
X.2 Hydrogen Education for Code Officials

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- Ecommerce Systems, Inc., Greenwood Village, CO
- Adrenaline, Boulder, CO

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Project End Date: October 30, 2009

Objectives

Develop an introductory information (e-learning) package for code officials that specifically addresses safety, codes, and standards for hydrogen technologies and facilitates demonstration and deployment projects.

Technical Barriers

This project addresses the following technical barriers from the Education section (3.9) of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

- (A) **Lack of Readily Available, Objective, and Technically Accurate Information**
Although a significant body of technical information exists, there is little readily available information about hydrogen and fuel cells for individuals outside of the research and development community, and many educational resources and training opportunities require participants to pay a fee. Moreover, explaining hydrogen and fuel cells to a non-technical audience – clearly and succinctly, while still retaining technical accuracy – is challenging.
- (C) **Disconnect Between Hydrogen Information and Dissemination Networks**
Educational materials and resources must reach their intended audiences to be effective, and institutional barriers can complicate or inhibit target audience access to information. Many target

audiences have established training mechanisms and legacy networks through which they are accustomed to receiving information. Tapping into these traditional training and education mechanisms is often the most efficient way in which to ensure access to the target audience, but it is often difficult to do.

(D) **Lack of Educated Trainers and Training Opportunities**

In-person training through workshops or seminars is one of the most effective information delivery mechanisms – there is less distraction for students and an opportunity for interaction between and among all participants. Availability of suitable trainers is low, however, and can be resource-intensive at a level that is cost prohibitive for most education programs.

Contribution to Achievement of DOE Education Milestones

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

- **Milestone 2:** Develop introductory package for code officials. (2Q, 2008)
- **Milestone 5:** Update introductory information package for code officials. (4Q, 2010)
- **Milestone 8:** Update introductory information package for code officials. (4Q, 2013)

Accomplishments

- Module 1–Hydrogen and Fuel Cell Technology Basics
 - Includes basic hydrogen and fuel cell properties, production, storage, and applications.
- Module 2–Hydrogen and Fuel Cell Applications
 - Provides the learner with a detailed look at hydrogen and fuel cell applications and how they work.
- Module 3–Permitting Hydrogen Fueling Stations
 - Provides examples of station designs and the codes and standards that could apply to hydrogen fueling stations as well as an interactive station design.
- Module 4–Permitting Fuel Cell Facilities
 - Educates the learner on aspects of permitting a hydrogen stationary facility, provides examples

of facility designs and the codes and standards that could apply as well as an interactive telecommunication facility graphic that provides the separation distances and codes and standards for the facility.



Introduction

The National Renewable Energy Laboratory (NREL) is developing an e-learning package for code officials. The courses in this package introduce code officials to hydrogen and fuel cells, hydrogen and fuel cell applications, and the safety, codes, and standards currently used for hydrogen technologies. This information will help facilitate demonstration and deployment projects across the nation.

The challenge of this project is the decentralized enforcement of codes or adopted standards. About 44,000 different jurisdictions in the United States use existing codes and standards by either incorporating appropriate sections, or by referring to those sections. States and municipalities may also impose more stringent or additional requirements. Incorporated content of codes and standards is enforceable by law. These modules will provide a uniform starting point for code officials and facilitate the permitting process.

Approach

To develop the code official learning package, we evaluated e-learning tools, methods, and software available to determine the most suitable approach for presenting the information. A detailed outline for each course was developed. Codes and standards as well as hydrogen experts then reviewed the content to ensure accuracy.

The e-learning resources are designed to maximize usability and engage the learner. Studies have shown that interaction between the learner and the software increases the information that learners remember upon completion. An example of this is the test-question method shown in Figure 1. At the end of each lesson, the learners are asked a series of questions about the content that was presented and they receive instant feedback about their answers.

Results

Module 1 is an introduction to hydrogen and fuel cells, which includes hydrogen properties, production and storage methods, and applications. Figure 2 displays the course content and navigation pages that the learner can access at any time by clicking on the course map tab

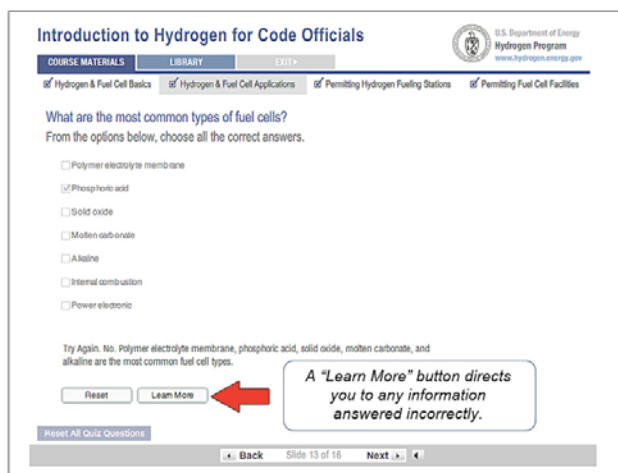


FIGURE 1. Screen Shot Showing Example of Test-Question Method

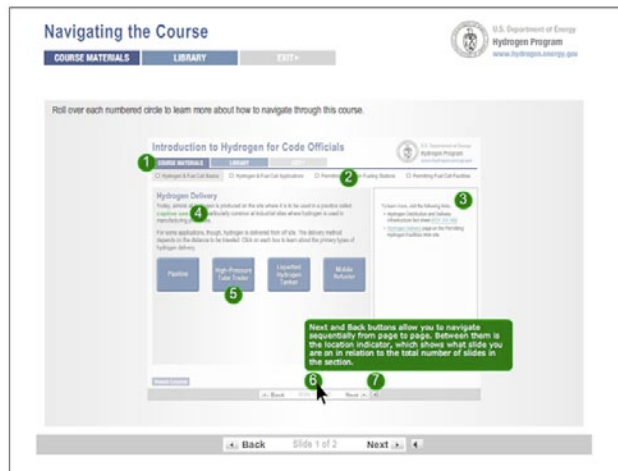


FIGURE 2. Screen Shots Displaying Course Content and Navigation Pages

at the top. This enables the learner to take the lessons in the course in any order or study just one or two lessons depending on their level of knowledge.

Module 2 provides a detailed look at fuel cells and their applications. It describes the common types of fuel cells, how each type works, and the applications for which they are best suited.

Module 3 provides the applicable codes and standards for permitting hydrogen fueling stations and has a fueling station design at the end that can be used as an example and includes the separation distances, and codes and standards that apply to that station design.

Module 4 addresses stationary hydrogen fuel cell facilities and provides examples of the codes and standards used to permit the construction and operation of these facilities. An interactive graphic is included that shows the separation distances and the codes and standards that apply (Figure 3).

Modules 3 and 4 are linked to a database that provides updated codes and standards as they become available.

The course is complete and available online at http://www.hydrogen.energy.gov/code_official_training.html. The content was put into a design template similar to the one used in the first responders online training developed by Pacific Northwest National Laboratory, meets 508 accessibility requirements, and contains an audio option. There is a library within the course that contains publications and other related information.

Conclusions and Future Directions

Future work will include the following:

- Content and usability will be reviewed by the hydrogen and code official community.
- Outreach activities, online resources, and publications will be used to distribute the information resources to the code official community.
- A Web page has been created to house and provide easy access to the Introduction to Hydrogen for Code Officials, along with the other online resources such as the First Responders Training.
- Interactive graphics will be updated when new separation distances become available.

FY 2009 Publications/Presentations

1. Hydrogen Conversion Factors and Facts Card
<http://www.hydrogen.energy.gov/permitting/pdfs/43061.pdf>
 - This conversion card contains basic facts about hydrogen, resource references, a fuel characteristics comparison chart, and conversion factors for common hydrogen measurements.
2. NREL Renewable Energy Permitting Workshops
 - February 11 & 12, Broomfield, CO
 - March 25, Los Angeles, CA
 - April 3, Columbia, SC
 - April 5, Seattle, WA

FIGURE 3. An example of a telecom backup power application (as pictured here) is provided in Module 4: Permitting Fuel Cell Facilities. It shows the learner applicable codes and standards as well as the separation distances.