Promoting the Transition to Hydrogen in the Energy Field

NATIONAL HYDROGEN ASSOCIATION

Managed by Technology Transition Corporation

KEY HYDROGEN MESSAGES

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SHARE WITH YOUR COLLEAGUES SO THE HYDROGEN INDUSTRY CAN SPEAK WITH ONE VOICE

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Key Hydrogen Messages: Quick-Reference

Speak with the common voice of hydrogen industry and communicate these key hydrogen messages to your audiences.

1. **Increased use of hydrogen as a fuel provides benefits to energy security, the environment and economic growth.**

    a. Hydrogen can benefit energy security because it can be produced from a variety of diverse energy resources, including renewable resources. For this reason, hydrogen contributes to our development of additional alternatives to oil.

    b. Hydrogen can benefit the environment because it can be produced and used in ways that have a minimal impact on health-related air quality and on greenhouse gas emissions.

    c. Hydrogen can benefit economic growth through job development, investment opportunities, and a sustainable, secure energy supply.

2. **Hydrogen-powered products are in use today, and hydrogen use will accelerate over the next 10 to 20 years as the technologies and infrastructure evolve.**

    a. There are emerging products in three key areas: grid-connected and off-grid power, portable electronics, and transportation.

    b. The technology for producing hydrogen from a variety of resources, including renewables, is evolving.

    c. Government support is needed to address critical areas of research and to help demonstrate early applications of the production, distribution and use of hydrogen fuel.

Key Hydrogen Messages with Proof Points

The same quick-reference key hydrogen messages with proof points for back-up information.

1. Increased use of hydrogen as a fuel provides benefits to energy security, the environment and economic growth.

a. Hydrogen can benefit energy security because it can be produced from a variety of diverse energy resources, including renewable resources. For this reason, hydrogen contributes to our development of additional alternatives to oil.

Proof points:

- Hydrogen is contained in many resources from which it can be released, or produced. These resources include natural gas, coal, water, landfill gases and biomass resources including biofuels (like ethanol) and other agricultural products.
  - Historically, most commercial hydrogen has been produced from natural gas, but it is anticipated that other sources will contribute increasingly to the supply of hydrogen.

- A variety of technologies can be used to produce the power needed to release hydrogen from these resources, including fossil fuel combustion, nuclear power and renewable technologies such as solar, wind, hydropower, bioenergy and geothermal.
  - Since hydrogen can be produced from so many different resources and with a variety of technologies, many regions of the country and the world will have increased capability for local production of fuel. For example: in some areas local solar, wind or nuclear power could be used for electrolysis of local water resources; in some areas locally-produced biomass products, like ethanol, could be a hydrogen feedstock; etc.

- Of the 42 million tons produced each year in the world today, the most common way to produce hydrogen is by running steam through natural gas (48%), oil (30%), coal (18%) and electrolysis of water (4%). *Sources: National Academy of Engineering, "The Hydrogen Economy: Opportunities, Costs, Barriers, and R&D Needs"(2004), Fig 7-1; Air Products (2003)*

- Projected costs for producing hydrogen (untaxed, incorporating the increased efficiency of a fuel cell vehicle over a gasoline hybrid electric vehicle, and including costs for production, distribution and dispensing) using current technology are $2.10-$9.70/kg (gallon of

gasoline equivalent) *Source: National Academy of Engineering, "The Hydrogen Economy: Opportunities, Costs, Barriers, and R&D Needs"(2004), Fig. 5-1*

- Using the above parameters, projected costs using future technology available, if current R&D efforts are successful, would be $1.75-$4.25/kg. *Source: National Academy of Engineering, "The Hydrogen Economy: Opportunities, Costs, Barriers, and R&D Needs"(2004), Fig. 5-3*

- Additional information sources:
  www.hydrogen.energy.gov/production.html
  www.nrel.gov/learning/eds_hydrogen.html
  www.hydrogenassociation.org (production fact sheets)
  http://www.nap.edu/books/0309091632/html/

b. Hydrogen can benefit the environment because it can be *produced* and *used* in ways that have a minimal impact on health-related air quality and on greenhouse gas emissions.

Proof points:

- The amount of emissions from hydrogen production depends on the type of technologies used.

- Hydrogen can be produced with zero air pollution and zero greenhouse gas emissions using renewable energy (e.g., solar, wind, hydro and geothermal) and nuclear power to separate hydrogen from water (through electrolysis).
  - In most cases, these are not currently cost-competitive ways to produce hydrogen, but work is underway to reduce the costs of production.

- Hydrogen can be produced with near-zero emissions from natural gas, coal and other fossil fuels, by using carbon capture technology where the hydrogen is produced.

- When hydrogen is produced from natural gas, as most currently is, or when it is produced using electric power generated with fossil fuels, there are carbon dioxide emissions.
  - These emissions can be contained using technology called carbon sequestration
  - Capturing carbon dioxide at a hydrogen production facility is much easier than capturing emissions individually from millions of tailpipes and generators. (There are about 600 million vehicles worldwide.)

- Hydrogen production from biomass resources is carbon neutral.

- When hydrogen is used in a fuel cell to generate electricity to power a building, appliance or vehicle, no air pollution or greenhouse gases are emitted.
  - Zero-emission, hydrogen-powered fuel cell systems can be especially valuable for reducing public health risks in areas with high concentrations of air pollution (nonattainment areas).
  - [add asthma statistics in nonattainment areas]
  - [Did you know that XX% of children who live in abc area have asthma as a result of the air pollution … or that there are YY deaths related to respiratory disease in xyz area every year.]

- If hydrogen is used as fuel for a combustion system, like those in gasoline vehicles, hydrogen burns cleanly with minimal emissions. When properly tuned, a hydrogen-powered internal combustion engine will have ultra low emissions.
  - Ultra low NOx emissions, and near-zero VOCs (volatile organic chemicals) and CO (carbon monoxide) emissions.

- Government and industry "well-to-wheel" studies have found that many of the hydrogen production methods (including hydrogen made from natural gas or water using renewable or nuclear energy) would release significantly less carbon dioxide into the atmosphere than when gasoline is used in conventional or even higher efficiency hybrid electric vehicles. *Source: National Research Council 2004*
  - Well-to-Wheel analyses are the all-inclusive, cradle-to-grave look at the production, distribution, dispensing and use of a fuel.

c. Hydrogen can benefit economic growth through job development, investment opportunities, and a sustainable, secure energy supply.

Proof points:

- Hydrogen is the common element in a growing technology market that spans many major economic sectors (business and home power supply, portable electronics, and transportation to name a few).
  - Grid-Connected and Off-Grid Power: distributed electricity generation for buildings, residential power, electricity for parks and remote wildlife areas, telecommunications stations, etc.
  - Portable Electronics Using Micro Fuel Cells: computers, cell phones cameras, surveillance equipment, portable communication centers, military-specific products, etc.

- Transportation: fuel and power systems for cars, buses and heavy duty vehicles, and specialty vehicles like fork lift trucks and airport tugs.

- Hydrogen can help assure economic growth by providing constant, secure power options in a world with increasing demand for energy.

2. Hydrogen-powered products are in use today, and hydrogen use will accelerate over the next 10 to 20 years as the technologies and infrastructure evolve.

a. There are emerging products in three key areas: grid-connected and off-grid power, portable electronics, and transportation.

- **Grid-connected and off-grid power: electricity generation equipment that supplements power for homes and businesses or back-up power;**
- **Portable electronics using micro-fuel cells: computers, cell phones cameras, surveillance equipment, portable communication centers, military-specific products, etc.**
- **Transportation: small vehicles like fork lift trucks and individual mobility vehicles, passenger cars, delivery trucks and buses.**

Proof points:

- **Grid-connected and off-grid power:** The first commercial electricity generation units powered by hydrogen fuel cells have been introduced and are now providing continuous, reliable electricity and heat to buildings (schools, commercial buildings, homes) as well as providing remote power and backup power for emergency response.
  - When grid-connected, equipment must be in compliance with regulations established by the local utility commission
  - Off-grid power equipment can be installed autonomously
  - Examples: *(to be tailored by individual companies)*

- **Portable electronics:** Some companies have products available today. Many of the world's largest electronics manufacturers have announced devices powered by micro fuel cells (for laptops, telephones, audio-video players) which will be commercially launched in the next year or two.
  - Examples: *(to be tailored by individual companies)*

- **Transportation:** Several hundred hydrogen vehicles are operating in demonstration projects and fueling at more than 50 fueling stations world-wide. Hydrogen fuel cell individual mobility vehicles and fork lift trucks are being introduced as an alternative to battery electric vehicles where a combustion engine is not tolerable and battery performance limits the range and time between charges.
  - Demonstration projects using cars, buses, taxis, delivery vans and other vehicles with accompanying fueling technologies are the first step in building the infrastructure needed to make driving a hydrogen vehicle convenient, economical and clean.
  - Hybrid and CNG vehicles are also allowing manufacturers to perfect electric power trains and gaseous fuel systems that are used by hydrogen powered vehicles.
  - Examples: *(to be tailored by individual companies)*

b. The technology for producing hydrogen from a variety of resources, including renewables, is evolving.

Proof points:

- A hydrogen infrastructure for industry exists today. Currently, the hydrogen production industry has the capacity to fuel at least 1 million vehicles today. *Source: Air Products*

- A hydrogen infrastructure is evolving and will be customized in different regions depending on resources.
  - Hydrogen can be produced from a variety of resources. Any region can use a mix of resources for producing hydrogen that makes the most sense economically and environmentally.
  - Historically, most commercial hydrogen has been produced from natural gas, but it is anticipated that other sources will contribute increasingly to the supply of hydrogen, like water using electricity from renewables and nuclear power.
  - Currently, over 42 million tons of hydrogen is produced worldwide each year. About 60% is used for making ammonia for fertilizer, 23% is used to make gasoline cleaner by removing sulfur, 9% is used to make methanol, and the remainder goes for chemical processing, metal production, electronics and for space exploration. *Source: Oakridge National Laboratory, 2003*

c. Government support is needed to address critical areas of research and to help demonstrate early applications of the production, distribution and use of hydrogen fuel.

Proof points:

- Continuous federal funding for research and partnerships with industry have led to lower hydrogen production costs, lower fuel cell costs and longer fuel cell life times.
  - Since 2003, DOE-funded research has doubled the lifetime of the fuel cell stack – from 1,000 hours to 2,000 hours – and reduced the projected high-volume cost by 60% – from $275 per kilowatt in 2002 to $110 per kilowatt today. *Source: US Department of Energy*
    - To compete in the commercial marketplace, fuel cells for automotive applications must be lower in cost than conventional transportation technologies.
    - Fuel cells must also be able to operate for more than 5,000 hours (the equivalent of more than 100,000 miles) under widely varying conditions, with frequent shutdowns and startups.
  - DOE-funded research has reduced the cost of hydrogen produced from natural gas from $5.00 in 2003 to approximately $3.00 in 2005. The Program has also made progress in hydrogen production from renewable resources. *Source: US Department of Energy*
    - The cost of hydrogen (which includes the cost of production as well as delivery) must be competitive with conventional fuels and technologies.
    - That means hydrogen must cost between $2 and $3 per gallon gasoline equivalent.