The H-Prize Act of 2006

Statement of

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Thank you, Ladies and Gentlemen, for this opportunity to discuss the H-Prize Act of 2006, now before this Committee. I believe the H-Prize offers an innovative policy that could accelerate our nation's transition toward more secure and sustainable energy by:

- Stimulating and nurturing the relevant science and engineering research from which innovation must spring; and,
- Accelerating hydrogen-related research to cross the gap from science opportunity to investment opportunity.

To fully accomplish this, the H-Prize program should operate with several principles in mind.

- Continuity. The prizes must be offered reliably and for a period long enough to build the technology pipeline, rather than simply create a windfall for those already there.
- Additionality. The funds needed to support the H-Prize must supplement rather than compete with the core funding appropriated in support of hydrogen-related research and development.
- Learning. We cannot now anticipate the changes, social as well as scientific, that will occur over the 10-year life of the H-Prize program, and so the administration of the prize program must carefully document its experience, learn from that experience, and adapt accordingly.

In what follows, I will set out my reasoning in support of these summary points, and offer suggestions for the operation of the H-Prize program.

Building the Foundation: Advancements

The first category of the H-Prize structure, "advancements in components or systems," can serve to expand the research base upon which innovations will draw. These prizes would accomplish this by drawing attention to the importance of the hydrogen revolution, and by combining prestige with monetary value in attracting additional researchers into the field. To achieve the greatest benefit, however, I would suggest that consideration be given to:

- Including scientific discoveries that lead directly to components or systems in the eligibility for an "advancements" prize;
- Allowing enabling technologies to be included in the award criteria; and,
- Ensuring continuity over the ten-year life of the program to lower the career risk for technologists considering hydrogen-related research.

Including Directly Related Scientific Discoveries The intent of the H-Prize is to accelerate the hydrogen transition by focusing on the application of technology, not the creation of new knowledge—and properly so. Yet the boundaries between science and innovation remain indistinct,[1] and in some cases a science breakthrough could directly release a wide array of components and systems. For example, Wilhelm Roentgen's announcement of the discovery of X-ray phenomena in 1895 was followed quickly by a host of applications in medical and other fields, none of which would have occurred in

[1] Research in science yields an understanding of the natural world and the laws that govern the behavior of materials, complex systems, living organisms, and so forth. In contrast, innovation concerns the man-made world and the creation of devices and methods that improve our daily lives. More so than science, innovation brings with it entrepreneurial and market considerations, thus making the real-world connections between these two phenomena complex and varied.

the absence of this seminal announcement. To allow this possibility for hydrogen, I would suggest including directly supporting science discoveries in the eligibility for this category of H-Prize.

Including directly connected science might offer two ancillary benefits as well. First, it could broaden the pool of researchers who would find the H-Prize relevant. And second it would remove any possible incentive to sequester a discovery until an applications device could be made.

Including Enabling Technologies Technology revolutions often build upon combinations of advances in seemingly unrelated fields—often termed "enabling technologies." Consider home refrigeration, for example. When the mechanical refrigerator swept into the market in the 1930s and 1940s, it destroyed an industry (ice manufacturing and delivery), reshaped another (the corner grocery became the supermarket), and improved the productivity of homemaking enormously. Yet this innovation depended upon several enabling technologies for its success—efficient, small scale refrigeration cycles; widespread availability of electric energy; and compact, powerful alternating-current motors.

In the case of hydrogen, enabling technologies can prove powerful also. For example, a technology that greatly enhanced the safety of hydrogen use would serve the transition well even if it were not strictly related to any single component or system. Similarly, a breakthrough in carbon sequestration might allow coal, shale, and other

abundant hydrocarbons to be used for hydrogen production without environmental damage. Such a breakthrough, though not strictly hydrogen production, would advance the transition markedly. Thus, I would encourage a very broad interpretation of the term "related to."

Providing Continuity The general principle of program continuity applies most strongly in this first prize category. That is true because human beings must invest many years of preparation as their entry ticket for any field of technological research. For the prize program to draw additional entrants to hydrogen-related research fields, it must be perceived as stable over the time required for preparation and career launch—and for that reason, this category of H-Prize might diminish in attractiveness to new entrants as its ten-year "sunset" approaches. None of this militates against learning and adaptation in the awards process; rather, it suggests that greater predictability will make the awards more attractive to those considering a career in the field. Less predictability would have the opposite effect.

Crossing the Gap: Prototypes

The second category of H-Prize addresses one of the most important problems in science and innovation—the availability of maturation funds to move a technology across the gap between research funding and investment funding. This gap arises because research funding tends to asks questions of discovery, seeking knowledge of how the natural world works. Answers to these questions do not always illuminate how the constructed world—that of the devices and systems that serve humans—can be improved through

innovation. In too many cases, potential investors cannot translate readily from scientific possibility to a marketable innovation, and so they await a prototype or some other evidence to help them judge the risks and returns from innovation. Thus a technology, even with ongoing research support, can languish in the chasm between research support and venture development funding. To be sure, some companies and foundations do invest in technology maturation research, but the resources are generally below the amount needed for greatest benefit. Thus, the prize would most probably add to the total resources available for innovation.[2]

The prototype category of the H-Prize could provide incentives for private parties—perhaps foundations, research corporations, or first stage investors—to commit technology maturation investments. In effect, it lowers the risk for investors funding a technology maturation project by offering the possibility that its cost can be recovered. The most astute of these investors would find their technology "bets" effectively hedged by the prize. The least astute would not—and, of course, should not.

Transformational Technologies

The third category of prize—a $10 million cash prize and a match for private investment funds up to $90 million—would reward major "...transformational changes in technologies for the distribution or production of hydrogen..." Thus it would provide incentives for the infrastructure side of the hydrogen market, which is likely to prove a

[2] The "prototype" prize category would also complement the SBIR, STTR, and ATP programs, which serve much the same function but with awards given in anticipation of success rather than after it occurs.

highly capital-intensive undertaking. However, this prize category also poses challenges that appear greater than in the previous categories.

First, the prize might prove redundant. Entrepreneurs and venture capital investors seek opportunities with demonstrable potential for exponential growth—exactly the kind of venture that appears to be contemplated in the prize description. A new venture meeting these objective criteria would probably have little difficulty attracting venture capital, especially in view of the increasing risk aversion now characterizing the venture investment industry.[3]

Second, one cannot know in advance the appropriate scale of investment, and hence the size of the award might not mesh well with the need. If the winning venture were small, the availability of a large federal match might tempt its owners to accept too much capital. Experienced venture investors recognize that too much funding can be as inimical to long term success as too little. On the other hand, if the winning venture were on the scale of, say, a shale oil plant (tens of billions of dollars), the prize would add little beyond prestige to the total incentive.

Learning and Adaptation

Learning and adaptation should be designed into the H-Prize process from the beginning for three reasons. First, the awards program will learn from its own experience, and can

[3] The most urgent need is for early stage funding. In 2005, for example, only 3 percent of venture funds committed went for startup and seed capital investments. Early stage investment occupied another 16 percent. The remaining 81 percent went for expansion and late-stage investments. Data from National Association of State Venture Funds.

improve in response to that learning. Second, the ten-year duration of the H-Prize program will surely see significant advances in every field of science, especially the hydrogen-related technologies. Award categories most relevant at the beginning might well recede in importance 10 years into the future. And third, an evolving public recognition of the scope and urgency of the worldwide energy-environment-economy trilemma could lead to changes in energy policy over the period. Because of such changes, the award criteria (and possibly the administrative processes) that are most appropriate at the beginning of the program might become less so by its end.

For these reasons, I suggest that some formal process for learning and adaptation be included in the H-Prize program. An annual or biennial report of progress, to be submitted by the administering institution, could establish the factual basis for learning. These reports should surely include a follow-up analysis of each award to ascertain its outcome as measured against progress toward a hydrogen transition. To be sure, there is some tension between the earlier-mentioned principle of consistency and the desirability of adaptation with learning. The core idea should be to adapt the means but hold constant the ends.

In Summary

Reducing our nation's dependence on oil will improve the environment, relieve the economy of large income transfers to oil producers, and strengthen our national security. I believe the H-Prize, as set out in HR 5143, could do much to accelerate this greatly

needed transition from petroleum to a hydrogen economy. This is a constructive and innovative proposal, and it deserves your fullest consideration.