



ACTIVITY 5

Scenario Planning

CARD-BASED INVESTIGATION

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ACTIVITY SUMMARY

Students use the technique of scenario planning to consider the possible energy futures for Vanwick. Students use their imaginations to envision various futures based on factors provided on cards. The conceptual tool of scenario planning helps inform a decision by considering a variety of positive and negative possible outcomes in the future. Then students reflect on how thinking about possible futures can inform decisions made now in Vanwick.

ACTIVITY TYPE
CARD-BASED
INVESTIGATION

NUMBER OF
40-50 MINUTE
CLASS PERIODS
2

KEY CONCEPTS & PROCESS SKILLS

- 1 Making optimal decisions includes envisioning a variety of possible futures with more desirable or less desirable outcomes and identifying the choices and trade-offs needed to prepare for those futures.
- 2 When gathering facts, first determine whether the source is credible before looking at the information or evidence provided by the source in more depth.

NEXT GENERATION SCIENCE STANDARDS (NGSS) CONNECTION:

Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. (*Science and Engineering Practice: Constructing Explanations and Designing Solutions*)

CONCEPTUAL
TOOLS



VOCABULARY DEVELOPMENT

electrification

(assumed prior knowledge)

the process of replacing technologies that include burning fossil fuels with energy generation and electrical devices that do not

factor

(assumed prior knowledge)

something that actively contributes to the production of a result

outcome

(assumed prior knowledge)

something that follows as a result or consequence

scenario planning

a technique that informs decision-making by imagining how uncertain factors might affect possible futures

trade-off

when a desirable outcome is given up to gain another desirable outcome

TEACHER BACKGROUND INFORMATION

Scenario Planning

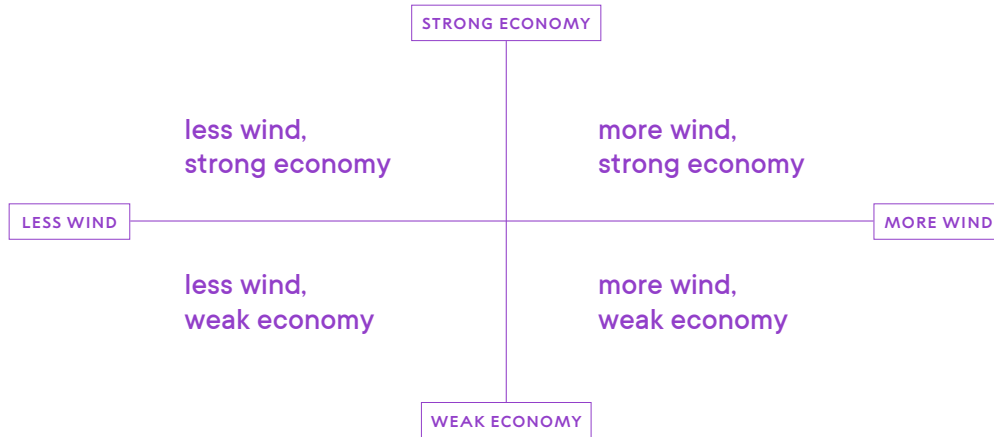
Scenario planning is a tool for informing decisions that involve considering different possible scenarios that might occur in the future, both to increase the likelihood of preferred possible futures and to prepare for multiple possible futures that we may not have power to control. Scenario planning is commonly used by businesses and governments to make more informed policy decisions and to avoid encountering completely unexpected events for which they are unprepared.

Scenario planning can also be used by individuals to prepare themselves for an uncertain future, helping them feel more confident and capable of coping with whatever happens. Individuals often imagine only one or two possible futures and are surprised and unprepared when some other unexpected future comes to pass.

There are several different ways to conduct scenario planning, but one common technique involves generating two important, uncertain, and orthogonal (uncorrelated) factors that may vary in the future. For example, in a situation of planning for renewable energy, one factor to consider is the amount of wind available for turbines, which could be high or low; another factor could be the economy in the region, which might go well or poorly.

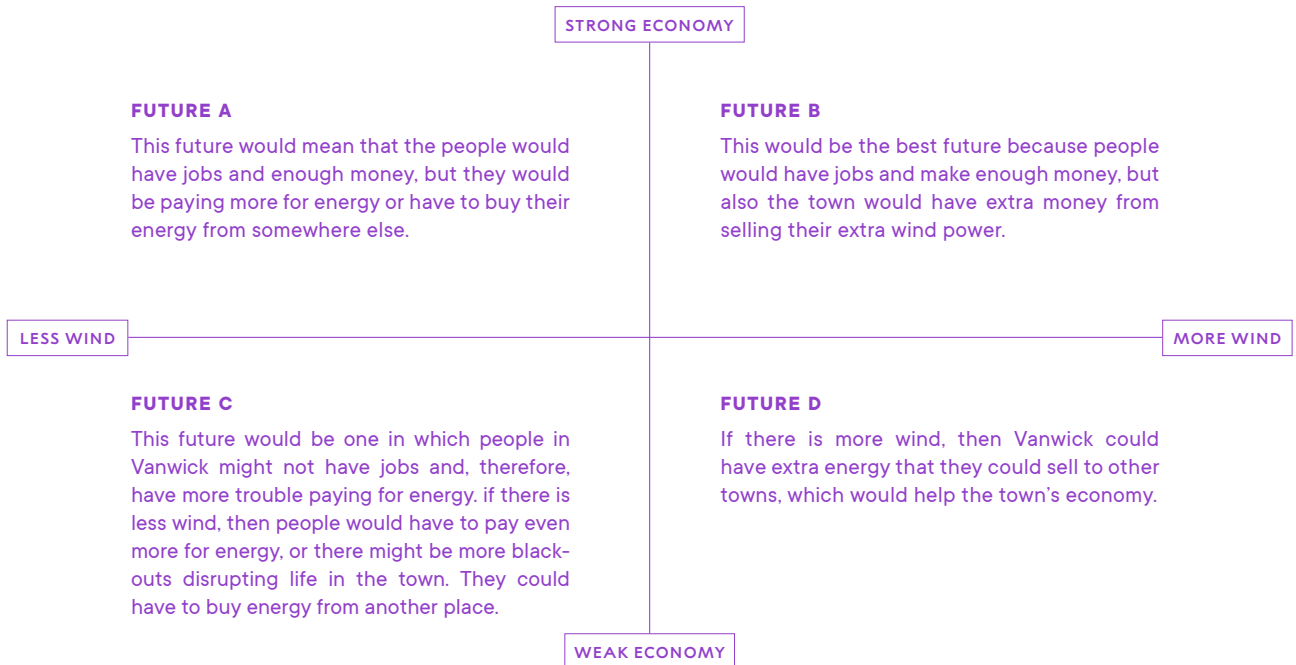
These two factors, sometimes called dimensions, are put into a graphic organizer that looks similar to a Cartesian coordinate plane. The four quadrants represent four different possible futures, as shown in Figures 5.1 and 5.2.

FIGURE 5.1
Scenario Planning Quadrants



The exercise is to envision what the reality would be for those four quadrants and describe each one, as shown in the following diagram. By systematically considering all four quadrants and what they would mean for the community, policymakers would be able to prepare for each possible future. This consideration of multiple eventualities can help minimize the damage if a more difficult possible future comes to pass.

FIGURE 5.2
Sample Quadrant Descriptions



MATERIALS & ADVANCE PREPARATION

FOR THE TEACHER

VISUAL AID 5.1
"Possible Futures"

FOR EACH GROUP
OF FOUR STUDENTS

SET OF SCENARIO
PLANNING CARDS
(SETS A–D)

FOR EACH STUDENT

STUDENT SHEET 5.1
"Scenario Planning"

Prepare the cards for students. There are 4 card sets (A–D), and each set includes 4 cards (1–4) for a total of 16 cards. Separate the cards into Sets A–D. Each group of 4 students should get cards from the same set.

TEACHING NOTES

Suggestions for **discussion questions** are highlighted in gold.

Strategies for the **equitable inclusion of diverse students** are highlighted in pink.

GETTING STARTED (10 MIN)

1 Elicit student ideas about what life might be like in the future.

- Ask students to generate a list of things that are uncertain about the future. This could be something small such as what the weather will be like tomorrow or something big such as what kind of job they will have as an adult. Guide students to think about societal uncertainties such as population size, climate, the economy, cost of living, education access, and job availability.
- To help students imagine different possible futures, ask them to compare the scenes shown on Visual Aid 5.1, “Possible Futures.” They can compare changes in population, environment, and electricity use between the two images. Use this to spur their imagination, as opposed to providing an answer.

2 Discuss what could change in Vanwick in the future.

- Ask, **How does uncertainty about the future make decision-making challenging?** Students’ responses might include not knowing what the outcomes will be later for something that is decided today or unpredictable factors changing an expected outcome. Reassure students that everyone has uncertainties in their future and that thinking about different possibilities can help make a more informed decision today.
- Ask, **What do you think the future might look like in Vanwick?** Ask students to describe how it might continue to change in the next 20–30 years based on the outcomes of Project REV. Have them make predictions about factors that might impact or be impacted by the renewable energy project such as:
 - electricity demand
 - environmental effects
 - changes in the landscape

Students should pair-share to discuss their predictions. Student responses will vary and could include topics about energy, everyday life, and the environment.

3 Ask students to consider what could impact the future.

- After students read the introduction, review the term *factor* as it is used in the activity. A factor describes any number of variables that can influence the outcome in the future, such as the economy, the climate, etc.
- Clarify for students that the word *scenario* is used in two ways in this unit. First, students were introduced to a fictional scenario in the city of Vanwick. Second, in this activity, students are presented with a decision-making tool called scenario planning. The word is used in two different contexts.
- Review the scenario provided in Procedure Step 1 that presents these future ideas in the context of Vanwick. If students are surprised to read that electrification will double the consumption of electricity, review the content provided in the Science Review found in the Student Book.

PROCEDURE SUPPORT (50 MIN)

4 Students engage in scenario planning in Part A.

- Cards 1–4 in each card set (Sets A, B, C, and D) used in the procedure reflect the four quadrants of scenario planning (see Teacher Background Information). Each card identifies a possible future described in terms of two factors. These factors were chosen because they are both uncertain and important in the future. Students use these to imagine possible outcomes in the future as it relates to these factors.
- In Procedure Step 3, encourage students to be imaginative about what Vanwick might look like 50 years in the future. Allow students to use the modality they prefer to communicate what they imagine. The following shows a written news story, but accept responses that could include storytelling, drawings, video, music, or narration to describe the possible future indicated on their cards.

Sample Student Response, Procedure Step 3

SET A, CARD 1

There are lots of new technological solutions to reducing greenhouse gases. Earth has some positive recovery from climate change.

Vanwick News Outlet
December 9, 2074

Carbon Mousetrap Helps Earth Recover

The most recent advancement in reducing greenhouse gas emissions by funneling harmful molecules into the center of Earth seems to be working better than expected. The new technology, nicknamed the Carbon Mousetrap, captures greenhouse gases by pressurizing them in the atmosphere

via satellites orbiting Earth. Then, the molecules are pushed through a series of nanotubes attached to the newest international satellite docking station 100 km (60 miles) above Earth. From there, gravity pulls the molecules down to the center of Earth.

Scientist Rio Charming, one of the lead engineers from Carbon Mousetrap says, “The latest data shows that this technology has been instrumental in removing greenhouse gases from the atmosphere. It shows that the technology has helped accelerate the removal of carbon from the atmosphere.” Preliminary results show that, much to the researchers’ surprise, some environmental indicators related to animal and plant recovery are very positive. For example, increases in biodiversity for plant and animal life have been observed in the town of Vanwick since Carbon Mousetrap began operation. This is a change from the pattern of decreased biodiversity recorded in this area over the last 100 years. It seems that Earth has made some positive recovery from climate change.

In Vanwick, where biodiversity data has been collected for decades, the community is rejoicing in the improvements in the environment. They have begun celebrating Earth Recovery Day when people flock to the streets dressed as their favorite species recovered from extinction. With cleaner air, water, and controlled climate temperatures in Vanwick, there is a lot to celebrate.

- In Procedure Step 4, if students haven’t already noticed, draw their attention to the fact that the collection of the four stories, pictures, or articles includes the four possibilities based on the two factors in their card set. In that way, each group has considered four related possible futures.
- In Procedure Step 5, if students are not able to deduce the relationship between the factors on Student Sheet 5.1, “Scenario Planning,” explain how each box represents a quadrant identified by the two factors. This shows how the cards relate to one another. Students should be able to see that, for each set of factors, the upper-right (Quadrant 1) shows the best possible future, while the lower-left (Quadrant 3) shows the worst possible future.

5 In Part B, students reflect on how scenario planning informs decision-making.

- When reviewing students’ stories, pictures, or articles, point out that what they imagined by using scenario planning are possible futures, as opposed to an actual outcome. Scenario planning does not predict an actual outcome—that would be a result.
- In Procedure Step 6, ask, **How important is the “Likelihood It Could Happen” column (in your Possible Outcomes table) when planning for the future?** Students should see that it is very important to balance the likelihood with the potential impact of that outcome. For example, if there is a catastrophic but unlikely outcome, it informs the decision you make now to address that possible future. A simple example is wearing a seatbelt. The chance of it being needed is not very high, but wearing one greatly increases having a good outcome in the infrequent but potentially catastrophic case of a crash.

Sample Student Response, Procedure Step 6

TABLE 5.1
Possible Outcomes

CARD NUMBER	TITLE	DESCRIPTION OF POSSIBLE OUTCOMES	LIKELIHOOD IT COULD HAPPEN (1 HIGH–4 LOW)
1	<i>Carbon Mousetrap</i>	<i>greenhouse gas is reduced; cleaner air, water, and controlled climate temperatures</i>	<i>highly unlikely: 4</i>
2	<i>Too Much, Too Late</i>	<i>greenhouse gas emissions continue despite lots of helpful technology; climate change effects of extreme weather and temperatures worsen</i>	<i>fairly likely: 2</i>
3	<i>Trouble Ahead</i>	<i>greenhouse gas emissions continue to increase, species die off, quality of life is poor everywhere</i>	<i>most likely: 1</i>
4	<i>We Got Lucky</i>	<i>greenhouse gas emissions are reduced with renewable energy; climate change impacts are reduced such as sea level rise, air quality</i>	<i>fairly unlikely: 3</i>

- Remind students that scenario planning is part of decision analysis because it is a tool used systematically that informs decision-making. It helps broaden what is considered before a decision is made. We cannot plan for futures that we have not imagined.

6 Introduce the concept of trade-offs and how it applies to decision-making.

- Introduce the idea that decisions about solutions to scientific and engineering problems often involve trade-offs. In Procedure Step 10, students use trade-offs when they make a decision about actions that can be taken now during Vanwick’s energy transition to support a positive future. Decision-making in the context of trade-offs includes the following key ideas:
 - Decisions often involve trade-offs.
 - Identifying trade-offs involves analyzing evidence.

The concept of trade-offs is used throughout the units of this course, especially as part of the decision-making focus. Specifically, the use of trade-offs in decision-making is assessed as part of Visual Aid 4.1, “Scoring Guide: Decision-Making (DM),” although it was omitted from the Build Understanding item 1 in Activity 4 since it had yet to be introduced to students.

- A trade-off is a desirable outcome given up to gain another desirable outcome. In a decision involving trade-offs, something positive (or desirable) is given up to gain another positive (or desirable) outcome. Since many decisions involve trade-offs, students should understand that a perfect choice that maximizes all goals is often not possible. It is possible, however, to recognize and analyze the trade-offs associated with each decision.
- Provide an example of a trade-off. For example, when choosing to purchase a disposable or reusable water bottle, there are several benefits and trade-offs to consider. A consumer who chooses the disposable water bottle may want a cheap option that doesn't need to be cleaned or maintained. Disposable bottles are also easily shared with others since they are not expected to be returned. However, in choosing the disposable water bottle, the consumer is contributing to environmental problems, such as increased energy use and higher amounts of solid waste in landfills if the bottle is not recycled. A consumer choosing to purchase a reusable water bottle may do so to save money over time, to save bottles from ending up in a landfill, and—by their example—to encourage others to purchase reusable bottles. However, this option has trade-offs as well, such as the increased upfront cost of the reusable bottle and the need to clean and maintain the bottle. Neither choice is ideal, and both choices have positives and negatives. Identifying the trade-offs helps clarify the reasoning that is being applied to make a decision.
- Develop some examples of trade-offs in students' lives by brainstorming with the class a list of decisions they make every day that involve trade-offs. Choose one and talk through the associated trade-offs of deciding one way or another. This practice will familiarize students with ways to identify and consider trade-offs in this and subsequent activities.
- The idea of a trade-off is similar to *compromise*, which is a word introduced later in the unit. A trade-off is giving up a desirable outcome to get another more desirable outcome during a decision. Compromise is similar but involves multiple people with different priorities who give something up during negotiation in service of getting to an agreement that is acceptable to everyone.
- Support students, particularly emerging multilingual learners, in sensemaking and language acquisition by adding words to the word wall. For this activity, record the terms *trade-off*, *scenario planning*, and *electrification*. Provide additional examples for each term as needed.

SYNTHESIS OF IDEAS (20 MIN)

7 Relate scenario planning to facts verified by credible sources.

- Review Build Understanding item 2, which asks students to connect what they learned in Activity 2 with the content in this activity. Students should see that having accurate facts is critical for planning. If the facts you have are not verified, then you risk planning for an impossible outcome or one that will not achieve what you expect.
- Guide a discussion that leads to the realization that credible information helps make better predictions. For example, the amount of electricity that needs to be generated for the community of Vanwick in the future will impact the decisions made for Project REV. Knowing that twice as much electricity is likely to be needed in the future for complete electrification (true fact) instead of less electricity being needed in the future (false claim of fact) will make a significant difference during planning for electricity generation.

8 Revisit how scenario planning informs decisions in the Vanwick scenario.

- Ask students to provide some examples of how scenario planning could inform the City Council as it decides how to plan for the future. Students should respond that it would help them plan for more situations, such as the very possible outcome that better technology is developed in the future or the unlikely event that the demand for electricity decreases. The City Council might rent equipment instead of buying equipment in the case of the first example or, in the case of the second example, make a deal that they can sell the energy to another community.
- To conclude the activity, formatively evaluate if your students are able to identify the purpose of scenario planning by revisiting the Guiding Question, **How can imagining the future inform current energy decisions?** Look for responses that reflect the use of the scenario-planning tool that helps envision a variety of possible futures. These multiple possibilities come with more desirable or less desirable outcomes, which leads to current choices and trade-offs to prepare for a variety of possible futures.

BUILD UNDERSTANDING

- ① **Pick the future scenario that came up in your class discussion that you found the most interesting.**

Answers can vary. One sample response (for Set C, Card 1) is shown here.

- a Identify the two factors involved in the scenario planning and why they were interesting to you.**

This scenario had lots of financial support and lots of international cooperation. This was interesting to me because it means a quick global transition to renewable energy, which I think is a good idea.

- b Describe how Vanwick citizens would be impacted if this possible future happens.**

Things for Vanwick residents would be good because they would quickly accomplish the goals of Project REV along with the rest of the world.

- c Decide what the City Council should do to increase or decrease the likelihood that this future will happen (if anything).**

The City Council could help this by working with other communities as they start Project REV, so other communities are more likely to cooperate.

- d Decide how the City Council can best prepare for this possible future.**

Put some money in the budget for marketing the idea outside of Vanwick after the project is finished.

- ② **Think about Activity 2 when facts were supported with credible sources. How do you think having accurate facts could support scenario planning?**

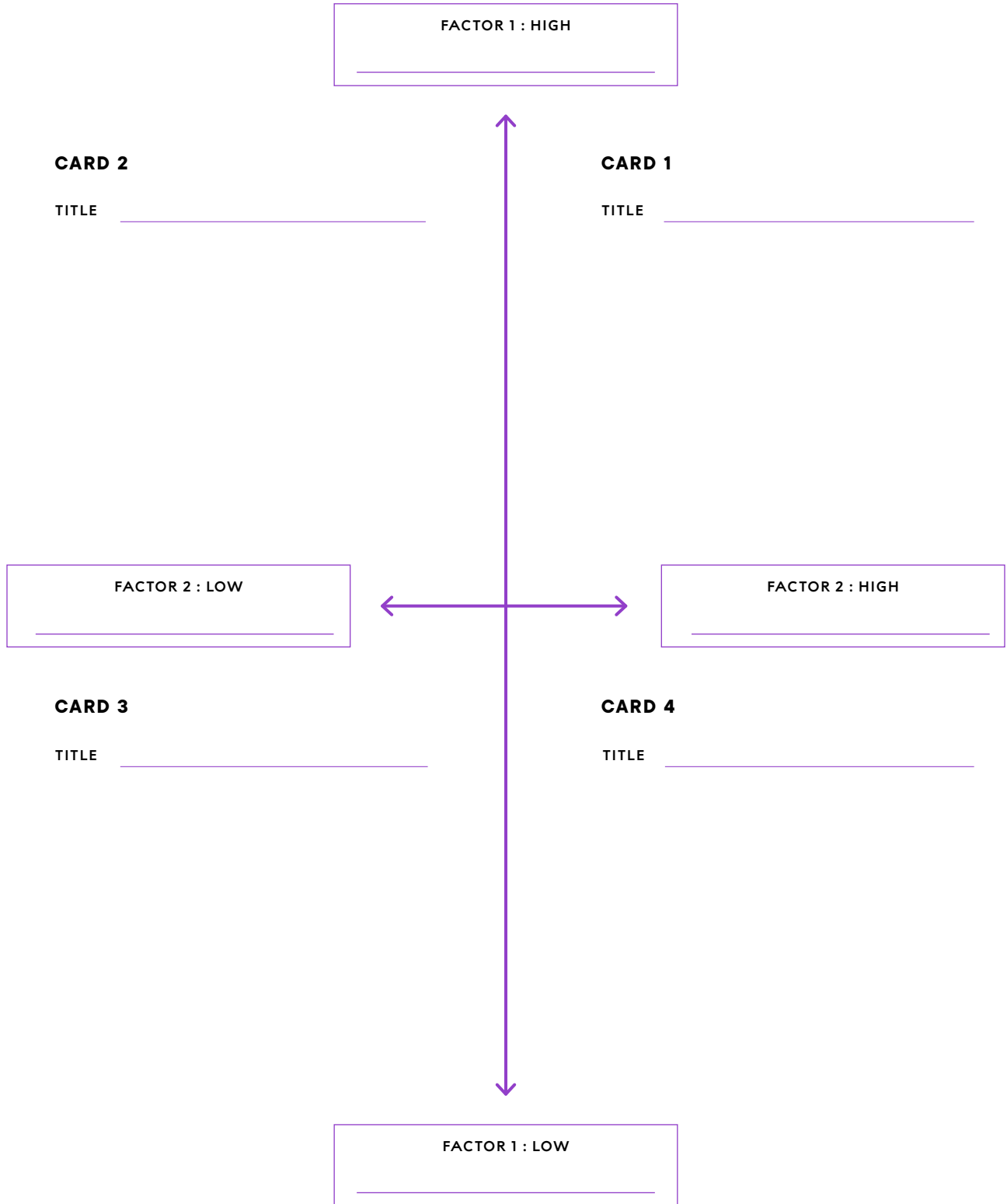
If you don't have an accurate fact, you might plan for the wrong outcome. That would result in wasted money and time. Plus, you wouldn't be ready for the outcome that actually happens.

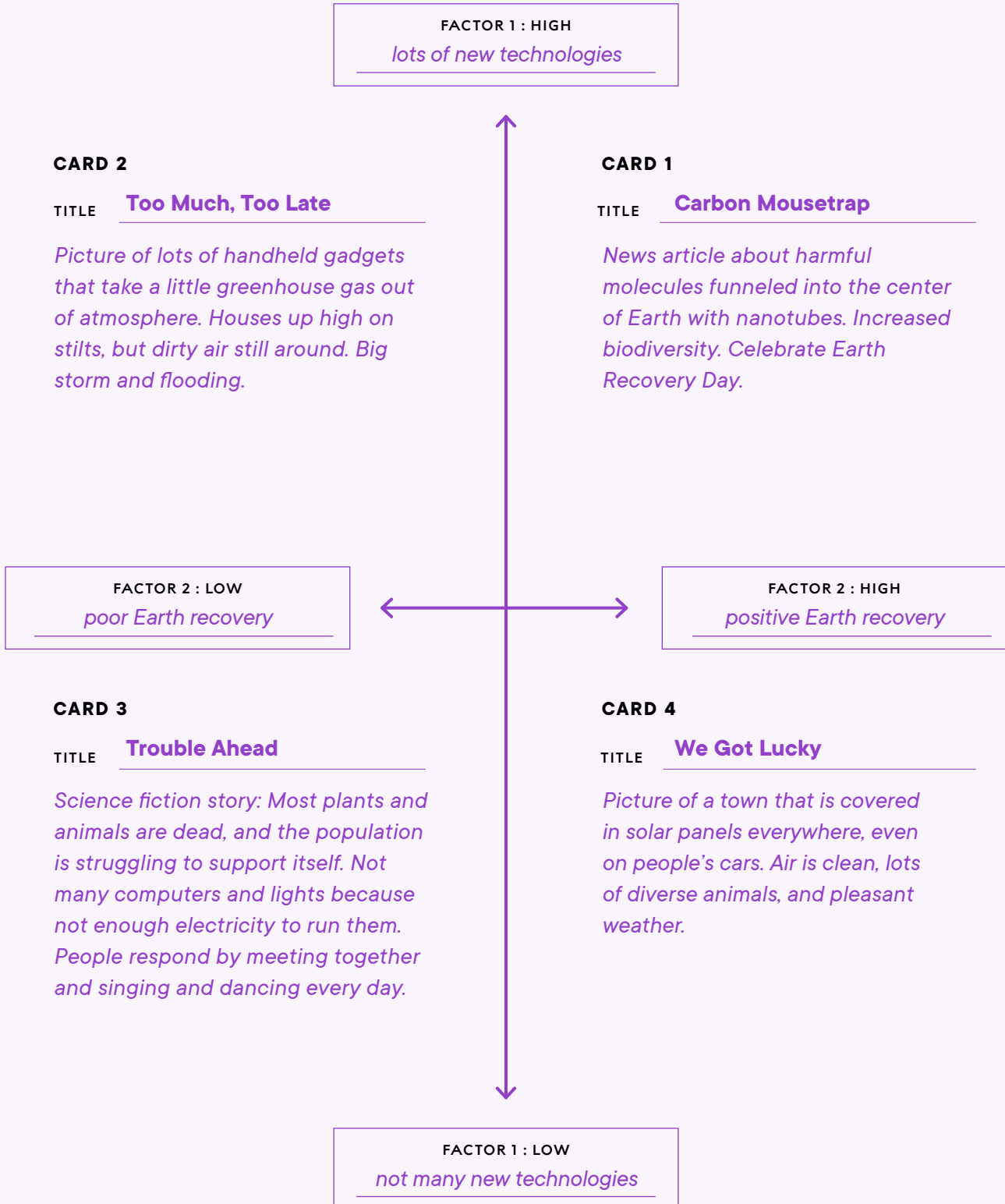
- ③ **If you are planning for the future, do you think it is more important to plan for an unlikely outcome that is catastrophic or a more likely outcome that is hurtful but not catastrophic? Explain why.**

Answers can vary. One sample response is shown here.

I think it is more important to plan for the unlikely outcome that is catastrophic. This is because the catastrophic outcome is much worse and should be avoided or planned for a reduction in harm if the catastrophic outcome cannot be avoided entirely. An example of this is how engineers make their bridges stronger than they need to be so as to avoid the catastrophic outcome of a bridge collapse due to poor design and/or construction.

Card Set _____



Card Set A 



SET A

CARD 1

What is the future for Vanwick as it relates to greenhouse gas emissions?

In this future:

- there are lots of new technological solutions to reducing greenhouse gases.

FACTOR 1

- Earth has some positive recovery from climate change.

FACTOR 2

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 6: Group Decision-Making, Activity 5

SET A

CARD 2

What is the future for Vanwick as it relates to greenhouse gas emissions?

In this future:

- there are lots of new technological solutions to reducing greenhouse gases.

FACTOR 1

- Earth does not recover well from climate change.

FACTOR 2

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 6: Group Decision-Making, Activity 5

SET A

CARD 3

What is the future for Vanwick as it relates to greenhouse gas emissions?

In this future:

- there are not many new technological solutions for reducing greenhouse gases.

FACTOR 1

- Earth does not recover well from climate change.

FACTOR 2

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 6: Group Decision-Making, Activity 5

SET A

CARD 4

What is the future for Vanwick as it relates to greenhouse gas emissions?

In this future:

- there are not many new technological solutions to reducing greenhouse gases.

FACTOR 1

- Earth has some positive recovery from climate change.

FACTOR 2

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 6: Group Decision-Making, Activity 5

SET B

CARD 1

What is the future for Vanwick as it relates to greenhouse gas emissions?

In this future:

- there is a lot of government support to reduce greenhouse gas emissions.

FACTOR 1

- there are many more than expected negative environmental impacts from emissions.

FACTOR 2

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 6: Group Decision-Making, Activity 5

SET B

CARD 2

What is the future for Vanwick as it relates to greenhouse gas emissions?

In this future:

- there is a lot of government support to reduce greenhouse gas emissions.

FACTOR 1

- there are fewer than expected negative environmental impacts from emissions.

FACTOR 2

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 6: Group Decision-Making, Activity 5

SET B

CARD 3

What is the future for Vanwick as it relates to greenhouse gas emissions?

In this future:

- there is little government support to reduce greenhouse gas emissions.

FACTOR 1

- there are fewer than expected negative environmental impacts from emissions.

FACTOR 2

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 6: Group Decision-Making, Activity 5

SET B

CARD 4

What is the future for Vanwick as it relates to greenhouse gas emissions?

In this future:

- there is little government support to reduce greenhouse gas emissions.

FACTOR 1

- there are many more than expected negative environmental impacts from emissions.

FACTOR 2

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 6: Group Decision-Making, Activity 5

SET C

CARD 1

What is the future for Vanwick as it relates to greenhouse gas emissions?

In this future:

- there is a lot of money applied to finding solutions to greenhouse gas emissions.
- there is a lot of international cooperation in reducing greenhouse gas emissions.

FACTOR 1

FACTOR 2

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 6: Group Decision-Making, Activity 5

SET C

CARD 2

What is the future for Vanwick as it relates to greenhouse gas emissions?

In this future:

- there is a lot of money applied to finding solutions to greenhouse gas emissions.
- there is a little international cooperation in reducing greenhouse gas emissions.

FACTOR 1

FACTOR 2

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 6: Group Decision-Making, Activity 5

SET C

CARD 3

What is the future for Vanwick as it relates to greenhouse gas emissions?

In this future:

- there is little money applied to finding solutions to greenhouse gas emissions.
- there is little international cooperation in reducing greenhouse gas emissions.

FACTOR 1

FACTOR 2

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 6: Group Decision-Making, Activity 5

SET C

CARD 4

What is the future for Vanwick as it relates to greenhouse gas emissions?

In this future:

- there is little money applied to finding solutions to greenhouse gas emissions.
- there is a lot of international cooperation in reducing greenhouse gas emissions.

FACTOR 1

FACTOR 2

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 6: Group Decision-Making, Activity 5

SET D

CARD 1

What is the future for Vanwick as it relates to greenhouse gas emissions?

In this future:

- there is a lot of community interest in reducing greenhouse gas emissions.

FACTOR 1

- new technologies make renewables significantly cheaper.

FACTOR 2

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 6: Group Decision-Making, Activity 5

SET D

CARD 2

What is the future for Vanwick as it relates to greenhouse gas emissions?

In this future:

- there is a lot of community interest in reducing greenhouse gas emissions.

FACTOR 1

- new technologies do not make renewables significantly cheaper.

FACTOR 2

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 6: Group Decision-Making, Activity 5

SET D

CARD 3

What is the future for Vanwick as it relates to greenhouse gas emissions?

In this future:

- there is little community interest in reducing greenhouse gas emissions.

FACTOR 1

- the transition to renewables happens relatively slowly.

FACTOR 2

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 6: Group Decision-Making, Activity 5

SET D

CARD 4

What is the future for Vanwick as it relates to greenhouse gas emissions?

In this future:

- there is little community interest in reducing greenhouse emissions.

FACTOR 1

- the transition to renewables happens relatively quickly.

FACTOR 2

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 6: Group Decision-Making, Activity 5