Data Puzzles

# Heatwaves, Air Conditioning, and Offshore Wind Energy - Teacher Guide

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## Setting the Stage

As the number of heatwaves increase in frequency, more and more people are relying on air conditioners (AC) to stay cool. But powering AC units takes a tremendous amount of energy, energy that is produced by the burning of fossil fuels. The burning of fossil fuels leads to further warming and increased reliance on AC - a vicious cycle. But what if the energy used for air conditioners could come from clean, renewable energy sources (e.g., wind and solar)? Scientists see huge potential to harness the power of wind to produce clean energy across the United States, especially along U.S. coastlines where offshore winds are strong and reliable. But before scientists and engineers can design offshore wind farms, they must study the offshore wind patterns to understand when and **WHY** wind speeds will be highest and therefore able to produce the greatest amount of clean energy.

## Lesson Overview

In this Data Puzzle, students will compare the timing of peak offshore wind speeds (*caused by a sea breeze*) to the timing of peak energy demands (*record energy demands occur during extreme heat*) in New York City to determine if the clean energy produced by offshore wind farms can help New York City and other major coastal cities meet record energy demands during extreme heat events.

**Day 1**

### Part 1 – (25 minutes) Eliciting Students' Ideas

Access students' prior knowledge about an opening scenario.

### Part 2 – (50 minutes) Identifying Important Science Ideas

Students engage with a contemporary science investigation through an interactive reading in which students are tasked with 1) making connections between the science investigation and the opening scenario, and 2) identifying an investigative question.

**Day 2**

### Part 3 – (45 minutes) Supporting Ongoing Changes in Thinking

Students test/compare their current understandings of the investigative question against authentic data.

## Part 4 – (60 minutes) Constructing Evidence-Based Explanations

Students finalize new understandings as they relate to the investigative question to create an explanatory model.

| Instructional Overview | |
|---|---|
| **Grade Level** | High School |
| **Instructional Time** | ~120 minutes |
| **Building Toward** | **NGSS Disciplinary Core Idea:**<br>• ESS3.D: Global Climate Change<br>**NGSS Science and Engineering Practices:**<br>• Analyzing and interpreting data<br>• Constructing explanations<br>**NGSS Crosscutting Concepts:**<br>• Patterns<br>• Energy and Matter |
| **Investigative Question** | • How does the timing of peak offshore wind speeds compare with the timing of peak energy demands in New York City during a hot, summer day? |
| **What Students Will Do** | • Analyze and interpret patterns in energy demand and offshore wind speeds from New York City to evaluate whether energy produced from future offshore wind farms can meet New York City demands.<br>• Construct an explanation for how energy from the development of future offshore wind farms will help meet the high energy demands of New York City. |
| **Materials** | ❑ Slide deck<br>❑ Student worksheet<br>❑ Answer Key |
| **Material Preparation** | ❑ Print student worksheets<br>❑ Review presenter notes in slide deck<br>❑ Review Answer Key<br>❑ Watch videos referenced in the teacher guide |
| **Vocabulary** | • Heatwave - a prolonged period of abnormally hot weather<br>• Renewable energy - often referred to as clean energy, is energy that comes from natural sources (wind, water, sun) that are constantly replenished<br>• Wind farm - an area where many large wind turbines are grouped together<br>• Sea breeze - a daytime breeze (wind) moving from the sea (ocean) towards the land |

## Part 1 - Eliciting Students' Ideas

25 minutes

Refer to Part 1 slides included in the slide deck. See presenter notes for additional information.

1. Facilitate a whole-class conversation related to the opening scenario prompt(s), "What is the hottest day you've ever experienced? Where were you? What time of year was it? How did you stay cool?".
    a. Teachers should be prepared to share details of the hottest day they've experienced.

**Note:** The goal of this conversation is to elicit students' experiences as it relates to extreme heat and get students thinking about when it occurs (during the summer) and how they and others stay cool (e.g., air conditioning (AC), swimming, shade). Make note of any patterns that may emerge from this discussion, namely that extreme heat is largely a summer phenomenon and that many rely on AC to stay cool.

2. Refer to the slide deck to introduce the term, "heatwave", and to highlight that the number of heatwaves in the United States is expected to increase in the future.
    a. Watch this video "Extreme heat will impact over 100 million by 2053, study says" (30 seconds long)

3. **Say**, "*Millions of Americans rely on air conditioners to stay cool during these hot summer days. While AC is an effective way to stay cool, it turns out that AC can actually cause more extreme heat outside!*"
    a. Facilitate a discussion around the following prompt, "How could using AC to cool a home or office cause more extreme heat outside?"
    b. Then, watch the video, "The Cruel Irony of Air Conditioning" (2:55 minutes long)
    c. Reinforce the air conditioning feedback loop concept, that the burning of fossil fuels to generate the electricity needed to power AC units contributes massively to human-caused global warming. Rising temperatures → more AC → rising temperatures.

4. **Say**, "*Air conditioners are going to be an important tool to keep people cool and avoid heat-related illnesses but we need to find different, cleaner, ways to power them…*"
    a. Introduce the term, "renewable energy" and facilitate a conversation about why it's important for communities and cities to invest in a variety of different renewable energy sources rather than relying on just one (like wind) for energy.

5. **Say**, "*Scientists are seeking to learn more about why some environments are consistently windier than others in hopes of identifying locations to build wind farms" (an area where many large wind turbines have been grouped together)*.

6. Introduce students to atmospheric scientist Julie Lundquist, the scientist featured in the Data Puzzle, who studies wind patterns across the United States to better predict when wind farms will produce the most energy (*during times of high wind speeds*).

## Part 2 - Identifying Important Science Ideas
50 minutes

Refer to Part 2 slides included in the slide deck. See presenter notes for additional information.

1. Students read the puzzle plot text included in the student worksheet either individually, in small groups, or as a whole class. While reading, students are asked to do the following tasks:
    a. Circle the investigative question the scientists are investigating.
    b. Identify similarities between the reading and the opening scenario.

2. When prompted in the text, have students "Turn and Talk" about the prompts below. Note that these prompts are designed to get students thinking about the why and how as well as priming them for the predictions they will be asked to make.
    a. *During hot summer days in New York City, what time of day do you think energy demands are the highest? And why?*
    b. *During hot summer days in New York City, what time of day are offshore wind speeds (caused by a sea breeze) the highest? And why?*

3. Show the following video/visualizations (*the links are also embedded in the puzzle plot text*) to help students visualize important science concepts like New York State's offshore wind farms and the factors that cause wind.
    a. Map of average wind speeds across the United States lands and waters
        - Note that these wind speeds are from 100 meters above the surface level, the hub height of most offshore wind turbines
    b. Powering New York State with Offshore Wind (2:24 minutes)
    c. Why does the wind blow? (2:59 minutes)
        - Students are asked to reflect on what they learned from this video to draw/represent the behavior of air molecules in warm and cool conditions

4. After students have read the puzzle plot text, facilitate a whole-class discussion to help make connections between the reading and the opening scenario by utilizing the following prompts:
    a. Think back to the hottest day you ever experienced, was it in the summer? Was it also a windy day?
        - **Note:** Reinforce the fact that it is not windy on all hot summer days
    b. In the future, New York City (NYC) residents will get some of their power/energy offshore wind farms. Why might it be important for NYC city managers to be able to predict when wind speeds will be highest? Lowest?
        - **Note:** Reinforce the fact that the higher the wind speeds, the more energy that can be generated

5. Students summarize important science ideas presented in the puzzle plot by having them draw and describe why on a hot summer day the air moves (wind) from the ocean onto the land. See Answer Key as needed.

6. Students make a prediction for the investigative question that they will test in Part 3 by analyzing real data.

## Part 3 - Supporting On-Going Changes in Thinking

45 minutes

Refer to Part 3 slides included in the slide deck. See presenter notes for additional information.

1. Orient students to the graph/figure by giving them an opportunity to study and discuss the graph both individually and with a partner.

2. Students work in pairs to identify patterns in the dataset.

3. Students cite evidence from the graph/map to evaluate whether or not the data supported or refuted their initial prediction for the investigative question.

4. Students answer the “Putting Pieces Together” questions that challenge students to consider if offshore wind energy can be an important and reliable energy source for New York City - especially on hot, summer days. See Answer Key as needed.

## Part 4 - Explanatory-Based Explanation

60 minutes

Refer to Part 4 slides included in the slide deck. See presenter notes for additional information.

1. Students summarize new understandings by writing a news story to address the prompt below. See Answer Key as needed.

   *"Imagine that you are part of a scientist Julie Lundquist's research team and are asked to write a newspaper article about how energy from the development of future offshore wind farms will help meet the high energy demands of New York City, especially on hot, summer days.*

   *P.S. Don't forget a headline!*"

2. Students share their new stories/articles with a partner, in small groups, or as a whole class.

3. Digging Deeper - Students visit **this site** to determine how much of the energy in their state comes from renewable sources and to research their state's future plans to transition from fossil fuels to renewable energy sources.

## Additional Teacher Resources and Extensions

**Videos**

- Steroids, baseball, and climate change (2:05 minutes)
- How to build the world's biggest offshore wind farm (~4 minutes)
- The Future of Offshore Energy (3:27 minutes)
- Why the US isn't ready for clean energy from Vox (6:50 minutes)

**Articles**

- The air conditioning trap: how cold are is heating the world from The Guardian.
- All 30 million British homes could be powered by offshore wind in 2030 from CNN Business.
- Conserve Energy: New York City Begs Residents to Help Avoid Outages from The New York Times (*subscription required to read full text*)
- Too Hot to Work, Too Hot to Play from Inside Climate News.
- German-Danish Offshore Wind Hub to Help Replace Russian Gas from Bloomberg. August 29th, 2022.

**Additional Resources**

- Climate Change Indicators: Heat Waves from The United States Environmental Protection Agency
- Climate Change and Extreme Heat: What You Can Do to Prepare from The United States Environmental Protection Agency
- Wind Energy in the UK: Learn the basics

**Demonstrations**

- What causes the wind? demo