

3.8 Education and Outreach

Expanding the role of hydrogen and fuel cell technologies as an integral part of the Nation's energy portfolio requires sustained education and outreach efforts. Increased efforts are required to facilitate near-term demonstration projects and early market fuel cell and hydrogen infrastructure installations, to increase public awareness and understanding, and to lower barriers to ease long-term market adoption. Fuel cell and hydrogen technologies are making an impact on the market

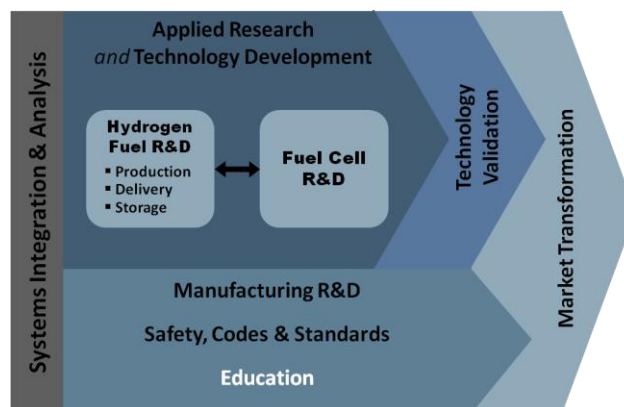
today in stationary power, emergency backup power, material handling equipment, portable power, niche transportation, and telecommunications applications. Current knowledge and awareness levels of hydrogen and fuel cells are still low in the general public, and misunderstandings of hydrogen properties continue to impart negative opinions about the safe use of hydrogen as a fuel. A sustained education and outreach program is needed to continue to build upon the progress that has been made to date and to leverage the success stories of early adoption.

The Education and Outreach activities within DOE's Hydrogen and Fuel Cell Program (the Program) seek to facilitate hydrogen and fuel cell early deployments and support future broader commercialization by providing technically accurate and objective information to key target audiences that are both directly and indirectly involved in the use of hydrogen and fuel cells technologies today. These audiences, originally identified in the National Hydrogen Energy Roadmap¹, include state and local government representatives and stakeholders, potential end users, early adopters, safety and code officials, local communities, and the general public. University faculty, undergraduate and graduate students, and middle and high school teachers and students comprise another important audience, as they are our Nation's future researchers, scientists, engineers, technicians, teachers, and technology users.

3.8.1 Goal and Objectives

Goal

The goal of the Education and Outreach activities within the Fuel Cell Technologies Program (subsequently abbreviated as the Education sub-program) is to educate key audiences about hydrogen and fuel cell technologies to facilitate near-term deployment, early adoption, broad commercialization, and long-term market acceptance.



¹ U.S. Department of Energy. *National Hydrogen Energy Roadmap*. November 2002. p. 36. Available on the web at http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/national_h2_roadmap.pdf

Objectives

The Education sub-program’s objectives are closely coordinated with technology demonstration and validation, safety, codes and standards, and early market deployment and associated market transformation activities, as well as state and regional-based hydrogen and fuel cell outreach programs—as part of a comprehensive strategy to transform success in demonstrating and deploying technologies into success in the broader marketplace. Specific objectives include the following:

- Increase the acceptance of the use of hydrogen and fuel cell technologies as a part of *a clean energy portfolio of energy efficiency and renewable energy technologies* in federal, state, and local government investments, and private sector investments
- Decrease “soft costs” associated with the deployment and early adoption of hydrogen and fuel cell technologies in multiple applications (e.g., insurance, permitting, uniform codes and standards) through education, outreach, and training of “second generation” clean energy professionals
- Increase general knowledge and awareness of the benefits of the use of hydrogen and fuel cell technologies in multiple applications among the key target audiences
- Increase awareness of the potential full range of fuel cell and hydrogen applications (e.g., not just light-duty vehicles and buses)

3.8.2 Approach

By supporting the successes achieved by existing hydrogen and fuel cell demonstrations and deployments, the Education sub-program is able to capitalize on the interest generated by these activities to reach a broader and more engaged audience, as well as the most likely early adopters. In addition, by providing valuable third-party information and testimonials from “real-world” users, education and outreach activities and materials help spread the message to facilitate the implementation and establishment of these projects and contribute to their success. Integrating education and outreach efforts into active demonstration and deployment activities is critical and helps ensure that these investments lead to genuine transformation of the marketplace, ultimately leading to long-term market adoption and acceptance.

Strategy

Expanding use of hydrogen and fuel cells as part of a clean energy portfolio of energy efficiency and renewable energy technologies will require a combination of technological progress, increased market acceptance, and investments in infrastructure. The education and outreach efforts must assume a phased and focused approach that considers technology competitiveness in a given market application and the associated Program’s overall market transformation strategy in that market.

The Education sub-program will “follow the technology” (and its accompanying applications) and concentrate on areas where hydrogen and fuel cells are publicly visible through demonstration projects and early market deployment and commercialization efforts. The efforts will evolve to ensure alignment with the Program’s priorities in technology demonstration and validation; safety, codes and standards; and market transformation activities and investments.

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The Education sub-program activities will support state and regional outreach efforts by providing consistent messages, readily available information resources, and other activities, as appropriate. Activities include the development and dissemination of information resources (e.g., fact sheets, business case studies, financial tools) and rely on partnerships to leverage limited resources and extend the reach of the Program's efforts. Examples include the following:

- **Webinars, Newsletters, and Online Media**

Today's world is built on the Internet. From Smart Phones and tablets to video conferencing, the boundaries of today's workplace are fluid and multi-dimensional. By offering information that is portable and fully accessible, the Education sub-program ensures that it reaches a broader audience. Webinars provided in place of traditional in-person meetings can significantly increase audience participation. Newsletters and news alerts sent electronically not only decrease production costs, but increase market reach. The Education sub-program focuses on fully leveraging the online tools available to increase market expansion.

- **Educational Materials and Information Resources**

Resources include traditional print materials, such as fact sheets, and information available on the Web, and via other forms of media including audio, CD, and video. Careful attention must be given to cost and to traditional forms of media/information delivery to which target audiences are accustomed. The primary distribution mechanism for education and outreach materials will be the Program Website, via Web pages, databases, electronic documents, and other interactive tools and resources.

- **Third-party Case Studies, Market Reports, and Project Tools**

The Education sub-program coordinates with other sub-programs within the Fuel Cell Technologies Program (FCT Program) to capture performance data and "real-world" operating experience. Third-party commissioned studies provide additional tools to project developers and industry for formulating business cases to utilize hydrogen and fuel cells to increase energy efficiency, reduce environmental impact, and improve reliability and productivity. Products include industry market reports, compendia of state activities, specific deployment case studies, and financial tools to estimate economic impacts.

- **Partnerships and Collaboration**

Coordination with other agencies and stakeholders helps to ensure effective use of taxpayer dollars by avoiding duplication and leveraging resources to achieve common goals. Partnerships with stakeholder organizations also provide a distribution channel for DOE-funded educational materials and information resources. Leveraging public-private partnerships such as U.S. DRIVE and the California Fuel Cell Partnership is critical. The Education sub-program will rely on strategic partnerships with hydrogen and fuel cell industry and clean energy trade associations such as the Fuel Cell and Hydrogen Energy Association, state energy programs, state and regional initiatives, and international partners (through the International Partnership for Hydrogen and Fuel Cells in the Economy and the International Energy Agency and its implementing agreements) to extend the reach of its efforts, as well as for informal feedback on ongoing efforts and future directions.

- **Training and Workforce Development Efforts**

As market demand for hydrogen and fuel cell technologies increases across sectors of our economy, there will be an increasing need for trained and experienced personnel and accompanying services such as qualified maintenance technicians, installers, manufacturing professionals, trainers, insurers, and educators, as examples. As market demand grows and resources allow, the Education sub-program will develop with stakeholders the “train the trainer” job certifications and curriculum required to support this growing workforce. In-person training via workshops or seminars can be an effective mode of targeted information delivery and training, as it essentially guarantees a captive audience with little distraction and allows for additional “unplanned” learning through interaction between and among the instructor and students. In-person training is expensive, however, and will be considered as budget allows and only for the areas with the greatest need (both geographic and topical, to align with the Program’s market transformation plans). Online training through webcasts and webinars will be considered as an alternative to increase the number of training opportunities provided and extend the reach of DOE-funded efforts to a larger audience. Audiences for the training and outreach will include job seekers, energy service companies and utilities, venture capital firms, insurance and underwriter industries, state government workforce development agencies, government code officials, first responders, and local public and community outreach.

Messaging

The Education sub-program considers a balanced message to help target audiences become familiar with hydrogen and fuel cell technologies and how they fit in the clean energy portfolio, to develop an accurate understanding of hydrogen safety, to recognize opportunities, and to understand their part in facilitating the use of hydrogen and fuel cell technologies in multiple market applications across the economy. Maintaining the Program’s reputation as a credible source of technically-accurate and objective information about hydrogen and fuel cell technologies is essential. All materials developed and funded by the Education sub-program will undergo critical review for accuracy of content, audience usability, and consistency with higher-level DOE programmatic material and messaging.

The Education sub-program will also utilize existing hydrogen and fuel cell deployments and early adoptions to showcase “real-world” success stories. By including these third party testimonials in outreach materials, the audience receives their information from their peers and colleagues, not just from the Federal Government. This approach provides the increased confidence with knowing that other customers are successfully using hydrogen and fuel cells.

The impact and effectiveness of messaging and education and outreach products can be assessed using survey tools. The FCT Program conducted a baseline survey in 2004 to evaluate basic understanding of hydrogen properties and align with simple messages relative to well-established energy security and environmental benefits of the use of hydrogen and fuel cell technologies. Data collected in the 2004 baseline survey indicated a direct correlation between knowledge of hydrogen and opinions about safety. As resources allow, the Education sub-program will conduct subsequent surveys in the mid to long-term to gauge progress of effective messaging and outreach efforts.

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Target Audiences

Table 3.8.1 identifies the target audiences for hydrogen and fuel cell education and outreach and briefly describes their information needs. As illustrated in the table, target audiences for education have been prioritized according to their involvement or role in the use of hydrogen and fuel cell technologies in the near term. While activities to educate all key target audiences are important, the Education sub-program must focus its limited resources on those with the greatest near-term need.

| Table 3.8.1 Key Target Audiences for the Education Sub-program | |
|---|---|
| Target Audience | Rationale |
| Potential End Users | Potential early adopters in stationary power, portable power, material handling, niche transportation, and light-duty vehicle applications need information about near- and mid-term opportunities |
| State and Local Government Representatives | A broad understanding of hydrogen and fuel cells and potential deployment opportunities supports decision-making on current opportunities and lays the foundation for long-term change. Key goals are to ensure that hydrogen and fuel cells technologies are viewed as one tool in a portfolio of options to reach energy efficiency and GHG reduction goals and to improve reliability and productivity and to provide economic benefits. |
| Local Communities/ General Public | Will be more likely to welcome local demonstration projects when they are familiar with the benefits and limitations of hydrogen and fuel cells |
| Code Officials | Must be familiar with use of hydrogen to facilitate the permitting process and local project approval, as appropriate |
| First Responders | Must know how to handle potential incidents; their understanding can also facilitate local project approval |
| University Faculty and Students | Current interest is high; graduates needed for research and development in industry and academia |
| Middle School and High School Teachers and Students | Current interest is high; teachers looking for technically accurate information and usable classroom activities |

3.8.3 Programmatic Status

New projects that were competitively awarded in FY2004 and FY2008 have been completed using FY2010 appropriations. Given budget constraints and the need for including hydrogen and fuel cells within the broader EERE portfolio, education and outreach activities will be coordinated with other DOE-wide efforts. Target audiences have been prioritized according to their near-term relevance and the effect on the use of hydrogen and fuel cell technologies today.

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The Education sub-program first focused its efforts on cross-cutting information resources, including the program website, as well as technology introduction fact sheets and overview material appropriate to multiple target audiences with little background in hydrogen or fuel cells. Existing hard copy materials are available at the EERE Information Center, described previously.

Table 3.8.2 summarizes current activities focused on the key target audiences. Technical expertise and an understanding of the audience are crucial to usability of the final product, whether it is training, outreach, or an educational tool. As a guiding principle for all of its activities, the Education sub-program seeks to pair hydrogen and fuel cell technology experts with professionals representing (or those intimately familiar with) the target audience.

| Table 3.8.2 Current Activities | |
|---|--|
| Target Audience | Activity Description |
| Activities Led by the Safety, Codes and Standards Sub-program: | |
| First Responders | <ul style="list-style-type: none"> • “Introduction to Hydrogen Safety for First Responders” project; course modules include information about hydrogen properties, comparisons to other common fuels and technologies, and initial emergency response actions (Pacific Northwest National Laboratory and other partners). |
| Code Officials | <ul style="list-style-type: none"> • “Introduction to Hydrogen for Code Officials,” an information package that builds on the first responders course with more information specific to codes and standards (National Renewable Energy Laboratory and other partners). |
| Activities Led by the Education & Outreach Sub-program (Coordinated with the Market Transformation Sub-program): | |
| Potential End Users | <ul style="list-style-type: none"> • Case studies of business models of the use of hydrogen and fuel cell technologies for applications such as back-up power and stationary power. • Economic tools such as employment and economic impact estimators at the state and regional level for early market fuel cell deployments. • Introductory information about hydrogen vehicles for fleets and other potential end users. |
| State and Local Government Representatives | <ul style="list-style-type: none"> • Database of state activities – demonstrations, policies, and initiatives (Fuel Cells 2000, Alternative Fuels Data Center). • Regular informational calls and public webinars with state and regional hydrogen and fuel cell initiatives |
| Local Communities/ General Public | <ul style="list-style-type: none"> • Materials are available for the general public through websites maintained by the Program and other hydrogen and fuel cell organizations. Local communities are served by the activities occurring with all of the other target audiences. |

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Table 3.8.2 Current Activities (continued)

| Target Audience | Activity Description |
|---------------------------------|--|
| University Faculty and Students | <ul style="list-style-type: none"> • Undergraduate and graduate level curriculum developed through FY2008 university projects • Student “H2U” University Design Contest (Hydrogen Education Foundation) • Partnerships for student internships and post doctoral fellow opportunities |
| Other Teachers and Students | <ul style="list-style-type: none"> • Teacher and student curriculum developed through FY2004 Pre-college projects: • “H2 Educate!” for middle schools (National Energy Education Development Project and partners). • “Hydrogen Technology and Energy Curriculum (HyTEC)” for high schools (Lawrence Hall of Science at the University of California, Berkeley and partners). |

3.8.4 Challenges

Considering our Nation’s long relationship with the gasoline internal combustion engine and use of fossil fuels for stationary power, the move to hydrogen and fuel cell technologies for transportation, stationary power and portable power is a fundamental change in the way we use energy. Resistance or hesitance to change is the overarching challenge to education, and it is fed by several different factors.

The first factor is low awareness. Rumors, misinterpretation, and misunderstanding of historical events and the facts about hydrogen safety may prompt people to express a “not in my backyard” mentality. Technically accurate information from a trusted and objective source can raise awareness, correct misinformation or false perceptions, and help to build comfort levels with using new energy technologies.

The second factor is that examples of “real-world” market applications using hydrogen and fuel cell technologies are not as well publicized as they could be. Technology demonstrations, though increasingly visible in the public space, are not common throughout the country. The number of demonstrations is growing, but there are still limited “real-world” examples to which we can highlight when introducing the idea of using hydrogen and fuel cells as one option in a clean energy portfolio. Some people may embrace the opportunity to be among the first to experience cutting-edge technology, while others may not want to feel that they are “part of the experiment.” Real-world examples and, better still, hands-on or first-hand experience, can greatly enhance understanding and comfort with using a new fuel and energy carrier and new power generation technologies.

The third factor that can feed resistance to change, and therefore influence the overall challenge to education, is the “what’s in it for me” factor. Although hydrogen and fuel cell technologies are emerging in the commercial market in some specialized niche applications such as stationary and

emergency back-up power and material handling equipment, they are considered primarily as technologies for the long term (e.g., fuel cell vehicles) – not readily available today and won't be for some time. When near-term and personal relevance or benefits are not obvious, engaging any of the key target audiences can be difficult.

3.8.5 Barriers

The following section outlines barriers to achieving the Education sub-program's goal and objectives.

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. Moreover, explaining hydrogen and fuel cells to a non-technical audience – clearly and succinctly, while still retaining technical accuracy – is challenging.

B. Mixed Messages

The growing public and mainstream media interest in energy has sparked increased outreach activity among many different organizations. The flurry of activity helps raise public awareness of energy issues, but it also creates potential for conflicting public messages, as well as confusion about how hydrogen and fuel cells fit in the portfolio of our Nation's energy choices.

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 webinars, 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 beyond the capability of most education programs to fund.

E. Regional Differences

Educational needs vary by audience, but they may also vary regionally. What works for a particular target audience group in one state, county, city, or district may not be the best approach for that

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same audience group in another area of the country (for example, education standards vary from state to state). Serving the education needs of a single target audience may therefore require multiple approaches tailored to serve the needs of various regions, which strains resources and can complicate activities developed at the national level.

F. Difficulty of Measuring Success

Quantifying the success of education activities is difficult. The number of fact sheets distributed or number of webinar attendees does not provide a meaningful measure of whether target audiences are actually gaining knowledge or understanding. External influences, such as mass media attention, can also affect public knowledge and opinion, making it difficult to determine whether or not measured changes in knowledge are actually the result of sub-program activities.

3.8.6 Task Descriptions

Task descriptions are presented in Table 3.8.3. All activities noted below will be developed and implemented according to the strategy described in the “Approach” section outlined above.

| Task | Description | Barriers |
|-------------|--|-----------------|
| 1 | <p>Educate Safety and Code Officials</p> <ul style="list-style-type: none"> Disseminate and maintain introductory “awareness-level” course modules for first responders. Disseminate the updated “prop-course” for first responders using hands-on training devices developed by the Safety sub-program. Raise awareness of available information at audience-specific events. Coordinate all activities under this task with Safety, Codes and Standards sub-program. Increase awareness of “authority having jurisdiction” (AHJ). Reduce the permitting/construction cost and time for new hydrogen and fuel cell installations. | A, B, C, D |
| 2 | <p>Educate Local Communities</p> <ul style="list-style-type: none"> Disseminate introductory information products that are designed for a non-technical audience. Develop and conduct targeted public outreach through different forms of media. Develop and conduct seminars to educate interested residents in communities. | A, B, C, D |
| 3 | <p>Educate State and Local Government Representatives</p> <ul style="list-style-type: none"> Develop and make available introductory information appropriate for a non-technical audience and specific to state and local government needs. Develop and conduct training workshops to increase understanding and share lessons learned. Raise awareness of available information at audience-specific events. | A, B, C, D, E |

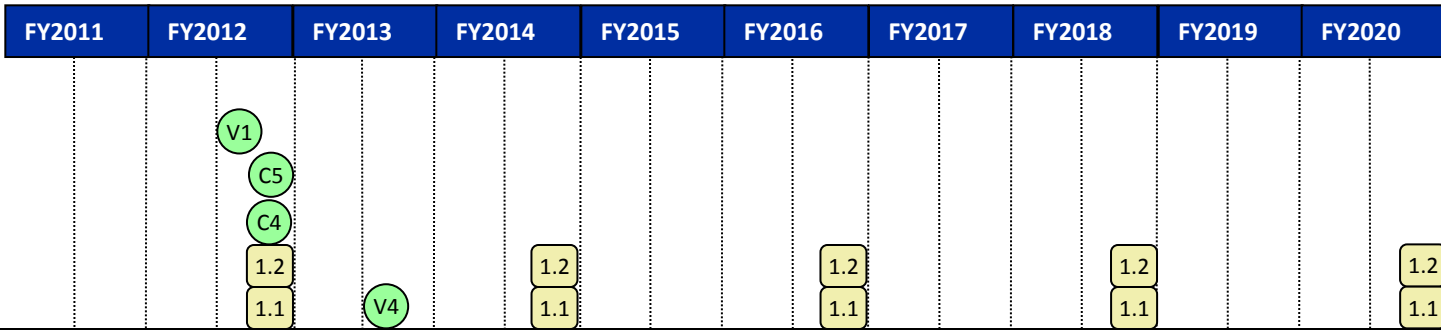
Table 3.8.3 Task Descriptions (continued)

| Task | Description | Barriers |
|------|---|---------------|
| 4 | <p>Educate Potential End-Users</p> <ul style="list-style-type: none"> Develop and make available introductory information focused specifically on the needs of different potential end-users. Develop and conduct information seminars and training at audience specific events. Work through traditional end-user information networks to develop and offer short courses specific to end-user needs. | A, B, C, D |
| 5 | <p>Facilitate Development and Expansion of College and University Hydrogen Technology Education Offerings</p> <ul style="list-style-type: none"> Disseminate a database of college and university programs. Disseminate a publicly available database of relevant textbooks and teaching resources for professors. Support university hydrogen competitions that engage students from a variety of disciplines. Work with university partners to develop and expand hydrogen technology course offerings and facilitate networking among schools with similar programs. Develop and offer technician training at community colleges and facilitate networking among interested schools. | A, B |
| 6 | <p>Facilitate Development and Expansion of Hydrogen Technology Education in Middle Schools and High Schools</p> <ul style="list-style-type: none"> Disseminate easily accessible, user-friendly classroom guides for teachers and students. Raise awareness of available information and resources at audience-specific events. | A, B, C, D, E |
| 7 | <p>Assess Knowledge and Opinions of Hydrogen Technologies</p> <ul style="list-style-type: none"> Recalibrate and conduct updated survey of target audiences' knowledge levels. Repeat surveys in out years to evaluate changes in knowledge and opinions over time. | A, B, F |

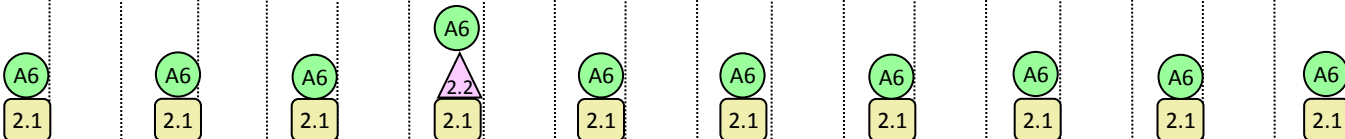
3.8.7 Milestones

The following chart shows the interrelationship of milestones, tasks, supporting inputs and outputs from other sub-programs from FY 2011 through FY 2020, subject to appropriations. This information is also summarized in Appendix B.

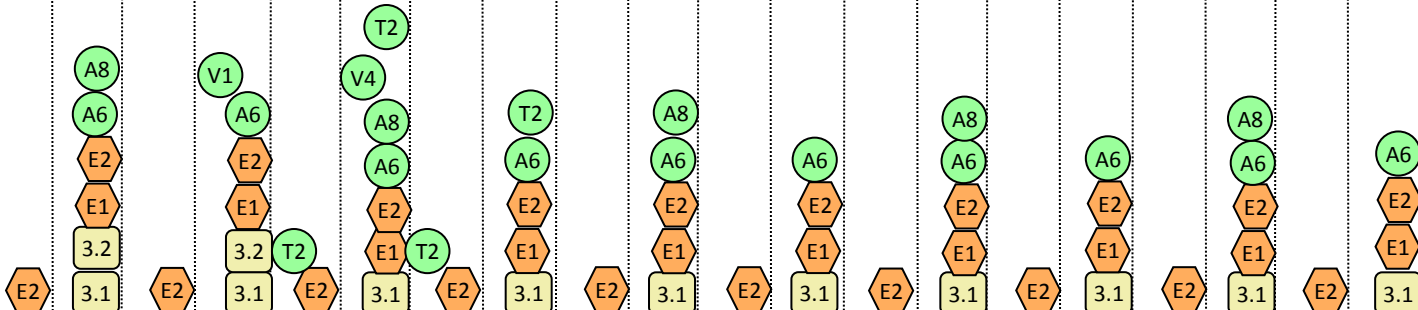
Education Milestone Chart



Task 1: Educate Safety and Code Officials

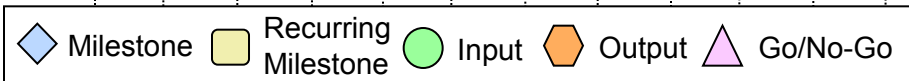


Task 2: Educate Local Communities

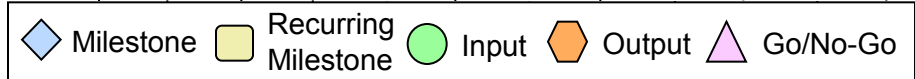
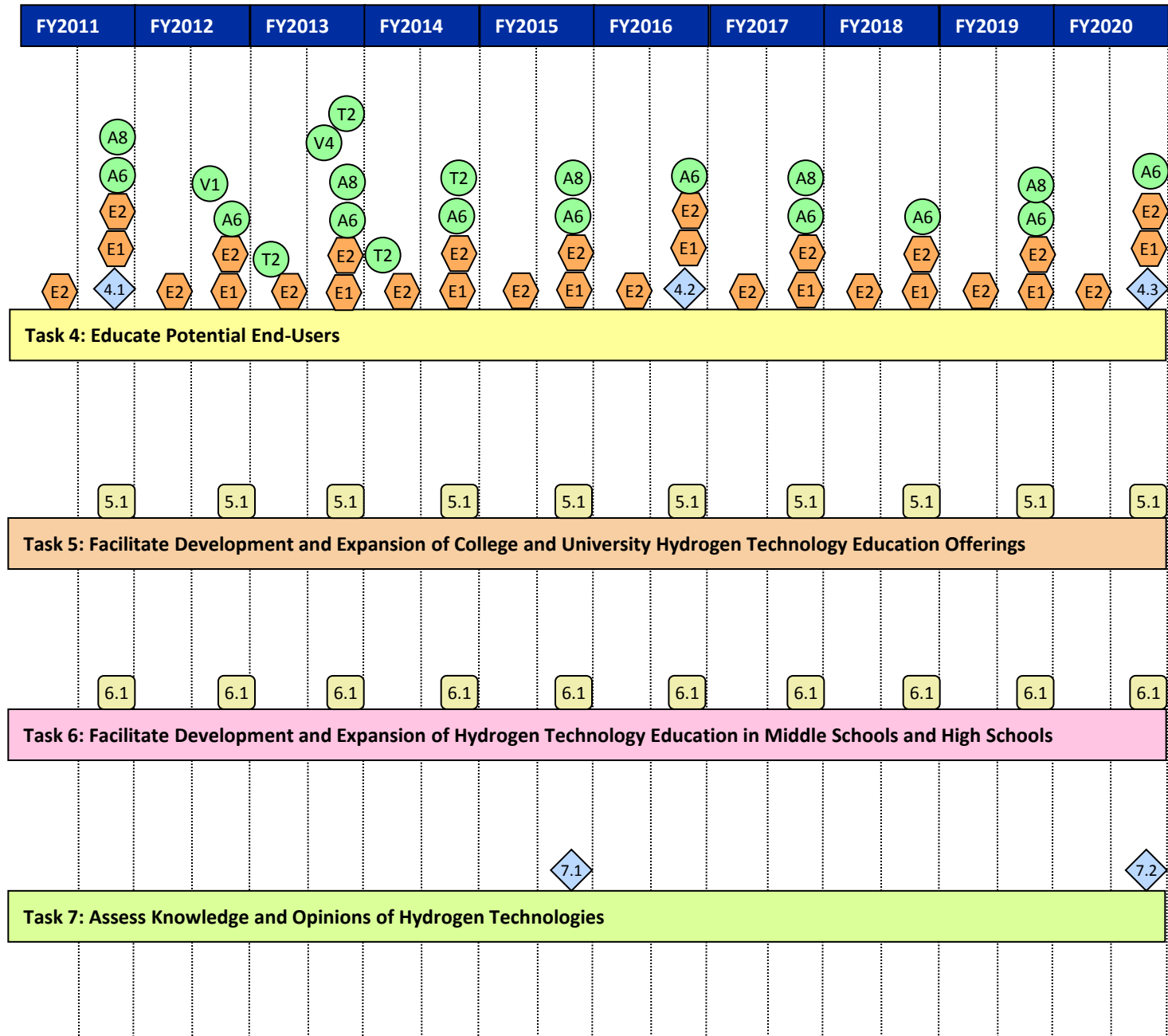


Task 3: Educate State and Local Government Representatives

Milestone 3.3 is updated quarterly through 2020, Milestone 3.4 is updated bimonthly through 2020



Education Milestone Chart



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Task 1: Educate Safety and Code Officials

| | |
|-----|---|
| 1.1 | Update “Introduction to Hydrogen Safety for First Responders” course for first responders. (Biannually) |
| 1.2 | Update “Introduction to Hydrogen Safety for Code Officials” course for code officials. (Biannually) |

Task 2: Educate Local Communities

| | |
|-----|---|
| 2.1 | Update website to reflect current information about hydrogen and fuel cells. (Annually) |
| 2.2 | Decision on national public education campaign. (4Q, 2014) |

Task 3: Educate State and Local Government Representatives

| | |
|-----|--|
| 3.1 | Update website with current state activities. (Annually) |
| 3.2 | Hold “Hydrogen 101” seminars. (through 4Q, 2012) |
| 3.3 | Update case studies, market reports, and projects tools on web site. (quarterly) |
| 3.4 | Hold frequent (bi-monthly) Hydrogen and Fuel Cell webinars. (through 4Q, 2020) |

Task 4: Educate Potential End-Users

| | |
|-----|--|
| 4.1 | Develop economic tools (e.g., employment and economic impact estimators). (4Q, 2011) |
| 4.2 | Update economic tools (e.g., employment and economic impact estimators). (4Q, 2016) |
| 4.3 | Update economic tools (e.g., employment and economic impact estimators). (4Q, 2020) |

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Task 5. Facilitate Development and Expansion of College and University Hydrogen Technology Education Offerings

| | |
|-----|--|
| 5.1 | Update web site with current hydrogen and fuel cell university education coursework and programs. (Annually) |
|-----|--|

Task 6: Facilitate Development and Expansion of Hydrogen Technology Education in Middle Schools and High Schools

| | |
|-----|---|
| 6.1 | Update website with current hydrogen and fuel cell middle school and high school programs. (Annually) |
|-----|---|

Task 7: Assess Knowledge and Opinions of Hydrogen Technologies

| | |
|-----|--|
| 7.1 | Evaluate knowledge and opinions of hydrogen technology of key target audiences. (4Q, 2015) |
| 7.2 | Evaluate knowledge and opinions of hydrogen technology of key target audiences. (4Q, 2020) |

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Outputs

- E1 Output to Market Transformation: List of conferences and seminars that are being attended. (4Q, 2011 - 2020)
- E2 Output to Market Transformation: List of literature and fact sheets under development/revision. (2Q and 4Q, 2011 - 2020)

Inputs

- A6 Input from Systems Analysis: Issue annual market reports on status of fuel cell and hydrogen industry. (4Q, 2011 - 2020)
- A8 Input from Systems Analysis: Issue reports on the status of government policies on non-automotive fuel cell industry. (4Q, 2011; 4Q, 2013; 4Q, 2015; 4Q, 2017; 4Q, 2019)
- C4 Input from Safety, Codes and Standards: Updated materials compatibility technical reference manual. (4Q, 2012)
- C5 Input from Safety, Codes and Standards: Updated best practices handbook on hydrogen safety. (4Q, 2012)
- T2 Input from Market Transformation: Issue reports on the status of early market deployments and industry needs. (1Q, 2013; 4Q, 2013; 1Q, 2014; 4Q, 2014)
- V1 Input from Technology Validation: Final learning demonstration summary report published. (3Q, 2012)
- V4 Input from Technology Validation: Safety event data and information from American Recovery and Reinvestment Act (ARRA) projects. (3Q, 2013)