



**Hythane Company LLC**

**Hythane®**

**Tomorrow's low cost, low emission fuel today**

**October 2006**



# Hythane Company LLC

A wholly owned subsidiary of Eden Energy Ltd

## PRODUCTS

**Hythane®** technology- a mixture of natural gas & hydrogen

**Hythane®** - production and dispensing equipment

**Cryogenic technology** - fuel storage/pipes/valves

- 14,000 sq. ft. R & D Facility in Littleton, Colorado
- World class team of employees and consultants
- Patents/ trademarks



# World Class Technical Team

- **Frank Lynch**- invented Hythane, 35 years H2 experience
- **Dr Tom Flynn**- 50 years NASA related H2 projects
  - wrote leading texts on crygenic engineering
- **Dr Bob Rudland**- 30 years experience in H2 in aerospace
- **Dr Glen McIntosh**- 50 years NASA H2 fabrication expert
- **Greg Egan**- 25 years experience in H2
- **Roger Marmaro**- co-invented Hythane-15 years
- **Justin Fulton**- leading gas combustion engineer
- **Steve Hensley** - 25+ years in cryogenics



# Patents and Trademarks

- Hythane® Patent- USA (granted)
- Hythane ® Blender- Worldwide (application)
- Cryogenic Storage Tank- Worldwide (application)
- Portable Superconducting Battery- Worldwide(application)
- Cryogenic Hythane ( LNG/ H<sub>2</sub>)- Worldwide (application)
- Hythane ® Operating System- Worldwide (application)
- Hythane ®Trademark-USA, Canada, Australia(granted)
  - India, China, Singapore(application)

Further patents under development

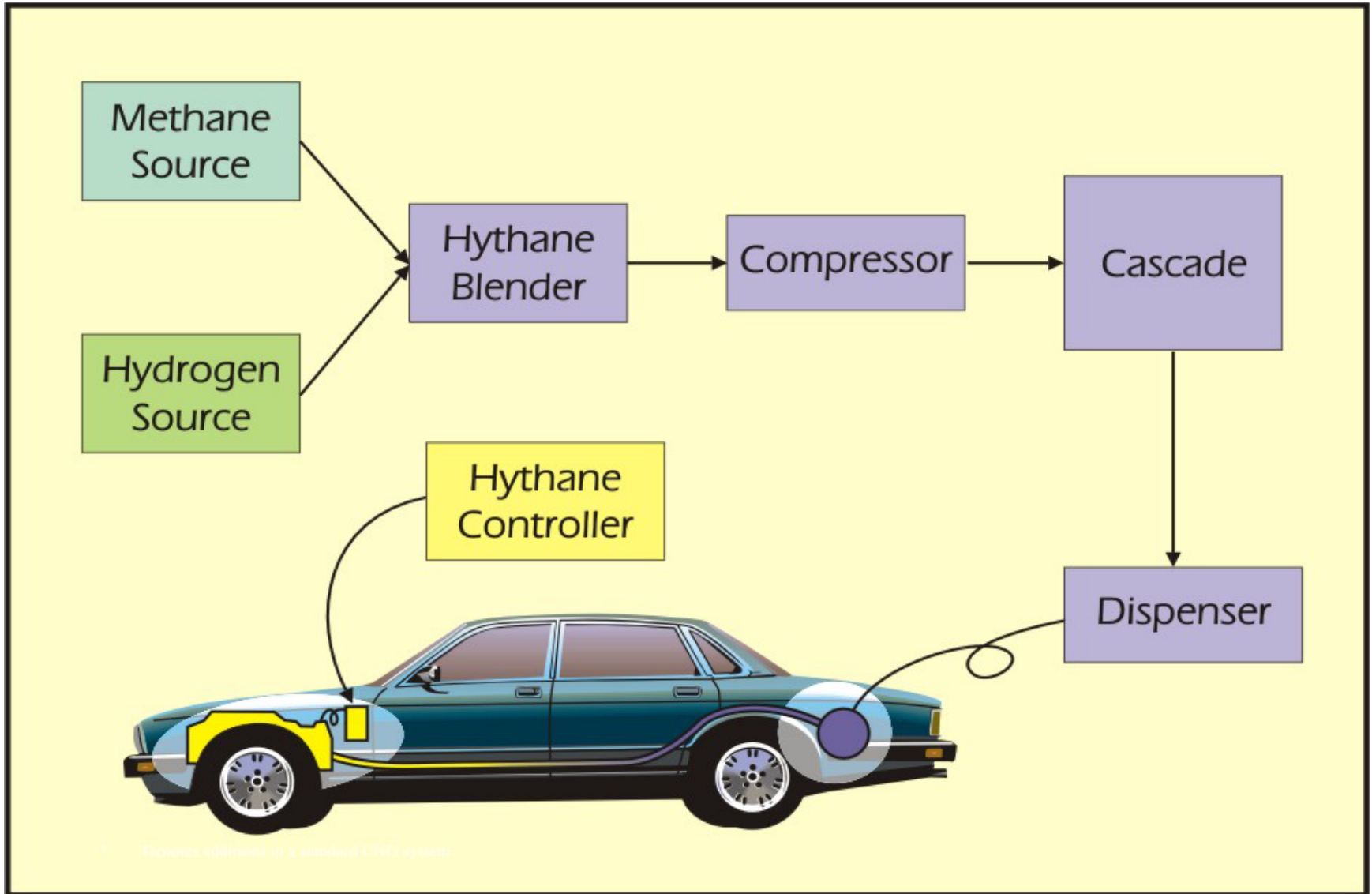


# Hythane®-the transition fuel

- Low cost technology proven over 15 years
- Uses existing Natural Gas/H<sub>2</sub> infrastructure
- 5-7% by Energy H<sub>2</sub>/Natural gas (no high purity required -can use waste H<sub>2</sub> streams)
- 50% NO<sub>x</sub> reduction compared with NG
- Suitable for CNG / LNG/Dual fuel



# Hythane<sup>®</sup> Operating System





# CNG / Hythane® Dispensers





# LNG Vehicles in California

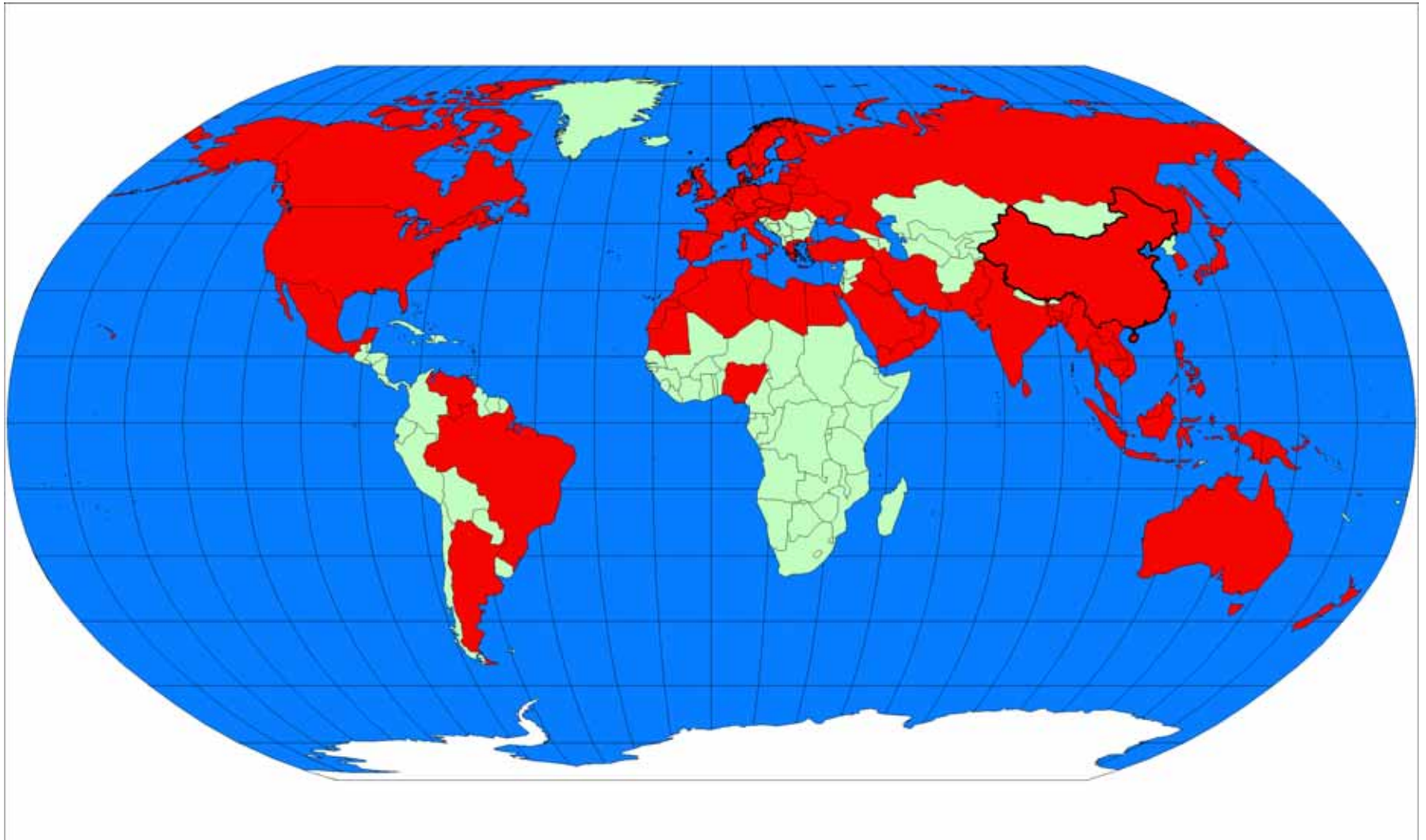
LA/DOE Clean Corridor Project





# Target markets for Hythane®

All Natural Gas Markets





# Factors driving transition to Hydrogen

- Peak in global oil production/ oil prices
- Concern over dependence on Middle East oil
- Concern over global climate change / warming
- New emission standards- US/ Europe
- Local Air Pollution- NO<sub>x</sub>

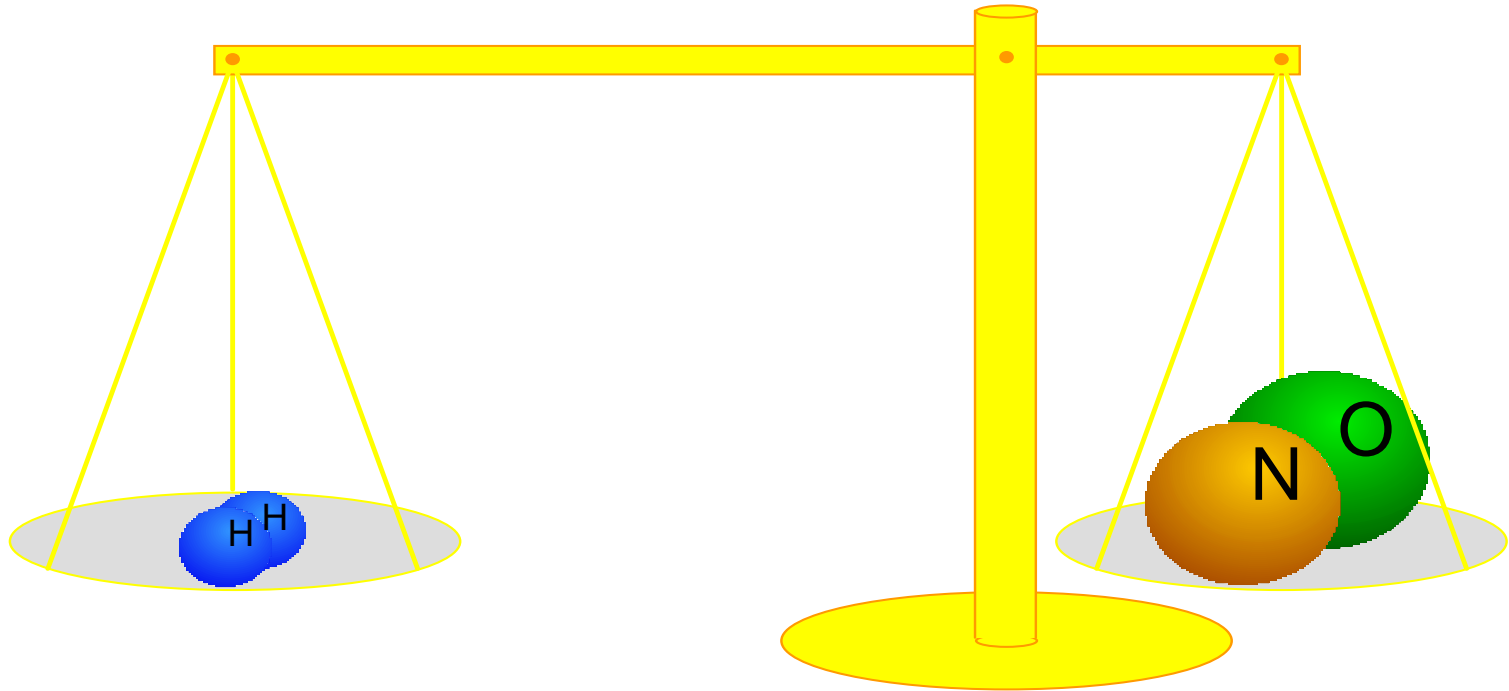


## Reasons to use Hythane®

- Immediately available- fully developed
- Reduces NO<sub>x</sub> by 50%
- Uses existing Natural Gas, H<sub>2</sub> infrastructure
- Low capital and operating costs
- Cheapest way to meet new emission standards
- Suitable for CNG / LNG / Dual fuel
- Minimal loss of range - only 5-7% H<sub>2</sub> ( by energy)



# Hythane®- leveraged use of hydrogen



5-7% hydrogen( by energy)= 50% NO<sub>x</sub> reduction

Hythane® reduces NO<sub>x</sub> by 7+ times more than if used as pure H<sub>2</sub>



# Suitable Hydrogen Sources

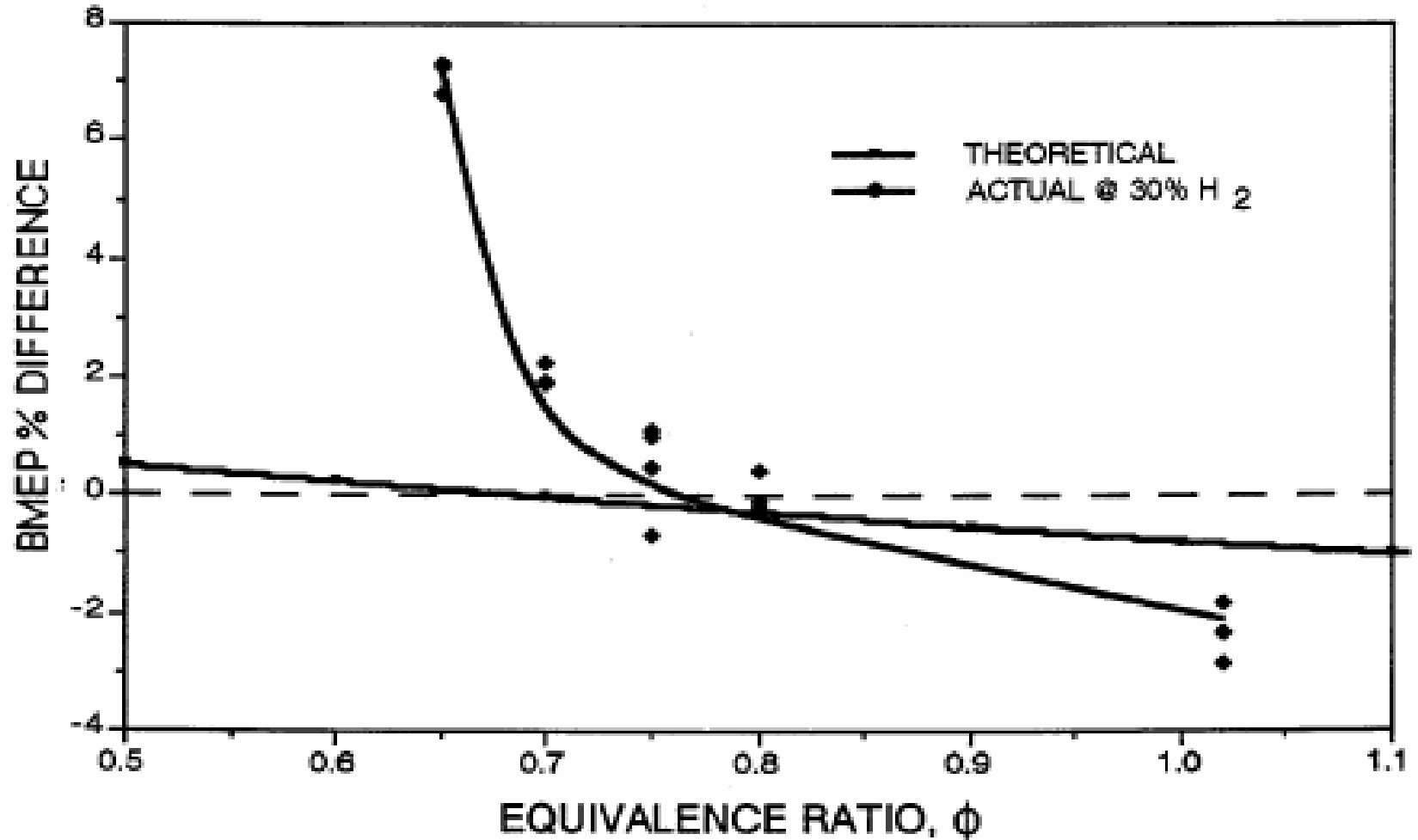
- Production from Natural Gas reformation
- Electrolysis
- Industrial Waste H<sub>2</sub> streams

(eg Steel mills, Chlor-Alkali and Glass Plants)

Low purity (90% +) H<sub>2</sub> suitable for Hythane ®



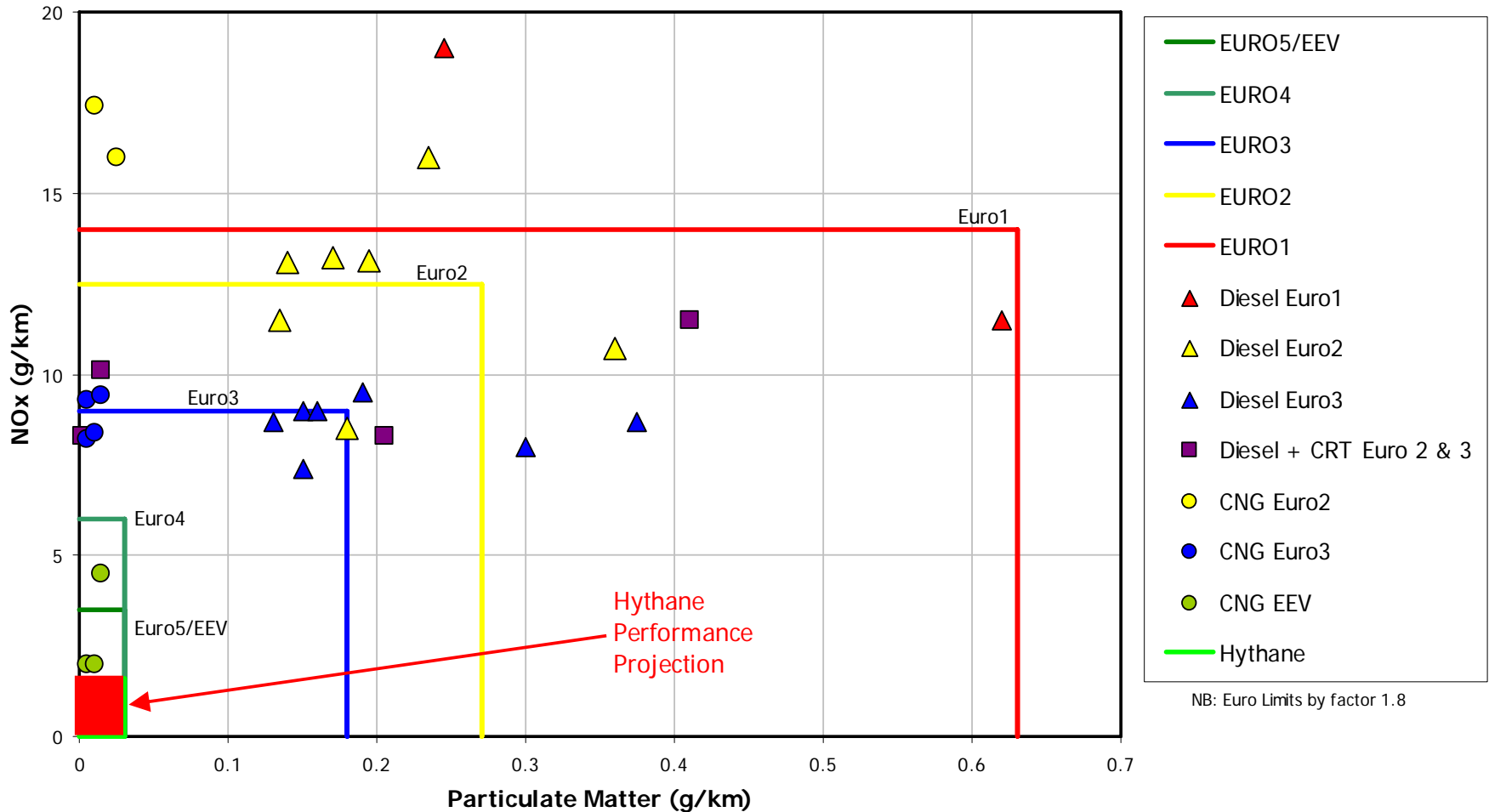
# Effect of Hydrogen Addition Near Lean Limit





# Hythane® meets Euro 1 - 5

## NO<sub>x</sub> & PM emissions over the Braunschweig city bus cycle

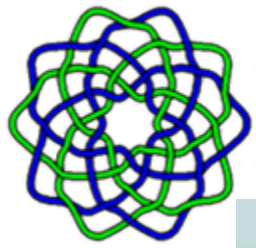


NB: Euro Limits by factor 1.8



# Hythane® Projects

- 1990 HCl-pickup truck
- 1992 Denver -3 light truck comparison project
- 1995-96 Montréal -2 bus pilot project
- 2002-04 Palm Springs, California-4 bus pilot project
- 2005 China -Yuchai engine conversion
- 2006-07 Projects planned- USA, India, Australia



# Hythane® Bus Projects

Montreal 1993-1995



California 2002-2004



# DENVER HYTHANE® PROJECT

1993

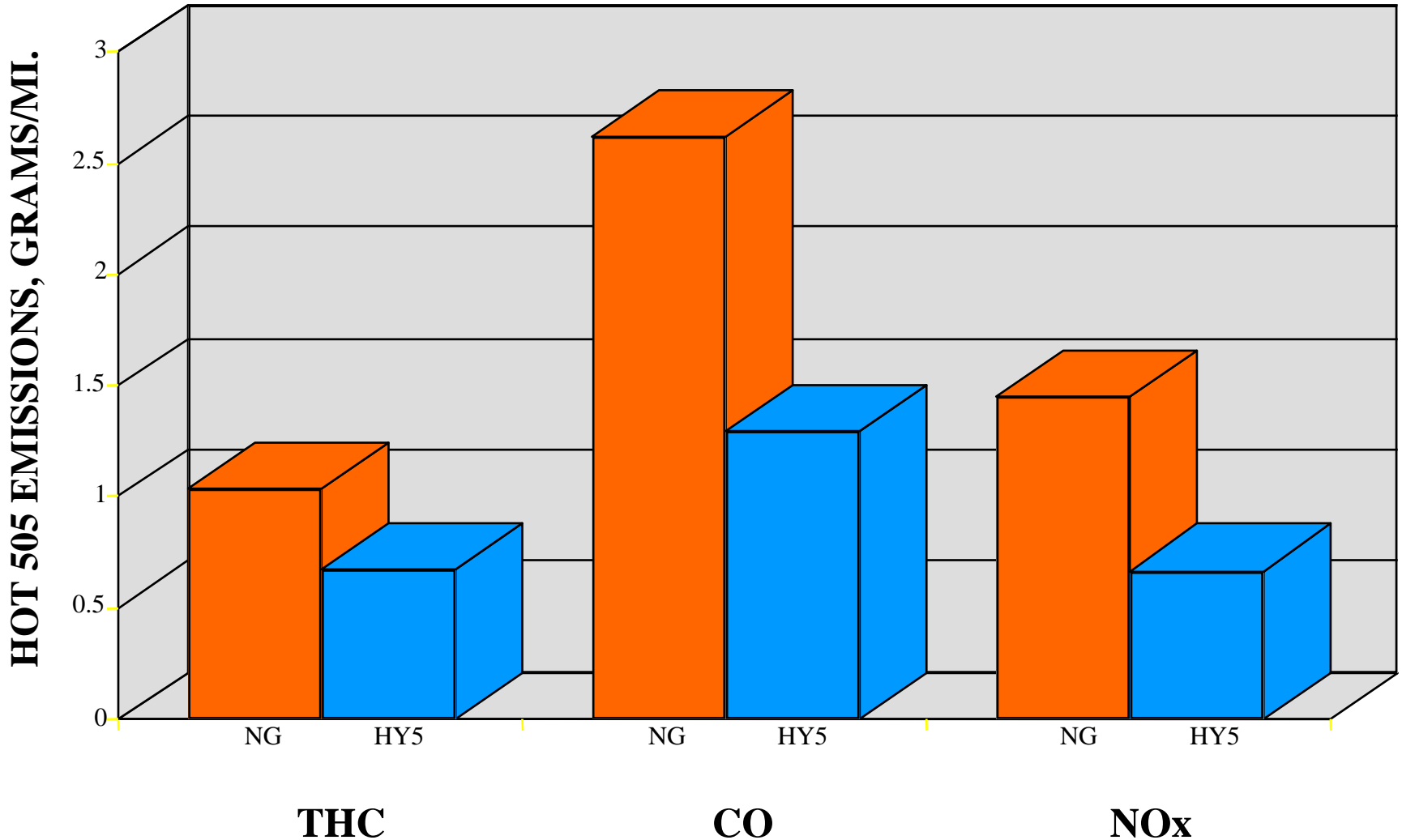


5 energy %  $H_2$  in CNG



# Two-test averages from Denver Hythane® Project.

Courtesy of Colorado Department of Health, March 1993.



50% Reductions in CO and NOx, 5% H<sub>2</sub>: Leverage Factor = 10!



# Hythane<sup>®</sup> Strategy

3 interdependent parameters in adjusting a lean burn CNG engine for Hythane<sup>®</sup>. Changing any one affects the others .



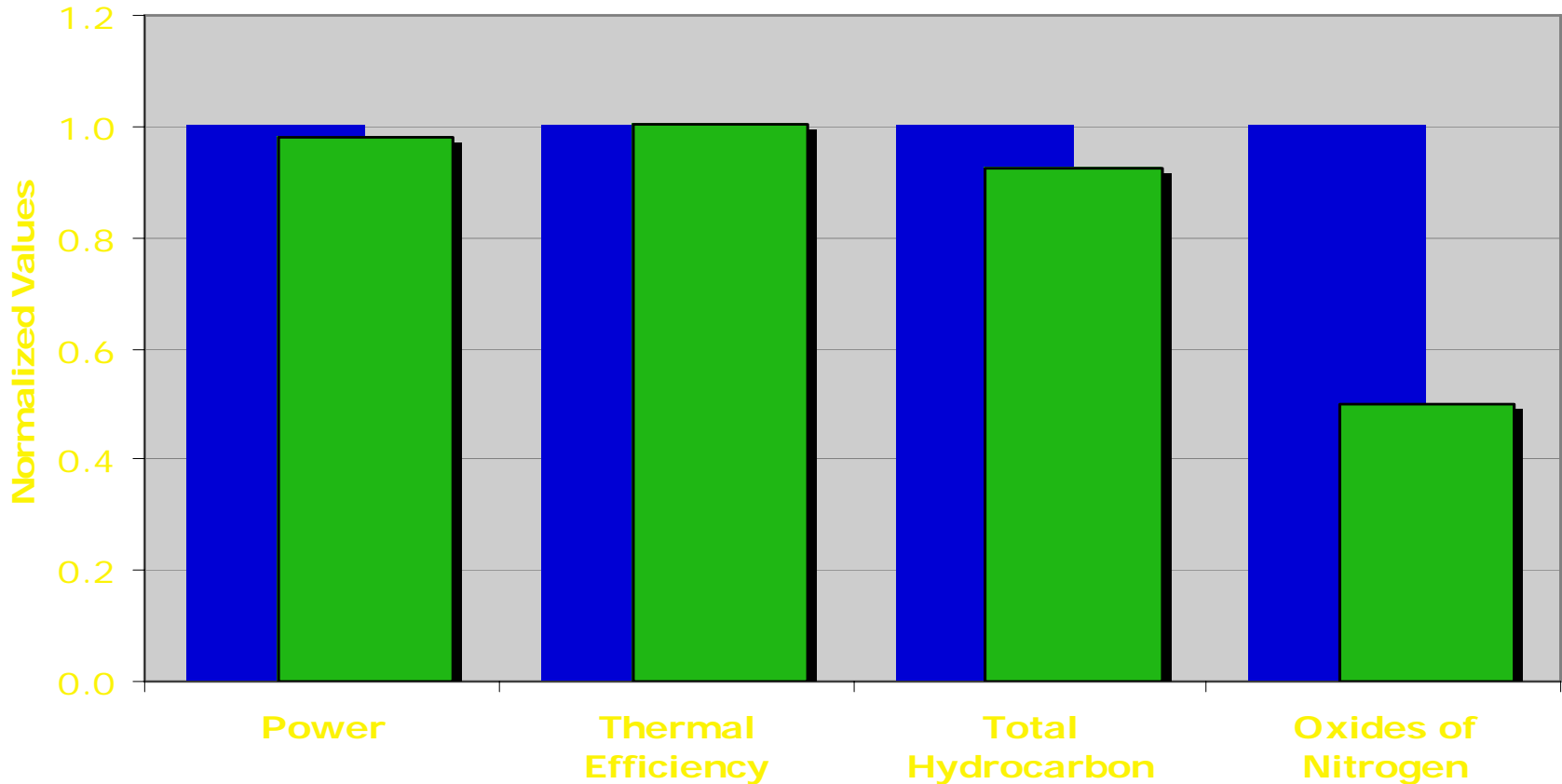
- Objective
- Reduce NO<sub>x</sub>
- Reduce NMHC
- Increase Efficiency



# Yuchai Hythane® Engine Data

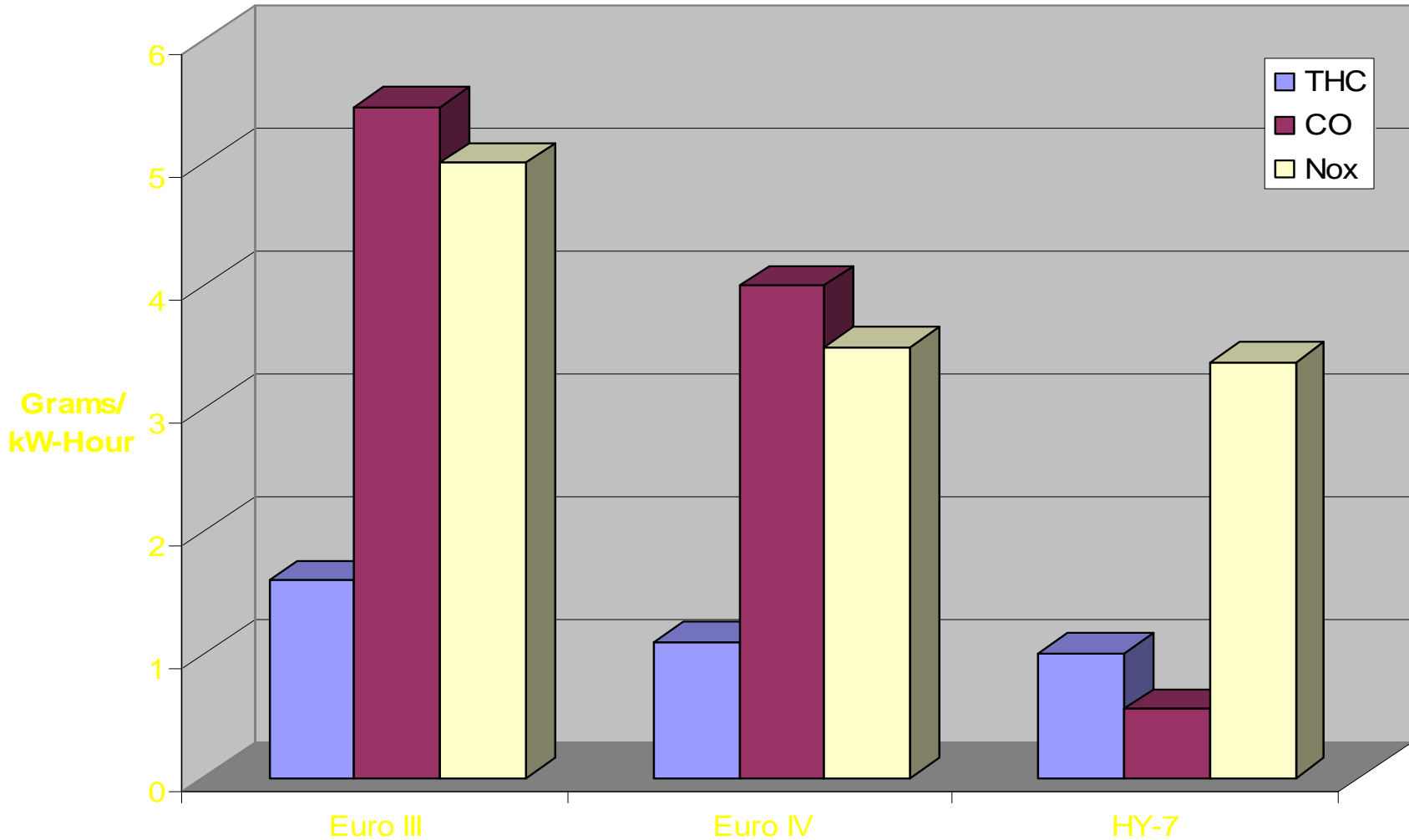
## Yuchai YC6G260N Emissions Results European Stationary Cycle

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





# Yuchai Euro IV Hythane® Emissions





# USA Hythane® Marketing Progress

- Californian ARB proposal to approve Hythane ® as Near Zero Emission Fuel under new emission standards
- First DOE contract for Hythane®/ hydrogen engines
- MOUs for several major demonstration projects signed/  
under negotiation in California and NE USA
- Growing interest from all relevant parties



# Indian Hythane® Marketing Progress

- Aim- to convert CNG bus fleets to Hythane®
  - to convert CNG taxis, autorickshaws to Hythane®
  - to target fleet truck operations -CNG / Dual Fuel
- Agreement for first Hythane® engine conversion
- Hythane® demonstration project planned for Q1 2007
- Strong Central Government for Hythane®
- Government Blue Sky Project- 11 cities



# Australian Hythane® Marketing Progress

- Interest in major Hythane ® bus demonstration project in Perth to use H2 infrastructure

- Interest in developing Hythane ® for:

LNG / Dual Fuel

locomotives

gas turbines



# Chinese Hythane® Marketing Progress

- 6 MOUs signed in 2005
- Yuchai engine conversion- Euro IV achieved
- Preliminary Approval for 16 City Clean Air Program
- Interest from Controller, Engine and Bus Manufacturers
- Central Government and Academic Support
- Demonstration Projects planned for 2007



# Hythane®- tomorrow's fuel today

- Proven / immediately available / trials commencing
- Ultra low emission -50% NO<sub>x</sub> reduction
- Cost effective way to meet new emission standards
- Uses Natural Gas/ H<sub>2</sub> infrastructure- low cost
- 5-7% H<sub>2</sub> by energy- efficient storage/ leveraged use of H<sub>2</sub>
- 90% + purity H<sub>2</sub> suitable- eg industrial waste streams
- CNG / LNG / Dual Fuel compatible