"If I were to be rewarded for success and reprimanded for failure, I would pursue NH3 (ammonia) as the most promising hydrogen carrier to meet the 2015 Freedom Car goals."
George Parks, Conoco/Phillips

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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 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. imported petroleum used in the U.S. each year.

“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:

- **Cost effective**: 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.
- **Fuel Flexibility**: NH3 can be produced from any primary energy source (e.g., wind, solar, biomass, coal, nuclear, hydro, ocean thermal etc.) is a tremendous advantage to an ideal fuel.
- **Infrastructure already in place for NH3 use in many areas of the U.S. 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:

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**Production Flexibility**

- **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 (ammonia/ammonium) as the leading alternative fuel candidate. NH3 has been called “the other hydrogens” 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**
- **Cost effective**
- **Sustainable**
- **Produced in the U.S.**

**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 transport 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 under 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.