

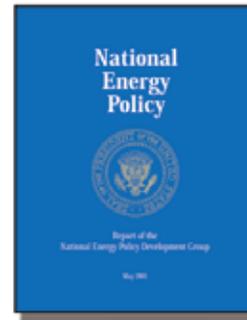
3.8 Education

The National Energy Policy and National Hydrogen Energy Roadmap, two guiding documents for DOE hydrogen activities, pay special attention to education.

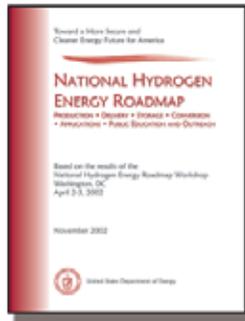
The National Energy Policy recommends that the Secretary of Energy develop an education campaign about hydrogen –

“The NEPD Group recommends that the President direct the Secretary of Energy to develop next-generation technology – including hydrogen... Develop an education campaign that communicates the benefits of alternative forms of energy, including hydrogen...”

– National Energy Policy, May 2001



The National Hydrogen Energy Roadmap, which lays the foundation for a national move toward the use of hydrogen energy, also establishes a priority for education activities and suggests that education is an appropriate activity for the federal government.



“Educating consumers, industry leaders, and public policy makers about the benefits of hydrogen is critical to achieving the Vision.”

– National Hydrogen Energy Roadmap, November 2002

Following the National Energy Policy and Roadmap recommendations, the Hydrogen, Fuel Cells & Infrastructure Technologies Program established the Education program element to accomplish the overall objective of educating target audiences about the long-term benefits and near-term realities of hydrogen, fuel cell systems, and related infrastructure. The education program will help audiences to do the following:

- Understand the general concept and value of a hydrogen economy.
- Recognize the near-term realities and opportunities of hydrogen and fuel cell technologies.
- Develop an accurate picture of hydrogen safety issues.
- Understand, where appropriate, their part in facilitating the transition to a hydrogen economy.

Education crosscuts all of the Hydrogen, Fuel Cells & Infrastructure Technologies Program components. Hydrogen Production, Delivery, Storage, Fuel Cells, Codes and Standards, Safety, and Technology Validation subprograms will provide input to the Education program element activities, particularly materials developed for distribution. With regard to programs focused on

the needs of specific target audiences, coordination with the Codes and Standards, Safety, and Technology Validation subprograms is particularly important.

3.8.1 Goal and Objectives

Goal

Educate key audiences about fuel cell and hydrogen systems to facilitate commercialization and market acceptance of these technologies.

Objectives

By 2010 –

- Achieve a fourfold increase in the number of students and teachers who understand the concept of a hydrogen economy and how it may affect them.
- Achieve a fourfold increase in the number of state and local government representatives who understand the concept of a hydrogen economy, and how it may affect them.
- Achieve a twofold increase in the number of large-scale end-users who understand the concept of a hydrogen economy, and how it may affect them.
- Launch a comprehensive and coordinated public education campaign about the hydrogen economy and fuel cell technology.

3.8.2 Approach

Education Framework

Although this plan establishes a framework for the Education program element and identifies activities for 2003–2010, it is not intended to limit or exclude the pursuit of any new or different opportunities that may arise over time. Projects outside the scope of this plan will be considered, as appropriate.

Coordination with Other Entities

Educational activities will be coordinated with other program element activities, particularly those of the Technology Validation, Safety, and Codes and Standards subprograms, as well as other DOE programs and relevant national laboratories. The educational potential of hydrogen and fuel cell demonstrations will be realized by leveraging existing information/education conduits to maximize visibility among the general public, state and local decision makers, and other stakeholders. Careful consideration will also be given to coordination with the Energy Efficiency and Renewable Energy's (EERE's) office of Communications and Outreach to ensure all program materials are developed according to EERE design and format guidelines.

Also, to the extent possible, the development and implementation of education strategies will be coordinated with emerging local, state, and regional hydrogen, fuel cell, and clean energy efforts. The Education program element will seek to facilitate networking among national, state, and local educational entities.

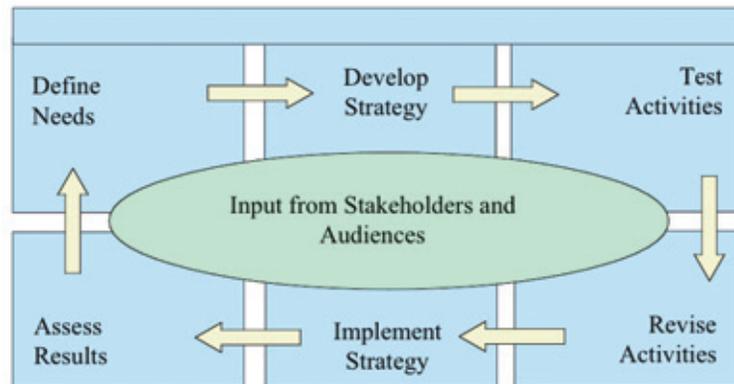
Priorities – Program Foundation, Target Audiences, and Activities

A comprehensive education campaign needs a foundation on which to build. This foundation includes readily available “groundwork” materials that provide program background and general information about hydrogen and fuel cells—as well as a means by which to distribute the information. Currently, there are few such materials and no formal distribution mechanism is in place. Although a growing number of people now refer to the Web for their informational needs, print documents, videos, and CDs remain in high demand. Education activities will rely on Web-based materials to the greatest extent possible, but in addition to building the Hydrogen, Fuel Cells & Infrastructure Technologies Program Web site, creating a library of hard copy educational materials and a distribution system will comprise initial priority activities. (Published materials will be reviewed and included in the library as appropriate.) The information dissemination infrastructure will provide users and program partners nationwide with quick and easy access to educational materials, and provide education activity managers with a mechanism for tracking use and collecting feedback that can improve the program.

Once a program foundation is established, attention can turn to activities that serve the specific needs of target audiences. As noted earlier, initial education efforts will focus on teachers and students, state and local governments, and large-scale end-users—target audiences identified as critical to the successful

implementation of near-term technology demonstrations and whose buy-in requires sustained education efforts. Safety and code officials are also top priority audiences; education activities to serve their needs will be conducted in conjunction with the Safety and Codes and Standards subprograms. The timeline for implementing strategies to reach each priority audience will vary slightly, however, according to their education needs relative to the market-readiness of the technology.

Figure 3.8.1 Education Program element Approach



Audience needs will be researched before new educational materials or programs are developed. When possible and to the extent resources will allow, activities and materials will be tested and revised before being implemented or published to ensure their effectiveness. Once launched, they will be monitored and audiences will have an opportunity to provide feedback for consideration in future editions or revisions. This process will help to ensure that audience

needs are served, education activities achieve success, and program goals are met. Potential projects will be pursued through the solicitation process to ensure equal and open access (see Figure 3.8.1).

Careful consideration will be given to the messaging. Although clearly communicating the benefits of using hydrogen and fuel cell technologies is important, fostering an understanding of the technical challenges ahead, the important research, development, and demonstration (RD&D) needed to ensure successful commercialization, and the timeframe for the potential mass market introduction of hydrogen and fuel cell technologies is equally important.

Program End-Point

Achieving the national vision for hydrogen and fuel cells will require a long-term R&D strategy—and an even longer term education strategy. DOE's R&D effort for hydrogen fuel cell vehicles, for example, is intended to allow a commercialization decision to be made in 2015 and a subsequent vehicle introduction to dealer showrooms by 2020. Education is needed to prepare for that market introduction, but it is also required after the introduction to facilitate market success and penetration beyond the niche of early adopters.

As noted earlier, target audiences that can enable or inhibit demonstrations and the initial market introduction of hydrogen and fuel cell technologies must receive special priority attention. Although the needs of the *interested* public will not be overlooked, a full-scale, national education campaign to reach the *general* public should include a call to action and therefore must be timed to reflect the market readiness of the technology. Such an effort launched too far in advance of the consumer market introduction of hydrogen and fuel cell systems may oversell the technology and jeopardize its commercial success. Timed correctly, however, a public education campaign can help overcome knowledge barriers, including safety concerns, and facilitate market success. As the technology moves from early adopters to mainstream consumers, however, a government role in education becomes less critical and a phase-out or ramping-down of government-funded education activities may be appropriate.

3.8.3 Programmatic Status

Stakeholder Input

To begin a serious dialogue with specialists on the content of and issues related to an educational program about hydrogen and fuel cells, DOE convened a workshop in Washington, D.C. on December 4 and 5, 2002. More than 50 individuals participated, representing industry, government, non-governmental organizations, national laboratories, and universities. Specific objectives were to solicit input regarding the following:

- Goals and objectives for the Hydrogen, Fuel Cells & Infrastructure Technologies Program's Education program element
- Factors driving the need for educational activities
- Target audiences and relative priorities
- Activities to reach target audiences
- Educational projects and activities that DOE might support

The Education Workshop was conducted in an open and participatory manner. Attendees met in plenary and parallel breakout sessions to discuss the eight target audience groups identified in Table 3.8.1, and gathered in plenary sessions to discuss common themes and cross-cutting activities, as well as overall program priorities.

Table 3.8.1 Key Objectives by Target Audience

Target Audience	Key Objectives
Educators and Students (e.g., primary and secondary schools, colleges, universities, and other post-secondary institutions)	<ul style="list-style-type: none"> • Improve the level and breadth of hydrogen and fuel cell education, using established resources wherever possible and appropriate. • Increase the number of schools teaching hydrogen and fuel cell courses. • Support and promote internships, academic research, and hands-on product demonstrations in these areas.
State and Local Government Representatives (e.g., city, county, state, and regional governments, agencies, and associations)	<ul style="list-style-type: none"> • Provide objective, accurate information that government representatives can rely on as part of their research to make informed decisions.
Large-Scale End Users (e.g., transit agencies, fleets, building associations and subdivisions, hospitals)	<ul style="list-style-type: none"> • Provide objective, accurate information that potential end users can use as part of their research to make informed decisions. • Support training for potential end users.
Code Writing Organizations	<ul style="list-style-type: none"> • Provide objective scientific and technical information to facilitate and expedite the implementation of codes and standards.
National Regulatory Agencies	<ul style="list-style-type: none"> • Provide objective scientific and technical information to support the timely development of hydrogen and fuel cell policies and regulations.
Professional, Labor, and Trade Organizations	<ul style="list-style-type: none"> • Support training for potential end-users and the labor force for a hydrogen infrastructure.
Financial Institutions (lenders, investors, and insurers)	<ul style="list-style-type: none"> • Provide objective, accurate information that these groups can use as part of their research to make informed decisions.
General Public	<ul style="list-style-type: none"> • Provide timely, objective, consumer-oriented information to support the transition to a hydrogen economy.

Of the eight target audience groups, participants placed a high priority on those whose immediate buy-in is important to overcome barriers to early hydrogen and fuel cell efforts. State and local government representatives, safety and code officials, and large-scale end users were singled out. Also, considering the need to develop the next generation workforce and provide accurate and objective information to the interested public, students, teachers, and the public were added to the list of priority audiences. (Note: Federal government representatives and legislators were also discussed as a priority audience; within DOE’s current organizational structure, however, activities to serve their needs largely fall under the purview of EERE and the EERE Office of Communications and Outreach).

Three cross-cutting areas also emerged as initial focal points of the Education program element—information management, including dissemination of accurate, objective information; educational activities; and coalition and partnership building. Activities in these three cross-cutting areas, coupled with the target audience priorities, provide focus for Education program element activities.

Current Activities

In the past, various DOE offices and programs pursued a number of hydrogen and fuel cell education activities, as noted in Table 3.8.2 and illustrated in Figures 3.8.2 and 3.8.3. Evaluating and coordinating these efforts are among the priority activities for the new Education program element.

Table 3.8.2. Ongoing Activities for Hydrogen and Fuel Cell Education

Activity	DOE Partners
Various educational tools, including brochures and other publications, videos, exhibits and demonstrations, lesson plans and Web sites	Non-profits, businesses and industry, trade associations, national laboratories, and universities
Training development	Industry and trade associations
GATE and FutureTruck programs for university-level activities	Universities, industry

Figure 3.8.2. Hands-on activities allow students to delve into hydrogen and fuel cell technologies. Educational materials developed for classroom use.



Figure 3.8.3. A traveling display that features a remote control fuel cell truck and hydrogen generating system helps demonstrate the technology to teachers and students, among others.



3.8.4 Challenges

Secretary Abraham, in his foreword to the National Hydrogen Energy Roadmap, writes: “To talk about the ‘hydrogen economy’ is to talk about a world that is fundamentally different than the one we know now.” He also refers to the change in how we produce, store, and use energy as revolutionary.

That the hydrogen economy is a revolutionary change from the world we know today is the fundamental challenge to the education activity. People are, by nature, hesitant—or resistant—to change, particularly when that change requires embracing a technology based on unfamiliar principles (such as the electrochemical oxidation of hydrogen). Anecdotes such as the Hindenburg tragedy also perpetuate false perceptions about the safety of hydrogen use and compound that resistance to change—despite the potential benefits of a hydrogen economy. In a December 2000 transportation energy survey conducted by Opinion Research Corporation International on behalf of the DOE, 1,000 people were asked the following question: “Consider a day when gasoline is no longer available. Which of the following do you think would be the worst fuel for use in personal vehicles: ethanol, hydrogen, or electricity?” Of the respondents who chose hydrogen as the worst fuel, more than 50% cited safety concerns, attributed largely to what they had heard or their own intuition. Another almost 20% reported that they didn’t know *why* hydrogen would be the worst—but that they simply thought it would be.

In contrast, our 100-year reliance on internal combustion engines has instilled a high degree of comfort with using gasoline, for example, despite the certain dangers of its use (dangers that exist with the handling of any fuel). Such familiarity and the convenience of our current energy infrastructure contribute to complacency with the status quo, which adds to the challenge of educating for change.

3.8.4.1 Barriers

Resistance to change and concerns about hydrogen safety comprise the overarching challenge for the Education program element. The following section outlines barriers to implementing the education activities intended to address the challenge and meet program goals and objectives.

- A. Lack of Awareness.** Interest in hydrogen and fuel cell technology is increasing, but there remains a general lack of awareness of hydrogen as an energy alternative. Moreover, although world events have drawn new attention to national energy security issues, there is little consensus about the severity of today’s environmental problems or linkages to fuel choice. With little awareness, understanding, or recognition of these issues, there is little impetus for change, and target audiences are less inclined to embrace new technology.
- B. Lack of Demonstrations or Examples of Real World Use.** Hands-on and personal experience greatly enhances understanding and comfort with using any new technology. Although the number of hydrogen and fuel cell demonstration projects is slowly growing, currently there are only a few real-world examples to which educators can point. The absence of installations and demonstrations also results in a lack of success stories and case studies to supplement educational materials and encourage early adopters.

C. Institutional Barriers and Access to Audiences. Audience information needs can be well researched and educational materials or training workshops can be well developed, but they must reach their intended audiences to be effective. Institutional barriers can complicate or inhibit access to target audiences. Moreover, identifying the right organizations, as well as a champion within each organization to embrace hydrogen and fuel cell technologies, can be challenging.

D. Regional Differences. Educational needs will vary by audience, but they may also vary regionally. What applies to one state, county, city, or district, may not apply to another. Serving the education needs of a single target audience may therefore require multiple approaches tailored to serve the needs of various regions. This strains resources and can complicate activities developed at the national level.

3.8.5 Task Descriptions

Task descriptions are presented in Table 3.8.3. The duration of a task and the barriers associated with it (see Section 3.8.4.1) appear after the task title.

Table 3.8.3. Task Descriptions		
Task	Description	Duration/Barriers
1	<p>Maintain and Update Informational Website</p> <ul style="list-style-type: none"> • Evaluate performance of Web site. • Update Web site and add new features to meet educational goals and address information gaps. • Build Web site visibility. 	32 Quarters/Barrier A
2	<p>Establish and Maintain Clearinghouse</p> <ul style="list-style-type: none"> • Determine needs and structure for a clearinghouse for print and other materials; identify opportunities to tie into existing hotline/clearinghouse capabilities. • Establish and promote availability of information clearinghouse. • Create “library” of education materials about popular hydrogen and fuel cell topics to serve initial needs of multiple audiences. • Create specialized and individualized distribution plans for high visibility materials, identifying partners as necessary. 	32 Quarters/Barrier A

3	<p>Build Presence of Hydrogen and Fuel Cells in K-12 Education</p> <ul style="list-style-type: none"> • Identify and review existing teaching materials. • Path 1 – Integrate into traditional science textbooks <ul style="list-style-type: none"> o Identify opportunities to integrate hydrogen and fuel cell information into subject materials. o Follow through as appropriate. • Path 2 – Establish coordinated materials development/teacher training program <ul style="list-style-type: none"> o Identify partners with science education and technical expertise. o Work with partners and practicing teachers to create coordinated, locally based, and sustained materials development/teacher training program for secondary school teachers. o Use secondary school model to develop corresponding program for elementary school teachers. 	32 Quarters/Barriers A, C, D
4	<p>Create and Maintain University Program Database</p> <ul style="list-style-type: none"> • Design and build internet-enabled database of university-level programs for hydrogen and fuel cells. 	32 Quarters/Barriers A, C
5	<p>Expand University Programs</p> <ul style="list-style-type: none"> • Expand hydrogen and fuel cell focus of current DOE-sponsored university programs. 	30 Quarters/Barriers A, B, D
6	<p>Assess Public Perceptions and Understanding of Hydrogen Economy and Fuel Cell Technologies</p> <ul style="list-style-type: none"> • In 2004, establish baseline of public perceptions of hydrogen and fuel cell systems. • Conduct periodic reassessments of public perceptions through 2010. 	32 Quarters/Barriers A, C, D
7	<p>Develop Public Education Campaign</p> <ul style="list-style-type: none"> • Use public perception/understanding assessment to identify audience education needs. • Work with local and state partners to distribute general education materials to address initial education needs. • Identify partners for coordinated public education campaign. • Develop comprehensive plan for education campaign—develop and test messages, identify cost-effective communication mechanisms and methods for evaluating success. • Implement public education campaign with partners. 	32 Quarters/Barrier A

8	<p>Facilitate Partnerships and Information Exchange among Local, State, and Regional Education Efforts, and National Partners</p> <ul style="list-style-type: none"> • Work with established and emerging state and local partnerships and coalitions to facilitate information exchange and coordinate activities to maximize the reach of education efforts and avoid duplication • Create a Hydrogen Education Review Panel to facilitate coordination of education activities among partners with objectives that are national in scope. 	32 Quarters/Barrier A, B, C, D
9	<p>Facilitate Educational Activities for State and Local Governments</p> <ul style="list-style-type: none"> • Provide objective information about the technology, safety, challenges to commercialization, codes and standards, and related incentives. • Identify partners and evaluate existing opportunities. • With partners, including the Safety and Codes and Standards subprograms, publish educational materials and develop training workshops to educate state and local governments. 	32 Quarters/Barriers A, B, C
10	<p>Facilitate Educational Activities for Large-Scale End Users</p> <ul style="list-style-type: none"> • Provide objective information about the technology and hydrogen safety; share case studies and best practices based on the experience of other current users and, in particular, participants in Technology Validation projects. • Identify partners and identify and evaluate existing opportunities. • With industry partners, as well as the Safety and Technology Validation subprograms, educate potential large-scale end users and facilitate technician and employee training. 	32 Quarters/Barriers A, B, C
<p>Note: The total duration of the program planning period is 32 quarters; tasks that begin before this period or continue beyond it do not reflect durations outside the planning period.</p>		

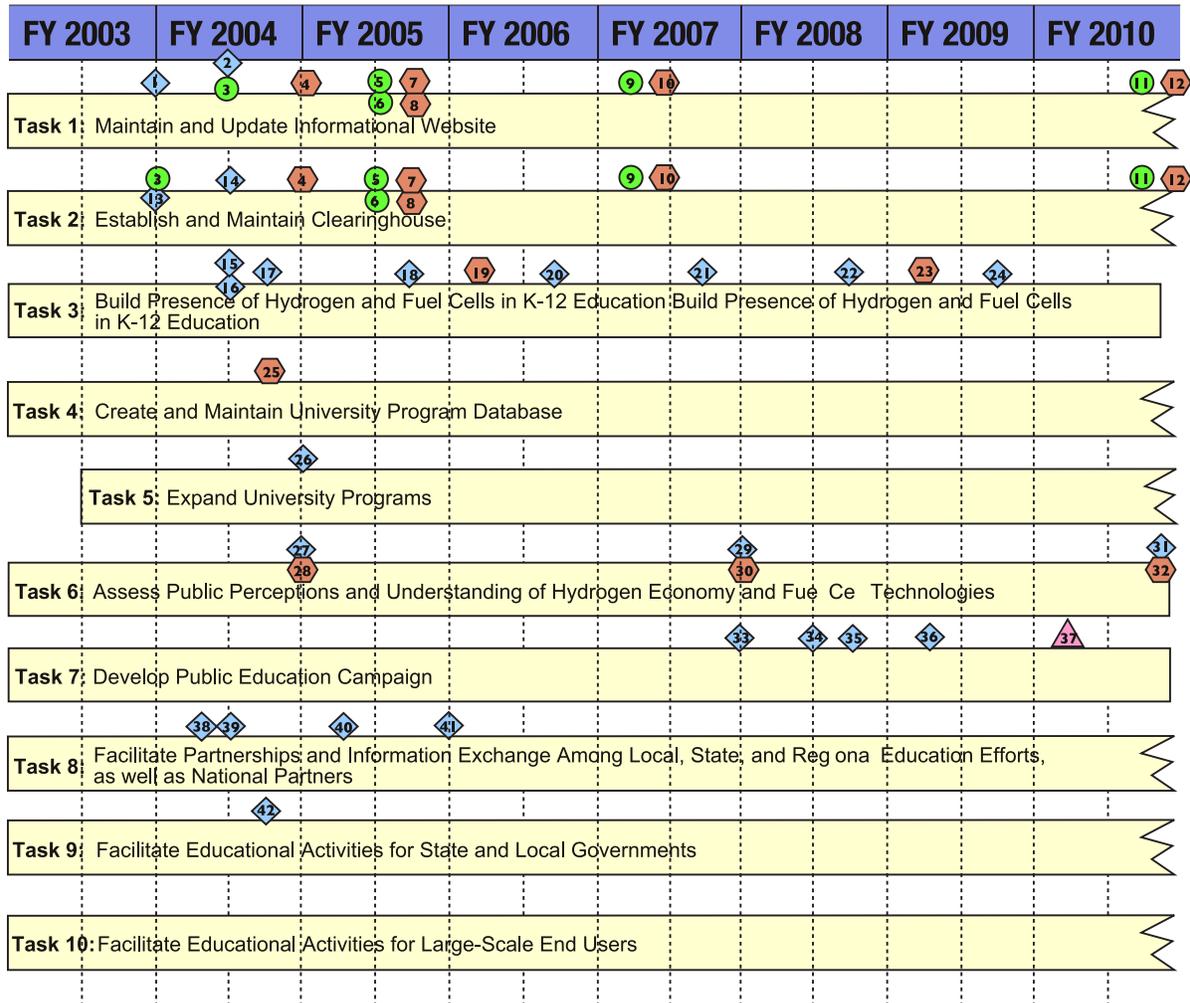
3.8.6 Milestones

Key education achievements often involve the creation of a product. As such, Figure 3.8.4 shows the milestones and deliverables, as well as the interrelationship of these elements with the tasks and inputs from other subprograms for the Education program element from FY 2004 through FY 2010. This information is also summarized in Table B.8 in Appendix B.

DRAFT (6/3/03)

Technical Plan—Education

Figure 3.8.4. Hydrogen Education R&D Network



Legend



For chart details see next page.

1. Complete website needs assessment.
 2. Complete “phase 2” website upgrades and improvements (“phase 1” was initial launch, completed January 28, 2003).
 3. Input from Codes & Standards: Training modules for current practices
 4. Deliverable: Create library of materials, including, but not limited to the following: fuel cell technology fact sheets, hydrogen “basics” fact sheet (production, storage, delivery), hydrogen safety fact sheet, technology “challenges” fact sheet
 5. Input from Codes & Standards: Training modules for amended practices for new technologies
 6. Input from Safety: Safety training materials for testing and certification for engineered systems
 7. Deliverable: Publish safety training materials
 8. Deliverable: Publish Codes and Standards modules
 9. Input from Technology Validation: Final report for first generation vehicles, interim progress report for second generation vehicles on performance, safety, and O&M
 10. Deliverable: Publish data from first generation Technology Validation projects
 11. Input from Technology Validation: Issue final report on vehicle performance, safety, and O&M
 12. Deliverable: Publish data from second generation Technology Validation projects
 13. Identify opportunities to tie into existing clearinghouse infrastructures.
 14. Establish information clearinghouse.
 15. Identify and review existing teaching materials for grades K-12.
 16. Identify partners and develop detailed plan for coordinated materials development/teacher training program.
 17. Identify and evaluate opportunities to work with traditional textbook companies to incorporate hydrogen and fuel cell information.
 18. Launch materials development component of secondary school education program in conjunction with pilot teacher training/professional development program for secondary school teachers.
 19. Deliverable: Publish secondary school teaching tools
 20. Complete comprehensive training of an additional 50-100 secondary school teachers and revise program, as appropriate.
 21. Complete training of 500-1,000 secondary school teachers.
 22. Expand/adapt teacher training program to elementary schools
 23. Deliverable: Publish elementary school teaching tools
 24. Complete comprehensive training of 50-100 elementary school teachers and revise program as appropriate.
 25. Deliverable: Publish database of existing university programs
 26. Expand hydrogen and fuel cell focus of current DOE-sponsored university programs.
 27. Establish baseline level of public awareness and perceptions.
 28. Output to Safety: Publish initial perceptions report
 29. Conduct follow-up public perception analysis.
 30. Output to Safety: Publish interim perceptions report
 31. Complete public perception assessment and results analysis.
 32. Output to Safety: Publish perceptions report
 33. Identify audience needs and complete initial list of industry and other partners for public education campaign.
 34. Create detailed plan for full-scale public education campaign.
 35. Develop and test key messages for public education campaign and identify effective communication mechanisms.
 36. Pilot public education campaign strategies in communities with ongoing technology validation activities.
 37. ¹Go-Now/Go-Later: Decision point on launch of full-scale public education campaign
 38. Complete assessment of opportunities for joint education activities with existing community partnership programs.
 39. Implement strategies to coordinate education activities with state and local partners and facilitate information sharing among partners.
 40. Identify partners to serve on Hydrogen Education Review Panel
 41. Launch Hydrogen Education Review Panel
 42. Establish a coordination plan with Codes and Standards and Safety subprograms to run workshops for state and local officials
- ¹Timing for the launch of a full-scale public education campaign depends on the status of the technology and whether there is a clear call to action