

IX.3 Hydrogen Technology and Energy Curriculum (HyTEC)

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Contract Number: DE-FG36-04-GO14277

Subcontractor:
• Schatz Energy Research Center, Humboldt State University, Arcata, CA

Project Start Date: September 1, 2004
Project End Date: August 31, 2012

Contribution to Achievement of DOE Education Milestones

This project will contribute to achievement of the following DOE milestones from the Education section of the Fuel Cell Technologies Program Multi-Year Research, Development and Demonstration Plan:

- Milestone 26: Develop modules for high schools. (4Q, 2007)
- Milestone 27: Launch high school teacher professional development. (4Q, 2008 through 3Q, 2011)

FY 2012 Accomplishments

- Completion of the website, including seven video segments for teacher professional development.
- Dissemination of the program through seven workshops at state, national, and regional science education conferences.
- A partnership was developed with the Connecticut Science Center, where a two-day workshop for teacher professional development was delivered in May 2012.
- Collaborated with the publisher to train teacher-trainers who provide professional development to adopters of the curriculum.



Fiscal Year (FY) 2012 Objectives

- Complete website materials and video for teacher professional development and support
- Collaborate with the publisher to disseminate the program through science teacher conferences
- Collaborate with the publisher to conduct professional development for new implementation sites and teacher leaders
- Develop partners for dissemination in areas with fuel cell projects

Technical Barriers

This project addresses the following technical barriers from the Education section (3.9.5) of the Fuel Cell Technologies Program Multi-Year Research, Development and Demonstration Plan:

- (A) Lack of Readily Available, Objective, and Technically Accurate Information
- (C) Disconnect Between Hydrogen Information and Dissemination Networks
- (D) Lack of Educated Trainers and Training Opportunities
- (E) Regional Differences

Introduction

This project has produced a two-week curriculum module about hydrogen and fuel cells for high school students. A group of experienced science curriculum developers, teacher professional developers, leaders in the field of hydrogen and fuel cell technology and its application to transportation, and publishers of instructional materials collaborated to develop and produce this curriculum as a commercial educational module. The module includes a teacher's guide, student handouts, an equipment kit, and support materials such as a compact disk (CD) and website. It is intended to fit into high school courses such as physical science, chemistry, environmental science, and physics. In order to ensure that it can be used in these courses, the module addresses topics teachers usually teach and correlates to the National Science Education Standards and/or state and local standards. The project has developed professional development workshops and videos to prepare teachers to teach the curriculum and develop teacher leaders. Project evaluation focuses on evaluating the classroom usability of the curriculum module, students' progress toward

the intended learning goals, and the effectiveness of the professional development workshops. The past years' work focused on completing the web support for the curriculum and on disseminating the curriculum module along with an equipment kit and support materials such as a CD and website.

Approach

The curriculum materials were developed and revised through a close collaboration between curriculum developers at the Lawrence Hall of Science (LHS), scientists and engineers at the Schatz Energy Research Center (SERC), experienced teacher associates, local and national field test teachers, and LAB-AIDS, Inc., an established publisher of kit-based science curriculum materials. The materials were developed by LHS with input from SERC, and classroom-tested by the developers, then by expert teachers, and finally by a broader group of teachers from local and national sites.

The module uses an issue-oriented approach to teaching concepts related to chemistry and energy topics. This approach teaches about hydrogen and fuel cells in the context of energy issues and current and future options for powering vehicles. This approach also demonstrates to students both the relevance of their science education to their lives and the role of scientists and engineers in conducting research and development to solve practical problems.

Teachers who field-test the curriculum receive two to three days of professional development prior to using the curriculum and have access to additional support as needed during the field test. The professional development workshops prepare the teachers with content background and hands-on experience for teaching the curriculum and for providing thorough feedback on the curriculum. In addition, these early professional development workshops for field-test teachers help to identify teacher leaders who will assist with dissemination and implementation of the published curriculum.

Dissemination is conducted by presentations and displays of the materials at science teacher education conferences and through the extensive networks of both LHS and LAB-AIDS, Inc.

Results

The curriculum module addresses Education technical barriers A (Lack of Readily Available, Objective, and Technically Accurate Information) by providing information about hydrogen and fuel cells in a curriculum format that is usable by teachers and students in typical classrooms. This module was developed during previous years of the grant through four rounds of classroom testing and revision to ensure that it works well in a wide variety of high school settings, thus addressing barrier E (Regional Differences).

Work during the past year focused on completing videos to support teachers' use of the module, building a partnership in Connecticut and providing professional development to Connecticut teachers, and disseminating the materials nationally.

The videos for teachers are complete and available on the project website and on YouTube. These videos provide general information helpful in disseminating the materials, as well as teacher professional development and support for using the curriculum with students. The videos address Education technical barriers A (Lack of Readily Available, Objective, and Technically Accurate Information) and C (Disconnect Between Hydrogen Information and Dissemination Networks) by providing teachers with an additional form of support, in addition to the teacher support materials embedded within the curriculum guide. The videos include:

1. An introduction to the curriculum.
2. How to set up and run the student electrolyzer and produce hydrogen (Curriculum Activity 2).
3. How to identify the gases produced by the electrolyzer (Curriculum Activity 2).
4. How to operate the fuel cell (Curriculum Activity 3).
5. Modeling the fuel cell reaction (Curriculum Activity 4).
6. Measuring the energy efficiency of the fuel cell (Curriculum Activity 5).
7. Safety and care of the equipment.

To view these videos, visit <http://sepuplhs.org/high/hydrogen/videos.html> and click on "Teacher Support Videos."

The professional development and dissemination work address Education technical barriers C (Disconnect Between Hydrogen Information and Dissemination Networks) and D (Lack of Educated Trainers and Training Opportunities) by building on the dissemination networks of the LHS and partners and preparing teachers who will be able to provide professional development in their regions. Presentations at science teacher conferences reached approximately 200 teachers during the past year. In these one- to two-hour presentations, teachers were introduced to the module and information about fuel cells in the U.S. and their state or region, and conducted an activity on the fuel cell reaction that they were then given to take back to their classrooms and try out.

A two-day professional development conference led by a project staff member and hosted by the Connecticut Science Center prepared 17 teachers to implement the module in their classrooms. The Lab-Aids sales representative from the northeast helped to recruit participants and attended the workshop to enhance her knowledge and ability to promote the module. Two science educators from the Connecticut

Science Center attended the conference, and a scientist from UTC power contributed a one-hour presentation. In addition to training the teacher participants, this event helped to build our relationships with potential partners in Connecticut.

Conclusions and Future Directions

Conclusions:

- The project is now nearly complete. In the past year, we have continued dissemination and professional development activities and have developed a relationship with the Connecticut Science Center around fuel cell education.

Future Directions:

- SEPUP and our publisher, Lab-Aids, Inc., will continue to promote the product, conduct awareness workshops, identify partners, and provide professional development to districts that purchase the curriculum.

FY 2012 Publications/Presentations

1. Willcox, M. "Alternative Energy for Transportation: Hydrogen and Fuel Cells." California Science Teachers Association Regional Conference. October 21, 2011. Pasadena, California.
2. Nagle, B. "Alternative Energy for Transportation: Hydrogen and Fuel Cells." National Science Teachers Association Regional Conference. October 29, 2011. Hartford, Connecticut.
3. Willcox, M. "Teaching about Hydrogen Fuel Cells." National Science Teachers Association Regional Conference. December 10, 2011. Seattle, Washington.

4. Willcox, M. "Investigating Alternative Energy: Hydrogen and Fuel Cells." Georgia Science Teachers Association Conference. February 17, 2012. Atlanta, Georgia.
5. Willcox, M. "Teaching Chemistry with Hydrogen and Fuel Cells." Wisconsin Science Teachers Association Conference. March 9, 2012. Madison, Wisconsin.
6. Lenz, L. "Fuel for the Next Generation." Michigan Science Teachers Association Conference. March 9, 2012. Lansing, Michigan.
7. Nagle, B. "Fuel for the Next Generation." National Science Teachers Association Conference. March 30, 2012. Indianapolis, Indiana.
8. Keller, C. "HyTEC." Two-day professional development session. May 30-31, 2012. Connecticut Science Center, Hartford, Connecticut.
9. Nagle, B. "HyTEC." Workshop presentation for teacher leaders. Scheduled for July 26, 2012. Elkhart, Indiana.