanding of rare earth elements changed?
- What do you think of the result of the game? Do you think the best proposal was selected? What would you change?
- Do you think the United States needs to make policy changes related to rare earth elements?
- Do you think there are things you can do as an individual or a class to help address concerns related to rare earth elements?

One possible way to begin the postgame discussion is to ask the Stewards why they selected the version of the Sustainability Seal they did. What made it the best choice? Did any of them prefer a different version? Why?

### *Assignments*

#### Written Reflection:

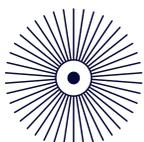
All students should write a one- to two-page reflection on their experiences with this project. A possible written format for this assignment appears on the final page of the Student Journal, but this assignment does not have to be a paper. It can take whatever form you find most effective. The assignment should answer the following questions:

- How did the final proposal you and your group wrote fit the goals of your role?
- In what areas were you unable to achieve your role's goals?
- What did you find the most challenging about the compromise process? The most rewarding?

### **Optional Extension | Community Program**

You may choose to expand *The Case of Rare Earth Elements* outside the classroom and into the community. A community program can serve as an opportunity for students to share what they learned with their families, other students, and interested community members. By organizing and addressing a community forum, sending letters to elected officials, or finding other ways to engage in the rare earth elements debate outside the classroom, students will begin to see how science and their classroom experiences can have real-world implications.

A community event or action can take any form. Students may present the program as part of a larger event already scheduled to bring parents and community members into the school, or a separate event or events can be organized either at the school or another local venue to share the program with parents and community members. Students can present their proposals to the audience and answer questions before audience members vote for their favorite Sustainability Seal.



## Timing Outline

Timing for *The Case of Rare Earth Elements* is flexible, and the timeline below is merely a suggestion to help guide implementation of the game.

Week	Day	Classroom Activities	Assignments
1	1	Introduce game to students	Rare Earth Elements in Our Lives
	2	Review "Rare Earth Elements in Our Lives" assignment  Explain game in more detail  Assign introductory readings	
	3-5	Students read materials/complete assignments out of class	Complete introductory readings
2	1-5	Continue from week 1	Continue from week 1
3	1	Review game structure and rules; assign roles	Select a name for assigned role
	2-5	Students research their roles and positions  Students meets in groups to prepare for the Summit  Stewards research and meet with assigned group  <i>Optional: Debate preparation</i>	Role reflection/introduction  Interest group reflection  Article review  Opposition research
4	1-5	Students meet in groups to prepare for the Summit  Stewards meet as a group to prepare for the Summit, write questions about their assigned group  <i>Optional: Role development</i>	Continue from week 3
5	1-2	Summit	
	3	Intersession: Explain new assignment to students; organize new groups	Summit reflection



	4-5	Intersession: Students meet in new groups to prepare Sustainability Seal proposal	Intersession reflection
6	1	Debate	
	2	Debate/Vote	Debate reflection
	3	Reflection, Conclusion, and Classroom Discussion	Final reflection

## Student Roles

*The Case of Rare Earth Elements* is designed to be played with 20 to 30 students. Brief descriptions of the 30 distinct roles, divided into 4 interest groups plus the Stewards group, are found below.

Roles marked with an (\*) are required roles that should always be included. Additional roles can be assigned in the order they are listed within each group.

### Stewards Group

#### Reading Assignments

Case Study: "Working Outside of Government Regulation to Protect Human Health and the Environment"

Conniff, Richard. ["Greenwashed Timber: How Sustainable Forest Certification Has Failed."](#) *Yale Environment 360*, February 20, 2018.

Sanders, Samantha, dir. ["A History of the Environmental Movement."](#) Commissioned by the Environmental Defense Fund. Green River Films and Kartemquin Films, prod., 2017. (Video, 4:30 min.)

#### **President of a Market-Oriented Environmental Nongovernmental Organization\***

(Works with Manufacturers Group)

An environmental advocate who leads a group that uses corporate partnerships and the pursuit of profit to solve serious environmental problems.

#### **Executive Director of a Wildlife-Focused Environmental Advocacy Organization\***

(Works with Consumers Group)

An environmental advocate who leads an organization with long experience in establishing Sustainability Seals.



**Social Scientist\***

(Works with Activists Group)

A geography professor who has researched the global rare earth industry through fieldwork in China and Brazil.

**Chemist\***

(Works with Producers Group)

An academic chemist interested in “green chemistry” who develops new approaches to producing the rare earth elements.

**Environmental Engineer**

(Works with either Manufacturers or Consumers Group)

An expert in measuring the environmental impacts of materials using the technique of life-cycle analysis.

**Materials Scientist**

(Works with either Producers or Activists Group)

A retired metallurgist who has led a national lab and advised a range of stakeholders about rare earth issues.

**Producers Group**

Reading Assignments

Case Study: “The Changing Geography of Rare Earth Element Production”

Ives, Mike. [“Boom in Mining Rare Earths Poses Mounting Toxic Risks.”](#) *Yale Environment 360*, January 28, 2013.

**Director of Corporate Communications for an American Mining Corporation\***

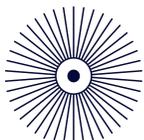
An environmentally conscious communications specialist who is both familiar with the science of rare earths and is convinced the stigma surrounding them is not entirely justified.

**Director of an International Mining Company\***

The CEO of a rare earth company located in Australia and Malaysia who is concerned about competitors who sacrifice sustainable practices for greater profits.

**Assistant Manager of Metal Mining Company in Brazil\***

A representative for a successful metals firm that wants to use existing mine waste to expand into rare earth production.

**Chinese Supplier of Rare Earth Elements\***

An executive at a large mining operation in China interested in keeping costs low and cracking down on smuggling operations.

### **Government Official Working to Stop Smuggling in China**

A government official working against illegal smuggling operations in China who is interested in stabilizing and maintaining China's rare earths economy.

### **Small-Business Chemical Entrepreneur**

A CEO concerned that low prices in the rare earths market discourage sustainable practices and the development of innovative methods of production.

## **Manufacturers Group**

### Reading Assignments

Case Study: "Using the Rare Earth Elements"

Ma, Alexandra. ["From iPhones to Fighter Jets: Here's a List of American Products That Could Be Affected If China Banned Rare-Earth Metal Exports to the US as a Trade-War Weapon."](#) *Business Insider*, May 21, 2019.

### **Vice President for Environmental and Social Initiatives at a Consumer Electronics Manufacturer\***

An executive at a multinational corporation reliant on rare earths who is interested in using the company's purchases to improve the environment and society.

### **Chief Executive Officer of a Wind Turbine Manufacturer\***

The leader of a European sustainable energy company interested in stabilizing the supply of rare earths for the future of global energy.

### **Vice President of a Defense Contractor\***

A vice president of a weapons-making company that regularly contracts with the U.S. government, mainly concerned about creating and sustaining a domestic supply of rare earth elements.

### **Chief Sustainability Officer for a Major Automaker\***

An executive at a Japanese electric car manufacturer concerned about pollution caused by rare earth mining.

### **Owner of a Catalytic Converters Company**

A Canadian business owner seeking to make auto parts from ethically sourced rare earth metals.

### **Consultant to Medical Device Makers**



A researcher based in Brazil who consults with companies about the medical applications of rare earth elements and is interested in ensuring a reliable supply of rare earth elements for medical applications.

## Consumers Group

### Reading Assignments

Case Study: "Can Consumer Choices Make Rare Earth Production More Sustainable?"

Atkin, Emily. "[Trump Is the Wrong Target for Climate Activists.](#)" *New Republic*, December 15, 2017.

### **Chief Merchandising Officer for a Large Electronics Retailer\***

An executive for a retail chain focused on avoiding consumer boycotts and making consumers feel good about their purchases.

### **U.S. Defense Department Official\***

An engineer with the Defense Logistics Agency who is concerned about the domestic supply of rare earths in the United States.

### **Chief Executive Officer of an Ethical Consumer Electronics Manufacturing Firm\***

An activist-turned-manufacturer who is deeply committed to sustainable practices, fair wages, and ethically sourced materials.

### **Ethical Consumer Journalist\***

A British magazine editor and investigative journalist interested in responsible consumerism and corporate transparency.

### **Technology Writer**

A journalist known for reviewing the latest consumer electronics who once hosted a TV program about materials science.

### **Famous Inventor**

A celebrity entrepreneur who needs rare earths for electric cars and is more interested in innovation than restricting production practices.

## Activists Group

### Reading Assignments

Case Study: "Protecting Health and the Environment in an Age of Global Trade"



Ives, Mike. "[Boom in Mining Rare Earths Poses Mounting Toxic Risks.](#)" *Yale Environment 360*, January 28, 2013.

### **Spokesperson for an Indigenous Rights Organization in Brazil\***

A representative for a group that has long called for indigenous people to have the right to mine their own lands sustainably but now needs international support against external mining companies.

### **Environmental Activist Based in Eastern California\***

A community college professor volunteering with a group pushing for better mining practices that reduce water pollution and work with local residents.

### **Environmental Activist Based in China\***

An investigative journalist who seeks to reduce pollution from Chinese manufacturing by stimulating concern among western consumers.

### **Environmental Activist Based in Malaysia\***

The founder of a nonprofit organization that promotes sustainable development but is concerned about radioactive waste from rare earth separations.

### **Environmentalism with an American Climate-Change Organization**

A climate educator sympathetic about local pollution but most concerned with ensuring there are enough rare earth metals to build low-carbon energy technologies.

### **Executive Director of a Prominent International Environmental Advocacy Organization**

The leader of an environmental organization famous for direct action who is uncertain about supporting yet another sustainability certification.

## **Student Readings**

Student readings should be assigned in stages as the game is introduced. Students should first read introductory materials assigned to all participants before they receive their interest group and role-specific reading assignments. Though limited class time may be spent on the game during this introductory period, it is important that students have adequate time to read and reflect on all materials and research their role.

All student reading materials are available via *The Case of Rare Earth Elements* website. Background materials that all students must read are listed on the website home page and each group page. The group pages contain all information students need to learn about their group and their role, including short introductory videos, a list of group goals, and detailed role sheets for each role. Assigned readings and video and audio files specific to each role can be found on the individual role pages.



A substantial list of articles, videos, audio files, and other sources can also be found in the online References. Students will need to read at least one source from that list and should explore others in order to learn as much as possible about their role's position and the positions of the other groups. Students are encouraged to do independent research outside the required readings, and the References web page is an excellent place to begin.

## Evaluation and Assessment

Students should be evaluated throughout the game process on their performance. Suggestions for assignments and evaluation opportunities are provided throughout the Instructor Manual as a guide to assessment. Sample rubrics are provided below for three different areas of evaluation: writing, game play, and debate.

The writing rubric can be used with any of the proposed writing assignments throughout the exercise, and the combined rubrics can serve as a starting point for developing an evaluation system for the project.

### WRITING

#### Excellent

1. Content  
Demonstrates a superior understanding of topic. Responds effectively to all aspects of the assignment. Exceptional use of sources and evidence where applicable.
2. Organization and Argument  
Connections between and among ideas are made. Independent thinking and creativity are evident. Claims and ideas consistently supported with evidence as necessary.
3. Quality of Writing  
Sentence form and word choice are varied and appropriate. Punctuation, grammar, spelling, and mechanics are appropriate. Readability enhanced by facility in language use.

#### Good

1. Content  
Responds adequately to all aspects of the assignment. Demonstrates strong understanding of topic. Uses evidence as appropriate.
2. Organization and Argument



Good sense of flow and connection between ideas. Claims and ideas clearly stated and mostly supported with evidence when appropriate. Clearly readable. Occasional errors in grammar, sentence structure, or spelling.

3. Quality of Writing

Clearly readable. Occasional errors in grammar, sentence structure, or spelling.

**Fair**

1. Content

Responds to the appropriate question or topic but shows limited understanding of the topic. Limited use of supporting evidence.

2. Organization and Argument

Examples used to support some points but not done consistently. More description and personal opinion than critical thinking. Evidence may at times be used inappropriately.

3. Quality of Writing

Generally readable but with consistent errors in grammar, sentence structure, or spelling. Little evidence of editing. Reading may be occasionally hampered by unclear language.

**Inadequate**

1. Content

Demonstrates little understanding of or misreads the assignment. Offers little or no analysis or evaluation of topic.

2. Organization and Argument

Very little or very weak attempt to relate evidence to argument; there may be no identifiable argument or no evidence to relate to the argument.

3. Quality of Writing

Writing is unedited or contains numerous errors. Readability seriously hampered by awkward or unclear language.

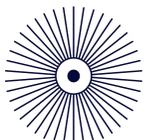
**GAME PLAY**

**Excellent**

1. Engagement

Brings memorable flair to playing the role. Inspires other students to engage more fully. Vocal and active in deliberations.

2. Interpersonal



Demonstrates leadership and suggests strategy during game play. Able to respectfully challenge ideas presented by other students and work effectively toward compromise.

3. Intellectual

Strong grasp of the complexities of the issues involved. Understands points of view beyond that of the student's own role or group. Demonstrates willingness to understand and empathize with multiple viewpoints.

**Good**

1. Engagement

Vocal and active in deliberations. Remains in character and stays focused on goals of role and group.

2. Interpersonal

Strong presence in group discussions with good ideas but not necessarily a group leader. Willing to challenge the ideas of other students, although not always in a polite manner. Sometimes willing to compromise.

3. Intellectual

Good understanding of issues. May struggle with compromise but generally displays efforts to understand multiple viewpoints.

**Fair**

1. Engagement

Attentive to deliberations and debates. Remains generally focused on goals of role and group.

2. Interpersonal

Adequate level of engagement with group. Not consistently respectful of other players. Defensive or diffident when criticized. Active in the game but more of a follower than a leader.

3. Intellectual

Basic understanding of issues being debated. May miss some important points. Good knowledge of student's own issues but lacks comprehensive grasp of the big picture.

**Inadequate**

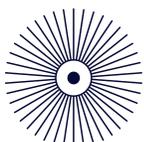
1. Engagement

Reluctant or resistant to the exercise. Limited participation in classroom activities.

2. Interpersonal

Does not effectively engage with other players. Either arrogant and dismissive of suggestions or diffident and silent. Unwilling to engage in conversations.

3. Intellectual



Little to no evidence of understanding, even of the perspective of the student's own role.

## DEBATE

### Excellent

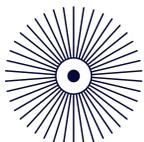
1. Content  
Demonstrates full knowledge of the topic. Makes accurate assertions and supports them with appropriate evidence. Shows mastery of and effectively counters opposition arguments. Comfortably answers questions.
2. Organization and Argumentation  
Presentation is clearly organized with effective introduction and conclusion with clear evidence of planning. Evidence introduced with a clear purpose.
3. Presentation  
Delivery is engaging and dynamic. Language choices and rhetoric promote engagement. Excellent voice control, eye contact, and physical demeanor.

### Good

1. Content  
Demonstrates strong knowledge of topic and makes accurate assertions, usually backed up with evidence. Shows passing familiarity with opposition arguments. Able to comfortably answer most questions.
2. Organization and Argumentation  
Presentation has discernible organization with introduction and conclusion. Evidence and statements generally support the main arguments.
3. Presentation  
Delivery is smooth and effective with clear evidence of preparation. Good voice control, eye contact, and demeanor.

### Fair

1. Content  
Information is generally correct, although rarely supported with evidence. Some errors or omissions demonstrate less than full mastery of the issues. May struggle to answer questions and shows little knowledge of opposition arguments.
2. Organization and Argumentation  
Presentation demonstrates some grasp of organization, with a discernible theme and use of supporting details.
3. Presentation



Speaker appears proficient with language and vocal and physical expression but may reveal a lack of sufficient preparation.

### **Inadequate**

1. Content  
Presentation is vague and nonspecific with little or no factual support. Student makes factual errors or omits important points of information. Student is unable to respond to questions.
2. Organization and Argumentation  
Presentation lacks focus or rambles, with main theme and supporting details presented in a disorganized way. Details are introduced without purpose.
3. Presentation  
Speaker appears unpracticed and uses many vocal crutches. Problems with voice control, eye contact, or posture. May use inappropriate language for forum.

## **Standards**

*Science Matters: The Case of Rare Earth Elements* correlates with the Common Core State Standards for English Language Arts and Literacy and the Next Generation Science Standards. The connections are outlined below. For the Next Generation Science Standards, each relevant topic is identified as are the performance expectations, science and engineering practices, disciplinary core ideas, and crosscutting concepts within each topic addressed by this game.

Please note that these standards correlations may or may not be relevant depending on exactly how you implement the game in your classroom and what additional lessons you choose to include. We strongly recommend that you evaluate each suggested standard below for its applicability to your experience.

### **Common Core State Standards for English Language Arts/Literacy**

#### **Reading: Science and Technical Subjects**

- RST.11-12.1: Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- RST.9-10.7: Translate quantitative or technical information expressed in words in a text into visual form and translate information expressed visually or mathematically into words.
- RST.11-12.7: Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.



- RST.9-10.8: Assess the extent to which the reasoning and evidence in a text support the author’s claim or a recommendation for solving a scientific or technical problem.
- RST.11-12.8: Evaluate the hypothesis, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
- RST.11-12.9: Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

### **Writing: History/Social Studies and Science and Technical Subjects**

- WHST.9-10.2 and 11-12.2: Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.
- WHST.9-10.7 and 11-12.7: Conduct short as well as more sustained research products to answer a question (including self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding on the subject under investigation.
- WHST.11-12.8: Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.
- WHST.9-10.9 and 11-12.9: Draw evidence from informational texts to support analysis, reflection, and research.

### **Speaking and Listening**

- SL.11-12.4: Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks.
- SL.11-12.5: Make strategic use of digital media in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

## **Next Generation Science Standards**

### **Topic: HS Structure and Properties of Matter**

#### Performance Expectations

- HS-PS2-6: Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.



#### Disciplinary Core Ideas

- PS1.A: Structure and Properties of Matter
- PS2.B: Types of Interactions

#### Crosscutting Concepts

- Patterns
- Structure and Function

### **Topic: HS Engineering Design Standards**

#### Performance Expectations

- HS-ETS1-1: Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- HS-ETS1-3: Evaluate a solution to a complex real-world problem, based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

#### Science and Engineering Practices

- Asking Questions and Defining Problems
- Constructing Explanations and Designing Solutions

#### Disciplinary Core Ideas

- ETS1.A: Defining and Delimiting Engineering Problems
- ETS1.B: Developing Possible Solutions
- ETS1.C: Optimizing the Design Solution

#### Crosscutting Concepts

- Systems and System Models

#### Connections to Engineering, Technology, and Applications of Science

- Influence of Engineering, Technology, and Science on Society and the Natural World

### **Topic: HS Human Sustainability**

#### Science and Engineering Practices

- Constructing Explanations and Designing Solutions
- Engaging in Argument from Evidence

#### Disciplinary Core Ideas

- ESS3.A: Natural Resources
- ESS3.C: Human Impacts on Earth Systems
- ETS1.B: Developing Possible Solutions

#### Crosscutting Concepts

- Cause and Effect
- Stability and Change

#### Connections to Nature of Science



- Science is a Human Endeavor
- Science Addresses Questions about the Natural and Material World

