



2007-2008 Hydrogen Design Contest: Hydrogen Applications for Airports

Official Rules and Design Guidelines

Last updated: 30 November 2007

Presented by the National Hydrogen Association's Hydrogen Education Foundation, the South Carolina Hydrogen and Fuel Cell Alliance, the U.S. Department of Energy, Chevron, Sacramento Municipal Utility District, Natural Resources Canada and American Wind Power and Hydrogen.

Introduction

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

The 2007-08 Challenge: Hydrogen Applications for Airports

"Officials from all of the nation's busiest airports report that balancing their operations with their impact on the environment is more difficult than it was a decade ago." U.S. Government Accountability Officeⁱ

"A study released in 2004 concludes that the rise in demand for air travel is one of the most serious environmental threats facing the world. One 747 arriving and departing from JFK airport in New York City produces as much smog as a car driven over 5,600 miles, and as much polluting nitrogen oxides as a car driven nearly 26,500 miles." State Environmental Resource Centerⁱⁱ

In addition to the task of handling millions of travelers every day, today's airports face challenges related to air and water quality, noise pollution, energy efficiency, and safety and security. Imagine your team has \$3 million USD to address these critical issues using hydrogen technologies at the Columbia Metropolitan Airport in Columbia, South Carolina. Although your design should aim to address the challenges at the Columbia Airport, a great design will have key elements that are applicable to other airports around the world. 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 2009.

Background

The city of Columbia, South Carolina intends to become a global model for the mass deployment and application of hydrogen and fuel cell technologies, as well as other alternative energy systems, in an urban community. Alternative energy technologies can revolutionize not only cities, but also the lives of its citizens through the security of energy independence, the benefits of a clean environment and economic growth generated by a new industry.

Airports are among the applications with the greatest opportunity for practical implementation of hydrogen technologies in the near term. Given South Carolina's commitment to hydrogen technologies, the Columbia Metropolitan Airport offers an excellent case study.

Since 2004, the Hydrogen 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, and business and marketing to the developing hydrogen economy. 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.

Winning teams, selected by a diverse panel of judges, are invited to present their designs at the NHA Annual Hydrogen Conference. The Hydrogen Conference is currently the largest hydrogen conference in the U.S. and the longest-running annual hydrogen conference in the world. In 2008, the NHA Annual Hydrogen Conference will be held in Sacramento, California; in 2009, it will be held in Columbia, South Carolina.

1 Rules

1.1 Eligibility and Team Structure

- The contest is open to current college and university undergraduate and graduate students in the U.S. or abroad. 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 1.3 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.
- Undergraduate-only and graduate-only/mixed teams are allowed. If your team has one or more graduate students, you must register as a graduate-only/mixed team. All teams compete equally for the grand prize. However, some honorable mentions will be reserved for each category.
- Given the multi-disciplinary nature of this competition, teams may wish to include members with various expertise including architecture/planning, industrial 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.

1.2 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.
- The website www.columbiaairport.com may be especially useful to the creation of your design. All technical questions specifically regarding the Columbia Airport should be directed to Chuck Henderson, Airport Deputy Director at c.henderson@columbiaairport.com
- 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.
- 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.

1.3 Report Format Submission and Scoring

- All entries must arrive at the location below **by 5 PM (ET), Friday, December 14, 2007**. Late entries will not be considered.
- Entries must be submitted in hardcopy (2 copies; see page requirements below) **and** on CD/DVD (see format requirements below) to the Hydrogen Education Foundation:
2007-2008 Hydrogen Student Design Contest
ATTN: Rex Hazelton
Hydrogen Education Foundation
1211 Connecticut Ave., NW
Suite 600
Washington, DC 20036
- Hardcopies (2): Pages should have 1" margins with single spacing and should use Times 12 point font. Bound hardcopies are appreciated but are not required and will not be judged differently.
- Electronic copy: The entire report, including graphics and citations, should appear on the CD as a single *.pdf file. **Please write your school name on the CD.** 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 assigned to the following sections:

<u>Section</u>	<u>Page Limit</u>
Cover Page	1
Executive Summary	1

The Design	12 (including drawings)
Safety Analysis	3
Economic/Business Plan Analysis	4
Environmental Analysis	4
Marketing and Education Plan	3 (2+1 for the advertisement)
Appendix	5
<u>References/citations</u>	<u>as necessary</u>
Max. No. Pages	33 + references/citations

- Entries that exceed the stated page limits will be deducted **3 POINTS** for each page that exceeds the limit.
- Teams must register online at www.HydrogenContest.org as an “undergraduate-only” or “graduate-only/hybrid” team before submitting your design.
- Each team must submit an abstract of less than 300 words to info@hydrogencontest.org by **October 26th, 2007**. 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.
- The final submission must include an executive summary that reviews the main features of the project plan 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 Annual Hydrogen Conference.
- The final submission can include an appendix of up to 5 additional pages (within the 33 page limit) for additional information, calculations, and background material if needed.
- Judging criteria:
 - Points:
 - 20 Technical accuracy
 - 20 Realism, ability to be installed by January 2009
 - 20 Practicality/usefulness
 - 20 Value per dollar spent
 - 20 Overall impact on airport operations and surrounding community
 - 20 Originality
 - 20 Educational value
 - 20 Ability to transition from the incumbent system to the new design
 - 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 published. 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.

1.4 Prizes

- One grand prize winning team and four honorable mention teams are expected to be selected. Two of the four honorable mentions are expected to be given to undergraduate-only teams and two honorable mentions to graduate-only/mixed teams.
- On **February 1, 2008**, the Hydrogen Education Foundation will notify winning teams (teams are expected to refrain from publicly announcing their achievements until the public announcement date).
- Contest winners will be announced publicly at the NHA Annual Hydrogen Conference and Expo in Sacramento, California, March 30-April 2, 2008 (for more information on the conference, visit: www.HydrogenConference.org). All five winning teams (one grand prize team plus four honorable mentions) will receive awards at the conference.
- Winning designs will be published in the conference proceedings and online at www.HydrogenContest.org. Five members from all winning teams will receive complimentary registrations to the conference, in addition to complimentary hotel accommodations. For conference registration and hotel information, please see www.HydrogenConference.org.
- The grand prize winning team:
 - will receive 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 conference registration for eight team members and their faculty representative;
 - will have the opportunity to present their design at a general session of the conference. The team must send at least 1 representative to present the team's design; however, the team is **strongly** encouraged to use the stipend to allow the maximum number of team members to attend and participate; and
 - must send a 20-minute PowerPoint presentation (20 slides max) with highlights of the project plan (presentation will be given by the team representative(s) referenced above); presentations are due via email to HazeltonR@hydrogenassociation.org by **March 2, 2008**.
- The four honorable mention teams:
 - will be invited to give poster presentations at the NHA Annual Hydrogen Conference and Expo; and
 - will receive complimentary hotel rooms (double occupancy) and conference registration for four team members and their faculty representative.

1.5 Contest Schedule

- The Hydrogen Design Contest begins!* **June 7, 2007**
- Rules review meeting (open to all interested, details to be posted on www.HydrogenContest.org) **September 26, 2007**
- **DUE:** Abstracts (info@hydrogencontest.org) **October 26, 2007**

- **DUE: Entries due (see Section 1.3)** **December 14, 2007**
- Announcement of winners to winning teams **February 1, 2008**
- **DUE: Grand Prize team submits presentation for NHA Annual Hydrogen Conference to HEF Staff** **March 2, 2008**
- Announcement and presentation of all winning designs **March 30 - April 2, 2008**

* - Teams may begin working on Contest Designs

2 Design Guidelines

In addition to the task of handling millions of travelers every day, today's airports face challenges related to air and water quality, noise pollution, energy efficiency, and safety and security. Imagine your team has \$3 million USD to address these critical issues using hydrogen technologies at the Columbia Metropolitan Airport in Columbia, South Carolina. Although your design should aim to address the challenges at the Columbia Airport, a great design will have key elements that are applicable to other airports around the world. 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 2009.

2.1 The Project Plan

In this section, teams must clearly communicate the project plan and the context in which hydrogen technologies will be installed and used. Teams must describe design elements, how they work, and the benefits they will provide. Depending on the design and applications your team chooses to focus on, you should consider supporting elements such as the following, where applicable:**

- 1) Design Documentation/Drawings
 - (a) Conceptual site and building plans
 - (b) Preliminary sections and elevations
 - (c) Preliminary selection of building systems and materials
 - (d) Development of approximate dimensions, areas, and volumes
 - (e) Perspective sketches
- 2) Mechanical Design Documentation
 - (a) Energy sources
 - (b) Energy conservation
 - (c) Special mechanical systems
 - (d) Process systems
 - (e) General space requirements
- 3) Electrical Design Documentation
 - (a) Power service and distribution
 - (b) Lighting
 - (c) Special electrical systems
- 4) Civil Design Documentation
 - (a) On-site utility systems

(b) Off-site utility systems

A note about page limits: Addressing every element above may require additional pages that exceed the limit for this section. To avoid a page-limit penalty, carefully consider how you choose to communicate your project plan and design. Remember that although visuals in the body of your design are highly encouraged for effective communication, additional visuals may be included in the Appendix and referenced in the text.

**Teams may include other elements useful to communicate the effectiveness of the design, as space allows.

2.2 Safety Analysis

Public safety is a paramount concern for the operation of any airport. In this section, teams must show how their designs will operate safely and maintain the safety of the surrounding environment. Teams must insure that safety is comprehensively addressed in the operation of all hydrogen systems.

Judges will score the design according to how well they think safety has been addressed. This includes safety equipment and operational safety, as well as public perception of safety. Teams must address the following minimum requirements:

- Teams should identify the most significant (at least four) major failure modes of their designs. In determining which failure modes should be addressed, teams should consider both potential damage and frequency.
- Teams should describe how their design mitigates the risk of identified failures.
- Teams must document their sources as necessary.

2.3 Economic/Business Plan Analysis

Capital, Installation, Transitional and Marketing Costs

The \$3 million USD available for this project must cover capital, installation, transitional, and marketing costs. That is, the cost of all equipment, the cost to install the system(s), and the cost of any other work that may be required for a transition from an incumbent system to a new one using hydrogen technologies. For example, if a fuel cell is designed to replace an electric generator and the generator must be removed and thrown away, the removal/disposal costs must be included in the project budget. Teams must clearly document all project costs and show that the total is less than or equal to \$3 million. In the end, if the Columbia Airport had \$3 million and wanted to implement your design, it should be able to do so.

Operational Costs

Operational costs should be documented separately. Teams should clearly document the annual operating costs of the system(s) for the first year. If operating costs will change significantly in the next 4 years after the first full year, those changes should also be documented. If energy efficiencies of the hydrogen systems you choose provide lifecycle cost savings compared to the technologies they replace, those savings should be clearly documented. If your design produces revenue, that revenue should be included in this part of the Economic Analysis. After reading

this subsection, the judges should have a clear idea of what it will cost to operate and maintain your design for 5 years.

Overall

In addition to the costs addressed above, teams should show the value of their design in realistic terms. For example, a design that costs \$100,000 but has a value of \$500,000 (it might save \$400,000 in other energy/maintenance costs) might be perceived very differently from one that costs \$500,000 and has a value \$500,000.

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.

2.4 Environmental Analysis

In this section, teams must document the project's environmental impact and the way in which it addresses air and water quality, noise pollution, and energy efficiency.

Air and Water Quality, Noise Pollution

Airports are constantly monitored for air quality, water quality and noise pollution. Regulating authorities may not approve airport expansion/growth plans if there is a history of failure to meet current environmental requirements. To the extent applicable, teams should document, quantify, and explain how their systems can improve air and water quality and reduce noise pollution.

Energy Efficiency

In addition to the air quality, water quality and noise pollution impacts, teams must show the overall balance of energy use for system(s) operation (i.e., energy in = energy out, in kWh). Teams should include detail for major subsystems. A visual representation of the energy balance, including tables and/or figures, is encouraged.

2.5 Marketing and Education Plan

By design, airports are highly populated facilities. Even when equipment is operated by trained airport staff and not in direct contact with the public, travelers wary of new technologies may express concerns about safety and efficiency. Public acceptance of hydrogen can be a particular challenge. A logical, well-placed education and outreach effort, however, can mitigate any concerns, facilitate public acceptance, and even generate support for its increased use.

To address the issue of public acceptance and build local support for the airport'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 or as a poster on-site at the airport. The cost of implementing this plan must be included in the allowable overall project budget. The plan should:

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

High resolution or large format images can be included on the team's CD. See Section 1.3.

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2007-08-Hydrogen Airport.DOC

ⁱ <http://www.gao.gov/docdb/lite/summary.php?rptno=RCED-00-153&accno=576543>

ⁱⁱ <http://serconline.org/airportAirPollution.html>