2010 Hydrogen Student Design Contest: Designing a Hydrogen Community

Official Rules and Design Guidelines v. 1.1

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Rules and Guidelines Updates

Version 1.1 – Released January 29, 2010
-Updated Additional Resources section

Version 1.0 – Released January 26, 2010

1 Introduction

The Hydrogen Education Foundation's Hydrogen Design Contest ("the Contest") challenges teams of university-level students from around the world to develop and design hydrogen applications for real-world use.

Established in 2004 by the Hydrogen Education Foundation, the Contest showcases the talents of students in many disciplines, including engineering, architecture, marketing, and entrepreneurship. Students from universities, four-year colleges, community colleges, and vocational schools worldwide are eligible to participate.

The 2010 Challenge: Designing a Hydrogen Community

The 2010 Hydrogen Student Design Contest will challenge university-level students to plan and design the basic elements of a hydrogen community in Santa Monica, CA.

Background

For the past decade, auto manufacturers and fuel providers have tested hydrogen vehicle and fueling station technologies in demonstration programs throughout the world. Much has been learned and proved through these programs and now these technologies are ready for the next step: beginning the transition to commercial operation.

The State of California is widely regarded to be a leader in beginning the transition. In February 2009, the California Fuel Cell Partnership (CaFCP) released an Action Plan[1] that outlines a near-term strategy for the development of early "hydrogen communities" in the state over the next eight years. A large component of this strategy to turn the corner from demonstration to commercialization is the deployment of multiple hydrogen fueling stations in key regions of Southern California: Irvine, Torrance, Santa Monica, and Newport Beach.

For this Contest, students will plan and design the basic elements of a hydrogen community in Santa Monica, California. Building on the fueling stations concept of the CaFCP Action Plan, this Contest will ask students to design one scalable hydrogen fueling station; to identify renewable hydrogen sources in the community; and to identify customers for early market hydrogen applications.

About the Contest

Since 2004, the NHA Hydrogen Student Design Contest has challenged multi-disciplinary teams of university students to apply their creativity and academic skills in the areas of design, engineering, economics, environmental science, business and marketing to the hydrogen and fuel cell industries. Although the Contest designs are concepts when submitted, the Grand Prize winning teams from 2004 and 2005 each attracted the funding necessary for actual development and implementation: a new hydrogen fueling station and power park, respectively. The station

[1] http://www.fuelcellpartnership.org/sites/files/Action%20Plan%20FINAL.pdf

designed in 2004 had its grand opening at Humboldt State University on September 9, 2008. The winning design in 2008, which included a back-up and portable power system powered by hydrogen for airports, has generated a great deal of interest for implementation at the Columbia International Airport in Columbia, South Carolina.

Judging

Submissions will be evaluated by a diverse panel of judges that include industry representatives and officials at U.S. Department of Energy.

Prizes

For the 2010 Contest, the Grand Prize winning team will be invited to present its design in a general session of the National Hydrogen Association's Hydrogen Conference and Expo in Long Beach, California (May 3-6, 2010) and in a session of the World Hydrogen Energy Conference in Essen, Germany (May 17-18, 2010). A stipend of up to $12,500 will be provided for travel to both events[2].

Honorable mention teams will receive invitations to give poster presentations at the NHA Conference and Hydrogen Expo and will be provided complimentary hotel rooms and registrations for the event.

For more details on contest prizes, please see Section 2.4.

2 Rules

2.1 Eligibility and Team Structure

- The Contest is open to current college, vocational, and university undergraduate and graduate students worldwide. Team members must be enrolled in a college or university at the time of the Contest but do not have to be enrolled full-time.
- Teams are encouraged to include members from only one school. If collaboration between different schools is desired, the team leader and designated faculty advisor must request approval by submitting the team registration form with a cover email to the address in Section 2.3 or by email to info@hydrogencontest.org. Teams with students from more than three schools are not allowed.
- Multiple teams from a single school are welcome, but each team must work independently to keep the competition fair to other teams.
- A team of about 10 students is recommended, although teams with fewer or more members are allowed.
- Given the multi-disciplinary nature of this competition, teams are encouraged to include members with various expertises, including: architecture/planning, industrial

[2] For teams outside of the United States, passport and visa arrangements must be made by the individual team members.

design, engineering (all types), economics, business, environmental science, policy, chemistry, marketing, education, or any other field of study relevant to the team's design.

- Each team must have a faculty advisor. The faculty advisor must be a faculty member of a college or university with at least three students on the team. Adjunct and emeritus faculty are welcome to serve in this capacity. Faculty advisors may give guidance and suggestions but cannot perform actual design work. Faculty advisors can advise more than one team, but they must assist in making sure the teams work independently to keep competition fair to other schools with one team.

2.2 Citations and Questions

- Teams may use any source of data or materials: journals, computers, software, references, web sites, books, etc. All sources used **MUST** be cited.
- Teams may contact professionals in the hydrogen and fuel cell industry, as desired, and are encouraged to do so. If information from them is used to develop the design, teams **MUST** cite all sources. Only open source data is allowed. No proprietary or confidential information should be included in any design or presentation.
- Teams may submit any questions about the contest by email (info@hydrogencontest.org); answers will be posted to an electronic public bulletin board on the contest web site www.HydrogenContest.org for the benefit of all competitors.

2.3 Report Format Submission and Scoring

- Each team must submit an abstract of less than 300 words to info@hydrogencontest.org by **Friday, February 19th, 2010.** Please include "**Hydrogen Contest Abstract – [Your school name]**" in the subject line of the email. The abstract should provide an overview of the team's project, highlighting the main features and goals of its design. The abstract does not need to be included in the final submission. This information will assist the contest organizers in planning for the rest of the contest.
- All final entries must arrive at the location below **by 5 PM (ET), March 24, 2010.** Late entries will not be considered.
- Entries may be submitted in electronic or hardcopy. If you would like to send a hardcopy, please send a printed copy and a CD/DVD with the electronic files to:

  2010 Hydrogen Student Design Contest
  ATTN: Kyle Gibeault
  Hydrogen Education Foundation
  1211 Connecticut Ave., NW
  Suite 600
  Washington, DC 20036

- **Electronic copy**: The entire report, including graphics and citations, should appear as a single PDF file. Reports submitted as multiple files will not be judged. Only the one electronic PDF file will be sent to the judges and scored.
- The following page limits have been recommended for the following sections. You may distribute the pages as you see fit provided that the final report does not exceed

34 pages + references and citations. Report pages must include 1 inch margins and minimum 11 point font.

Section	**Page Recommendation**
Cover Page	1
Executive Summary	1
Hydrogen Production Evaluation	4
Early Market Customer Identification	4
Hydrogen Station Technical Designs	10 (including drawings)
Safety Analysis	1
Economic/Business Plan Analysis	3
Environmental Analysis	3
Marketing and Education Plan	2 (1+1 for the advertisement)
Appendix	5
References/citations	as necessary (not inc. in page count)
Max. No. Pages	**34 + references/citations**

- Entries that exceed the stated page limits will be deducted **3 POINTS** for each page that exceeds the limit.
- The final submission must include an executive summary that reviews the main features of the project in language that a general audience can understand. For the other sections, as you describe your design, keep in mind that the judging panel will include both technical and non-technical experts.
- Each section of the final project plan should concisely and completely fulfill the specific requirements in the design guidelines (Section 2) and provide any other relevant information.
- The marketing ad should appear in the body of the project plan so judges may evaluate it. Teams are encouraged, however, to include additional high-resolution versions of the ad and any other pertinent graphics (design drawings, site plot, etc.) as separate files in a folder on the same submitted CD/DVD for Contest marketing purposes at the NHA Conference and Expo.
- The final submission can include an appendix of up to 5 additional pages (within the 34 page limit) for additional information, calculations, and background material if needed.
- Judging criteria:
  Points:
  20 Technical accuracy
  20 Realism, ability to be effectively implemented and/or installed
  20 Effective uses of renewable resources/energy efficiency
  20 Practicality/usefulness
  20 Value per dollar spent
  20 Overall impact on community
  20 Originality/Creativity
  20 Safety
  20 Comprehensive nature of the design
  20 Clarity of writing
  200 Total

- Teams are encouraged to copyright their designs. By submitting a design in this contest, however, teams agree to have their papers professionally published in the proceedings for the NHA Conference. The Hydrogen Education Foundation and Contest sponsors assert the right to publicize the design concepts for their own purposes. All work will be given due credit to its authors.

2.4 Prizes

General Information

- One grand prize winning team and up to two honorable mention teams are expected to be selected.
- On **April, 7, 2010** the Hydrogen Education Foundation will notify winning teams (teams are expected to refrain from publicly announcing their achievements until the public announcement date on May 5, 2010).
- Contest winners will be announced publicly at the NHA Hydrogen Conference and Expo in Long Beach, CA May 3-6, 2010 (for more information on the conference, visit: www.HydrogenConference.org). All winning teams will receive awards at the conference.
- Winning designs will be published in the NHA conference proceedings and online at www.HydrogenContest.org.
- For teams outside of the United States, passport and visa arrangements must be made by the individual team members.

Grand Prize

The grand prize winning team will receive:

- An invitation to present its design at the NHA Hydrogen Conference and Expo in Long, Beach CA (May 3-6, 2010) and at the World Hydrogen Energy Conference in Essen, Germany (May 17-18, 2010).
- For the NHA Conference, a stipend of up to $5,000 to cover airfare, meals, and incidental trip expenses (must be documented), as well as complimentary hotel rooms (double occupancy) and NHA conference registration for up to eight team members and their faculty representative;
- For the World Hydrogen Energy Conference, a stipend of up to $7,500 to cover airfare, meals, and incidental trip expenses (must be documented), as well as complimentary hotel rooms (double occupancy) and WHEC conference registration for up to five team members.

Important Information:

1. Teams must send at least 1 representative to present the team's design at the NHA conference. However, the team is **strongly** encouraged to use the stipends to allow the maximum number of team members to attend and participate in both conferences.

2. Teams must send a 20-minute PowerPoint presentation (maximum of 20 slides) with highlights of the project plan (presentation will be given by the team representative(s) referenced above during sessions of the NHA and WHEC conferences). Presentations are due via email to gibeaultk@hydrogenassociation.org by **April 23, 2010**.

Honorable Mentions

The honorable mention teams will receive:

- An invitation to give a poster presentation at the NHA Conference and Hydrogen Expo;
- For the NHA conference, complimentary hotel rooms (double occupancy) and conference registration for up to four team members and their faculty representative.

2.5 Contest Schedule

• **DUE: Entries due (see Section 2.3)**	**March 24, 2010**
• Announcement of winners to winning teams	**April 7, 2010**
• **DUE: Grand Prize team submits presentation for NHA Annual Hydrogen Conference to HEF Staff**	**April 23, 2010**
• Announcement and presentation of all winning designs at NHA Annual Conference in Long Beach, CA	**May 3-6, 2010**
• Presentation of Grand Prize winning design at World Hydrogen Energy Conference in Essen, Germany	**May 17-18, 2010**

3 Guidelines

For this Contest, student teams are challenged to plan and design the basic elements of a hydrogen community in Santa Monica, CA. In addition to designing one scalable fueling station, student teams will identify renewable hydrogen sources in the community and customers for early market hydrogen applications. At least 33% of the hydrogen used by the fueling station must be generated from renewable sources.

The hydrogen technologies and systems you select for your project plan must be commercially available and possible to implement for practical, real-world use by May 2010. Participants should clearly state any assumptions (if any) used in their entries.

3.1 Hydrogen Production Evaluation

Hydrogen can be produced from many different resources. In most cases, hydrogen is either produced on-site at the point of use or in large centralized facilities. For this portion of the contest, teams will evaluate and identify the potential for the production of hydrogen from renewable or byproduct sources in or near the Santa Monica, CA community.

Teams should identify at least three existing facilities or sites within 25 miles of Santa Monica city limits that could be a producer of renewable or byproduct hydrogen. Production must add up

to a minimum of 1,000kg/day. Examples include hydrogen produced from biogas, landfill gas, or as a byproduct of industrial processes. Hydrogen produced from electrolysis with renewable electricity is not eligible in this category.

Teams must create a description of each producer. Each description should include the following:

- Name of producer and location
- Description of how they would produce hydrogen and an estimate of daily hydrogen production
- Description of the production method
- Estimate of production facility availability or on-line factor

Teams should incorporate their findings to the best of their ability into the early market customer identification in Section 3.2 and the vehicle fueling station design in Section 3.3 of the Rules and Guidelines. In accordance with California state law, at least 33% of the hydrogen supplied to vehicle fueling stations that receive state funding must come from renewable sources.

3.2 Early Market Customer Identification

One of the first steps to transitioning to a hydrogen economy is identifying early customers for the hydrogen supply. There are three main early markets where hydrogen is being used to meet end-use energy needs:

- Materials Handling Vehicles
- Stationary Back-Up Power
- Portable Power

Teams will identify at least three potential customers in Santa Monica, CA which together use a total of 250kg/day of hydrogen demand in any of these early market categories. Teams will contact prospective customers to evaluate the potential for using hydrogen as an energy source at their facilities. All customers must be existing companies or organizations.

Teams must create a description of each customer. Students should try to utilize the resources identified in Section 3.1 to meet the production needs of customers in this section.
Each description should include the following:

- Type of customer (which early market)
- Name of customer and location
- Contact information for person contacted at customer organization
- How customers could use hydrogen and an estimate of daily hydrogen consumption
- Description of the production method (Delivered or on-site production. Include resources identified in Section 3.1 if possible).

3.3 Hydrogen Stations Technical Design

The CAFCP Action Plan outlines a deployment schedule of six new hydrogen fueling stations in Santa Monica in the period of 2009-2014. For this Contest, students will design the major components of a permanent 200kg/day station proposed for deployment in 2013. Recognizing that this is just one of several stations outlined in the Action Plan, this station design must be reproducible and scalable to a production level of at least 400kg/day of gaseous hydrogen.

At least 33% of the station's hydrogen supply must come from renewable sources. Students should try to utilize the resources identified in Section 3.1 to meet at least a portion of the production needs of customers in this section. The station must be sited in Santa Monica, CA and accessible to the general public.

The station design can be based on either on-site production or centralized production and distribution. In either case the project team must provide a detailed description of the hydrogen production and distribution technologies used to deliver hydrogen to the station. In the case of on-site production, the project team must describe the hydrogen production equipment as part of the station. In the case of centralized production, the project team would need to describe the centralized production (e.g. large-scale SMR, biomass, electrolysis, etc.) and distribution mechanism (LH_2 tanker, pipeline, tube trailer, etc.) used to deliver hydrogen to the station.

Station design must comply with California state requirements for hydrogen stations. More information on these requirements:
http://er.cafcp.org/pdf/20080506_H2Station_Installation_Worksheet.pdf

The technical design will include:

1. Site location. Station must be sited within the city limits of Santa Monica, CA. The station location should be in areas with nearby freeway access and convenient to commuter and local needs alike.

2. Site (plot) plan. The plot plan should include a diagram of the location and number of re-fueling pumps, re-fueling island design, canopy (if included), any buildings (e.g. convenience store), ingress/egress, any auxiliary equipment and any other items the project team wishes to include. The plan should include enough fueling pumps to ensure that at least two customers can fuel conveniently at the same time. In 2008, the average vehicle fueling was in the range of 2-3kg of gaseous hydrogen.

3. Description of major station components with specifications and rationale for their choice. Major components include:
    a. Production
    b. Storage
    c. Compression
    d. Dispensing (Should dispense gaseous hydrogen at both 5000psi and 10,000psi)
    e. Safety Equipment

3.4 Safety Analysis

Public safety is a paramount concern for any public building or space. In this section, teams must show how their station design will operate safely and maintain the safety of the surrounding environment. Teams should describe how safety concerns have been addressed at their station. This includes safety equipment and operational safety, as well as public perception of safety.

Judges will score the design according to how well they think safety has been addressed. Teams must address the following minimum requirements:

- Teams should identify the most significant risks to public safety in their design. In determining which failure modes should be addressed, teams should consider both the magnitude of potential damage and frequency.
- Teams should describe how their design mitigates the risk of any identified issues.
- Teams must document their sources as necessary.

3.5 Economic/Business Plan Analysis

The project team will complete an economic analysis of the station that includes capital costs, operating costs, and maintenance costs. The project team should determine the selling price of dispensed hydrogen ($/kg) based on the economic analysis.

The analysis should include:

- Capital costs for all equipment sited at station, including installation costs.
- Operating costs of all fuel, power, water or other resources necessary for station operation (i.e., water for electrolysis, natural gas for reformers, LH_2 supply, electricity for compressors and controls). Justify costs for water, natural gas and electricity (when needed) using relevant local utilities prices.
- Costs for delivered H_2 justified with a cost analysis of production and delivery systems.
- Costs of natural gas, electricity, and water, documented for the region and for any special prices (time of day or volume sales).
- Maintenance requirements and costs.
- Selling price of hydrogen, based on a discounted cash flow analysis with an after-tax internal rate of return of 10% for a 10-year analysis.
- A comparison of the cost in $/mile of hydrogen fuel for the fuel cell vehicle compared to the $/mile for comparable conventional vehicle using gasoline. Assume the fuel cell vehicle fuel economy is 60 mile/kg of hydrogen. Assume the cost per mile for conventional vehicles is $0.058/mile.
- For all costing analyses, teams must use documented sources.
- Teams may examine potential tax credits that could help reduce the total cost of the project

Teams are encouraged to address any other issues that may affect the economic viability of the project plan (within the page limitations of this section). In all cases above, teams may use tables and figures to illustrate key points.

3.6 Environmental Analysis

Each team will perform a well-to-tank energy and emissions (CO_2 only) analysis. The analysis should include:

- An energy balance for all major components (production, delivery, compression, etc.) of the system. The well-to-tank analysis should show the grams CO_2/ kg hydrogen produced compared to the amount of CO_2/gal gasoline produced. Assume that a 2009 gasoline-powered light duty passenger vehicle emits 422g CO_2/mi and that the average fuel economy is 32.6 miles per gallon[3]. Teams should take into account the production source of the hydrogen.
- An example of such a standard analysis for a baseline vehicle is the MIT study entitled "On the Road in 2020." (http://web.mit.edu/energylab/www/pubs/el00-003.pdf)
- For all emissions analyses, teams must use documented sources.

Other

Teams should clearly communicate the environmental impacts (positive and negative) of other elements of the design. For example, water use should be considered if your design produces hydrogen through electrolysis.

3.7 Marketing and Education Plan

To address the issue of public acceptance and build local support for the community's use of hydrogen technologies, teams must create a realistic marketing plan and a one-page ad (scaled to fit on a 8.5" x 11" page) for inclusion in a local publication. The cost of implementing this plan must be included in the allowable overall project budget.

Note: Be creative with your marketing plan. Public acceptance is a key element in adopting hydrogen and fuel cell technologies.

The plan should:

- build support for your design and understanding of hydrogen and fuel cell technologies;
- allay public safety fears or reduce potential resistance; and
- raise local awareness of the benefits of hydrogen and fuel cell technologies so your designs can be built and installed with maximum acceptance.

4 Additional Resources

For links to informative websites, presentations, and publications that may help with your project, please visit our website, www.hydrogencontest.org/resources.asp. We will update this page throughout the course of the Contest.

[3] Source: http://www.epa.gov/oms/fetrends.htm