



Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
2011 Volume IV: Energy, Environment, and Health

Introduction

I first conceived this seminar to explore how different sources of energy affect our environments and human health. The U.S., with only 5 percent of the global population, consumes nearly 25 percent of the world's annual supplies of energy. The 2011 Fukushima nuclear reactor failures and the 2010 BP oil spill highlight the dangers of energy exploration, extraction, and distribution. Additional controversies over natural gas extraction, mountaintop excavation for coal, and the siting of offshore wind turbines near Cape Cod collectively demonstrate that no energy source is free from environmental and health concerns.

The Fukushima crisis caused all nations with nuclear programs to reconsider the safety of existing and proposed facilities. President Obama ordered a review of all U.S. plants, but will not likely deviate from previous plans to encourage development of next generation technologies to build new plants. Russia declared it will not change its nuclear development plans, nor will China or India. Germany and Switzerland by contrast have announced a phase-out of their existing plants by 2030, and their intent to abandon planned additional plants. For Switzerland, this means they will need to compensate for 40 percent of lost supply that is now provided by five active nuclear reactors. Swiss authorities are pursuing aggressive conservation plans, while their power companies are purchasing equity in French nuclear plants, and hoping to import their power. Germany will likely rely increasingly on coal and oil, and this could easily lead to increased air pollution and health loss.

Nuclear power has long held promise for national energy independence. Now, the prospect of plant closures or the abandonment of plans to build new reactors demands a careful consideration of available alternatives, and their relative costs, benefits, and risks. The U.S. is rich in coal and natural gas, but these natural resources will not fuel our vehicle fleets, at least in the foreseeable future. Solar power is a viable option in many of the southwestern and some mountain states, but not in most northern states. Wind energy is most abundant offshore and near coastal waters, the plains and some mountainous areas. And each source of energy creates distinctive health hazards and environmental damage, often associated with extraction, processing, distribution, and/or combustion by-products.

U.S. land development and zoning policies have strongly affected patterns of energy consumption. Cold War statutes adopted by Congress in the 1950s included federal funding to construct the interstate highway system, in part to make evacuation a possibility in the event of a Soviet attack. At the same time federal mortgage subsidies encouraged urban residents to move from cities to rural environments. Detached houses on large lots led to dependence on cars and an ever-growing per capita consumption of gas and oil. Federal oil and gas subsidies, relatively low fuel taxes, and the absence of investment in public transit increased national dependence on cars and trucks. Today nearly 250 million cars and trucks are owned by approximately 250

million eligible drivers, now the highest ratio in the world. Each vehicle is driven on average 12,000 miles per year, and collectively the U.S. fleet is driven nearly 3 trillion miles annually.

This seminar considered all of these trends among others, and our discussions became the foundation for an exceptionally thoughtful set of curricular innovations. Paula Daddio's curriculum unit examines our national reliance on oil, and our history of offshore exploration. She documents government permits to drill further from shore in deeper water. Industry assurance that hazards are well understood and manageable were convincing to the Department of the Interior, responsible for permitting the Deepwater Horizon drilling operation in the Gulf of Mexico. Paula also reviews the environmental effects on sea life, especially fisheries, and unforeseen problems associated with using the oil dispersant "Corexit" that was never tested for its toxicity prior to government authorization to release millions of gallons in the Gulf. Later discovery of Corexit's high toxicity, especially when combined with Gulf oil, led to recognition that government and private clean-up workers were exposed to the dispersant without their knowledge. The spill also resulted in widespread marine life and bird mortality. Contamination of commercial fishing grounds created an international food safety problem given the popularity of many fish species, including Gulf shrimp. Paula will use these lessons to teach students about New Haven Harbor, the oil terminal, tanks, and different environmental and health effects associated with use of oil, gas, and diesel fuel in Connecticut.

Deborah James-Johnson explores how energy efficient building construction can lead to increasing levels of chemicals in indoor air. She points out that on average Americans are spending 95 percent of their time indoors, more than ever before, and that the diversity of chemicals in building materials, furnishings, cleansers, paints, and floor coverings all may release gases and particles that can easily be inhaled. Although the mixtures vary day to day, it is clear that we are all exposed routinely to synthetic chemicals that past generations never experienced. Rising rates of childhood asthma are troubling, and many chemicals in building materials, cleaning agents, and perfumes are well recognized to exacerbate asthma. Within Connecticut, asthma rates among school children vary from 4-22 percent with highest levels near urban schools such as in Stamford, Bridgeport, and New Haven. These cities lie in counties that are already beyond compliance with Clean Air Act standards for ozone and particulate matter. Thus the threat to children's health grows from both indoor and outdoor pollution sources.

Octavia Loyd-Oliver designed a curriculum unit to encourage students' use of mathematics to understand the energy required to produce different foods. The foods we consume are grown, processed, packaged, transported, and sold in patterns so complex that most of us have little conception of the energy it takes to produce even a single meal. Octavia examines the rise of the "local food" movement, and will teach students how to estimate the relative energy demands of foods such as hamburger, corn, cheese, bananas and vegetables. Many academic institutions are now attempting to purchase a percentage of their foods within a local boundary. The motive is to reduce energy and CO2 emissions associated with food production, processing, packaging, distribution, preparation, and waste disposal. Students will build their own data sets by keeping food intake journals, and these will become the basis for analyses of caloric intake, distance traveled from producer to consumer, energy expenditure per calorie. The data will become a basis for teaching statistics as well as graphic display of quantitative information.

Kathleen Rooney designed a high-school statistics curriculum unit that will examine school bus transit patterns in New Haven, Connecticut. It is well known that air quality within diesel school buses is often worse than air quality outside, providing logic to design a transit system that minimizes the amount of time students spend in transit. Kathleen provides an excellent overview of the health risks posed by diesel exhaust, even from short-term exposures. The high asthma prevalence rate in New Haven, and the chronic ozone and particulate

pollution that exceeds federal standards, further demonstrate the need to minimize additional exposures to bus exhaust. High-quality data sets are available from monitoring equipment that provides hourly pollution readings, and these data will provide Kathleen with the opportunity to teach a variety of statistical and analytic methods. Students will have the opportunity to collect their own data, analyze these data, interpret their significance, and to test compliance of pollution detected with federal pollution limits.

Kenneth Spinka examines the future of nuclear power, and prepared a balanced and detailed analysis of the state of nuclear technologies, along with a discussion of benefits and hazards. The March 2011 Japanese offshore earthquake and tsunami demonstrate the entanglement of a natural disaster with human error. The plant was built near a well-known geologic fault line, and like many reactors in the U.S., Fukushima units were designed to withstand a quake of magnitude 7.0 on the logarithmic Richter scale, far below the 9.0 level that occurred. Thus, flawed risk assessment and a hopeful facility siting decision significantly increased the probability of plant failures. The potential release of radioactive particles to the atmosphere and the ocean was seriously underestimated, and scientists now find that even a 20-kilometer evacuation zone was inadequate to protect property, natural resources, and human health. The U.S. State Department eventually warned U.S citizens to evacuate the area within a 50-mile radius of the damaged reactors.

Kimberly Workinger created a curriculum unit to explore agricultural production. She examines several historical trends, including increasing farm size together with fewer farmers who tend to specialize in single crops or animals. These trends have led to increased use of fertilizers, pesticides, irrigation, and mechanical equipment, all demanding more energy. Since many of the most consumed foods in the U.S. are produced in areas far from population centers, transit costs from producers to consumers have risen. The concept of "food-miles" is a metric of energy expenditure that varies considerably by commodity, but is rarely understood by consumers. Kimberly's students will calculate food-miles necessary to produce the foods that they consume. Although the government now recommends a 2,000 calorie diet to protect health, the average American now consumes 3,747 calories per day, or 2,200 pounds per year. The rise in obesity and associated illnesses such as diabetes, hypertension, and cardiovascular diseases have led health scientists to predict declining longevity for Americans, for the first time in a century.

Together, these units represent sober evaluations of pressing and important environmental, health, and energy management problems. They also offer a wonderful collection of diverse teaching strategies and lesson plans that promise to train students to identify problems, to think critically, to develop disciplinary and interdisciplinary understanding. Our discussions were always animated, creative, and energetic. And I am very thankful to these very thoughtful Yale-New Haven Teachers Institute Fellows, who once again taught me a great deal.

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