

White Paper Study Guide Answers

Background research resources: Learn about Instream Energy Generation Technology (IEGT) as an innovative alternative energy solution by studying the information provided at www.verdantpower.com, especially the “Technology” pages and “Newsroom” articles:

Sixth-Graders Get a First Hand Look as Island Has a Role in Electric Power's Green Revolution
<http://nyc10044.com/wire/2310/verdant.html>

Firm Plans to Tap Tides in East Channel for Power <http://nyc10044.com/wire/2223/rivrpowr.html>

Meetings this Week to Explain Underwater Power Generation Plan
<http://nyc10044.com/wire/2321/wire2321.pdf#page=7>

Using your Internet research, answer the following questions on a separate sheet of paper.

The Problem

1. How many people in the world live without electrical power? (**Answer: 2 billion**)
2. Imagine you lived without electricity. What would your life be like? (**Answer: Various**)
3. How is electricity produced? (**Answer: The conventional way is to burn some type of fossil fuel to produce steam that drives a turbine. The kinetic energy of the turbine drives an electric generator. The electricity goes through wires and into homes.**)
4. What are some problems with **fossil fuels**? (**Answer: The supply will not last forever; burning them pollutes the air and causes green-house gases, such as carbon dioxide, that contribute to global warming, as well as particles that cause asthma and other respiratory illnesses.**)
5. What are some **alternative sources** of energy? (**Answer: Solar power, wind power, tidal power, geothermal, biomass, etc.**)
6. Why are these sources of energy **renewable**? (**Answer: They cycle all the time causing movement that can be harnessed in the form of kinetic energy or are continually produced.**)

How the Technology Works

7. What does IEGT stand for? (**Answer: Instream Energy Generation Technology**)
8. What are some synonyms for IEGT? (**Answer: Free-flow hydropower technology or kinetic hydro energy systems**)
9. How do Verdant Power’s IEGT systems generate electricity? (**Answer: From the kinetic energy present in flowing water.**) How are they like underwater “**windfarms**”? (**Answer: Turbines are placed in the current, which turns the blades because they are set at an angle. [Blow gently on a toy windmill to show how the current turns the blades.]**)
10. How is that different from the way **hydropower dams** generate electricity? (**Answer: IEGT systems don’t require water to be stored [impounded] behind high dams [called “artificial water-head”] in order to turn the turbines.**)
11. Do Verdant Power’s IEGT systems need to operate just in big rivers? (**Answer: No, they can also operate in smaller streams, manmade channels, tidal waters, or ocean currents.**)
12. IEGT systems use **turbines**. How does a turbine work? (**Answer: A turbine has blades like a propeller or windmill. As the water flows through the turbine, the blades slowly turn. The kinetic energy of the blades drives an electric generator in the nacelle [housing for housing an engine] or an on-shore electric generator.**)
13. How many different types of turbines are used in Verdant Power’s systems? (**Answer: Four. Students with technical interests may want to learn the different types.**)
14. How fast do the blades spin? (**Answer: 32 revolutions per minute, expected to be slow enough for diving birds to avoid the blades and fish to pass through unharmed [to be verified by further testing].**)

15. How do lift or flutter vanes work? **(Answer: Like a Venetian blind. [Note how an analogy may be used to describe how something works.]**)
16. Where are the systems placed? **(Answer: About one-third below the surface of the water. In the East River that would be 8-12 feet below the surface of the water, deep enough so that recreational boats, but not deep-draft ships, could move over them.)**

How the Technology Solves the Problem

17. What does it mean if a technology has low **environmental impact**? **(Answer: It does not harm the environment.)**
18. What is **installed capacity**? **(Answer: You are able to run enough generators to generate the amount of electricity you need. It is the amount of total power of the combined turbine/generators of a given site based on capability of each generator [e.g., 300 turbines with 37 kW generators in each is an installed capacity of 11,100 kW or 11 MW].)**
19. In terms of a percentage, what would be the **capacity factor** of a Verdant Power system that is operating in a big river? **(Answer: 80-90% running 24 hours per day. That would allow for down time based on scheduled service and unexpected maintenance, not because the water is not flowing. U.S. hydroelectric dams have an average capacity factor of 56% because of other demands on water use. Inland wind farms have an average capacity factor of 30%. Off-shore wind farms have a capacity factor near 45%.)**
20. What is a **megawatt**? **(Answer: One million watts; 1000 kilowatts.)**
21. How many homes will a ten-megawatt Verdant Power system in New York's East River serve? **(Answer: 5,000-10,000 homes. Given Americans' need of electricity, it may actually be closer to 5,000 homes, but internationally, 1 kW per home still holds true.)**
22. How much is electricity generated by the East River projected to cost per **kilowatt-hour** (kWh)? **(Answer: 7-9 cents initially.)** How does it compare with the cost of traditionally generated power? **(Answer: Favorably, because of lower environmental clean-up and healthcare costs.)**
23. What is **peak-shaving** and how will this technology help? **(Answer: There are certain times of day when people use lots of electricity called "peak periods," when electricity is expensive because it is in demand. With a supplementary source of power, less electricity is drawn from the grid during peak periods, reducing overall power costs.)**
24. How will excess power from the IEGT system be used? **(Answer: There is such a demand for green power that most likely there will not be excess power. However, theoretically, excess power or off-peak power could be used for recharging large batteries or electrolysis to extract hydrogen from water to use in fuel cells. Either storage system then could operate between tidal cycles, for example, so that tidal turbine fields could provide uninterrupted electricity.)**
25. What is a **distributed generation system**? **(Answer: Communities become their own electricity producers, while still drawing power from the grid, or they may sell their surplus power back to the grid.)**
26. Why will IEGT technology be good in developing countries? **(Answer: Population centers are near streams; expensive dams are not required; the technology can purify and desalinate water, run irrigation systems, aerate streams, extract hydrogen from the water for fuel cells. [This could be an opportunity to explore with students how these other systems would work; for example, the mechanical power of free-flowing turbines can pump water from a river into irrigation canals and also pump oxygen to aerate waters.]**

Answers prepared with the assistance of the Verdant Power executive team, with special thanks to Trey Taylor, President, and Cindy Coker, Manager of Business Operations. August 2004. For additional information, please contact:
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