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Lesson Plan

Clean Energy Transition: Optimizing Renewable Energy Systems

Objective:

- Students will understand the key concepts and challenges of the clean energy transition and how optimization techniques can be used to improve energy systems. The lesson will explore the importance of renewable energy sources, the challenges of integrating these sources into traditional energy grids, and the role of operations research (OR) in enhancing energy efficiency.

Materials:

- Projector and slides on clean energy and renewable energy sources (wind, solar, hydro, etc.)
 - Printouts or digital versions of optimization case studies in renewable energy
 - Internet access for research and data collection
 - Sticky notes, markers, and flipchart for brainstorming sessions
 - Graph paper or digital tools for creating energy flow models
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Background Information:

The clean energy transition refers to the global shift from fossil fuels (coal, oil, and natural gas) to renewable energy sources such as solar, wind, and hydropower. This transition is essential to reduce carbon emissions and combat climate change. However, integrating renewable energy into existing energy grids presents challenges, including variability in energy supply, resource



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management, and grid stability. Optimization techniques can help address these challenges by improving the efficiency of energy systems and ensuring that renewable energy sources are effectively used.

Steps for Activity:

1. Introduction to Clean Energy Transition (15 minutes):

- Begin by discussing the importance of reducing carbon emissions and the need for renewable energy to meet future energy demands.
- Explain the challenges posed by the intermittent nature of renewable energy sources, such as how solar power depends on sunlight, and wind power relies on wind speed.
- Introduce key renewable energy sources (solar, wind, hydro) and their potential to reduce reliance on fossil fuels.
- Discuss the role of optimization in addressing energy system challenges, focusing on how it helps balance supply and demand.

2. Explore Renewable Energy Sources (20 minutes):

- Divide the class into small groups. Assign each group a renewable energy source (solar, wind, hydropower, etc.).
- Ask each group to research and present the pros and cons of their assigned energy source, including its potential for integration into traditional power grids.
- Have groups explain the variability challenges (e.g., wind energy's dependence on weather patterns) and how these challenges can be addressed through optimization.

3. Hands-on Activity: Energy System Optimization Simulation (30 minutes):

- Give students a simplified energy grid model with different energy inputs (e.g., solar, wind, fossil fuels) and energy demands.



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- The task: Use optimization techniques to balance energy supply and demand, ensuring minimal carbon emissions while maximizing renewable energy use.
 - Example: Solar panels produce more energy during the day, while demand peaks at night. Students must figure out how to store excess solar energy or use wind power at night to meet demand.
- Students will use graph paper or digital tools to map out energy flows and determine the most efficient way to distribute energy.

4. Analyze Results and Discuss (20 minutes):

- Each group presents their energy flow models, explaining how they balanced renewable and traditional energy sources to meet the demand.
- Encourage a discussion on the trade-offs they encountered (e.g., increased use of renewables vs. the cost of storage systems).
- Relate their results to real-world challenges, such as grid stability and the integration of renewable energy sources into national energy systems.

Visualize and Discuss:

- Create a class-wide energy grid on a flipchart or whiteboard where students combine their solutions to create an optimized energy system.
- Discuss how real-world energy systems could benefit from similar optimization models and how governments and energy companies use these methods to plan for a cleaner energy future.

Additional Discussion Points:

- Applications of Optimization in Energy Systems: Discuss real-world examples of how governments and companies use optimization to



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manage energy resources, such as in Denmark's wind energy grid or Germany's solar power initiatives.

- **Challenges of Clean Energy Transition:** Explore the challenges, including public policy, economic constraints, and technological advancements.
- **Future of Energy:** Discuss how innovation in energy storage and grid management could accelerate the clean energy transition..

Assessment:

- Ask students to write a reflection on the following:
 1. What were the key challenges they faced in optimizing the energy system during the simulation?
 2. How can optimization techniques be applied to real-world energy grids?
 3. What role do renewable energy sources play in the clean energy transition, and how can they be better integrated into traditional grids?
- Students will also be evaluated based on their group presentations and participation in the energy system simulation.



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