Chapter 10
Energy and Environment

ABSTRACT

The "Energy and Environment" project is a mental exercise intended to assist the reader in thinking and communicating with the use of visual language. Inspiration for this project comes from the theme of energy (such as kinetic, potential, mechanical, electrical, chemical, light, radiant, nuclear, and heat energy) and a need for its conservation. It also tells about the environmental concerns related to energy production and use. Visual and verbal projects provide analogies and comparisons of some energy related processes and events to our everyday experiences.

INTRODUCTION

The sources for generation of electric energy in the United States are coal (42%), natural gas (25%), nuclear energy (19%), and renewable energy (13%). Renewable energy comprises 63% hydropower, 23% wind, 7% wood, 4% waste, 3% geothermal, and 1% solar energy, without taking into account solar energy produced by the residential and commercial rooftop solar installations (eia, 2012).

Energy consumption goes in tens of quadrillions Btu in the United States (a quadrillion Btu equals 10^{15} Btu). An acronym Btu (the British thermal unit) denotes a unit of energy equal to about 1,055 joules or 252 cal. A Btu is defined as amount of heat required to raise the temperature of one pound (0.454 kg) of water from 39 °F to 40 °F (3.8 °C to 4.4 °C) at a constant pressure of one atmosphere (Business Dictionary.com, 2012).

There are a variety of oils in nature; it may be any substance that does not mix with water but can mix with other oils and organic solvents. Organic oils produced by plants, animals, and other organisms through metabolic processes, mineral oils (called also petrochemicals) originated from ancient fossilized organic tissues, and synthetic oils are used for energy production.

Every form of energy can be generated from matter, in accordance with the Enstein's formula $E = m c^2$ telling that energy (E) equals mass (m) times the velocity or the speed of light raised to the second power (c^2). The further text discusses several forms of energy used or generated to satisfy

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human needs, especially some of those available from natural resources such as water, wind, ocean thermal energy coming from a difference in water temperature, coal as a fossil fuel, solar, and nuclear energy trapped in an atom. The following projects: Hydropower, The Ocean Thermal Energy Conversion, Building a zero-energy house; bird's eye view and orthographic projection, Windmill: A Rondo (but not a perpetuum mobile), Nuclear power plant: a company as an atom, Greenhouse effect and global warming, and Solar cooking aim at encouraging the reader in thinking and communicating visually.

PROJECT 1: HYDROPOWER

People have been harnessing energy from hydropower for centuries but presently only about 7% of electricity produced in the United States and about 21% of the world's electricity comes from hydropower. Hydroelectric plants take energy from water flowing from dams and rivers. There are now about 8,000 dams in the United States. The important parts of a hydroelectric plant are a dam (with a high or low head) and a large pipe called a penstock that carries water from the dam to a generator (usually located in a power house). The vertical distance from the water level to a power-producing turbine is called a head. This distance – elevation change – allows for converting potential energy into kinetic energy. A high-head dam (e.g., about 300 m – 1000 ft) can provide a large volume of water to a turbine, to supply energy for a generator and produce thousands of megawatts (MW) of energy. When there is a low-head dam (for instance, less than 30 m – 100 ft) the output, that means the water flow, depends on the diameter of the penstock. The main types of turbines are the impulse and the reaction turbines. The impulse turbine, for example, the Pelton or the Francis turbine, uses nozzles aimed at cupped blades, so water pushes a wheel with blades; this type of turbine can rotate with a speed up to 1300 rpm (revolutions per minute). The reaction turbine, for example, the Kaplan turbine turns the wheel according to the Newton's third law, which states that mutual forces of action and reaction between two bodies are equal, opposite and collinear.

The author and illustrator David MacAulay (1989) designed a book entitled "Mill," which shows visual explanation of the planning, construction, and operation typical of mills developed in New England throughout the nineteenth century. This book is helpful in understanding how to gain energy from water.

The following project can be designed as a comparison of advantages and disadvantages of various types of hydroelectric energy systems. Maybe you would like to make a model of a turbine, with Flash or a physical model made of cardboard. For tips, see Table 1.

A sculptor, media artist, and filmmaker Scott Hessel (2012) developed a kinetic sculpture entitled "The Image Mill" and a video "No.1: Image Mill." This time-based artwork provides the moving image of galloping horses, mediated versions of cinema and computer forms. According to the artist's description, "The Image mill is a rotating steel machine that uses the force and beauty of falling water as the energy to create a moving picture. As water falls over the 4-meter-tall wheel, a transmission assembly causes two disks to spin in opposite directions. On the interior wheel are a series of animation frames painted onto plexiglass; on the black outside wheel, rotating in the opposite direction, are cut slits. As the two wheels spin, the slits act as a shutter and the animation becomes visible; a movie plays in the falling water." (Hessels, 2012, p. 98). When one visit Scott Hessel's website (http://www.dshessels.com/) and watch the 'No.1: Image Mill' video (http://www.dshessels.com/artworks/Imagemill/image_mill.htm) one can see a mill with horses