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/ H2)- Worldwide (application)
- Hythane ® Operating System- Worldwide (application)
- Hythane ®Trademark-USA, Canada, Australia(accepted)
  - India, China, Singapore(application)

Further patents under development
Hythane®-the transition fuel

- Low cost technology proven over 15 years
- Uses existing Natural Gas/H2 infrastructure
- 5-7% by Energy H2/Natural gas (no high purity required -can use waste H2 streams)
- 50% NOx reduction compared with NG
- Suitable for CNG / LNG/Dual fuel
Hythane® Operating System

- Methane Source
- Hythane Blender
- Compressor
- Cascade
- Hydrogen Source
- Hythane Controller
- Dispenser
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- NOx
Reasons to use Hythane®

• Immediately available - fully developed
• Reduces NOx by 50%
• Uses existing Natural Gas, H2 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% H2 (by energy)
Hythane®- leveraged use of hydrogen

5-7% hydrogen (by energy) = 50% NOx reduction

Hythane® reduces NOx by 7+ times more than if used as pure H2
Suitable Hydrogen Sources

- Production from Natural Gas reformation
- Electrolysis
- Industrial Waste H2 streams (eg Steel mills, Chlor-Alkali and Glass Plants)

Low purity (90% +) H2 suitable for Hythane®
Effect of Hydrogen Addition Near Lean Limit
Hythane® meets Euro 1 - 5

NO\textsubscript{x} & PM emissions over the Braunschweig city bus cycle

- EURO5/EEV
- EURO4
- EURO3
- EURO2
- EURO1
- Diesel Euro1
- Diesel Euro2
- Diesel Euro3
- Diesel + CRT Euro 2 & 3
- CNG Euro2
- CNG Euro3
- CNG EEV
- Hythane

NB: Euro Limits by factor 1.8
Hythane® Projects

- 1990  HCI-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 % H₂ in CNG
Two-test averages from Denver Hythane® Project.

50% Reductions in CO and NOx, 5% H₂: Leverage Factor = 10!

Hythane® Strategy

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

- Objective
  - Reduce NOx
  - Reduce NMHC
  - Increase Efficiency
Yuchai YC6G260N Emissions Results
European Stationary Cycle

[Graph showing normalized values for Power, Thermal Efficiency, Total Hydrocarbon, and Oxides of Nitrogen for CNG (baseline) and Hythane (7% H2 by energy).]
Yuchai Euro IV Hythane® Emissions

Grams/kW-Hour

Euro III

Euro IV

HY-7
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% NOx reduction

• Cost effective way to meet new emission standards

• Uses Natural Gas/ H2 infrastructure - low cost

• 5-7% H2 by energy - efficient storage/ leveraged use of H2

• 90% + purity H2 suitable - eg industrial waste streams

• CNG / LNG / Dual Fuel compatible