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Curriculum Units by Fellows of the National Initiative
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Introduction

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There is little scientific doubt that climate warming is occurring globally at rates unprecedented in human history. It is also clear that human-caused CO2 release to the atmosphere is a predominant cause. Society's use of fossil fuels that release CO2 to the atmosphere is the primary source of CO2 and other gases that contribution to the warming effects. These are well understood to include polar icecap melting, sea level rise, more intense storms, desertification in some areas and increased rainfall in others, rapid loss of biological diversity on land and at sea, foul and unhealthy air quality, and a resurgence of vector borne diseases such as malaria and dengue fever.

Within this Yale National Initiative seminar we focused on what I believe to be the underlying human behavioral causes of climate change, predominantly our choices as consumers in a global economy. Economic growth and associated lifestyle changes have radically increased the average energy consumed by individuals. For example, we have long been encouraged to buy larger cars that are less fuel efficient. Our society has fled urban centers and sprawled into suburbs increasing both the number of vehicles per household, and the miles driven each year. Nearly 240 million vehicles exist in the U.S. today, one for everyone eligible to drive. We are burning more fuel, moving more miles, but driving in greater comfort than any previous society in human history.

Our homes are also larger on average than ever before. In the 1980s the typical home included approximately 1,700 square feet of floor space. Today average home size has grown by nearly one-third to 2,400 square feet. This means there is more space to heat and cool, more electronic gadgets, bigger refrigerators, freezers, ovens, and increased water consumption. Why be concerned about water consumption? It takes energy to pump it from its source to its point-of-use, and to both heat and cool it for cooking and washing.

By 1970 many far-sighted scholars — including Donella and Dennis Meadows at Dartmouth College, Paul and Anne Ehrlich at Stanford University, René Dubos and Ian McHarg at the University of Pennsylvania, and Barry Commoner at City University in New York — all understood that the underlying driver behind loss of global environmental quality is individual consumer behavior. We react quite predictably to advertising, rushing to buy the latest cell phones, Ipods, laptops, and much more. All have exceptionally short lifespans - often only two years - and all are produced abroad, many in Asia. It takes energy to produce the chemicals, formulate the products, move them to their point of sale, and to dispose of them. Few products are labeled to indicate their energy use during a year, but no labels tell the story of energy costs associated with their creation, delivery, and ultimate disposal. This form of "product lifecycle assessment" has led to the concept of producer lifecycle responsibility, now required in a number of European nations.

Our seminar also considered the energy associated with food production and consumption. For breakfast this

morning I had a cup of coffee from Brazil, a glass of apple juice from concentrate produced in eight different European nations, a bagel produced from wheat grown in the U.S. Midwest, and a mango from Costa Rica. I don't have any idea how much energy was used to grow these foods, process them, and move them to the store where I bought them, or what energy I consumed to prepare them at home. In short, the energy consequences of our daily diets are almost impossible to know. Surprisingly without this knowledge, we could still adjust our diets to consume far less energy by buying food that is grown locally, unprocessed, and low on the predatory food chain. Although I enjoy a well-cooked steak occasionally, the energy used to produce a calorie of beef is nearly 30 times higher than the energy used to produce a calorie from locally grown vegetables (not even accounting for transportation or processing costs). And the average American consumes nearly 70 pounds of beef each year.

Buildings provide another example. They account for nearly 70% of the electricity consumed in the U.S., and electricity used to operate them is created predominantly by burning coal, oil, or natural gas, all important sources of greenhouse gases. We examined energy efficient building technologies, and toured one of the newest buildings at Yale University that will be soon certified under the U.S. LEED Green Building Program, designed to encourage and recognize buildings that are energy efficient and protective of indoor air quality. The seminar discovered that the LEED program depends upon a scoring system within which points can be earned in different categories. When we analyzed the LEED standards with care, we found that indeed a building could receive the highest "platinum rating" while paying no attention to indoor air quality and this is a concern because tighter buildings that trap airborne chemicals indoors can harm human health. Indeed, one of the more convincing explanations of the rise in asthma prevalence during the 1980s and 1990s is that indoor air quality declined as buildings became more energy efficient. Similarly, by gaining points for landscaping, reuse of formerly developed sites, among other categories, the highest rating could be achieved with little attention paid to energy conservation. Then we found that these LEED standards are being codified into federal, state and local laws, conferring an undeserved impression of energy-conserving legitimacy — all while enhancing property value.

We also considered what we called "the quiet revolution in plastics," well predicted by the 1968 film *The Graduate*, starring Dustin Hoffman. Plastic molecules are now found in the human tissues of most people tested in industrialized nations. Disturbingly, several plastic ingredients are recognized to be estrogen or androgen mimics, and they are capable of producing hormonal responses in many species of animals tested, even when exceptionally low doses are administered. The average individual in the U.S. purchases nearly 200 pounds of plastic each year, with little understanding of its chemical composition or ultimate fate when disposed. Many assume it will simply be recycled, however on average only 5% of plastics are recycled and the remainder is discarded in landfills or is incinerated. Since nearly all plastics are derived from petroleum, and nearly 600 billion pounds are produced each year in the world, we are creating an enormous chemical burden on the environment and our bodies, one that will persist for centuries given the slow rate of plastic decay.

Each of the seminar Fellows prepared a unit that addresses these issues in a way that is tailored to the grade level and subject areas they are responsible to teach. The units are exceptionally creative, well organized, and will certainly engage school children to understand the complexity of the energy and climate change challenge we all face. Even more important, the units will also empower the students to reflect on their own behavior, and that of their families and schools, to see opportunities to reduce their energy demands. I am deeply indebted to my Fellows, as they have inspired me to examine how complex and often technical knowledge may be reframed and taught far earlier in our school systems that anyone had imagined. For their passion, patience, humor and intelligence, I am deeply thankful!

John P. Wargo