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09-ALT-1	
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Leslie Baroody
CA Energy Commission
Fuels & Transportation Division
Emerging Fuels and Technologies Office
1516 9th Street MS 27
Sacramento, CA 95814

Dear Leslie:

As requested please find enclosed additional information on Dimethyl Ether (DME). Please note that what is not included in the description below is the fact that DME can be produced from multiple feedstocks such as natural gas, coal, woody mass, black liquor as well as our own patented technology that can be discuss under confidential provisions.

I have also attached a co-funding letter that was received from the CEC this year in support of a TIGGER application for the implementation of the onboard technologies (see COORGA DME FUEL DELIVERY SYSTEM) for a project that would have synthesized DME from byproducts at a California Ethanol plant. Unfortunately the FTA only approved projects that had a small budgetary requirement which meant our project which had a budget of $22.5 million did not make the cut.

I look forward in educating the CEC Energy and Transportation division more about the benefits of DME as a clean burning hydrocarbon that can replace a whole range of fossil fuels including diesel, propane and natural gas.

Below you will find our application to the EPA to add COORGA's DME to the emerging technologies list; this will provide you with the required overview of the benefits of using DME as a means to repower diesel engines.

Sincerely,
Garfield Coore
Coorga International Holding Ltd.
Tel: 416-829-9052
gcoore@coorga.com

CALIFORNIA ENERGY COMMISSION
KAREN DOUGLAS, CHAIRMAN
1516 NINTH STREET, MS 33
SACRAMENTO, CA 95814-5512
(916) 654-5036
FAX (916) 653-9040

May 20, 2009

Mr. Garfield Coore
COORGA
30 Crown Acres Court
Scarborough, ON M1S 4W1
Canada

Dear Mr. Coore:

The California Energy Commission (Energy Commission) is pleased to inform you of the acceptance of your pre-proposal entitled, Transit Busses: Today Hybrid Electric Diesel Fuel Production, Transport, and Infrastructure, in response to PON-08-010 – American Recovery and Reinvestment Act Cost Share: Alternative and Renewable Fuel and Vehicle Technology Program. This letter signifies the Energy Commission's intent to provide cost sharing for your proposal for an amount up to $6,000,000, in the event that your final proposal to the Energy Commission under PON-09-010 is successful and that you receive a federal award in response to the Department of Energy's Recovery Act – Transit Investments for Greenhouse Gas and Energy Reduction (TIGGER). You may include this letter in an application for TIGGER.

This letter does not guarantee funding by the Energy Commission. Please note that certain activities outlined in your proposal may be inconsistent with the Energy Commission's *Investment Plan for the Alternative and Renewable Fuel and Vehicle Technology Program*, or otherwise ineligible for funding. Energy Commission staff will provide you with a summary of potential inconsistencies.

Due to the high response to PON-08-010, the Energy Commission may award less than the requested match funding amount. In addition, the Energy Commission may reduce an award in the event that the California Budget Act for 2009-10 allocates less funding than anticipated for the Alternative and Renewable Fuel and Vehicle Technology Program. In either event, the applicant will be responsible for obtaining sufficient cost share to meet the funding requirements of TIGGER.

You are invited to submit a final proposal to the Energy Commission. The final proposal must include the information specified in PON-08-010 and must be received by the Energy Commission no later than 3 p.m. on May 29, 2009. Please include five hard copies and one electronic copy of your final proposal (including all applicable files) in one or more of the following formats: Microsoft Word, Microsoft Excel, or the format specified by the federal solicitation. The Energy Commission may invite applicants to a clarification interview for their final proposals. Following the final proposal evaluation, you will receive notification of the Energy Commission's final decision regarding funding.

For administrative or process-related questions regarding PON-08-010, please contact Sarah Williams at (916) 654-4584.

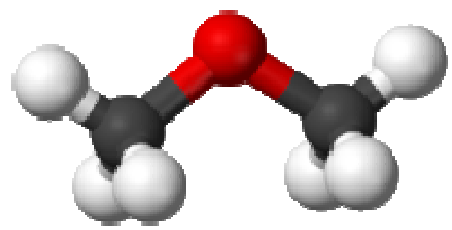
For technical related questions regarding PON-08-010, please contact Kevyn Piper at (916) 654-4845.

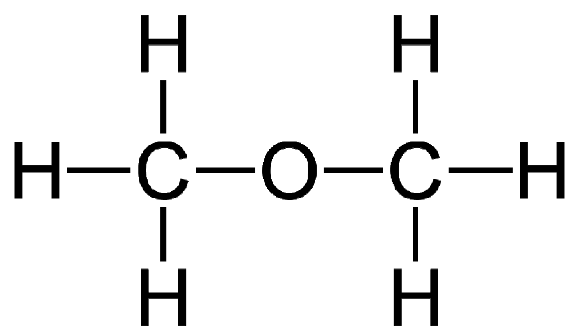
Thank you for your interest in our program.

Sincerely,

KAREN DOUGLAS
Chairman

Dimethyl Ether (DME) Repower & Retrofit System for Heavy Duty Diesel Engines





Manufacturer: COORGA International Holding Ltd.
Contact: Garfield Coore
Phone: 416-829-9052
Email: gcoore@coorga.com

DME Repower & Retrofit System for Heavy Duty Diesel Engines

INTRODUCTION

We believe that Dimethyl ether (DME) holds the greatest promise of ALL current alternative diesel fuel technologies in providing a low cost, facile pathway towards the reduction of tailpipe emissions. The San Joaquin Air Pollution Control District, the air regulator of one of the most highly air polluted regions of the US, is supportive of the potential of our technology and our approach (See Document: Valley Air District Support Letter - Appendix A)

DME is the organic compound with the molecular formula CH_3OCH_3. The simplest ether, it is a colorless gas currently used as a replacement for CFCs in hairspray and other aerosol propellant applications. It's environmentally benign and non-toxic (See Report 1: DME Toxicity Study Results - Appendix B).

DME is a promising and unique clean-burning hydrocarbon fuel that has two distinct phases. In its gaseous phase it's a replacement for gaseous fuels such as propane and natural gas. In its liquid phase (achieve at modest pressures of around 60 psi) it's an excellent replacement for diesel fuel. A two-year study by Volvo of 7 alternative diesel fuel showed DME to have the greatest promise on the basis of lowered emissions, energy efficiency, ease of adaptation, cost of production and feedstock availability (see Volvo: Comparative Suitability of Various Biofuels / Volvo: Summary of 7 Alternative Fuels - Appendix B).

DME lacks a carbon-carbon bond as indicated by the molecular formula above. This unique attribute means that DME is incapable of producing particulate matter emissions on combustion and burns soot free.

Further, it has a higher Cetane value than diesel fuel which means that it's a better compression fuel for diesel engines. As a result, diesel engines running DME are quieter and completely sootless, emitting less particulate matter and oxides of nitrogen. In fact, the simple replacement of standard diesel fuel with DME in an EGR equipped diesel engine is sufficient to meet emissions standards of 2010 without any additional remedial activities required (See Figs 2A & 2B: A New Clean Diesel Technology: Demonstration of ULEV Emissions on a Navistar Engine Fueled with DME. SAE Paper # 950061 - Appendix B).

A high Cetane rating of 55 – 60 and boiling point of -25ºC provide fast fuel/air mixing, reduced ignition delay, and excellent cold starting properties – key additional advantages of DME as an alternative diesel fuel.

The low hydrocarbon (HC) emissions from the combustion of DME consist almost entirely of unburnt DME and since DME is environmentally benign, this HC emission is also environmentally benign.

Summarized DME Combustion Characteristics Relative to Diesel Fuel

• High Cetane
• Completely SOOTLESS (No smoke)
• No Sulphur
• Low HC, CO
• Meets/exceeds US EPA and CARB 2010 emission standards today.
• Quiet combustion (engine noise reduction)
• Uses the same Fuel Distribution infrastructure as LPG (propane)

BENEFITS OF THIS EMERGING TECHNOLOGY:

1) **Clean Air:** Lower air pollution, reduction in the rate of increase of atmospheric CO_2, carbon neutral when produced from renewable feedstock.
2) **Less Smog Days:** Reduction in Particulate Matter (Black Carbon) & NOx.
3) **Better Economics:** Reduction in the overall cost of fuel.
4) **Energy Independence:** Displacement of imported fossil fuel with a locally produced renewable fuel.
5) **Beacon to others:** Provide a blueprint for the low cost retrofitting of legacy diesel fleets, with simultaneous reductions in air pollution and operating costs.

SCIENTIFIC JUSTIFICATION

DME's diesel engine-compatible properties are its high cetane number and low auto-ignition temperature. In addition, its simple chemical structure and high oxygen content result in soot-free combustion in diesel engines. Fuel injection of DME can be achieved through both conventional mechanical and current common-rail systems.

DME is an excellent, efficient alternative fuel for use in a diesel engine, with almost smoke-free combustion. This is not only because of its low auto-ignition temperature and its almost instantaneous vapourization when injected into the diesel engine's cylinder, but also because of its high oxygen content (around 35% by mass) and the absence of C–C bonds in the molecular structure.

Overall, the low particulate matter production of DME provides adequate justification for its consideration as a candidate fuel in compression-ignition engines. Recent research and development shows comparable output performance to a diesel fuel fed engine but with lower particulate emissions. NOx emissions from DME fuel fed engines can meet future regulations with high exhaust gas recirculation (EGR).

Table 1
Properties of DME and diesel fuel

Property (unit/condition)	Unit	DME	Diesel fuel
Chemical structure		CH_3OCH_3	$C_{12}H_{23}$
Molar mass	g/mol	46	170
Carbon content	mass%	52.2	86
Hydrogen content	mass%	13	14
Oxygen content	mass%	34.8	0
Carbon-to-hydrogen ratio		0.337	0.516
Critical temperature	K	400	708
Critical pressure	MPa	5.37	3.00[a]
Critical density	kg/m^3	259	-
Liquid density	kg/m^3	667	831
Relative gas density (air = 1)		1.59	-
Cetane number		>55	40-50
Auto-ignition temperature		508	523
Stoichiometric air/fuel mass ratio		9.0	14.6
Boiling point at 1 atm	K	248.1	450–643
Enthalpy of vapourization	kJ/kg	467.13	300
Lower heating value	MJ/k	27.6	42.5
Gaseous specific heat capacity	kJ/kg K	2.99	1.7
Ignition limits	Volume % in air	3.4/18.6	0.6/6.5
Modulus of elasticity	N/m^2	6.37E+08	14.86E+08
Kinematic viscosity of liquid	cSt	<0.1	3
Surface tension (at 298 K)	N/m	0.012	0.027
Vapour pressure (at 298 K) _	kPa	530	<<10

[a] Estimated on the basis of the equivalent chemical formula.

(Source: *"The potential of di-methyl ether (DME) as an alternative fuel for compression-ignition engines: A review" - SCIENCEDIRECT - Fuel 87, 2008)*

DME PRODUCTION

DME is produced from the dehydration of methanol over specialized catalyst. Methanol itself can be synthesized from multiple sources such as natural gas, biomass and other known feedstocks. When DME is produced from methanol synthesize from renewable feedstock it's referred to as BioDME and is considered carbon neutral since it would be 100% biogenic. As demonstrated by the formula below, the synthesis of DME from methanol (CH_3OH) has only water (H_2O) as a byproduct so the synthesis itself is also environmentally benign (see Diagram 1: DME Production Process Flow - Appendix A).

DME Synthesis Formula: $2CH_3OH = CH_3OCH_3 + H_2O$

DME will be produced both on a regional level in COORGA licensed commercial scale facilities in addition to being synthesized onsite by fleet operators utilizing a COORGA manufactured mini dehydration skid mounted plant. DME fuel produced from either the licensed facilities or the mini-plants will utilize COORGA's DME synthesis technologies and as such will meet our fuel specification below.

COORGA DME FUEL SPECIFICATION

The recommended fuel grade specification to be used to repower heavy duty diesel engines are outline below and will form part of this Emerging Technologies application. The test method will be via Gas-liquid Chromatography (GC). With this specification we seek to make sure that DME used in diesel engines remain non-acidic and non-corrosive and compliant with our fuel delivery components (see below). DME is hydrophilic so care must be taken in its storage and handling to prevent excessive moisture content.

Quality	Standard Value
DME Purity (mass)	≥ 99.00%
Methanol (mass)	≥ 0.05%
Moisture Content (mass)	≤ 0.01%
Methyl ethyl ether (mass)	≤ 0.2%
Carbon Dioxide (mass)	≤ 1.0%
Sulfur (mass ppm)	Not detected
Vapor pressure (MPa) 40℃	≤ 1.05

DME FUEL SAFETY RELATED ISSUES

In concentration DME has a light sweet odor which is beneficial to identify leakage. Further when it burns it gives of a blue flame which is also advantageous. DME has low viscosity in addition to being antagonistic to regular elastomers used as seals in standard diesel fuel common rail systems. Both these properties may lead to leakage if used in an unmodified high pressure common rail injection system. Viscosity and lubricity is enhanced by adding 50 – 100 ppm of Ricinoleic Acid, a renewable organic triglyceride, capable of protecting the fuel injectors and pumps against accelerated wear. Further DME is 4 to 6 times more compressible than diesel fuel so using the standard diesel fuel pump to transport the fuel from the tank to the engine may lead to early failure of the standard diesel fuel pump since it has to work harder than it was designed to. To remain in liquid phase DME is stored in a pressurized tank instead of the standard diesel tank. This pressurized tank is lighter than tanks used in LPG and Natural Gas because the pressure requirements are modest.

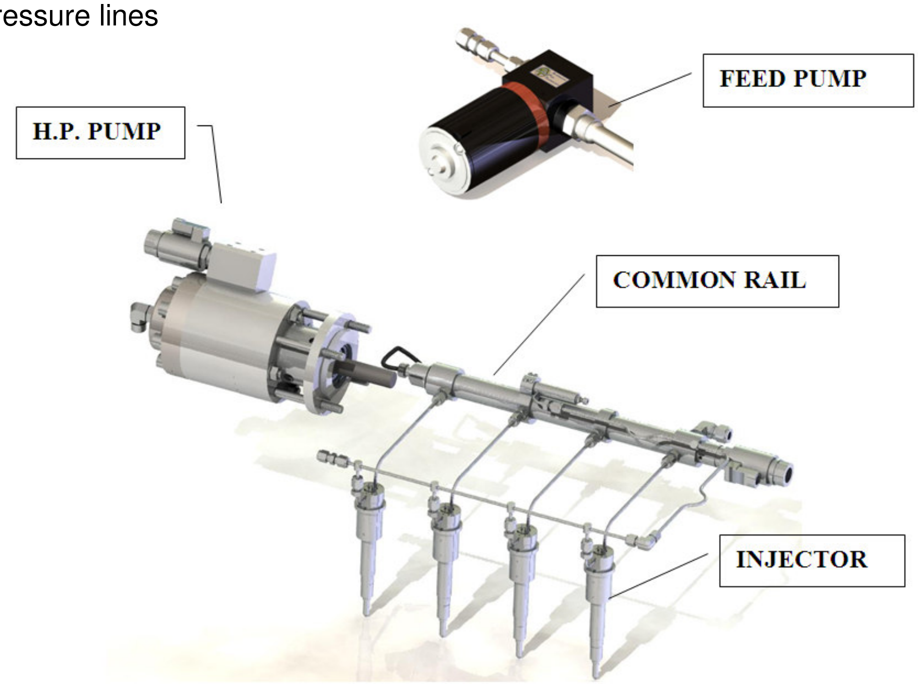
COORGA DME FUEL DELIVERY SYSTEM

To address the issues identified above, a purpose-built common rail fuel injection system was design for use with our DME fuel that is specifically gear towards large diesel truck and bus engines. This purpose-built common rail fuel injection system operates at a lower pressure level than standard diesel fuel common rail systems, 20–30 MPa as opposed to 50–150 MPa, and comes with solenoid three-way-valves, has leakage control with double seals and a purge system. It has shown promising results for engine performance, exhaust emissions and safety in operation. Further, the independence of injection pressure on engine speed gives a significant boost to the engine and allows optimization of injection timing, injection duration, rate of injection, and rate-shaping to be achieved for the unique DME spray pattern. The components of this purpose-built common rail fuel injection system and accompanying DME fuel pump form part of this Emerging Technology application and are referred collectively as the COORGA DME Fuel Delivery System. These components are designed and manufactured on our behalf by Alternative Fuel Technologies, our components partner in this project.

Also please note that the purpose-built common rail system, which is fed by a closed loop fuel delivery system supplied from a dedicated DME fuel tank would bypass entirely the OEM diesel fuel delivery system thereby leaving it in place (not including the OEM common rail) and available if a reversal of the retrofit is deemed desirable.

COMPONENTS:

- Fuel feed pump to move fuel from the fuel tank to the engine fuel injection system.
- High Pressure Common Rail Fuel Injection System including high pressure supply pump with integral inlet throttle valve.
- High Pressure common rail with integrated pressure control valve and pressure sensor
- Solenoid actuated fuel injector
- Fuel filters
- High and low pressure lines



COMPONENT LONGEVITY AND COST

Heavy-duty engines have a B50 life (an engineering term that means the point at which half of the engines are still running and half require rebuilding) of about 1 million miles. Medium-duty engines have a B50 life of about 500,000 miles. The onboard DME Fuel Delivery System is expected to meet this specification handsomely. In addition the commercial production level cost of $5000 - $7,000 per vehicle for installing these components on a diesel engine as an emission mitigation system is cost competitive with current after treatment systems that sell for $10,000 to $15,000.

WARRANTY

The DME fuel delivery system will come with a 100% parts replacement warranty of 200,000 miles or 320,000 km as of the date of initial installation.

INSTALLATION & TRAINING

As part of the verification and certification process we will be creating an installation manual and instruction video available to servicing dealerships on how to properly install the COORGA DME Fuel Delivery System.

SUPPORTING DOCUMENTATION

APPENDIX A

(Internally Produced Documents)

San Joaquin Valley
AIR POLLUTION CONTROL DISTRICT

May 20, 2009

Mr. Garfield Coore
Coorga International Holding Ltd.
14-2001 Thickson Road South
Whitby, Ontario Canada
L1N 6J3

RE: **Support for the Coorga International Holding Ltd San Joaquin Regional Transit District Project - Transit Investments for Greenhouse Gas and Energy Reduction**

The challenges faced by the San Joaquin Valley with respect to air quality are unmatched by any other region in the State. The Valley's topography, climate, geography and the presence of two major transportation corridors connecting Northern and Southern California all contribute to the region's air quality problem. In fact, over 80% of the oxides of nitrogen (NO_X) inventory in the San Joaquin Valley Air Pollution Control District (SJVAPCD) are attributed to mobile sources.

The SJVAPCD supports the referenced proposal submitted by Coorga International Holding Ltd in partnership with the San Joaquin Regional Transit District to convert existing diesel fueled buses to run on Bio Di-methyl Ether (DME). Reducing the amount of diesel fuel consumed is an important strategy for reducing smog-forming criteria pollutants, reducing children's exposure to toxic diesel exhaust and improving air quality in the Valley.

Should you have any questions, please do not hesitate to contact me at (559) 230-6000.

Sincerely,

Seyed Sadredin
Executive Director/Air Pollution Control Officer

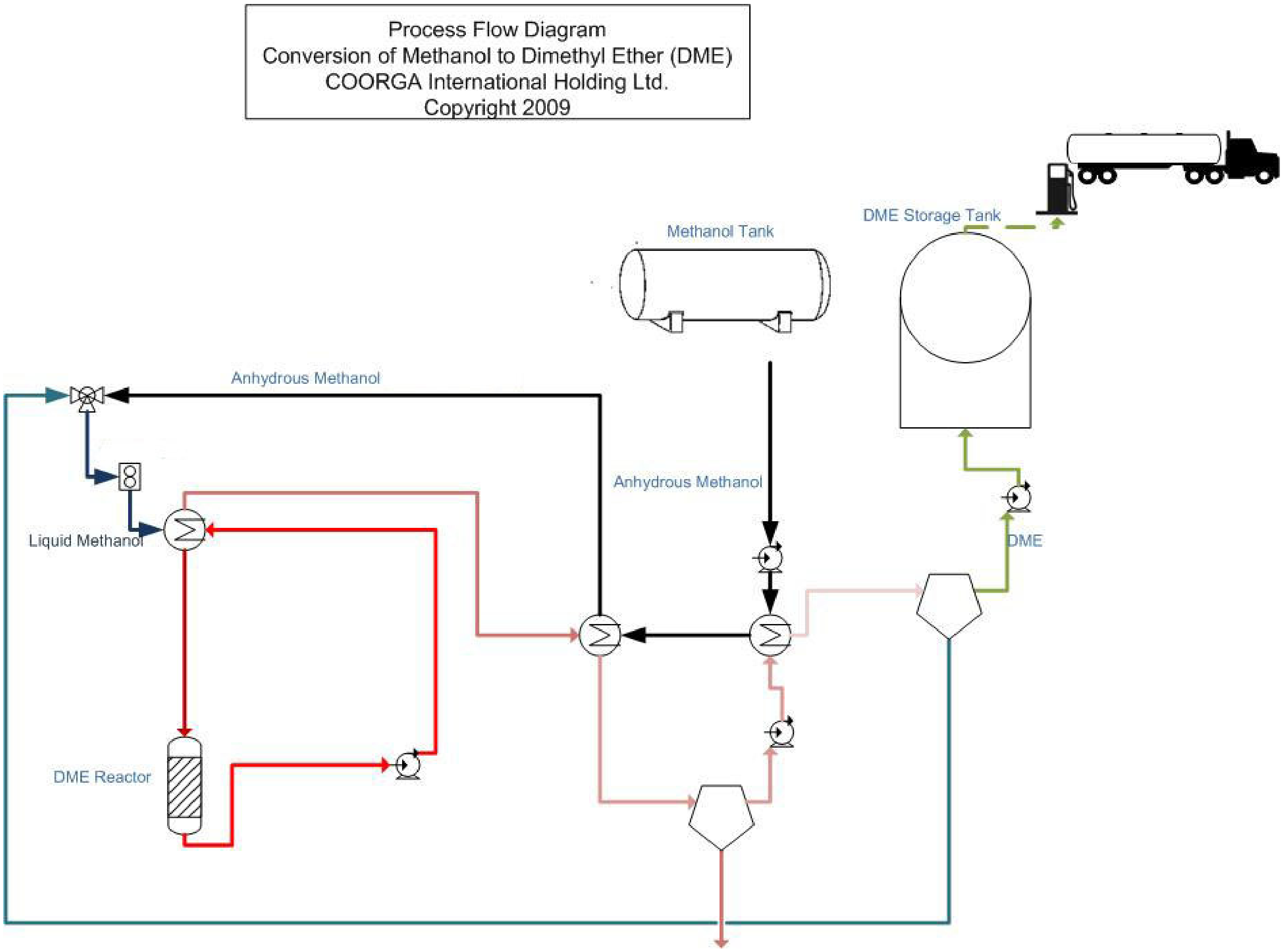
Seyed Sadredin
Executive Director/Air Pollution Control Officer

Northern Region
4800 Enterprise Way
Modesto, CA 95356-8718
Tel: (209) 557-6400 FAX: (209) 557-6475

Central Region (Main Office)
1990 E. Gettysburg Avenue
Fresno, CA 93726-0244
Tel: (559) 230-6000 FAX: (559) 230-6061
www.valleyair.org

Southern Region
34946 Flyover Court
Bakersfield, CA 93308-9725
Tel: (661) 392-5500 FAX: (661) 392-5585

Diagram 1: DME Production Process Flow



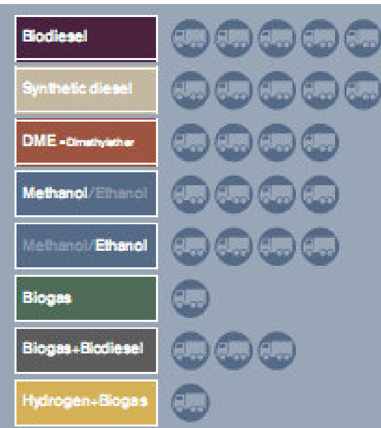
SUPPORTING DOCUMENTATION
APPENDIX B
(Third Party Public Documents)

Volvo: Comparative Suitability of Various Biofuels

The following is an overall assessment of the technical complexity of adapting vehicles to use the new fuels.

Assessment includes the effects of various parameters – such as maximum engine performance, increased weight and range between refueling – on vehicle efficiency. The last of these, for example, may affect vehicle payload.

The complexity of adaptation includes factors that necessitate additional fuel storage capacity, and require new and more expensive components, as well as the technology needed to meet future emission standards. As an example, some fuels require more advanced emission control systems than others.



Biodiesel and synthetic diesel receive the highest rating. Vehicles powered by these fuels are essentially comparable with conventional diesels. However, biodiesel necessitates more service and generates higher nitrogen oxide emissions.

Although the lower energy content of DME reduces vehicle range by 50%, the fuel can still be used for long-haul transport. While it requires a unique and advanced fuel system, DME also offers savings in terms of the cost and weight of exhaust silencing and post-treatment systems.

The lower energy content of ethanol reduces the range of the vehicle by 30% per tank of fuel.

Although biogas+biodiesel offers maximum engine performance, vehicle range is cut by half if the gas is in liquid form. In addition, two separate fuel systems are required.

Biogas and hydrogen+biogas require an Otto (spark-ignition) engine, which limits power output. The low energy density of the compressed gas limits the range of the vehicle to approximately 20% of that of a diesel. Cost and weight are increased by a complex fuel tank system.

Suitable for all heavy applications; no special vehicle adaptation required.

Suitable for most applications; no expensive or extensive vehicle adaptation required.

Suitable for most applications; expensive and extensive vehicle adaptation required.

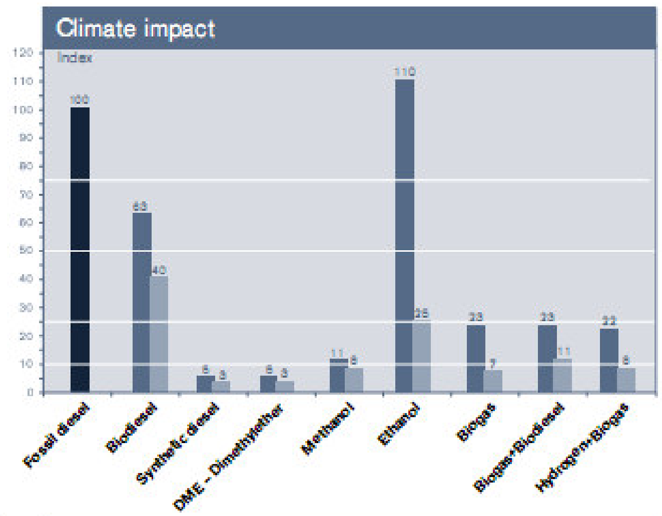
Suitable for up to half of all applications; complex, expensive and extensive vehicle adaptation required.

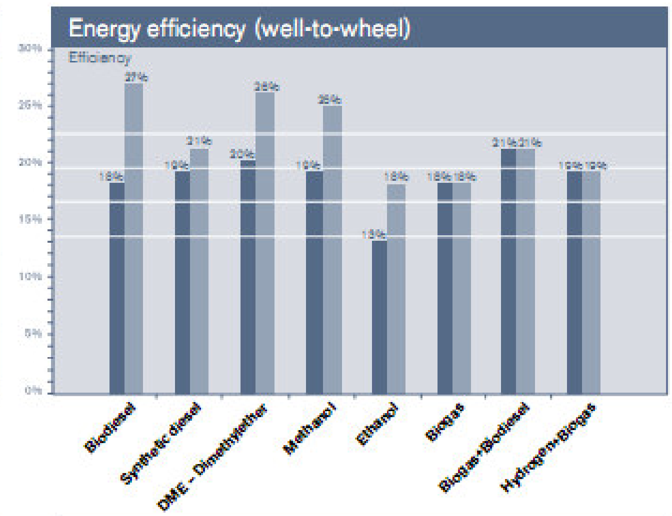
Suitable for only a limited number of applications; major, expensive and extensive vehicle adaptation required.

Detailed evaluation of fuels

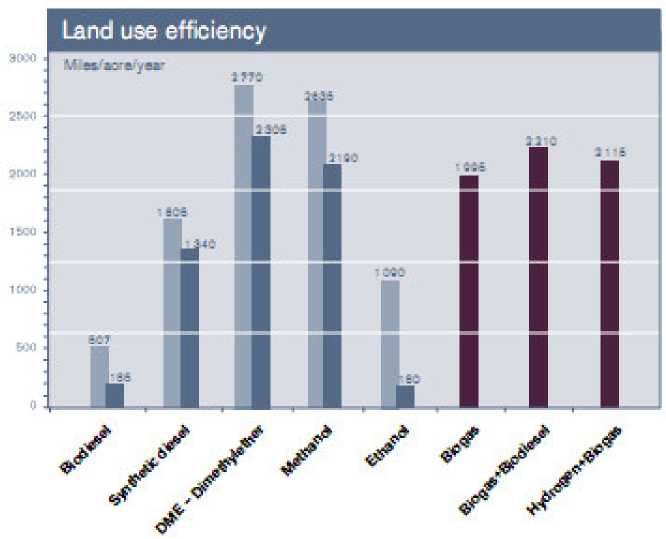
Detailed summary of figures used to evaluate fuels in accordance with specified criteria.

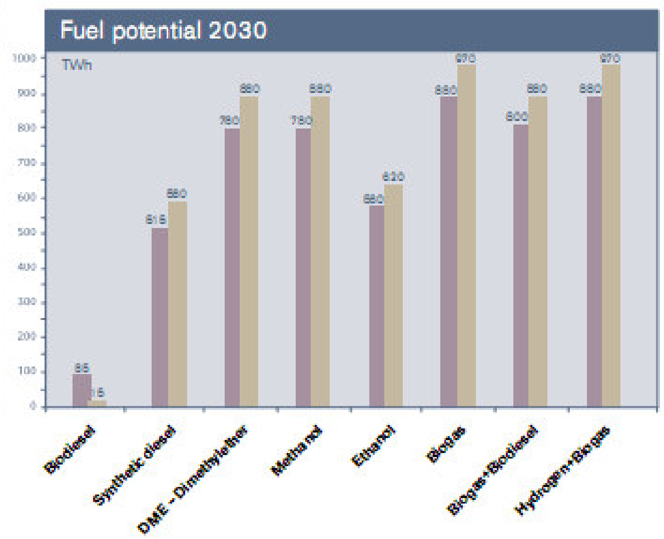
Production is considered from a North American and European perspective.

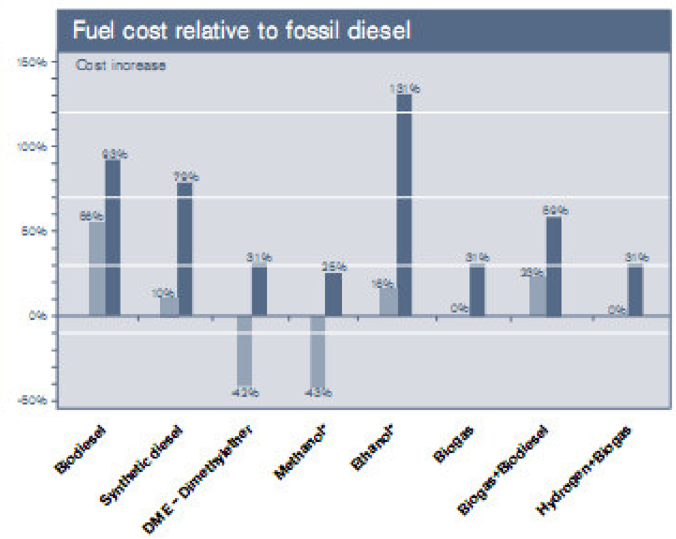




Best case Worst case Typical value
EU US







Full Reference for Figs 2A & 2B: A New Clean Diesel Technology: Demonstration of ULEV Emissions on a Navistar Engine Fueled with DME. SAE Paper # 950061

FIGURE 2A: Regulated NOx & PM Emissions

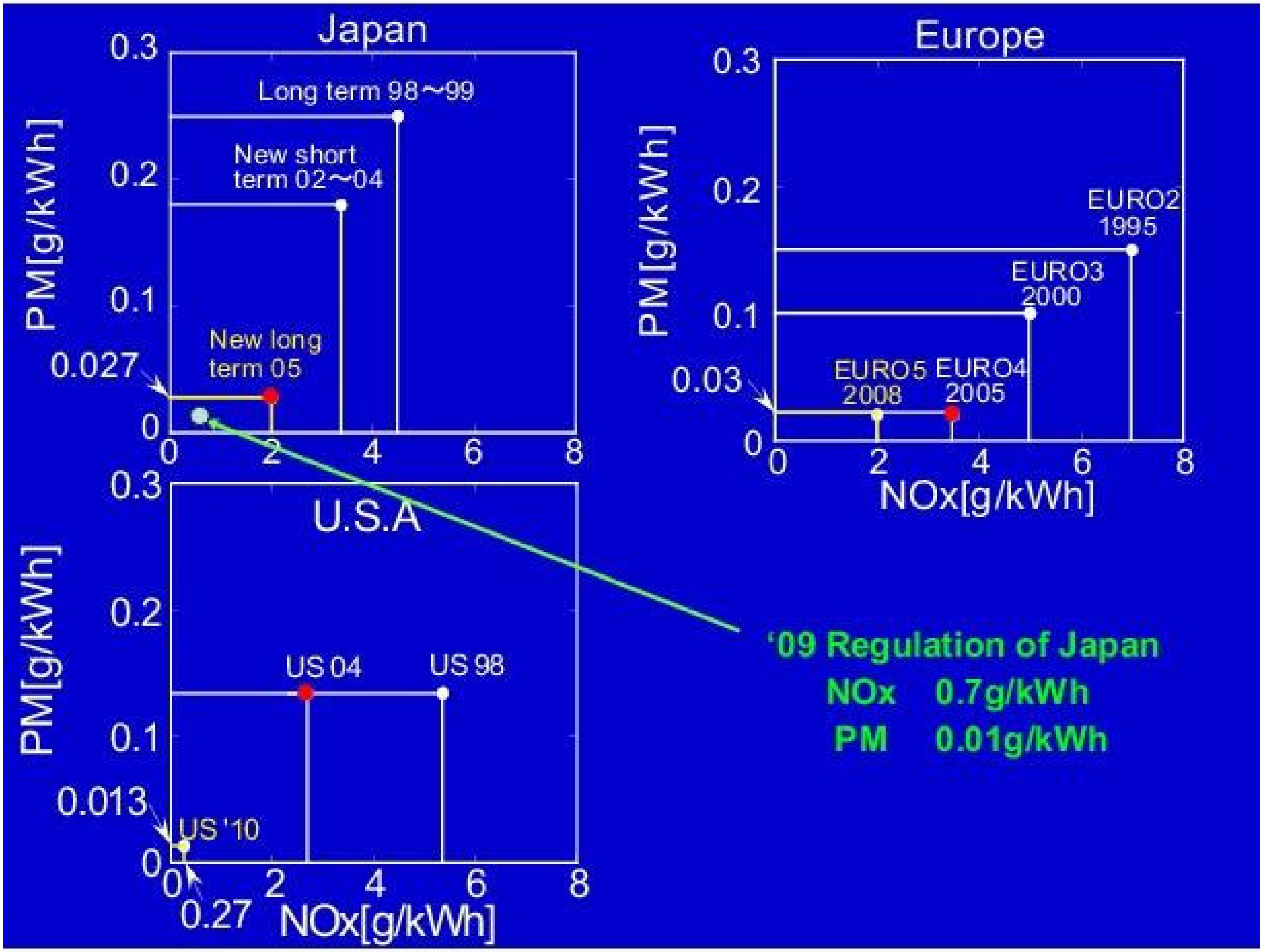
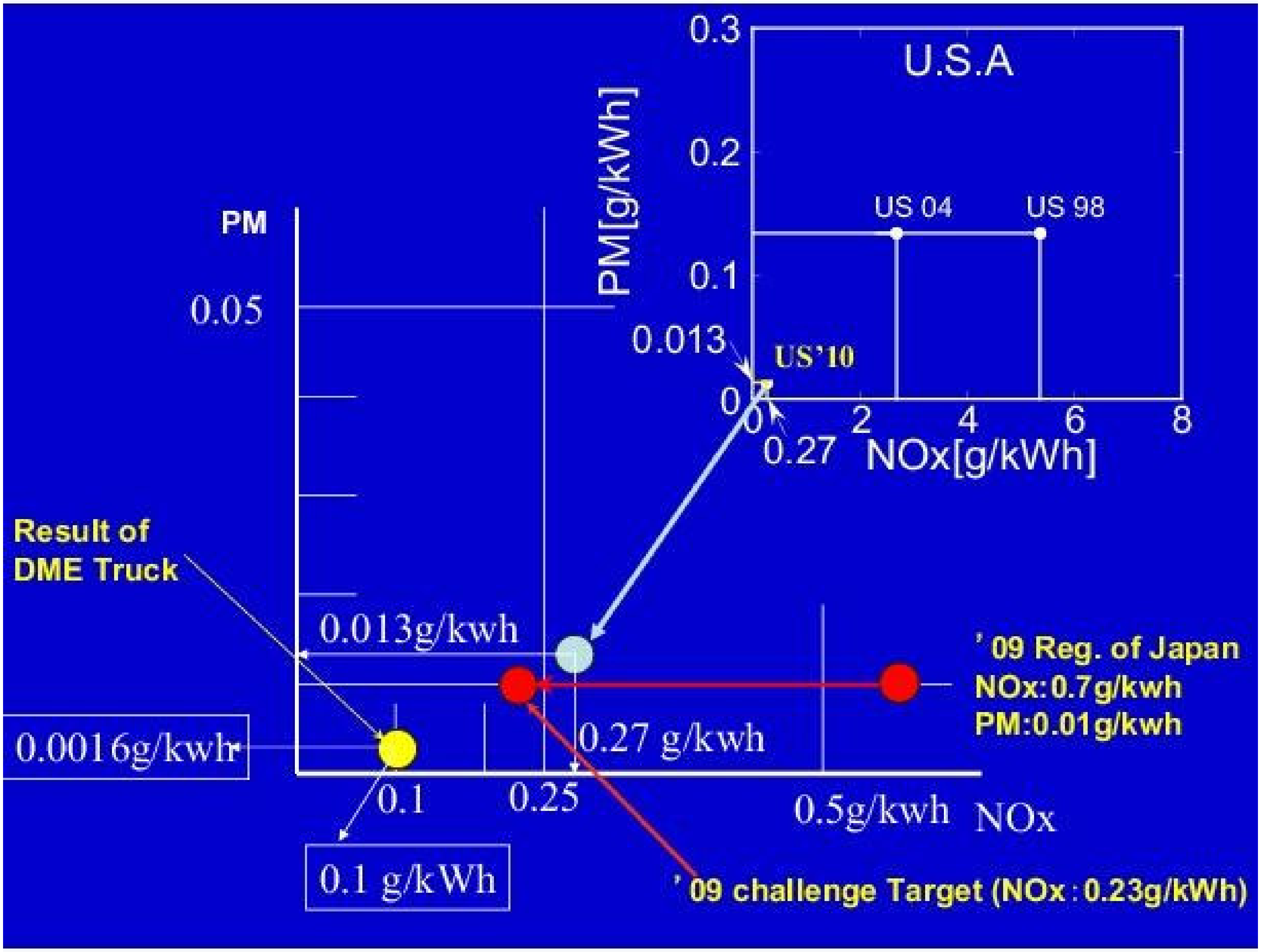


Figure 2B: DME Truck Emission (NOx & PM)



Technical Information

DUPONT

Dymel®

aerosol propellants

ATS-1

TOXICITY SUMMARY FOR DIMETHYL ETHER (DME); DYMEL® A PROPELLANT

Dimethyl ether has a low order of toxicity on both an acute and chronic basis. Although an ACGIH TLV® has not been established for DME, a value of 1,000 ppm (v/v; 8-hr TWA) seems appropriate based on its low toxicity potential. DuPont has established a 1,000 ppm Acceptable Exposure Limit (AEL) for its workplace environment.

The main physiological action of DME is that of "weak anesthesia" at high inhaled levels. Its 4-hour LC50 for rats is 164,000 ppm[1]. DME can also, in gross misuse situations, sensitize the heart to the body's own adrenaline, similar to the action mental screening studies using dogs and simulating stress with a large injected dose of adrenaline, cardiac sensitization was observed only at inhaled concentrations of 200,000 ppm and higher[2].

The toxicity of DME on a repeated exposure basis is also very low. In a 10-day (6 hours/day, 5 days/week) inhalation study[3], rats showed a decrease in body weight gain and slight evidence of anesthesia but no histopathologic evidence of tissue damage at 50,000 ppm; no significant adverse effects occurred at 10,000 ppm. In a four-week study[4] and in a 90-day study[5], rats showed no gross, clinical, or histopathologic evidence of toxicity at exposure levels ≤ 10,000 ppm and ≤ 20,000 ppm, respectively. Other investigators exposed rats for 6 hours/day, 5 days/week for 30 weeks at 0, 200, 2,000, or 20,000 ppm DME. Except for a slight liver weight decrease and slight serum SGPT increase at 20,000 ppm, there were not adverse effects attributable to exposure at any test level.

A lifetime inhalation toxicity and carcinogenicity bioassay[7] was completed at DuPont's Haskell Laboratory. In the lifetime inhalation study in rats, DME produced slight hemolytic (blood) effects at 25,000 ppm (2.5% DME) and was negative for carcinogenicity. The no-observable-adverse-effect-level (NOAEL) for this life-time inhalation study was 2000 ppm (0.2% DME) and was based on an increase in body weight and decrease in survival in male rats exposed at 10,000 and 25,000 ppm, and on the blood effects seen at the 25,000 ppm exposure level.

In a study[8] to evaluate developmental toxicity, pregnant rats were exposed to DME at 0, 1,250, 5,000, 20,000, or 40,000 ppm on days 6-15 of gestation. There was slight evidence of both maternal and fetal toxicity at the two highest levels. However, no evidence of teratogenicity was seen at <u>any</u> test level. A similar investigation[9] in another rat strain at exposure levels ≤ 28,000 ppm DME also showed no evidence of teratogenic potential.

DME has also been tested for genotoxic activity in in vitro bacterial assays.[1] It was not mutagenic in several S. typhimurium strains with or without metabolic activation. In pharmacokinetic investigations[10, 11] in animals and humans, DME has shown no evidence of accumulation in tissues and appears to have a very short biological half-life.

In conclusion, on the basis of animal toxicity studies and human experience to date, DME appears to have a very low degree of reactivity in biological systems. An 8-hour exposure limit of 1,000 ppm (v/v) in the workplace should pose no special hazard.

GLOSSARY:

ACGIH: American Conference of Governmental Industrial Hygienists
TLV®: Threshold Limit Value
TWA: Time Weighted Average
AEL: Acceptable Exposure Limit
SGPT: Serum Glutamic Pyruvic Transaminase
v/v: volume/volume
ppm: parts per million

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