

Kalmar & LNG Power for Terminal Equipment

December 2004
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Kalmar's mission statement

Kalmar's overriding mission is to provide solutions to make container and materials handling faster and more efficient. This commitment has driven Kalmar to become the leading global supplier of heavy-duty material handling equipment and services in the container, trailer and heavy industrial sectors.

To meet new and challenging market requirements, Kalmar will decisively expand its range of value-added services to further develop its position as being more than just a supplier of machines.

Being supported by the best global network in the industry is a basic prerequisite for a successful expansion into the service market for Kalmar.

By remaining at the forefront of both product technology and value adding services, Kalmar will sustain its position as the leading global solutions provider.

Why we are here today...

- We must find new and innovative ways to reduce the environmental impact of terminal and transportation equipment.
- This can be facilitated through the application and improvement of existing products as well as through research and development of new technologies.
- All solutions must be evaluated and acceptable to Personnel and Terminal Operators.
- Solutions must be economically viable to engineer, build and support and should take into account foreseeable economics wherever possible. Resource depth, Blending or formulating, and handling, transportation, and dispensing issues.
- As Kalmar is committed to the preservation of our environment and it's resources, solutions should always be evaluated by their overall impact upon our planet.

Possible solutions

- Replace fleets with more modern equipment in compliance with Federal Tier Two emissions level requirements
- Replace fleets with more modern and lower emissions equipment powered by On Highway, Current Year Model engines.
- Replace engines in existing equipment/trucks with tier two engines
- Replace engines in existing equipment/ trucks with On Highway, Current year model engines.
- **Replace fleets with alternative fuel powered equipment**
- Utilize after treatment systems for emissions reductions
- Invest in developing new systems or technologies, such as Hybrid or Electric, to replace and or reduce existing equipment.
- Some combination of the above

Today's discussion:

LNG (& CNG) A power choice for today?



Factors Favoring LNG/CNG Engines:

- LNG and CNG are simply variations in storage and handling concepts of what is principally Methane (CH₄)
- Both are becoming very commercially available*.
- Short Chain Hydrocarbons are easier to work with when attempting to reduce harmful emissions.
- Engine systems are already developed which utilize these fuels.
- Proven technology with trained technical base.
- Some types of equipment are already engineered for these fuels.
- Adequate power to perform work required.
- Others?

Factors which may discourage:

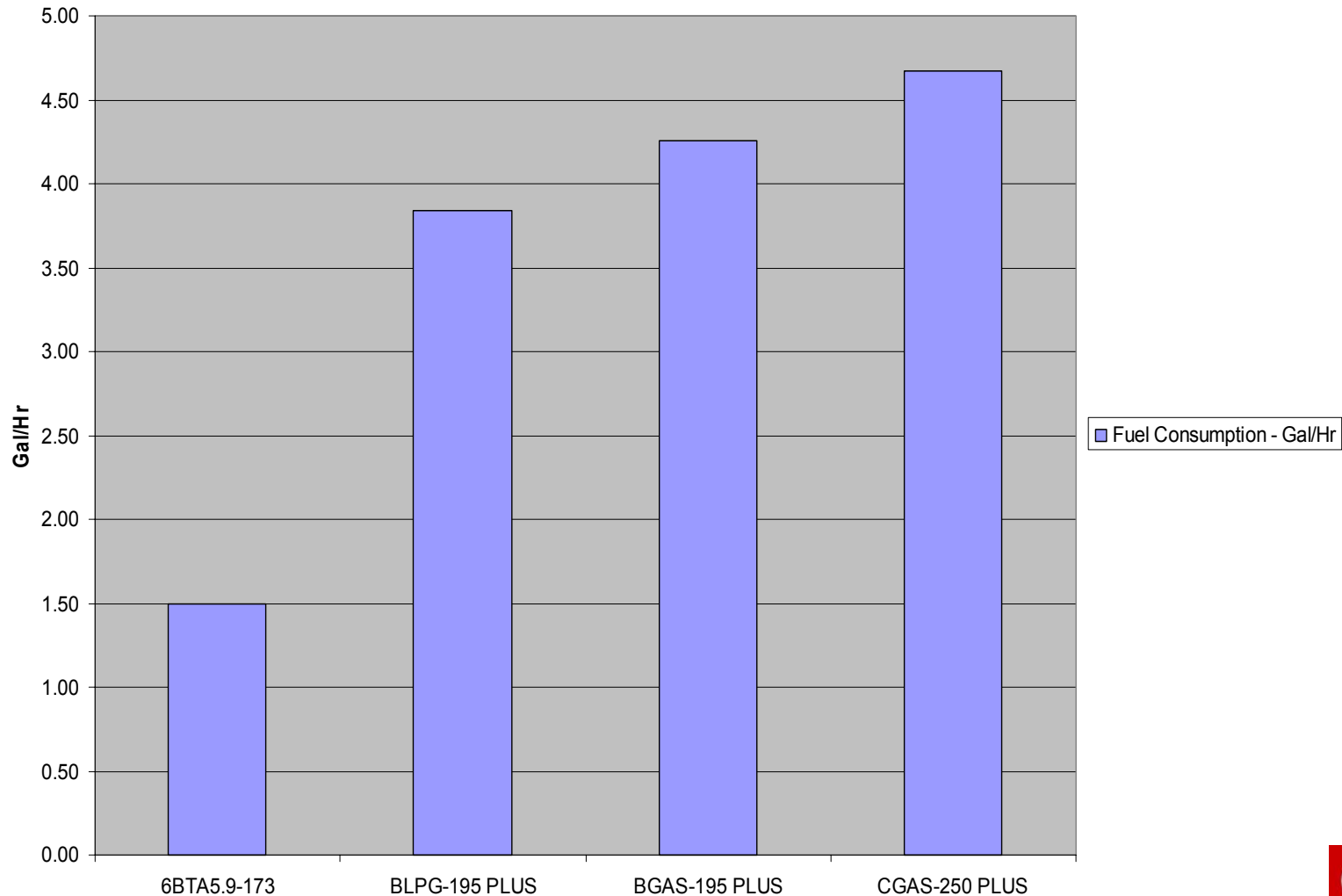
- **Cost of Equipment option and Fuel Station itself.**
- **Technologies training involved with fuel station and its operation.**
- Intervals between fueling stops.
- Concerns with cryogenic liquid storage and handling.
- Will still require the use of after treatment systems
- May not be easily or cost effectively applied to existing equipment ; requires replacement at this time
- Costs for maintenance may be higher due to additional complexity, Engine life is largely undetermined, less common parts etc.
- **Difficulties arising from the need to locate larger tank or tanks on the vehicle which may affect the vehicle's size or maneuverability as well as cost and reliability.**
- Others?

Facts about LNG

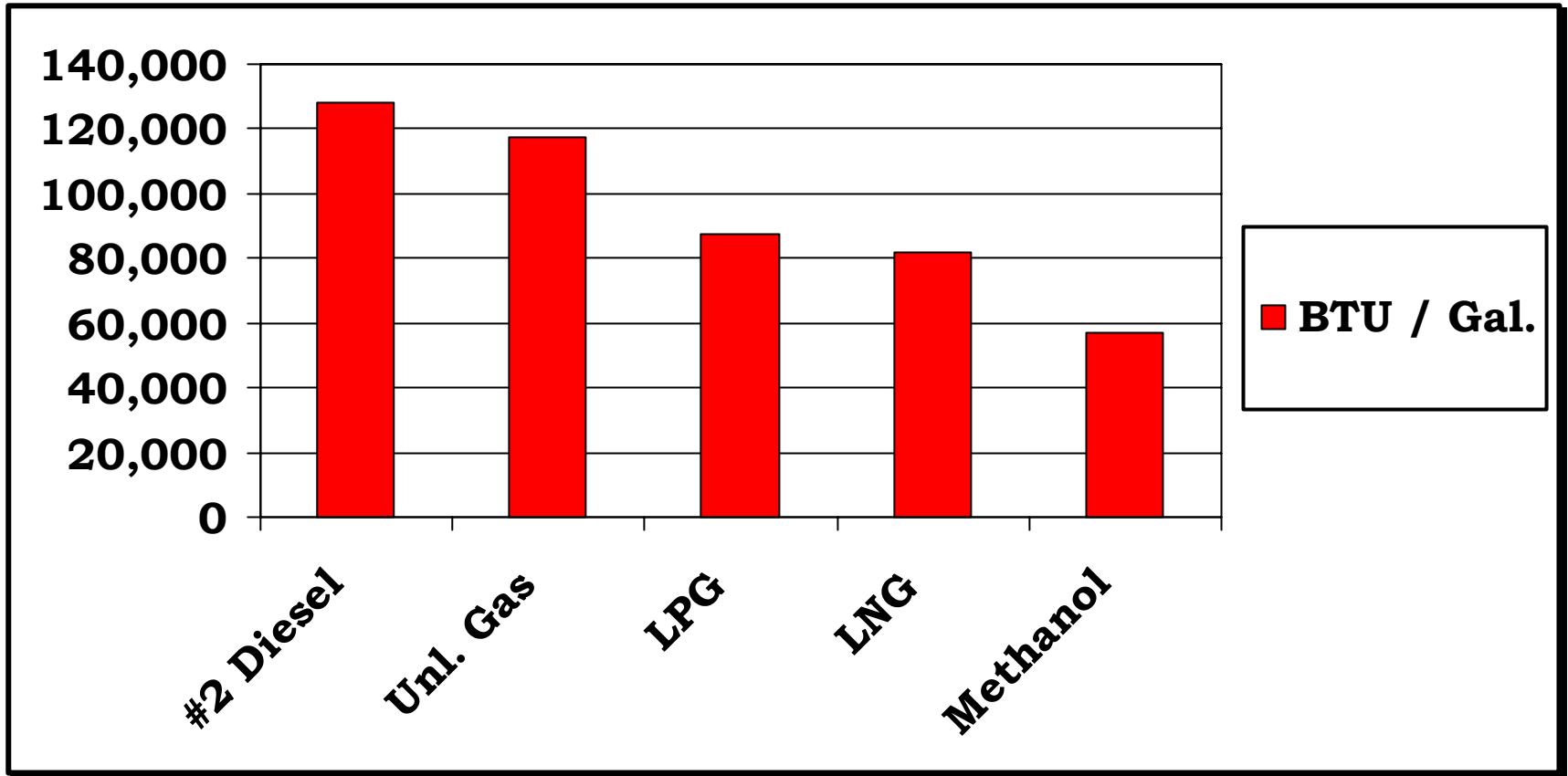
- LNG in fuel tank is stored at less than 100 PSI but at temperatures of -259 F and lower. It has the ability to contain more fuel in slightly less space and much lower pressure than CNG
- Fuel consumption in gallons per hour is about 3.5-4.5 gallons per hour. (Cummins C Gas + 250 HP/750lb/ft T)
- Based upon a 57 gallon usable tank size this would limit to about 12 –16 Hours on LNG vs. about 24-30 on a standard 50 gallon tank of diesel.
- Clear, odorless, and non-corrosive

Engine Alternative Fuel Comparisons

Fuel Consumption - Gal/Hr



Energy Comparison



Cummins Engine Emissions per engine



	2004 EPA Std	2004 CARB	2004 CARB Optional Low NOx	Euro III Std
PM (g/bhp-hr)	0.10	0.10	0.03	0.075
NOx+NMHC (g/bhp-hr)	2.5	2.5	1.8	3.73
<u>L Gas Plus</u>	✓	✓	✓	✓
<u>C Gas Plus</u>	✓	✓	✓	✓
<u>B Gas Plus</u>	✓	✓	✓	✓
<u>B LPG Plus</u>	✓	✓	✗	✗
<u>B Gas International</u>	✗	✗	✗	✓

(with catalyst)

Key:

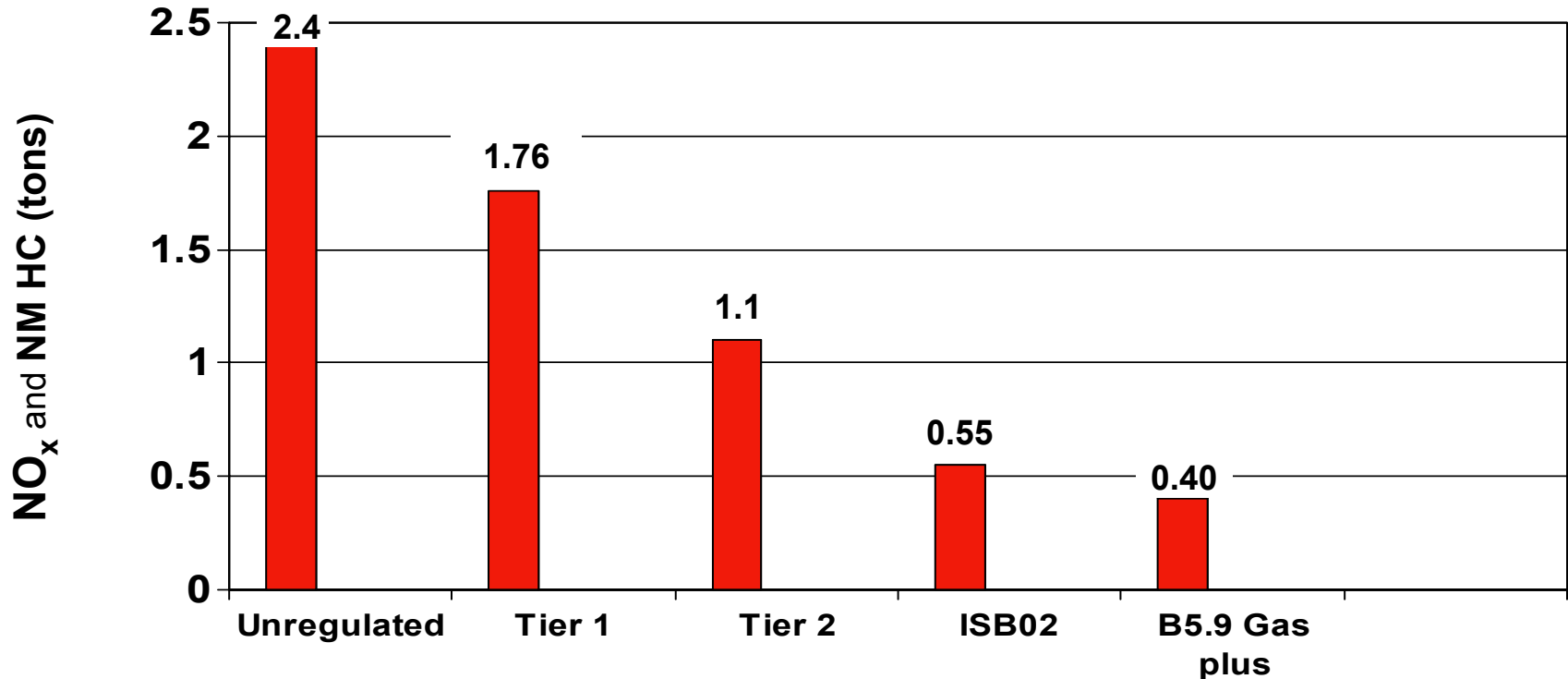
g/bhp-hr = grams per brake-horsepower-hour

PM = Particulate Matter

NOx = Nitrogen Oxides

NMHC = Non-Methane Hydrocarbons

Cummins Engine Emissions per engine

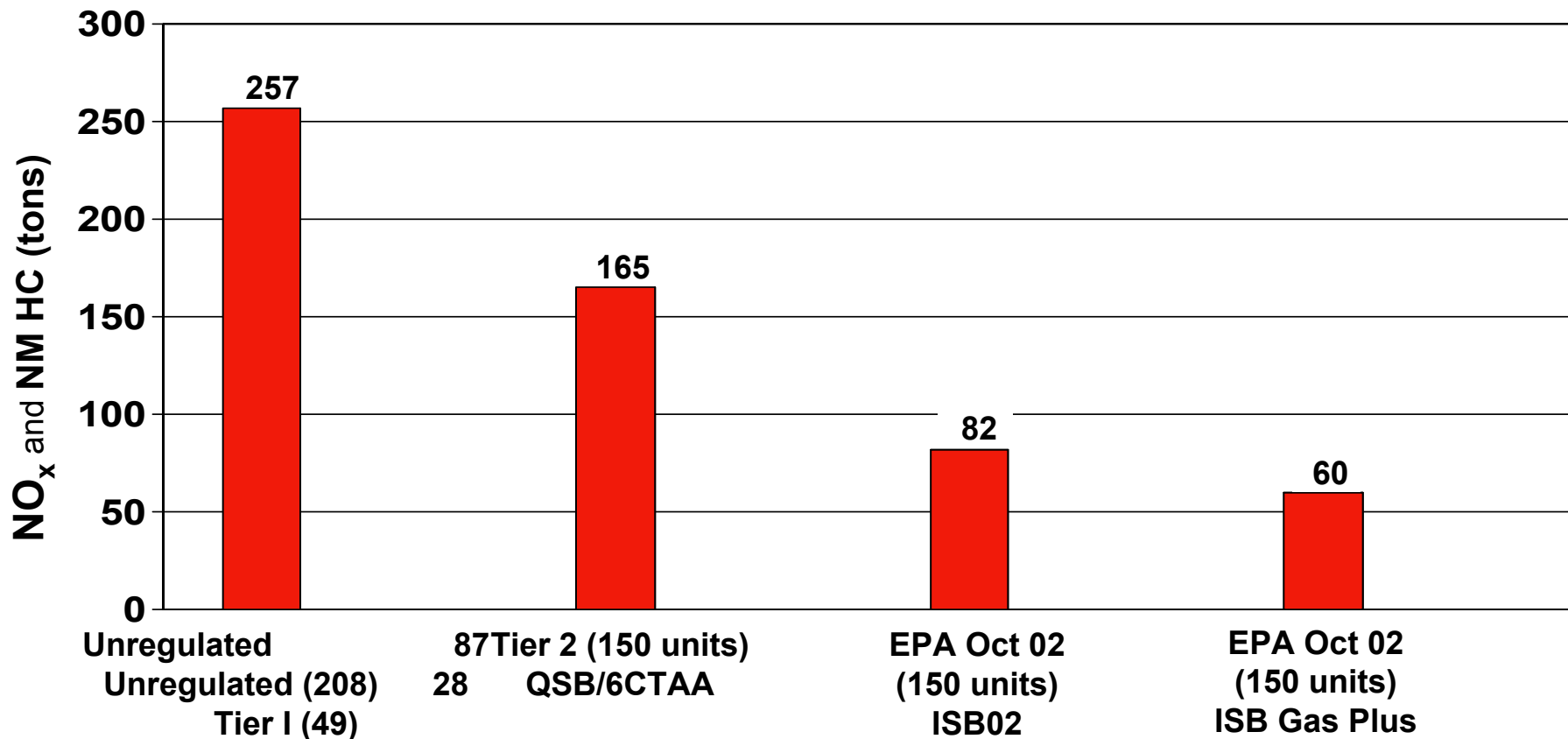


Based calculations:

1. 2,500 hours of usage per year
2. Average load factor on the engine of 80 horsepower
3. Method of calculation

$$\text{Emissions in grams} \times \text{Average horsepower} \times \text{Usage in hours per year} = \text{Tons per year}$$

Cummins Engine Emissions per year



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Re-power Opportunities?

- Most likely impossible due to wheelbase requirement to fit LNG or CNG tank.
- Very likely not cost effective. Maybe on very new units where the net emission reduction would be minimal and therefore less desirable.
- Manufacturers providing a “kit” would be most desirable but the “short run” of such kits would make them expensive. Difficult to recoup the engineering costs etc.
- The more expensive the equipment the better the re-power might be; RTG’s, very large equipment etc.

Lets talk about cost...

The cost of the LNG or CNG option on an Ottawa Kalmar terminal tractor Includes:

Cummins ISC Gas Plus EPA with 250HP & 750 Lb /ft of torque. LNG Tank (57 gallon net) or CNG Tank (41 gallon net), Vaporizer system, Safety valves, Leak detection system, All required plumbing etc. and Tank guard,Installation, CAC, Catalytic converter,Full Ottawa and Cummins warranty.Full documentation and manuals.

Makes good sense in terminal tractors

- Kalmar Ottawa has plans and purchase orders in place to produce the latest versions. Certain design criteria are being discussed and these are the only impediments to production at this time.
- Proven engine and fuel system design
- Subsidies are available.
- Emissions controls are backed by Engine manufacturer's infrastructure. (As opposed to after treatment systems companies)
- Leaves some room for after treatment as well.
- Expanding availability of fuel sources and fueling stations as well as support will help to grow the opportunities.

Fuel Station Cost?

- These figures vary considerably. Many suppliers such as Sound Energy Solutions offer programs designed to defray or offset cost of LNG station.
- Can be 30,000.00 demonstration station upwards of \$2.2 Million for a station to fuel 200 units Plus.
- CNG fast fill stations can be around \$7-800,000.00 for a 15 GPM filling station.

How About Fuel?

- Diesel equivalent costs vary widely.
- Some estimates around \$1.70 per diesel equivalent gallon
- These costs and the fuel station costs should be obtained from the vendor such as Sound Energy Solutions or others.

Diesels Face More Stringent Standards in the future

- Tier three Off Highway begins in 2006 for 174hp and up to 301hp.
- Tier three MOH begins in 2007 for 100hp up to 173 hp
- 2007- On Highway standards become more stringent

Thank You