



HYTHANE®

If Hydrogen is the answer; What is the question?

Presentation to

Clean Cities Conference May 8th, 2006

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Hydrogen Energy Use Today

- Hydrogen is used as a commodity chemical in diverse applications

- Food processing
- Metals
- Refining
- Ammonia/fertilizer
- Methanol
- Electronics



- Hydrogen is used in the transportation sector

- Directly
 - space shuttle
 - demo H₂ ICE and fuel cell vehicles
- Indirectly
 - in refined products
 - as blended fuel (CNG+H₂)



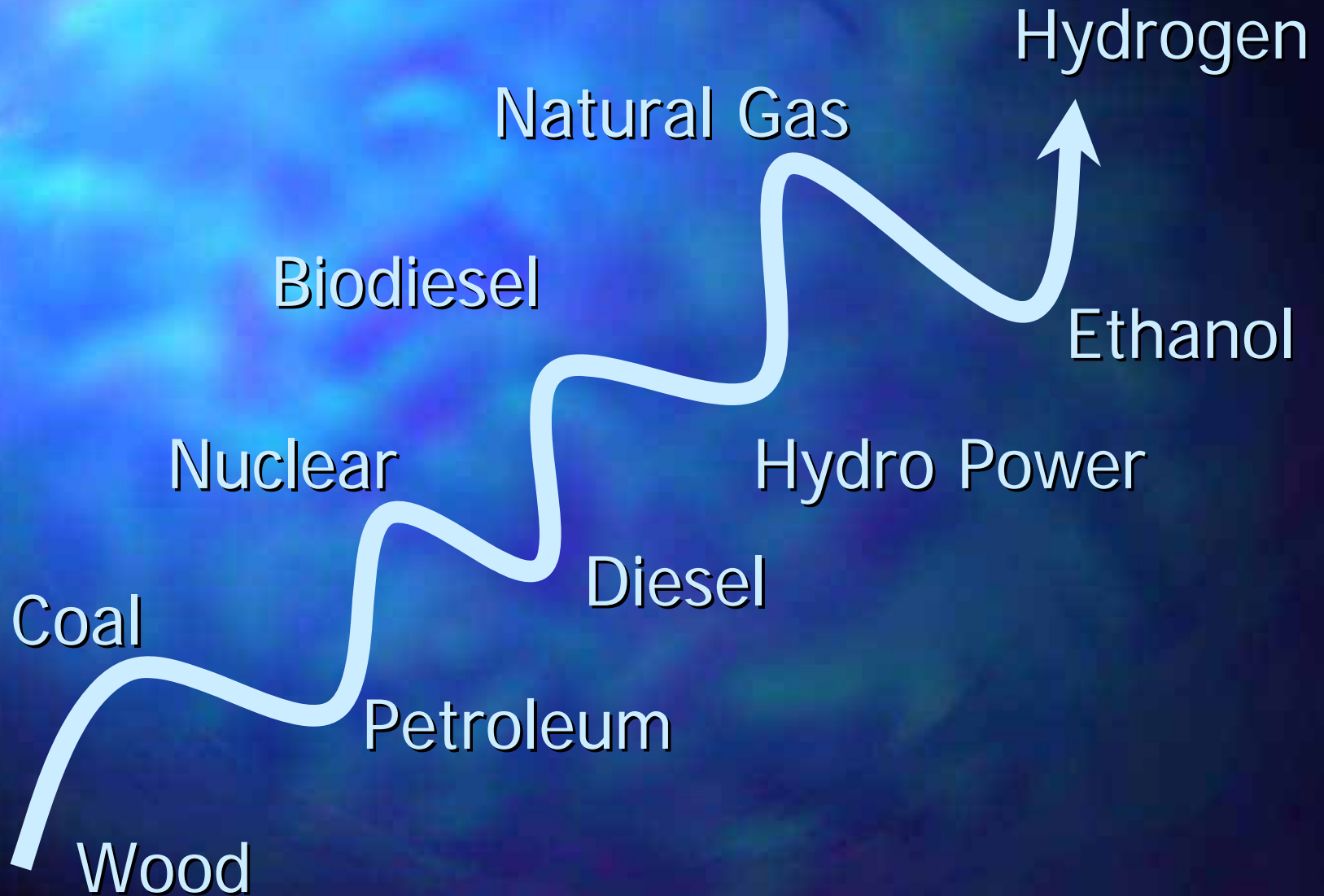
- Major sources

- Natural gas reforming (>80%)
- Purification of Chemical By-Products (20%)





Energy Utilization Trends





Why Change? & Why Hydrogen?

- Economics

- Cost of oil is on a steady incline
- Cost of Hydrogen will decrease as Technology improves

- Environmental

- Global Warming from greenhouse gases
- Clean burning in combustion engine

- Political

- Decrease our dependence on foreign oil
- Renewable energy lets us fortify ourselves from external impact through supply crisis

- Necessity

- Approaching global shortfall of >40 million barrels per day
- Hydrogen is the only long term fuel that makes sense



Sounds Great; What's the Problem?

- Economics - Production Cost still an issue
 - Reasonable cost to the Consumer
- Physical Storage issue (density)
- Perception - Fear Factor
 - (actually hydrogen is a commodity)
- Lack of Infrastructure
 - Increase Gaseous Distribution
- We need large NO_x reduction with limited H₂



Now we that know Hydrogen is the future, how do we get there?

- Implement a cost effective technology
- Energy efficient engines (IC, Hybrid or FC)
- Provide greater Storage Density
- Increase Gaseous Distribution
- Reasonable cost to the Consumer
- Build an infrastructure to support the the hydrogen economy when it gets here
- What can do all of this?



Hythane[®]-The Transition Fuel

- 5-7 % by Energy of H₂/Natural gas blend
- piggy backs on CNG/NG infrastructure
- Proven technology
- Up to 50% NO_x emission reductions
- Possible Emissions benefits through Fungible Assets
 - Kyoto Protocol commencement of E.U. Carbon Credit Trading
 - NO_x emission credits
- Clean H₂ Enriched NG Fuel is available NOW!



How can Natural Gas Help?

- Via Time to Market
 - No longer experimental- over 3 mil vehicles on the globe now
 - CNG is growing a robust infrastructure, with many sources, stations, capabilities, engines
 - Provides customers already accustomed to running on a gaseous fuel
- Hydrogen is a renewable gas selected as the future Energy Carrier be of it's abundance
 - It can be described as the "Forever Fuel"
 - But it may be many years before pure Hydrogen becomes a technical and economic reality

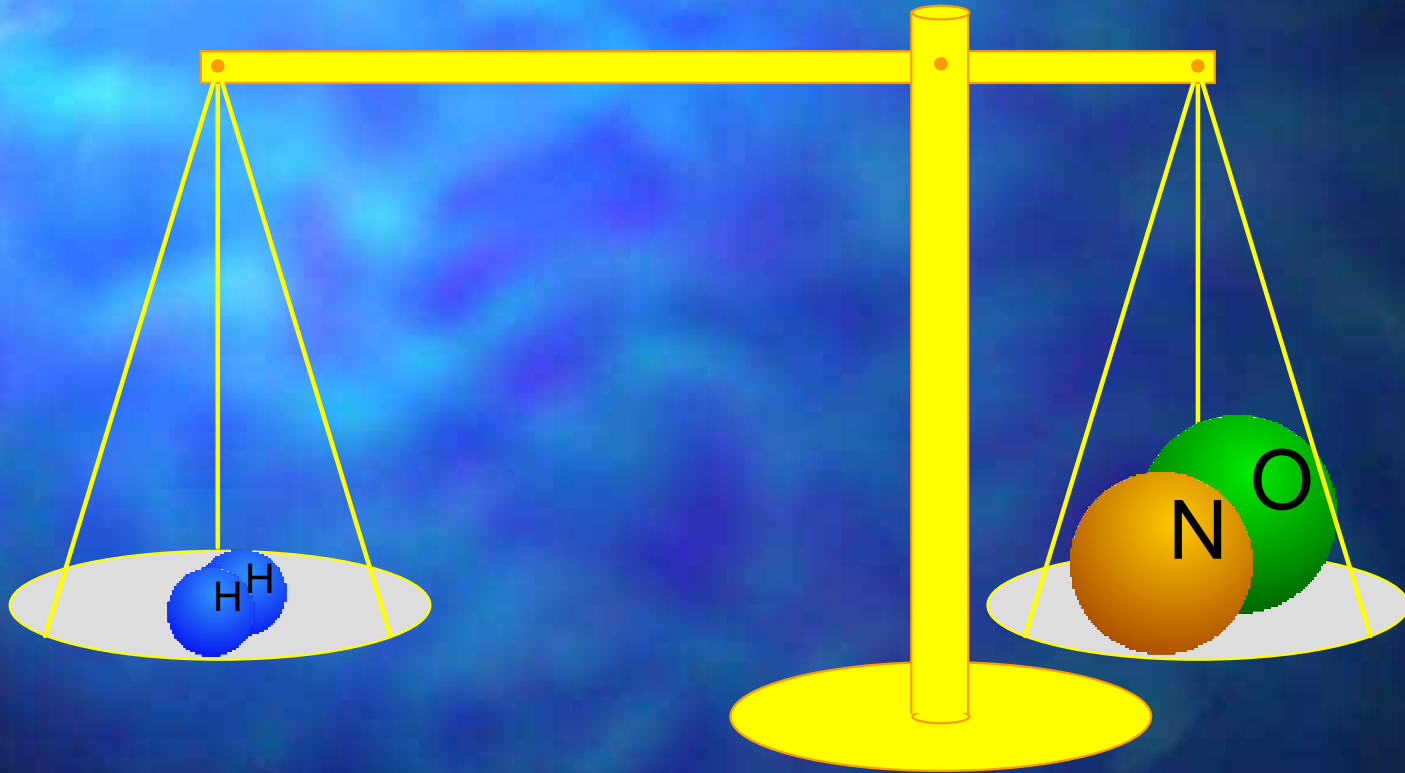


In the beginning...

- Supply of hydrogen will be limited and the cost will be high
- Vehicles numbers will grow in time
- Alt Fuel stations can supply all 3 fuels
 - Natural Gas, Hythane, and Hydrogen
- Cleaner air is needed now
- We need to:
 - Get large NO_x reduction with limited H₂
 - Always use "Leverage"






Hythane[®] Leverage



MOST COST-EFFECTIVE USE OF H₂

What is the best use of 7% Hydrogen Energy?

-  Hydrogen Bus
-  CNG Bus
-  Hythane Bus





Conclusions

- Hythane is the transitional step to getting hydrogen introduced into our transportation infrastructure now
- Hydrogen presents a significant economic opportunity for U.S. Industry, including the transportation sector
- Technological innovation, National cooperation, and strategic thinking can make the hydrogen economy a reality
- The hydrogen economy is within sight. How fast we get there will depend on how committed we are to weaning ourselves off of oil
- What are we waiting for?



HYTHANE®

Thank You from Hythane Company!

Questions?

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Hythane[®] History

- Invented in 1989 by Frank Lynch and Roger Marmaro
- Studies and demonstrations through 1990s



Montreal 1995

- By 2003 extensive testing validated the “sweet spot” for heavy-duty Hythane[®] engines at 7% H₂ by energy (20% by volume).

Legacy of Hythane[®] Achievements



- 1st Hythane[®] Vehicle Burns "HY5", 1990
- 5% Hydrogen (by Energy Content), Balance CNG
- Tanks Under Truck Give 250 km Range
- CARB tests showed ULEV emissions

- 3-Vehicle Denver Hythane[®] Project, 1992
- Gasoline Truck, Compressed Natural Gas (CNG) Truck and "HY5" Truck (5 energy % H₂ in CNG)
- CDH Tests show 50% NO_x reduction



- Montreal Hythane[®] Bus Project (1995)
- Environment Canada test shows 45% NO_x reduction

Legacy of Hythane® Achievements (cont.)



SunLine's Second Hythane Bus Project (2004)

- First engine manufacturer involvement in Hythane (Cummins-Westport)
- Best emissions reduction to date (50% NOx decrease with 7% hydrogen energy)
- SunLine's hydrogen is from renewable solar energy

Hythane[®] Strategy

There are 3 interdependent parameters in adjusting a lean burn CNG engine for Hythane[®]. Changing any one of them affects the other two. We can:



- Lower NO_x, at the expense of NMHC and efficiency
- Lower NMHC, at the expense of NO_x and efficiency
- Higher Efficiency, at the expense of NO_x and NMHC

The Hythane strategy for reducing urban smog is "Reduce NO_x as much as possible without making NMHC or efficiency worse than CNG".

YUCHAI HYTHANE ENGINE NOVEMBER 2005 DATA

Yuchai YC6G260N Emissions Results European Stationary Cycle

■]CNG [baseline ■]Hythane [7% H2 by energy

