Sponsors

2017-2018 HYDROGEN STUDENT DESIGN CONTEST

DESIGNING A POWER-TO-GAS SYSTEM

OFFICIAL RULES AND DESIGN GUIDELINES

August 1, 2017

Any revisions will be posted at www.hydrogencontest.org.

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(Please start the subject line with "HEF Student Contest")

The Hydrogen Student Design Contest is managed by the Hydrogen Education Foundation, a 501(c)(3) charitable organization. For more information on the Hydrogen Education Foundation, go to www.hydrogeneducationfoundation.org. All donations and sponsorships are tax-deductible.

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1. AT A GLANCE

1.1. REGISTRATION

Register your team via the Hydrogen Energy Foundation (HEF) Contest website at www.hydrogencontest.org/register.asp by September 15, 2017. You will be asked to provide the name of your Institution, your name and email, and your faculty advisor's name and email address.

1.2. ELIGIBILITY

The Contest is open to undergraduate and graduate students worldwide. All team members must have been enrolled in a college or university by September 1, 2017 but do not have to be enrolled full-time.

1.3. IMPORTANT DATES

1 June 2017	Initial Topic Announcement
1 August 2017	Rules and Guidelines posted
1 September 2017	Webinar on Topic, Resources
15 September 2017	Registration Deadline
15 October 2017	Project Outline (Abstract and Approach) Due
1 November 2017	Webinar on Progress, Feedback
31 January 2018	Final Project Submission Deadline
15 March 2018	Winner Notification
June 2018	Winner Announcement at DOE Annual Merit Review

2. INTRODUCTION

Each year, the Hydrogen Education Foundation's Hydrogen Student 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, urban planning, marketing, and entrepreneurship. Undergraduate and graduate students worldwide are eligible to participate.

2.1. THE CHALLENGE

The 2017 Hydrogen Student Design Contest will challenge student teams from around the world to develop a design for a system that uses electricity to produce hydrogen for cross market uses, including energy storage, ancillary services, and transportation fuel. The teams will choose a site in their area, engage their local electric and gas utility, coordinate with regulatory bodies and safety experts, and create educational materials, including a short video.

2.2. BACKGROUND

In a global effort to reduce carbon emissions from the combustion of fossil fuels, which are causing anthropogenic climate change[i], many countries around the globe have committed to renewable energy and zero emission technologies. This is causing a transition of the energy sector from centralized to a more decentralized form of production, leading to significant challenges along the way. The challenges on the electricity side include overproduction of renewable energy during peak times, resulting in curtailment and loss of resources, strains on the transmission grid during times of high production, intermittency issues with the need for energy storage or reserve generation, etc. Furthermore, many stakeholders in the transportation sector are preparing for adoption of near-zero or zero emission transportation solutions, not only for passenger vehicles, but also the entire goods movement sector, to reduce or eliminate local health hazards from criteria pollutants like particulate matter, SOx and NOx. Finally, governments are also creating global ozone and greenhouse gas reduction goals.

While there is no solution that can address all of these challenges, power-to-gas (P2G) can address a number of these issues, and deserves to be evaluated closely. Power-to-gas systems use excess renewable power to produce hydrogen from water through electrolysis. The hydrogen can then be transported through the natural gas grid via direct blending or further conversion to methane from waste carbon streams. The hydrogen could also be transported by other means, such as trucks, or used directly at the point of production. The stored chemical energy can then be used to generate electricity via a fuel cell or other generation device, as a transportation fuel, for space and water heating in residential and commercial building, to provide heat for industrial processes, and any other purpose for which hydrogen or methane is currently used.

Unlike batteries that will require massive capital investments and can only provide storage for a few hours, P2G has the potential to leverage the installed natural gas pipeline system to provide energy storage for days, weeks, or months, shifting energy from season to season as needed. As the world transitions more toward renewable power sources like wind and solar, the ability to store large amounts of excess power for extended time periods will be critical to supporting a renewable power grid.

2.3. ABOUT THE CONTEST

Since 2004, the HEF 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 of a new hydrogen fueling station and a hydrogen power park, respectively. The station 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 attention at the Columbia International Airport in Columbia, South Carolina.

The Contest is open to undergraduate, graduate and Ph.D. students worldwide. Multiple teams from one institution are permitted, but students may not belong to more than one team, and teams must work independently.

2.4. JUDGING

A panel of expert judges from federal agencies, sponsors, industry and academia will be grading the student teams' submissions.

Each judge will be assigned a random set of entries. The scores from the judges' set will then be normalized using standard deviation formulas to account for individual bias. For the final entry, the top 5 entries will be reviewed a second time by a select panel of judges to identify the winning teams.

2.5. PRIZE SUMMARY

For this Contest, the Grand Prize winning team will receive a travel stipend to attend and present their design at the 2016 DOE AMR.[ii] If contest sponsorship is sufficient, top teams may receive a monetary award as well.

Honorable mentions (awards depend on available funding) will receive waived conference registration, accommodations for the 2018 DOE AMR, an invitation to present the design in a poster presentation component of the event.

All winning teams' designs are also planned to be published in the International Journal for Hydrogen Energy (IJHE), a major industry publication. Sponsors may also consider students for internship positions.

For more details on contest prizes, please see Section 3.7.

3. RULES

3.1. ELIGIBILITY AND TEAM STRUCTURE

The Contest is open to undergraduate and graduate (including Ph.D.) students worldwide. Team members must be enrolled in a college or university at the time of abstract submission but do not have to be enrolled full-time. Students who are working or researching part-time in the field or a related field of the Contest topic may participate.

Students who are enrolled at a university at the time of abstract submission, but will graduate before August 31, 2018, may still participate.

Given the multi-disciplinary nature of this competition, teams are highly encouraged to include students with various expertise, including: 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. A team with students from diverse backgrounds will help address non-technical sections much better than a homogenous team.

Each team is limited to a maximum of two faculty advisors. The faculty advisors must be faculty members of a college or university. 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 ensuring that the teams work independently to maintain a fair competitive atmosphere for all participants.

Multiple teams from one institution are permitted. However, each team must work independently to keep the competition fair for other teams. Students may not participate in more than one team at any given 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 letter to the address in Section 2.3 [PT1]or by email to ewagner@ttcorp.com. Teams with students from more than three schools are not allowed.

A team of about 8 students is recommended, although teams with no less than 3 or up to 12 students are allowed. **Teams may not exceed 12 students at any time.** In cases where more than 12 students are interested in participating in the Contest, students are encouraged to split into two separate teams.

Please send an updated team roster to ewagner@ttcorp.com if any changes to your team roster are made during the course of the contest.

3.2. 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 using common citation styles.
- Teams may contact professionals in the hydrogen and fuel cell industry as desired, and are encouraged to do so. If information from industry experts is used to develop the design, teams **MUST** cite all sources. No proprietary or confidential information should be included in any design or presentation.
- Teams may submit any questions about the contest by email (ewagner@ttcorp.com). Please include “HEF Student Contest” in the subject line for a timely response.

3.3. TEAM REGISTRATION AND MEMBER LIST

- Each team must register via the HEF Contest website at www.hydrogencontest.org/register.asp by September 15, 2017. Team leaders will be asked to provide the name of your Institution, your name and email, and your faculty advisor’s name and email address.
- Registered teams will be made public on the contest website and may be included in contest announcements.
- Teams must submit their member roster with their abstract. The list needs to be in an Excel spreadsheet format. This list shall include the following:
    - Name and email address of Faculty Advisor(s)
    - Name and email address of Team Leader, alternative Team Leader and **all** participating students
- Teams are encouraged to submit additional information that could be shared via social media, e.g. team photos, short team description or even motivational videos. This information will be posted on the Hydrogen Student Design Contest Website and/or the HEF Facebook site (www.facebook.com/Hydrogen.Education.Foundation) and linked to the team’s university website or own site, if desired. Students agree that the information that the Contest receives may be shared in the ways described above (excluding name and email address).

3.4. PROJECT OUTLINE SUBMISSION

- All submissions must be in English. The **metric system** must be used throughout the entry. Currency must be U.S. dollars. Where conversions are required, the exchange rate from September 1, 2017 shall be used.[iii]
- Must be submitted by **5:00 PM ET on October 15, 2017**
- The Project Outline must contain: a 4-page (maximum) abstract, an identified location for the siting of the system and rationale, a description of the major system components and rationale for the choice, and a timeline that details how the team will be approaching the design of the power to gas system.
    - This section will require background research into system design, and the safety/environmental considerations associated with such a system.
- The submissions will be reviewed by the judges and feedback will be given within two weeks.

3.5. FULL ENTRY SUBMISSION

- Final entries must be submitted **by 5:00 PM ET, January 31, 2018**
- Late entries will be penalized.
- The entire report, including graphics and citations, should appear as a single PDF file. The electronic copy of the report must be emailed to ewagner@ttcorp.com. Please include "**HEF Student Contest Entry – [Your school name]"** in the subject line of the email. Please be cautious about the file size of the document. HEF will respond within 24 hours upon receipt of the submission.
- You may set up a Dropbox account or FTP site if the attachments exceed 8MB
- All materials must be submitted electronically. Mailings will not be accepted.

PAGE LIMITS

The following page limits have been recommended for each section. You may distribute the pages as you see fit provided that the final report does not exceed 38 pages, not including references and citations. Report pages must include 1 inch (2.5 cm) margins and be written using a font no smaller than 11 point size, single spaced.

Section	Recommended Page Count
Cover Page	(Not included in page count)
Executive Summary	1
Table of Contents	1
Design Data and Equipment Drawings	15
Cost and Economics	4
Safety Analysis & Codes and Standards	5
Siting, Operation and Maintenance	4
Environmental Analysis	4
Commercialization Analysis	1
Policy/Regulatory Analysis	3
References/Citations	As necessary (not included)
Max. No. Pages	**38 plus references/citations**

Entries that exceed the maximum total page limit will be deducted **5 POINTS** for **each page** that exceeds the limit, excluding references and citations.

Entries that are received after the official deadline will be deducted **5 POINTS** for **each day** that it is late. However, the Hydrogen Education Foundation reserves the right not to accept late entries.

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, 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 3) and provide any other relevant information.

3.6. JUDGING CRITERIA

Points	Topic
65	Design
10	Siting
40	Cost and Economics, Commercial Viability
20	Safety Analysis & Codes and Standards
10	Operation and Maintenance
20	Environmental Analysis
35	Policy Analysis & 1 Pager for Policy Makers
20	Brochure for Public Education
15	5 minute video
15	Accuracy, Graphics, Readability
250	**TOTAL**

Teams are encouraged to copyright their submissions. By submitting a design in this contest, however, teams agree to allow their papers to be published professionally in participating media partners' publications and archived on the Contest website. 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.

3.7. PRIZES

3.7.1. GENERAL INFORMATION

All prizes are dependent on available funding and may change accordingly throughout the Contest. One grand prize winning team and one or more honorable mention teams will be selected.

The Hydrogen Education Foundation will notify winning team on March 15, 2018. Teams are required to refrain from publicly announcing their achievements until the award ceremony. Contest winners will be announced publicly at the 2018 DOE AMR in Washington, DC June 2018. All winning teams will receive awards at the conference. Winning designs will be published online at www.HydrogenContest.org and the IJHE, a leading industry trade publication.

For winning teams outside of the United States, passport and visa arrangements must be made by the individual team members to attend the 2018 DOE AMR. The travel stipend will not be increased for teams outside of the U.S.

Depending on opportunities provided, some of the winning teams may be invited to present their design or meet sponsors or decision makers at events not identified in the prize description.

3.7.2. GRAND PRIZE

The grand prize winning team will receive:

- An invitation to present their design to industry leaders in a session of the 2018 DOE AMR
- A stipend of up to $5,000 to cover airfare, meals, accommodation and incidental trip expenses (must be documented) and 2016 DOE AMR registration for up to eight team members and their faculty representative
- Publication of their design in an issue of the International Journal for Hydrogen Energy (IJHE)
- Priority consideration for summer internships at sponsor organizations
- Presentation in a DOE/HEF webinar
- Monetary prize (if contest funding allows)

Important Information:

The winning team must send at least one representative to present the team's design at the 2018 DOE AMR. However, the team is **strongly** encouraged to use the stipend to allow the maximum number of team members to attend and participate in the conference.

The team must send a 15-minute PowerPoint presentation (maximum of 15 slides) with highlights of the project plan, to be given by the team representative(s) during a session of the 2018 DOE AMR. Presentation is due via email to ewagner@ttcorp.com by **two weeks prior to the 2018 DOE AMR**.

3.7.3. HONORABLE MENTIONS

The honorable mention teams will receive:

- A stipend of up to $2,500 to cover airfare, meals, accommodation and incidental trip expenses (must be documented) and 2018 DOE AMR registration for up to eight team members and their faculty representative
- An invitation to give a poster presentation or short presentation at the 2018 DOE AMR
- Conference registration for up to four team members and their faculty representative 2018 DOE AMR
- Publication of their design in an issue of the International Journal for Hydrogen Energy (IJHE)
- Presentation in a DOE/HEF webinar
- Priority consideration for summer internships at participating sponsor organizations

3.8. CONTEST SCHEDULE

1 June 2017	Initial Topic Announcement
1 August 2017	Rules and Guidelines posted
1 September 2017	Webinar on Topic, Resources
15 September 2017	Registration Deadline

15 October 2017	Project Outline (Abstract and Approach) Due
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June 2018	Winner Announcement at DOE Annual Merit Review

3.9. TIPS

3.9.1. TIME MANAGEMENT

It is important for your team to start Contest work early to be able to adhere to the deadlines of the Contest. Previous teams found the most challenging part of the Contest to finish their submission on time while allowing for a high quality submission. Connect with researchers and industry from the start; they can help you to refine your approach and ideas and help save time. Allow for enough time at the end for a thorough review period of your final submission. Be aware that many companies may not give you all the information you may desire, especially related to cost information. Feel free to connect with HEF staff if you encounter such issues.

3.9.2. LEARN FROM SUCCESSFUL TEAMS

Review previous winning entries and see how they approached the contest. All winning entries are archived on the Contest website.

4. GUIDELINES

Undergraduate, graduate and post-graduate students from around the world are invited to participate in the contest by identifying a location in their community that could use excess renewable electricity produced during certain times of the day and produce hydrogen.

Working with their local utility and regulators, the students will then determine the most effective use cases for that renewable hydrogen. Examples include[PT2] using the hydrogen for energy storage by storing it or feeding it directly or via methanation into the natural gas pipeline, feeding it back into the grid via a fuel cell during peak demand times, or use it for other applications like vehicle fuels or for the chemical sector. The students are invited to explore other avenues that generate revenue to improve the ROI on the system, e.g. by providing ancillary services to the grid. The students will be able to work with several electrolyzer manufacturers to better understand the capabilities of power-to-gas systems.

Additional aspects of the contest will include an economic analysis to determine the financial viability of their project, an environmental and safety analysis, and a policy and regulatory section. In an effort to educate the public, the students will be tasked to develop a brochure on Power-to-Gas, which describes the technology, supported by a video of no more than 5 minutes, and a separate document to educate regulators on how the technology would fit into their market, identifying potential barriers to adoption under the existing regulation scheme.

In cases where student teams are not able to work with a local utility, or in which the electricity portfolio does not include a significant portion of renewable energy production, the student teams will be able to use a location within the territory of the Southern California Gas Company, which will provide the required information for this service area. The contact at Southern California Gas Company to receive information is Matt Gregori, Clean Energy Technology Scout at Southern California Gas Company,: mgregori@semprautilities.com.

The technologies and systems participating teams select for their design must be commercially available and feasible to implement for practical, real-world use by September 1, 2017. Participants should clearly state any assumptions used in their entries.

4.1. PROJECT OUTLINE

All teams **are required** to develop an up to 4-page project outline for review and commentary by the judges. This entry will **NOT** be graded, but rather provides participating teams with the feedback needed to either continue to pursue their design or to amend their design and incorporate the judges' comments. To improve the feedback from judges, teams should strive to provide a detailed submission.

Submissions must include:

- Abstract – Narrative of the team's approach to their micro-grid, outlining the key challenges and solutions for their system design.
- Timeline of how the team plans to finish the project
- Description of major system components with specifications and rationale for their choice.

4.2. FULL ENTRY

For the full entry, the teams must submit a complete design based on the following criteria.

4.2.1. COVER SHEET, EXECUTIVE SUMMARY & TABLE OF CONTENT

The submission needs to feature a cover sheet, including the title of their submission, list the members of the team and general contact information.

Teams are required to provide a one-page executive summary outlining the key components, challenges and solutions included in their design.

The submission needs to include a Table of Content (TOC) with page numbers for easy reference. If submitted in electronic form, a linked TOC to the specific sections is highly recommended.

4.2.2. SITING INFORMATION

This section should show the results of the interaction with the local utility, identifying where at the local gas/utility grid the system would be sited to provide the highest benefit for the electric & gas grids. The reasoning for the specific site choice should be declared in detail.

4.2.3. DESIGN DATA AND EQUIPMENT DRAWINGS

In this section, all components of the system need to be described in detail, including their interconnection, supported by detailed high-resolution schematics. A blueprint and schematics of the entire systems with specs on key data, including footprint, weight, and interconnection requirements needs to be included.

- Electricity to Hydrogen Conversion
- Gas Transportation and Storage
    - Compression
    - Storage Equipment
    - Liquefaction
    - Truck Transport
    - Pipeline Injection
- Hydrogen Use
    - Methanation
    - Electricity Production via fuel cell, natural gas combined cycle, etc.
    - Hydrogen for Energy / Fueling, including compression, storage, dispensing
    - Space and water heating
    - Industrial and chemical processes
    - Hydrogen for other uses
- Communications Equipment
- Safety Equipment

4.2.4. COST AND ECONOMIC ANALYSIS, COMMERCIAL VIABILITY

In this section, the teams will determine the costs of their proposed power-to-gas system. Using a line-itemization chart, this comprehensive analysis should include all fixed costs associated with the team's design. Furthermore, the teams need to estimate the operating costs of the system as well as estimate costs for replacements of parts.

The analysis should include:

- **Capital costs** for all equipment, including installation costs.
- **Operating costs** of all resources necessary for operation (i.e., water for electrolysis, electricity for compressors and controls[iv]). Justify costs for water and electricity (when needed) using average U.S. utility prices.[v]
- **Maintenance requirements and costs**.

Additionally, students will need to develop a matrix for the price of hydrogen ($/kg) and electricity ($/kWh) for sale. This will be based on the cost of the system and different estimates for demand. With those results, a return on investment analysis needs to be developed with a payback period no longer than 10 years.[vi] In general, students should consider different approaches in order to reduce costs, e.g. off-peak hydrogen production using real-time pricing for electricity or developing additional value streams for the system or its products. See "Optional Features" section for details.

4.2.5. SAFETY ANALYSIS & CODES AND STANDARDS

In this section, teams must show how their system design will operate safely and maintain the safety of the surrounding environment. Teams shall describe how safety concerns and applicable codes and standards have been addressed for their fueling system. Safety equipment and operational safety, as well as public perception of safety, are included.

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

- Perform a Failure Mode and Effects Analysis (FMEA) by identifying the most significant safety risks in the design. In determining the failure modes that need to be addressed, teams should consider both the magnitude of potential damage and frequency.
- Describe how their design mitigates the risk of any identified issues.
- List applicable codes and standards, show how the design is compliant, and describe how code requirements were used to ensure safety (visit www.fuelcellstandards.com for information on different relevant codes) The majority of hydrogen codes and standards are safety related, such as National Fire Protection Association (NFPA) codes 2 and 55, as well as the Society of Automotive Engineers (SAE) codes relating to connections between dispenser nozzles and fuel cell electric vehicles. However, not all codes, standards and regulations relate to safety, e.g. standards relating to hydrogen fuel quality[vii].

Resources for hydrogen related codes and standards are:

- Hydrogen and Fuel Cell Safety - http://www.hydrogenandfuelcellsafety.info
- Fuel Cell Standards - http://www.fuelcellstandards.com
- National Fire Protection Association - http://www.nfpa.org
- International Code Council - http://www.iccsafe.org

Other good resources include the HEF H-Prize website[viii], DOE Hydrogen Permitting website[ix], SAE hydrogen standards, and the corresponding regulatory agencies for the states and counties in which the students plan to construct hydrogen sourcing and refueling stations.

FINAL SUBMISSIONS FOR THIS SECTION MUST INCLUDE:

Show that the team's design addresses the issues identified in FMEA and provides solutions, and meets all the necessary codes, standards and regulations. Ensuring these codes, standards and regulations are met will demonstrate a high level of reliability, safety and quality of the design. Teams must document their sources as necessary.

4.2.6. OPERATION AND MAINTENANCE

The system should be capable of operating nearly autonomously with at most a single team of system operators at the system location at any one time. The system thus needs to be able to collect performance data on all key system components.

The system shall be designed to facilitate rapid and easy replacement of most parts to minimize potential downtime. Teams are required to identify the ability to conduct repairs and maintenance of the system, e.g. accessibility of key systems.

Consideration should be given to minimum operational levels of equipment when usage is low and to the cycling of systems as concerns peak hour output. Teams should also provide information of life expectancy of the components used.

4.2.7. ENVIRONMENTAL ANALYSIS

The impact of the system on the surrounding is a key component in siting any system. Teams must provide a narrative of the environmental impacts of the design. This should include considerations of how residents may be impacted.

4.2.8. POLICY AND REGULATORY ANALYSIS & 1 PAGER FOR POLICY MAKERS

The teams need to analyze obstacles to implementation of a power-to-gas system, based on the interactions with their local utilities and policymakers. In this section, it should be identify if the services provided by the system are adequately considered and priced by the local regulators. The barriers should be identified and proposals for amending the existing framework should be made.

Based on the assessment, the teams are required to develop a 1-page document, which educates the regulators and policymakers on the technology and the barriers that exist to its implementation.

4.2.9. BROCHURE FOR PUBLIC EDUCATION

Teams are tasked to develop a brochure on Power-to-Gas, which describes the technology for the public in non-technical language. The brochure should contain market and technology information.

4.2.10. MARKETING VIDEO

Teams are to support their entry by developing a video of no more than 5 minutes, which will attempt to “sell” their design to the judges. The intent of this video is to display all the major characteristics of the system so that the judges may have an easier time evaluating systems, and so that the teams gain valuable marketing experience.

4.2.11. OPTIONAL FEATURES

Teams may think about additional features for their system that may increase the profitability and usability of the system.

5. 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.

6. LIABILITY

The Hydrogen Student Design Contest, the Hydrogen Education Foundation and any sponsoring or supporting organization assume no liability or responsibility for accidents or injury related to the Contest.

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[i] IPCC 5th Assessment report
[ii] Prizes are subject to change and depend on number of sponsors.
[iii] Students shall use www.xe.com for currency conversions.
[iv] For comparison, use http://www.ttcorp.com/pdf/marketReport.pdf, page 11 for costs of delivered hydrogen in the U.S. Note that these prices do not include sales tax. Do not calculate the distance from the production facility.
[v] For electricity, use 10.58ct/kWh (http://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_5_6_a)
[vi] Useful information on station cost can be gleaned from this NREL Paper: http://www.nrel.gov/docs/fy13osti/56412.pdf
[vii] Ensuring fuel quality is of particularly high importance to the reliability of PEMFC technology.
[viii] http://www.hydrogenprize.org
[ix] http://www.hydrogen.energy.gov/permitting/index.cfm