"If I were to be rewarded for success and reprimanded for failure, I would pursue NH_3 (ammonia) as the most promising hydrogen carrier to meet the 2015 Freedom Car goals."
George Parks, Conoco/Phillips

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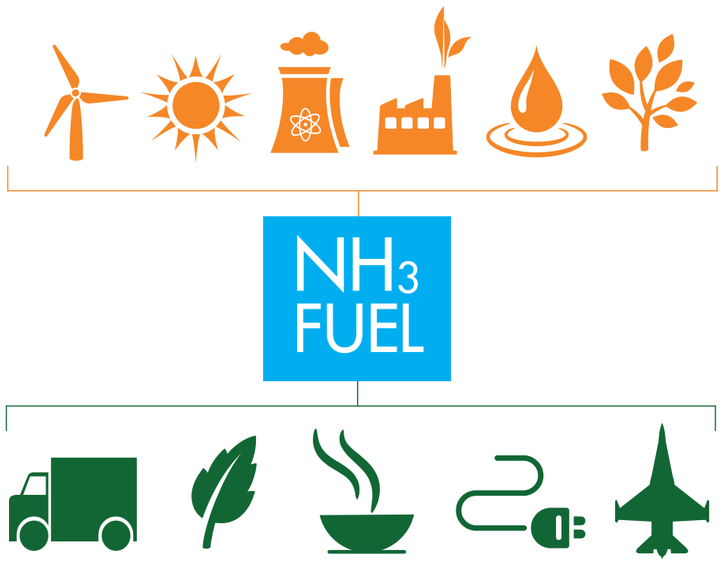

The Stick

The search for the "ideal" alternative fuel to eliminate U.S. addiction to imported petroleum has been a long, difficult trek. The ominous impacts of the 1973 OPEC oil embargo and subsequent oil price shocks brought to light a very "unfortunate truth", that the fate of the U.S. economy and our very way of life is dictated by our long-standing addiction to imported petroleum. Largely due to our disproportionate share of consumption of petroleum supplies, the U.S. is far more negatively impacted by petroleum supply disruptions and price increases than any other nation in the world. Although every President since Richard Nixon has identified U.S. dependence on imported petroleum a matter of national priority, we now import a higher percentage of petroleum than we did in 1974. Failure to effectively act on this issue may prove to be the most devastating public policy failure in the history of the U.S. Finding a viable substitute to the staggering amount of imported petroleum used in the U.S. each year will determine the ultimate fate of our country.

As we have seen in the recent past, the tenuous supply chain associated with imported petroleum is easily disrupted by natural disasters (hurricanes, earthquakes, floods, etc.), terrorism, technical failures (BP spill), wars and even the political whims of unstable regimes. Peak oil, though still a highly debated topic in terms of timing, adds another area of uncertainty and risk for countries dependent on imported petroleum. Even without these disruptive, doomsday scenarios, simple supply/demand economics should make one wary of excessive dependence on imported petroleum due to one sobering statistic; in 2009 China displaced the United States as the world's largest automobile market. The sales of vehicles in China jumped 45 percent from 2008 to 2009 and vehicle sales are expected to increase another 25 percent to 17 million units in 2010. Failure to understand or acknowledge the obvious implications relative to petroleum demand and price, due to this huge new demand for petroleum, could prove costly.

The Carrot

On a more positive note, producing transportation fuels domestically to replace imported petroleum would produce positive, transformational benefits for the U.S. The huge drain on our economy associated with imported petroleum, an outflow of nearly $400 billion annually, would be eliminated. Hundreds of thousands of new jobs would be created, jobs that would remain in the U.S. for at least the next seventy-five years. National security would be vastly improved as the risks associated with the uncertain supply of imported petroleum are eliminated. U.S. military involvement in certain regions of the world may be altered, as it may be argued that at least a part of the reason we are involved militarily in the Mid-East is related to U.S. petroleum interests. In summary, ending U.S. addiction to imported petroleum would result in a vibrant U.S. economy, dramatically improve our balance of trade, significantly improve our national security, decrease the potential for world conflict over petroleum supplies (saving U.S. soldiers' lives should be of paramount importance) and provide the opportunity to decrease the negative impacts of petroleum on the environment.

"NH3 is the only realistic energy solution that makes sense."

Matt Simmons, National Petroleum Council, Council on Foreign Relations, Founder, Ocean Energy Institute

The Logical Path Forward

There are numerous choices being proposed as viable alternative fuels. Some of the leading candidates include biofuels (e.g., ethanol, butanol, methanol, bio-diesel, renewable diesel), natural gas, hydrogen, propane and dimethyl ether (DME). Each of these choices have associated benefits and liabilities. The optimal path for determining which alternative fuel (or fuels) would best serve the needs of the U.S. should begin with a thorough, logical identification of the characteristics of an "ideal" fuel. The critical task then becomes evaluating each alternative fuel choice relative to the following ideal fuel criteria.

The characteristics of an ideal fuel include:

- Produced from any primary energy source (e.g., wind, solar, biomass, coal, nuclear, hydro, ocean thermal etc.)
- Cost effective vs. gasoline, natural gas, batteries, biofuels, hydrogen, etc.
- Significant storage and delivery systems already in place
- Environmentally friendly (no carbon, low emissions)
- Practical application (i.e. diesel engines, fuel cells, SI engines, gas turbines, etc.)
- Proven, acceptable safety history
- Sustainable
- Produced in the U.S.

NH3 Fuel: The Closest Alternative to an Ideal Fuel

A thorough evaluation of each potential alternative fuel against the ideal fuel criteria listed, leads to the choice of NH3 Fuel (anhydrous ammonia) as the leading alternative fuel candidate. NH3 has been called "the other hydrogen" and exhibits all of the advantages of hydrogen. Importantly, NH3 provides proven, practical, low-cost storage and delivery of hydrogen, the main barrier to a hydrogen economy.

NH3 performance:

Production Flexibility

NH3 can be produced from any primary energy source (e.g., wind, solar, biomass, coal, nuclear, hydro, ocean thermal etc.) Hydrogen is the only other fuel that can make this claim.

Cost effective

NH3 has historically been priced competitively with gasoline and petroleum on an energy content (i.e., $/MM BTU basis). NH3 is currently produced from natural gas and coal. Current (April 2010) U.S. prices for coal, natural gas and gasoline are $1.20, $3.97 and $20.00 per million BTU respectively. Since NH3 is currently made from coal and natural gas, both of which are substantially lower in cost than gasoline, NH3 will generally be cost competitive with gasoline as long as the historical relative cost difference between coal, natural gas and gasoline remain.

Infrastructure

Significant, world-wide storage and delivery systems are already in place for NH3 used in fertilizer applications. It is in the top three chemicals transported annually. NH3 has been transported by ship, barge, rail car, truck and pipeline for decades. Large (20,000 to 30.000 ton), low-cost NH3 storage tanks are currently installed in many areas of the U.S. There are over 800 retail NH3 distribution facilities already in existence in Iowa alone.

Environmental Performance

NH3 is environmentally friendly, producing zero carbon dioxide and low overall emissions. The only significant pollutant emitted by either hydrogen or NH3 is NOx. It is easy and cost effective to use a small amount of NH3 to react with NOx over a low-cost catalyst to produce environmentally benign N2 and H2O.

Fuel Flexibility

The ability to be used in any prime mover (e.g., diesel engines, fuel cells, SI engines, gas turbines, etc.) is a tremendous advantage associated with NH3 Fuel.

Safety

NH3 has an extensive, proven record of acceptably safe use. In addition, two very credible studies have shown that NH3 would be safer than propane and as safe as gasoline when used as a transportation fuel. There are many misconceptions surrounding the safety of NH3 and providing credible, factual data on this topic is very important.

Sustainable

NH3 can be produced from wind, solar and any other renewable fuel by means of in-development production methods.

Conclusion

Establishing domestically-produced alternative transportation fuels as a top national priority will provide huge positive benefits to the U.S. and end our potentially disastrous addiction to imported petroleum. NH3 Fuel is the optimal choice for a versatile, sustainable, cost-effective alternative transportation fuel.