Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
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Introduction

With concerns about the impact on the environment of our current use of fossil fuels and our national energy security, renewable energy is in the news on a daily basis. Many students have seen Al Gore's movie "An Inconvenient Truth" and are familiar with some of the issues relating to energy use, but they may not know much about the science related to renewable energy. The aim for this seminar was to discuss the science related to current sources of energy and potential future sources of energy, with a focus on renewable energy. We can learn much about sustainable energy use by studying natural processes. Nature has solved the renewable energy problem through the process of photosynthesis that is carried out by green plants. Plants are amazing chemical factories and provide a working example of renewable solar energy conversion, but this is often not appreciated. By understanding how plants carry out the processes of solar energy utilization, we can obtain some answers to the question of how we can harvest solar energy by using processes of artificial photosynthesis.

My own interest in science stems from my hands-on experiences as a child. Therefore, many demonstrations were included in this seminar – at least one demonstration, and frequently two or three, in each seminar meeting. These demonstrations were chosen so that they could actively involve the students and at the same time illustrate the scientific principles related to renewable energy.

The books, by David Walker entitled *Energy, Plants and Man* and by David J. C. MacKay entitled *Sustainable Energy – without the Hot Air* , were used as the primary texts for the seminar. A special issue of *Scientific American* on "Energy's Future Beyond Carbon" (September 2006) served as a supplementary "text." The beginning of the seminar focused on energy, light and photosynthesis. The seminar began with a discussion of how plants use light to convert carbon dioxide and water into sugar and oxygen gas. This was followed by discussions on the nature of light and the fundamental steps by which light is absorbed by plants and converted into chemical energy. Demonstrations of the colors in light using diffraction glasses and a spectrophotometer aided these discussions. Plant pigments were discussed next, together with demonstrations on light absorption/emission by pigments extracted from plants and algae, and on pigment separation by using paper chromatography. The process of carbon fixation was discussed and an attempt was made to "photographically" illustrate this process by making starch pictures on geranium leaves (although this demonstration was not as successful as I had hoped). Next, we delved into various forms of energy, including hydroelectric, biofuels, wind, geothermal, solar and nuclear. A highlight of the seminar was the production of biodiesel fuel from cooking oil that culminated in the combustion of biodiesel fuel in an oil furnace burner. The seminar also included a discussion of energy use in the future that included progress in development of systems for artificial photosynthesis and fuel cells. The timeliness of these discussions was brought home by the BP oil spill in the Gulf of Mexico, which was ongoing during the seminar and provided a fertile topic for

discussion.

The curriculum units developed from this seminar are suitable for elementary to middle-school to high-school students. In all of the units, the science content is integrated with language arts, mathematics and social studies to provide a balanced program that meets the literacy requirements of the school system. The Fellows have prepared extensive lists of materials that can be used in the classroom or as supplementary resources. These materials include books that the students can read, textbooks that the teachers can use, demonstration sourcebooks, suppliers of equipment and many addresses of sites on the World Wide Web. Several of the Fellows developed units around a theme or activity related to solar energy, including an innovative mathematics unit on the use of solar heat to create convection currents for solar energy conversion in solar chimneys. Other units are related to projections of sources of energy for the future and the responsible use of current sources of energy to lower our carbon footprint, as well as the impact of our energy use on the planet Earth. The units include a number of excellent activities that will engage the students' interest and teach them about renewable energy.

I would encourage all teachers of elementary through high-school students to review these curriculum units. These materials provide a valuable resource for incorporating topics of science and society related to "Renewable Energy" into the classroom.

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