Episode 5: Wind Energy and Urban Solutions

8th Grade Science Lesson

Summary

In this episode, students will learn how wind is a renewable energy source powered by the sun's heat. Erica Boeing from Accelerate Wind discusses the development of affordable wind turbines for commercial buildings, including how urban wind energy can be harnessed through the sun-driven wind patterns that naturally occur around rooftops and tall buildings.

Teacher Discussion Guide:

Objective:

- Understand how the sun is the primary source of energy that drives wind.
- Explore the real-world application of wind energy in urban environments.
- Discuss the relationship between wind energy, renewable energy sources, and sustainability.

Key Concepts:

1. **Wind Energy**: Energy produced by wind turbines that convert wind into electrical power.
2. **Solar Heating**: The sun's energy heats the Earth's surface unevenly, causing air pressure differences and driving wind.
3. **Urban Wind Patterns**: The faster wind speeds that occur near rooftops and tall buildings due to the sun's heat.
4. **Renewable Energy**: Energy derived from natural resources that are replenished over time, such as wind and solar power.
5. **Net Zero**: A state where the energy a building produces (from renewable sources like wind and solar) is equal to or greater than the energy it consumes.

Key Vocabulary:

Renewable Energy: Energy that is collected from resources that are naturally replenished on a human timescale, such as sunlight, wind, rain, tides, waves, geothermal heat, and more. Unlike fossil fuels, renewable energy does not deplete the Earth's resources.

- Example: Solar panels and wind turbines are examples of renewable energy sources.

Wind Energy: Energy that is harnessed from the movement of air (wind) through wind turbines. Wind energy is a form of renewable energy.

- Example: Wind turbines are used to convert wind energy into electricity, which can power homes and businesses.

Solar Energy: Energy that is captured from the sun's rays, typically using solar panels. It is one of the most popular forms of renewable energy.

- Example: Solar panels on rooftops absorb sunlight and convert it into electricity.

Net Zero: A state in which a building or area generates as much energy as it consumes, meaning there is no net increase in energy usage or carbon emissions. This can be achieved by combining energy-efficient technologies and renewable energy sources.

- Example: A building with solar panels, wind turbines, and efficient insulation that generates all the energy it needs is considered to be net zero.

Energy Storage: The process of storing energy for later use, typically in batteries or other storage systems. Energy storage is crucial for renewable energy, as it allows energy to be saved when production exceeds demand and used when production is low.

- Example: A battery system in a building stores excess energy generated by wind or solar power for use when the wind isn't blowing or the sun isn't shining.

Decarbonization: The process of reducing carbon emissions, particularly those from burning fossil fuels. It is a key goal in efforts to mitigate climate change and promote sustainability.

- Example: Using renewable energy like wind and solar helps with the decarbonization of buildings by reducing reliance on fossil fuels for energy.

Pre-Video Discussion Questions:

1. **What are some examples of renewable energy sources?**

- Discuss the concept of renewable energy (energy that comes from sources that are naturally replenished over time).
- Ask students to think about different types of renewable energy they've heard of: wind, solar, hydropower, geothermal, and biomass.
- Explore where these energy sources might be used (e.g., wind turbines in open fields or rooftops, solar panels on buildings, hydropower in rivers).

2. **How do you think the sun's energy affects the wind?**
   - Introduce the idea that the sun heats the Earth's surface unevenly, creating temperature differences.
   - Explain how warmer air rises and cooler air rushes in to replace it, creating wind.
   - Encourage students to think about how the Earth's rotation and the sun's position affect wind patterns across different areas of the globe.
3. **What might be some benefits of using wind energy in cities?**
   - Ask students to think about the challenges cities face with energy consumption, like air pollution and grid dependence.
   - Discuss how wind energy can help reduce these issues by providing clean, renewable energy to urban areas.
   - Talk about how urban wind energy could complement other renewable sources, like solar, to make buildings more energy-efficient and sustainable.
4. **How might we be able to combine solar and wind energy to power buildings?**
   - Introduce the concept of "hybrid" renewable energy systems, where different types of renewable energy (solar, wind) work together to meet a building's energy needs.
   - Ask students to consider how solar and wind energy each work in different conditions (solar works best during the day, while wind can happen at any time).
   - Discuss the idea that by combining solar and wind, a building can generate power when the sun is not shining, such as at night or during cloudy days.
   - Encourage students to think about how storage systems (like batteries) could store excess energy for later use when wind or solar energy is not available.
   - Explore the concept of "net zero" buildings, where the amount of energy generated equals the amount used, and how combining solar and wind could help achieve this goal.

Revised Activity: Urban Wind Energy Design

Objective:

Students will design a wind turbine solution for an urban building, considering space constraints and complementary use with solar energy.

Materials Needed:

- Large sheets of paper or poster board
- Markers, pencils, and rulers
- Internet access or pre-provided resources on wind turbines and urban energy solutions
- Sample data on wind speeds in urban environments (optional)

Procedure:

1. **Class Discussion and Brainstorming:**
    - Begin with a brief discussion on how urban wind patterns (e.g., around tall buildings) make certain areas suitable for wind turbines.
    - Introduce the idea of integrating wind and solar energy to power buildings sustainably.
2. **Group Design Challenge:**
    - Divide students into small groups.
    - Each group will design a wind energy solution for a hypothetical urban building (e.g., a school or office).
    - Designs must include:
        - Placement of turbines on the building (e.g., rooftop, sides).
        - Features to optimize energy capture (e.g., size, orientation).
        - A plan to combine wind energy with solar energy for a hybrid system.
        - Considerations for minimizing environmental and aesthetic impacts.
3. **Presentation:**
    - Groups will present their designs to the class, explaining:
        - How their design takes advantage of urban wind patterns.
        - How it complements solar energy to create a more sustainable building.
        - The challenges they addressed, such as space limitations or noise concerns.
4. **Class Feedback:**
    - After presentations, engage the class in providing constructive feedback. Ask questions like:
        - "What makes this design innovative or practical?"
        - "How well does this design balance efficiency and environmental impact?"

Analysis:

Students will write a brief reflection:

- How does wind energy complement solar energy in urban environments?
- What challenges might engineers face when implementing wind energy in cities?
- How does their design demonstrate the relationship between the sun's energy, wind patterns, and renewable energy solutions?

Extension Activities:

1. **Research Project**:
    - Have students research and present on different renewable energy sources (wind, solar, geothermal) and how they can be integrated into urban infrastructure.
2. **Community Wind Assessment**:
    - Students conduct a walk-through of their school or neighborhood, observing areas where wind energy might be successfully harnessed, such as rooftops or open fields. Create a report or presentation on their findings.

Post-Video Discussion Questions:

1. **How is the sun related to the wind energy used in turbines?**

   Answer: The sun heats the Earth's surface unevenly, creating air pressure differences. These differences in pressure cause wind, which can be harnessed for energy.

2. **Why might wind energy be a good choice for urban buildings, as mentioned by Erica Boeing?**

   Answer: Wind accelerates around buildings, especially rooftops, due to the sun's heating effects. This makes it a great location for harnessing wind energy in urban areas where space is limited.

3. **How can combining wind and solar energy help buildings achieve net zero?**

   Answer: Solar energy can power buildings during the day, while wind energy can be used when the sun isn't shining. By combining both, buildings can generate enough energy to meet their needs, reducing reliance on the grid.