

IV.E.8 Administration of H-Prize for Hydrogen Storage

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SCRA, Charleston, SC

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Objectives

- Over a three-year period, design and implement a pilot program for the initial H-Prize award under Section 654 of the Energy Independence and Security Act of 2007 (see the Introduction for a description of H-Prize).
 - If a qualified winner is identified, award \$1 million for a significant advancement in hydrogen storage materials for light-duty vehicle applications.
- Create a pilot award process.
- Organize and execute a comprehensive fundraising program to supplement and/or create other awards under Sec. 654.
- Combine the fundraising program with a systematic process that deploys collected funds through fair and open competitions.

Technical Barriers

This project addresses the following technical barriers from section 3.3: Hydrogen Storage of the Fuel Cell Technologies Program Multi-Year Research, Development and Demonstration Plan:

- (A) System Weight and Volume
- (C) Efficiency
- (D) Durability/Operability
- (E) Charging/Discharging Rates
- (G) Materials of Construction

- (J) Thermal Management
- (K) System Life-Cycle Assessments
- (Q) Reproducibility of Performance
- (R) Regeneration Process
- (S) By-Product/Spent Material Removal

Technical Targets

H-Prize consists of a series of contests that leverage private funds with core funding provided by the federal government to broaden the base of investment in development of hydrogen technology and advance that technology into the marketplace.

The first H-Prize in this series, for hydrogen storage, was designed to address the challenges that exist in advancing automotive hydrogen storage for fuel cell electric drive vehicles. Its goal was to produce a material that has the potential to be an on-board rechargeable hydrogen storage material. Specifically, the H-Prize required that the storage material have the following characteristics:

- Gravimetric capacity of >7.5 wt% hydrogen (releasable hydrogen):
 - Reversible hydrogen capacity between -40 to $+85^{\circ}\text{C}$, and between 1.5 to 150 bar hydrogen pressure.
- Volumetric capacity of >70 g/liter (releasable hydrogen):
 - Total volume of hydrogen ab/adsorbed by the solid plus the pressurized hydrogen contained within the pore spaces all divided by the total sample volume including the material's skeletal volume.
- Charging kinetics: greater than or equal to 4×10^{-4} (i.e. 0.0004) grams of hydrogen per gram of material per second:
 - Charging kinetics are to be measured with an inlet hydrogen gas temperature of between -40 to $+85$ degrees C and an inlet hydrogen pressure of not greater than 150 bar.
- Discharge kinetics: greater than or equal to 2×10^{-5} (i.e. 0.00002) grams of hydrogen per gram of material per second:
 - Discharge kinetics are to be measured at a sample temperature between -40 to $+85^{\circ}\text{C}$ and with an outlet hydrogen pressure of greater than or equal to 1.5 bar.
- Cycle life of >100 cycles.
- At completion of 100 charge/discharge cycles from less than 5% to greater than 95% of reversible capacity, the sample's reversible capacity must still be greater than or equal to 95% of the gravimetric capacity target (i.e. ≥ 0.95 times 7.5 wt% or ≥ 7.1 wt%).

Figures 1 and 2 show the relationship between the state of the art for hydrogen storage in 2008 and 2011 compared to the gravimetric and volumetric targets for the hydrogen storage material sought by the first H-Prize.

Accomplishments

Task 1: Contest Rules

- Specific goals and technical targets were established in partnership with DOE staff.
- Feedback was sought from industry and the hydrogen community on technical evaluation criteria for initial H-Prize contest; draft criteria were presented to the Hydrogen and Fuel Cell Technical Advisory Committee (HTAC) in November 2008 and Hydrogen Interagency Working Group in December 2008.
- Set of criteria and basic contest parameters for inclusion in a draft Federal Register Notice was submitted to DOE for review and action in February and March 2009.

Task 2: Announce and Promote Contest

- Preliminary presentations made in November 2008 (to HTAC) and December 2008 (to the Hydrogen Interagency Working Group).
- First announcement was made at National Hydrogen Association Annual Conference in March-April 2009.

- Poster presentation during DOE Annual Merit Review in May 2009.
- Federal Register Notice released on August 26, 2009, announcing the beginning of the outreach campaign.
- HEF press released about contest on September 30, 2009.
- H-Prize website operational at <http://hydrogenprize.org>.
- Presentation about H-Prize to conference: *Hydrogen Production and Storage* in October 2009.
- Presentation at Resources for the Future in Washington: *The Role of Prizes in Innovation and Entrepreneurship* in December 2009.
- Scores of individual calls and e-mails were sent to people we could identify who were working in or interested in this niche area of hydrogen storage.
- E-mail campaigns were sent out to HEF's 30,000+ person hydrogen and fuel cell mailing list to attract other interest.
- Of 20 registrants, 15 submitted all the materials necessary to participate in the contest.

Task 3: Judging

- In consultation with DOE staff, the panel of judges was developed and their willingness to participate was confirmed.

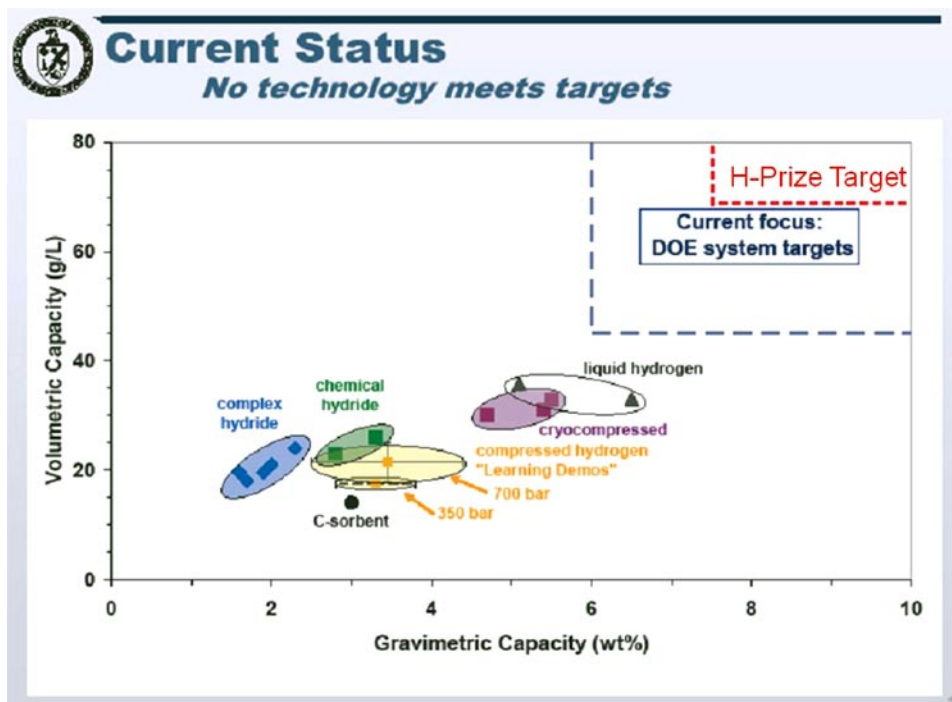


FIGURE 1. H-Prize Targets Relative to the State of Hydrogen Storage Technology as Reported by DOE in 2008 (modified from "Hydrogen Storage," Sunita Satyapal, 2008 Annual Merit Review Proceedings to include H-Prize targets)

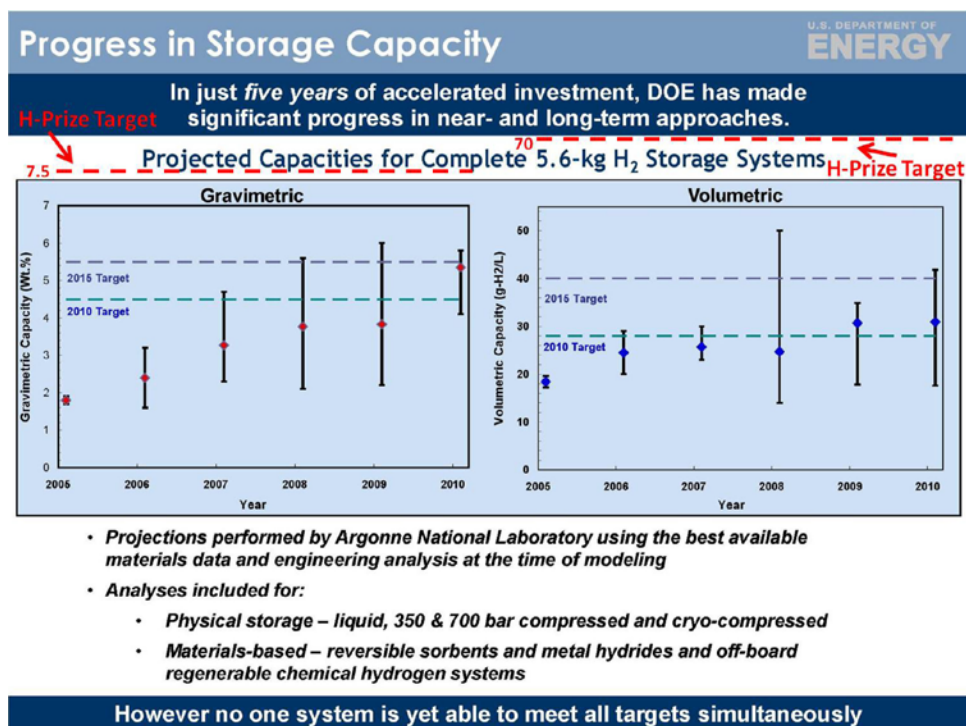


FIGURE 2. H-Prize Targets Relative to the State of Hydrogen Storage Technology as Reported by DOE in 2011 (modified from “Overview of Hydrogen Storage,” Ned Stetson, 2011 Annual Merit Review Proceedings to include H-Prize targets)

- In third quarter of 2010, HEF staff and DOE completed Conflict of Interest and Non-Disclosure Agreement forms for panel of H-Prize judges.
- HEF Board of Directors approved slate of recommended judges in third quarter of 2010.
- With the November 15, 2010 deadline for receipt of materials approaching, HEF staff prepared and sent a detailed message to all the eligible H-Prize participants to remind participants of the key upcoming contest deadlines, discuss contest procedures for testing and verification, and encourage the participants to secure their independent testing with adequate time for meeting the November 15th deadline should their storage material qualify.
- Two eligible participant teams, Microbes Unlimited and Zaromb Research Corporation, submitted their testing results. Both submissions were found not to meet the minimum requirements set by the H-Prize and therefore were not sent off to our independent laboratory.
- Zaromb Research Corporation did write a letter disputing the judges’ findings. Judge, Bob Bowman, and DOE Staff, Ned Stetson, collaborated on a response to address the issue. They refuted Zaromb Research Corporation’s argument.
- No team qualified to advance to the next phase of the Competition.

Task 4: Management

- Kick-off meeting held on October 17, 2008.
- Revised budgets and award contingencies remedied.
- HEF staff met with DOE on March 24, 2010 to discuss next steps and upcoming work items for the H-Prize, such as the judging process, details for how to conduct the required sample testing, and a status update on HEF’s administration of the contest. HEF and DOE staff discussed selections for the H-Prize’s judging panel.
- Draft conflict of interest and nondisclosure agreements necessary for judging panel were completed.
- Receipt of test results and materials for subsequent independent verification of results deadline was November 15, 2010.

Task 5: Fundraising

- Marketing lists and fliers created in mid-2009 and awaited Federal Register notice authorization.
- Subcontractor SCRA developed and executed the majority of the fundraising plan.
- Outreach completed by physical mail and phone to 226 different foundations identified as having interest in supporting energy-related programs.
 - Received over 130 rejections for funding including 100% of our “top prospects.”

- Successful application to the 2010 Combined Federal Campaign (CFC).
- Promoted the H-Prize and Hydrogen Education Foundation to CFC offices around the country to encourage donors.
- Launched an online ad campaign on Govexec.com that targeted visitors interested in activities at the Department of Energy, Green Government, as well as a run of site for visitors in the D.C. area.
- Received donations from 30 different CFC administrators around the U.S. totaling about \$2,300 at the time of writing.
- Utilized a mobile fundraising service to reach a broader audience of givers and allow givers to donate by text message.
- Sent out individual letters to key contacts/philanthropists, asking for individual donations.



Introduction

The H-Prize was created by an act of Congress as part of the Energy Independence and Security Act of 2007, Section 654, to accelerate the development of hydrogen and fuel cell technologies by offering prizes to motivate and reward outstanding scientific and engineering achievements. H-Prize consists of a series of contests that leverage private funds with core funding provided by the federal government to broaden the base of investment in development of hydrogen and fuel cell technologies and advance that technology into the marketplace.

Approach

HEF staff worked in concert with DOE to develop a contest that supported DOE's program and the legislation enacted by Congress. The first competition was designed to address challenges in hydrogen storage. While developing the Contest, we solicited feedback from industry stakeholders (both individual experts and groups like DOE's HTAC) to create the guidelines and parameters for assessing entries.

In parallel, a vigorous fundraising campaign was launched by HEF and its former subcontractor SCRA to seek non-government financial support for future contests named in the legislation. Over 220 potential sponsors were identified and contacted for possible funding of the contest. In addition, HEF staff applied for and succeeded in participation with the CFC in 2010. HEF has also been accepted into the 2011 CFC.

In addition to the fundraising efforts for future prizes, a marketing campaign was created to promote the first H-Prize competition for on-board hydrogen storage once the theme and guidelines were finalized. After input from various experts and stakeholders, the guidelines were

approved by the HEF board of directors and the U.S. Department of Energy and published in the Federal Register in August 2009.

Announcements were made at several industry events, such as the National Hydrogen Association's Annual Conference in Columbia, South Carolina and DOE's Annual Merit Review, through press releases, and individual contact to hydrogen storage experts and groups. Staff developed a contest website, <http://www.hydrogenprize.org> for communicating the contest to the public and to serve as a tool for administering the competition.

Results

Administration of the H-Prize for Hydrogen Storage:

Applying to compete in the H-Prize for Hydrogen Storage included these basic four steps:

- Register online.
- Submit your application.
- Submit independent testing results showing that your material meets the established criteria.
- Submit a sample of the material for testing by the H-Prize's official laboratory.

For this first completion, a total of 20 organizations registered to participate. Given the niche focus on a specific area of hydrogen storage plus the fact that many of the experts in the hydrogen storage community are funded in part through DOE projects (and therefore were not eligible to compete), this left a very small number of potential applicants. We believe that these 20 registrants represented a majority of the people who could have qualified to compete.

Of the 20 registrants, 15 entities submitted full applications to be considered for the H-Prize and when the deadline passed to submit independent testing results, only two contestants remained. (The 13 organizations who withdrew cited costly independent laboratory work and a lack of resources to complete the required testing.)

The two remaining contestants, Microbes Unlimited and Zaromb Research Corporation, submitted their test results to the HEF and judging panel for review and to determine whether the contestants were qualified for step 4: to submit their hydrogen storage material for testing. The judges determined that the test results from Microbes Unlimited and Zaromb Research Corporation were insufficient for the prize to be awarded based on the parameters identified in the contest. Since both submissions were found not to meet the minimum requirements set by the H-Prize, no materials were requested or tested by the H-Prize laboratory.

Zaromb Research Corporation did write a letter disputing the judges' findings. Chief Judge, Bob Bowman, and DOE's Hydrogen Storage Team Leader for Metal

Hydrides, Ned Stetson, collaborated on a response to address the issue refuting Zaromb Research Corporation's argument. No team advanced to the next phase of the competition and the \$1 million prize was not awarded. The contestants were notified, but no public announcement was made.

Looking ahead, significant opportunities exist to administer future prizes differently, and we have options to use the unawarded \$1 million prize money in other areas to broaden the base of investment in development of hydrogen and fuel cell technologies.

Fund-Raising for Future H-Prizes:

During the fund-raising period for the H-Prize, over 220 foundations, tens of thousands of individuals and more than 100 companies were contacted to donate funds to support current or future H-Prizes described by the Sec. 654 legislation. Unfortunately, the results of this significant fund-raising effort did not bear the large sum of donations sought: \$1-5 million.

From the more than 220 foundations, we received over 130 rejections for funding including 100% of our "top prospects." Since this was one of the primary tactics envisioned for fund raising, once we received rejections from most of our top prospects, we changed our approach and reallocated funding into other areas to try new methods to attract new funding. That shift mostly included utilizing the CFC and raising awareness of HEF's participation in it.

At the time of writing, approximately \$2,300 had been collected, entirely from individual donations made through 30 different administrators for the 2010 CFC. Since all but one of the donations were anonymous, we do not know how many donors contributed, but the distribution of the CFC administrators that sent in checks to the HEF seem to indicate that our marketing had good nationwide reach and an unexpected international reach as well. The largest donations were received from the following CFC administrators:

- CFC-Overseas
- National Capital Area CFC
- CFC Portland Oregon
- Southeast Connecticut CFC
- South Hampton Roads (VA) CFC
- Texas Gulf Coast CFC
- Heart of Alabama CFC

We believe the small number of dollars collected can be mostly attributed to a few key things:

- Depressed economy (foundations, corporations and individuals all cited a lack of available resources).
- The subject of the current H-Prize in a very niche area of a technical field did not have the mass/popular appeal to attract funding from entities that would be considered "outside the choir" of the hydrogen and fuel cell industry.

- The technique for reaching out to foundations has changed significantly from the time we competed to administer the H-Prize to the time we started reaching out foundations. More specifically:
 - In the past, one could be successful with a well composed letter, printed materials about the proposed project, follow-up phone calls, etc. (in other words, fund raising remotely).
 - Today, after consulting with foundation fund-raising experts to try to learn if we could change our approach to increase our success with foundations, we learned that hardly anyone raises funds with foundations without first developing an in-person relationship with the foundation's staff. This equates to travel and significant time which the budget of this project was not designed to support.
 - As a result, we decreased our work with our fund-raising subcontractor and added resources to other creative fund-raising methods, including the CFC.

Conclusions and Future Directions

The initial H-Prize contest was not awarded as the two organizations competing for the prize did not meet the criteria for awarding the prize as was determined by the judging panel. In assessing the theme and parameters post-contest, it has become clear that the initial contest was quite limited in scope and the bar set extremely high (see Figures 1 and 2), thus reducing the numbers of prospective contestants. However, if the goal was to reach most of the American organizations who were not receiving DOE funding in hydrogen storage to encourage greater investment among this group, we believe that goal was reached. The number of people who meet these qualifications just happens to be very small.

The staff at the HEF will meet with DOE's H-Prize Manager, Dr. Ned Stetson to discuss lessons learned and new ideas for a new H-Prize since some administration funds remain as well as the \$1 million prize money. Prior to this meeting, the HEF will reach out to industry stakeholders to seek input on the challenges they are experiencing today and how the H-Prize may help address those challenges within the context of its objectives as defined above. Initial discussions with colleagues in the hydrogen community have revealed that there is a desire to strengthen relations between hydrogen and fuel cells with the broader renewable energy community including solar, biomass, and wind.

With a fully functional website that is active, marketing capabilities established, and lessons learned from the initial contest, DOE has a significant opportunity to build on these resources to create an even more successful prize in several different categories named in the H-Prize legislation. HEF staff looks forward to discussion what options exist in working with DOE on a second H-Prize in the near future.