SCIENTISTS IN THE FIELD

WHERE SCIENCE MEETS ADVENTURE

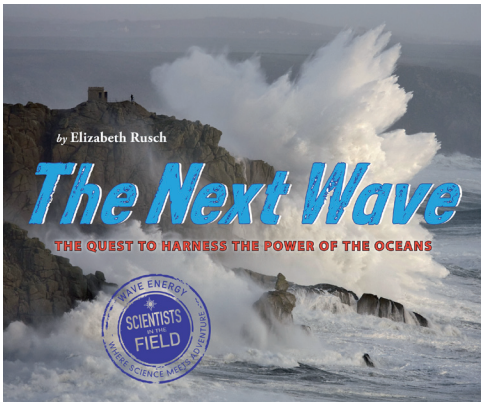
DISCUSSION AND ACTIVITY GUIDE

The Next Wave: The Quest to Harness the Power of the Oceans

BY ELIZABETH RUSCH

About the Series

The Next Wave: The Quest to Harness the Power of the Oceans is part of the award-winning Scientists in the Field series, which began in 1999. This distinguished and innovative series examines the work of real-life scientists doing actual research. Young readers discover what it is like to be a working scientist, investigate an intriguing research project in action and gain a wealth of knowledge about fascinating scientific topics. Outstanding writing and stellar photography are features of every book in the series. Reading levels vary, but the books will interest a wide range of readers.



The Next Wave: The Quest to Harness the Power of the Ocean by Elizabeth Rusch

About the Book

Journey to the wave-battered coast of the Pacific Northwest to meet engineers and scientists working to harness the punishing force of our oceans, one of nature's powerful and renewable energy sources. With an array of devices that cling to the bottom of the sea floor and surf on the crests of waves, these inventors use science, imagination, and innovation to try to generate electricity from waves to someday power our lives in a cleaner, more sustainable way.

About the Author

Elizabeth Rusch has written about robots, crayons, exploding volcanoes, musicians, and inventors—anything that catches her interest! She didn't always write for kids, though, as she started her career writing about kids for *Teacher* magazine, an award-winning magazine for teachers. Her books for children have won many awards, including an Orbis Pictus Honor and several NSTA Outstanding Trade Book awards. She lives in Oregon, where the ocean creates lots of waves.

Pre-Reading Activity

Spend time with students reviewing the difference between weather and climate before reading this book. Also look at magnetic fields, electrical grids, and how new sources of energy eventually reach our homes.

Have students discuss their earliest weather memories before going on to describe the differences between climate and weather.

Trace with students the history of our understanding of the link between oil and gasoline use and pollution and climate change. How and when did we learn that burning gas and oil pollute? What was done legislatively to control this pollution? How and when did we learn

that burning gas and oil causes climate change? What is being done currently to address this problem?

Get out magnets and have students play with magnetic fields. While they are investigating, ask these students to demonstrate their understanding of how magnetic trains (such as the Maglev bullet train in Japan) might work: See www.youtube.com/watch?v=IPduAYKk_6I.

Have students daydream about inventions they would like to see in the world, and then have them make a list of some of their favorite current inventions. What part does science play in any of these inventions?

Prepare a chart of your neighborhood, your community, your state, and the United States showing the various sources of our current energy usage.

Discussion Questions

What energy sources do you use on a daily, monthly and yearly basis? What energy sources do you use at home? What do you use for transportation? Do you anticipate making any personal sacrifices in the next fifty years to move to cleaner, more renewable energy sources?

Many cars use gasoline-burning engines. To use many renewable energy sources like wind, solar, and waves, cars must be powered with electricity. If the switch from gas to electricity were made, what would become of all the gas engines? Buses and trains use energy more efficiently. Would you be willing to sacrifice the convenience of personal transportation for the sake of a less harmful ecological footprint? Would the price of gasoline or electricity make a difference in your decision?

No one renewable energy source currently in use or under development will completely cover our current energy needs. Each source has trade-offs, such as taking up land or sea space that could be used in other ways, injuring local animals and habitats, and otherwise affecting the environment. How should we decide which alternative energy sources to develop and install? What should our priorities be? How does cost play into the decision?

How persistent are you when it comes to investigating challenging problems? What sorts of problems will you pursue for longer periods of time? What sorts of problems or puzzles do you have little or no patience for solving?

What do we do as a country to encourage people to invent new things? What should we do to encourage inventors? Have you ever had a class in which you were asked to invent something? Have you ever tried to invent something?

Applying and Extending Our Knowledge

Ocean waves come primarily from wind moving across water. But waves can also be generated by sudden geological disturbances such as landslides and earthquakes. And the changing of the tides also moves water.

- Research the pros and cons of using tides to produce usable energy. Are there any places in the world that use this source of energy to produce energy? How does this type of energy production differ from the energy produced by the two Mikes or by Annette von Jouanne? Would there be any way to produce energy from a tsunami caused by a landslide or earthquake?
- Using pans or tubs, build a wave tank and simulate the movement of water generated by wind, tides, landslides, and earthquakes. Create charts or a video explaining the differences and similarities of these kinds of water movements.
- Find a tide chart for some specific area (and another area halfway around the world). Prepare charts and models to show the class how the tides work. Graph the highs and lows and include information about the effects of the fullness of the moon. Research the tides through the seasons. When are the tides the highest and when are they the lowest? What are the tides like on the opposite side of the world? Are there any patterns to notice? Show your answer with graphs and captions.

Common Core Connections
CCSS.ELA-Literacy.W.7.7

The Next Wave: The Quest to Harness the Power of the Oceans

By Elizabeth Rusch

Conduct short research projects to answer a question, drawing on several sources and generating additional related, focused questions for further research and investigation.

CCSS.ELA-Literacy.RST.6-8.3
Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
CCSS.ELA-Literacy.RH.6-8.7
Integrate visual information (e.g., in charts, graphs, photographs, videos, or maps) with other information in print and digital texts.
CCSS.ELA-Literacy.SL.7.5
Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points.

On page 18 we read, "The Mikes started putting the pieces together. They had very different ideas about how to do things and both were opinionated. When they disagreed on an idea, they bet a dollar on it and tried it. 'Turns out that's a pretty effective rapid development tool,' Mike Morrow says. Instead of wasting time debating good and bad ideas, they tested all the ideas that either one thought was promising."

- Divide your students into teams. Provide each team with an identical set of materials (a fan, a rubber duck or plastic boat, rubber bands, balloons, popsicle sticks, twisty-ties, aluminum foil, a large pan of water, plastic bags, etc.). Using the "test all ideas" maxim of the two Mikes, have students invent a method for powering a boat or a duck from one side of the pan to the other as quickly as possible. Have races. Have each student make notes on what worked well, what did not work well, what did not work well but has potential, etc. Then have the class work on combining the best ideas from the individual groups to make an even better prototype.
- Look at the various prototypes of "Wild Wave Inventions" shown on pages 34–36. Divide the class into groups to analyze and explain how each of these inventions work. Remember that these huge pieces of equipment originally began as ideas that used (in the case of the two Mikes) materials found in dumpsters. Have students make models using similar items to show how hydraulic cylinders pump fluids.
- One of the notable points in this book is that people who shared a passion for swimming and surfing in the ocean used that passion to guide a future career. Divide the class into groups that are sorted by common interests. Like the Mikes (as described on page 16), brainstorm ways that these interests could generate a science project (don't limit the projects to wave energy—just insist that they have a testable scientific premise). If warranted, have groups design and test a premise, documenting all the materials and steps predicted for proving or disproving the theory. Adjust as required.

Both of the Mikes liked to tinker with things. Mike Morrow was really good at taking things apart and not so good at putting them back together. Mike Delos-Reyes grew up able to build things. He had a knack.

- Find some old clocks to take apart and reassemble.
- Take apart a fan or a typewriter and put it back together.
- Using Legos or other blocks or building tools, have students make scale replicas of various classroom furniture pieces or items.

Common Core Connections

CCSS.ELA-Literacy.RST.6-8.3
Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
CCSS.ELA-Literacy.SL.7.1
Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 7 topics, texts, and issues, building on others' ideas and expressing their own clearly.
CCSS.ELA-Literacy.SL.7.1.c
Pose questions that elicit elaboration and respond to others' questions and comments with relevant observations and ideas that bring the discussion back on topic as needed.
CCSS.ELA-Literacy.SL.7.1.d
Acknowledge new information expressed by others and, when warranted, modify their own views.

All of the different approaches to converting the power of waves into energy that we can use in our neighborhoods must channel this energy into our nation's (or the world's) electrical grid.

- Pick any of the existing inventions for converting wave energy into consumer energy, and prepare a presentation showing how the invention would sell energy to an electric company. How does this work?
- On a smaller scale, daydream about your own

The Next Wave: The Quest to Harness the Power of the Oceans

By Elizabeth Rusch

"home energy invention." If you were to invent something to provide energy to your house, how would it work? How would it connect to your existing energy structure?

Common Core Connections

CCSS.ELA-Literacy.W.7.7
Conduct short research projects to answer a question, drawing on several sources and generating additional related, focused questions for further research and investigation.
CCSS.ELA-Literacy.RH.6-8.7
Integrate visual information (e.g., in charts, graphs, photographs, videos, or maps) with other information in print and digital texts.
CCSS.ELA-Literacy.SL.7.5
Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points.
CCSS.ELA-Literacy.W.7.1
Write arguments to support claims with clear reasons and relevant evidence.
CCSS.ELA-Literacy.W.7.1.a
Introduce claim(s), acknowledge alternate or opposing claims, and organize the reasons and evidence logically.
CCSS.ELA-Literacy.W.7.1.b
Support claim(s) with logical reasoning and relevant evidence, using accurate, credible sources and demonstrating an understanding of the topic or text.
CCSS.ELA-Literacy.W.7.1.c
Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), reasons, and evidence.

On page 21 we read that the Mikes finally built a prototype that would produce energy. They tested it with a variety of different waves, and it continued to work. But we also read, "The pair took home medals in regional, national, and international engineering competitions. Then they graduated, packed the device in a cardboard crate, and stashed it in Mike Morrow's mom's attic. The Mikes didn't open the crate again for two decades." No one else did anything with their work either!

- Prepare a mock trial of our country for failing to address the need for clean, sustainable energy and for contributing to the global climate-change problems that have raised global temperatures, increased global sea levels, and may melt Arctic sea ice and glaciers to our detriment.

- Speculate on why nothing was done with the two Mikes' work, and with the benefit of hindsight, create a strategy that would have prevented this work from sitting in a crate for twenty years.

Common Core Connections

CCSS.ELA-Literacy.W.7.1
Write arguments to support claims with clear reasons and relevant evidence.
CCSS.ELA-Literacy.W.7.1.a
Introduce claim(s), acknowledge alternate or opposing claims, and organize the reasons and evidence logically.
CCSS.ELA-Literacy.W.7.1.b
Support claim(s) with logical reasoning and relevant evidence, using accurate, credible sources and demonstrating an understanding of the topic or text.
CCSS.ELA-Literacy.W.7.1.c
Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), reasons, and evidence.
CCSS.ELA-Literacy.W.7.3
Write narratives to develop real or imagined experiences or events using effective technique, relevant descriptive details, and well-structured event sequences.
CCSS.ELA-Literacy.SL.7.4
Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details, and examples; use appropriate eye contact, adequate volume, and clear pronunciation.

Further Reading

Peppas, Lynn. *Energy: Power from the Sea.* Crabtree, 2009.

Rowell, Rebecca. *Energy and Waves Through Infographics.* Lerner, 2014.

Includes a good basic explanation of power grids and power usage in the U.S.

Other Websites to Explore

Power Grids:
www.science.smith.edu/~jcardell/Courses/EGR220/ElecPwr_HSW.html

An explanation of the power generation and distribution network in the United States.

Guide created by:
Ed Spicer, curriculum consultant, and Lynn Rutan, retired middle school librarian, now reviewer and blogger at *Bookends: The Booklist Youth Blog*