

Methanol

as a

Fuel Alternative



Gil Dankner - Chairman

June 2017

Let Us Be...

A photograph of a city skyline, likely New York City, with a hazy, polluted atmosphere. The Empire State Building is prominent on the right. A bridge is visible in the background. The sky is a uniform greyish-brown color, indicating smog or heavy pollution.

Pollution - Leading Cause of Death Globally

The Future...



Creating Fuel Alternatives

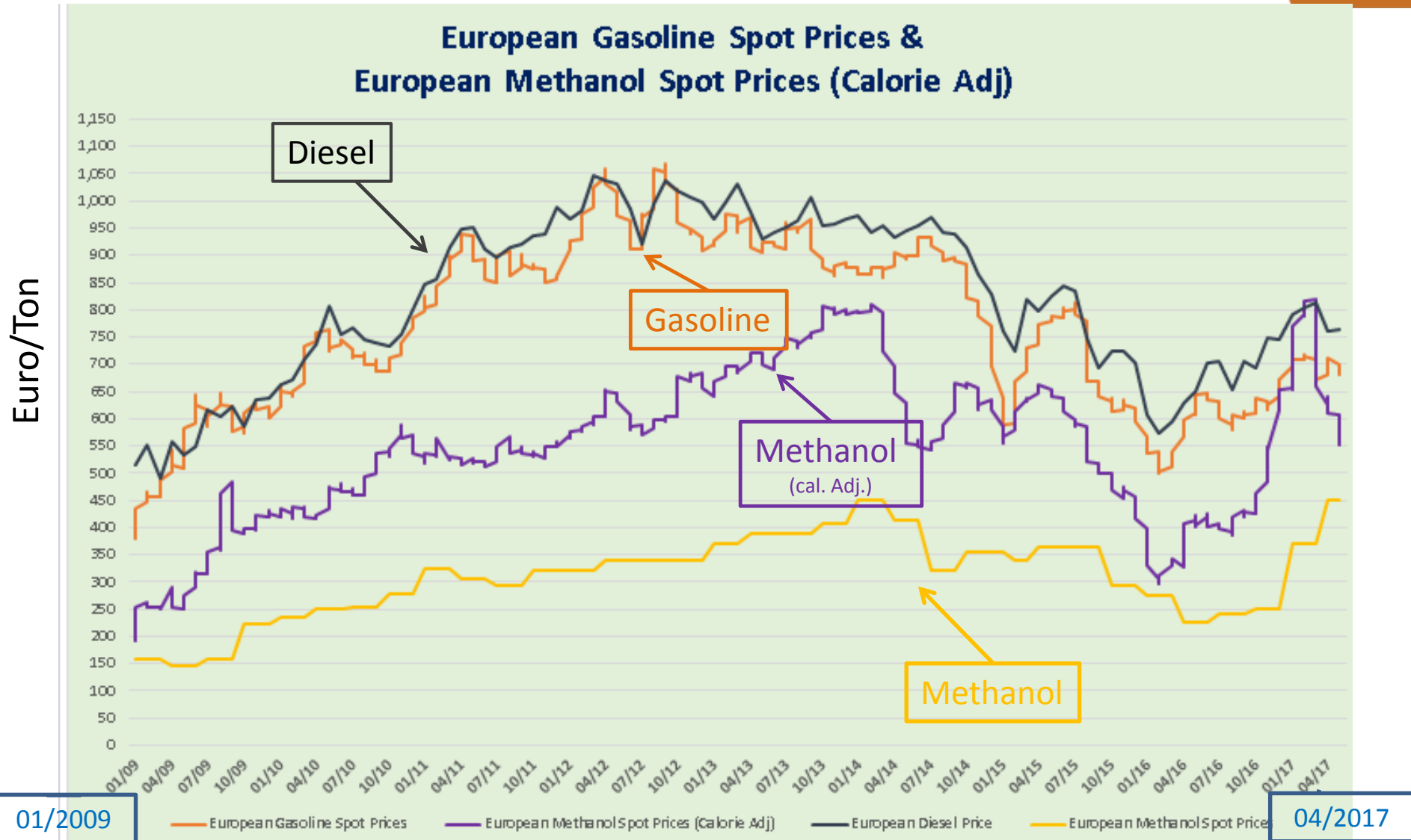
Dor Group - General



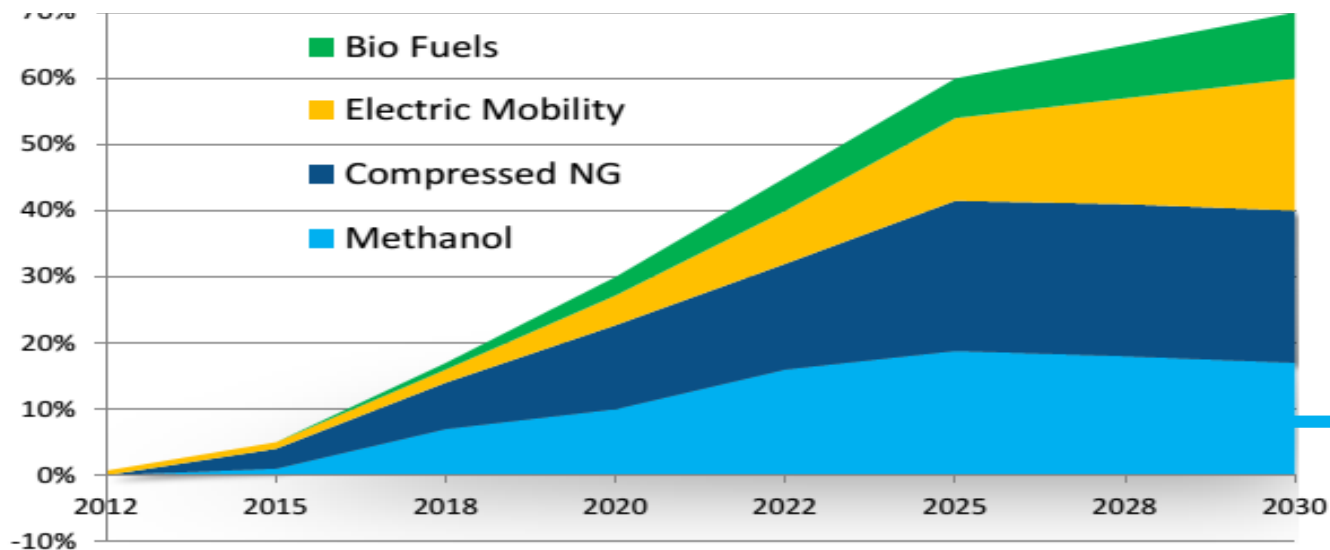
Providing an Alternative!



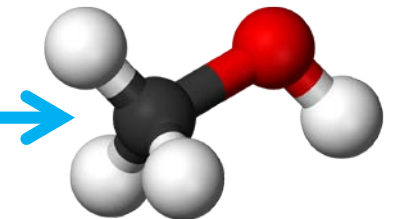
Energy Cost Comparison



Reduce the share of crude oil in Israel's transportation sector by 30% by 2020 and by 60% by 2025



Methanol



[For the Full directive please click here](#)

M15 – Promoted by Dor

A Newly approved Fuel Standard in Israel

Foreword

This Israeli Standard, SI 90 part 4, is based on the Israeli Standard SI 90 part 2 *Automotive gasoline - Unleaded gasoline* (which adopts the European Standard EN 228 *Automotive fuels - Unleaded petrol - Requirements and test methods*, with national modifications and additions).

This Standard is part of a Standard series dealing with automotive gasoline. The Standards in this series are the following:

SI 90 part 2 – Automotive gasoline: Unleaded gasoline

SI 90 part 4 – Automotive gasoline: Methanol-gasoline (petrol) fuel blend composed of 85% unleaded gasoline (petrol) and 15% methanol (M15)

Methanol - Advantages



- ✓ Lower Price per Calorie
- ✓ Lower Emissions
- ✓ Safer Liquid Fuel
- ✓ Energy Efficiency, High Octane
- ✓ A solution for internal combustion engines
- ✓ Utilize existing infrastructure
- ✓ Creation of local employment opportunities

A large blue 3D arrow pointing upwards and to the right, with a semi-transparent box containing the text 'Economic Growth' overlaid on it.

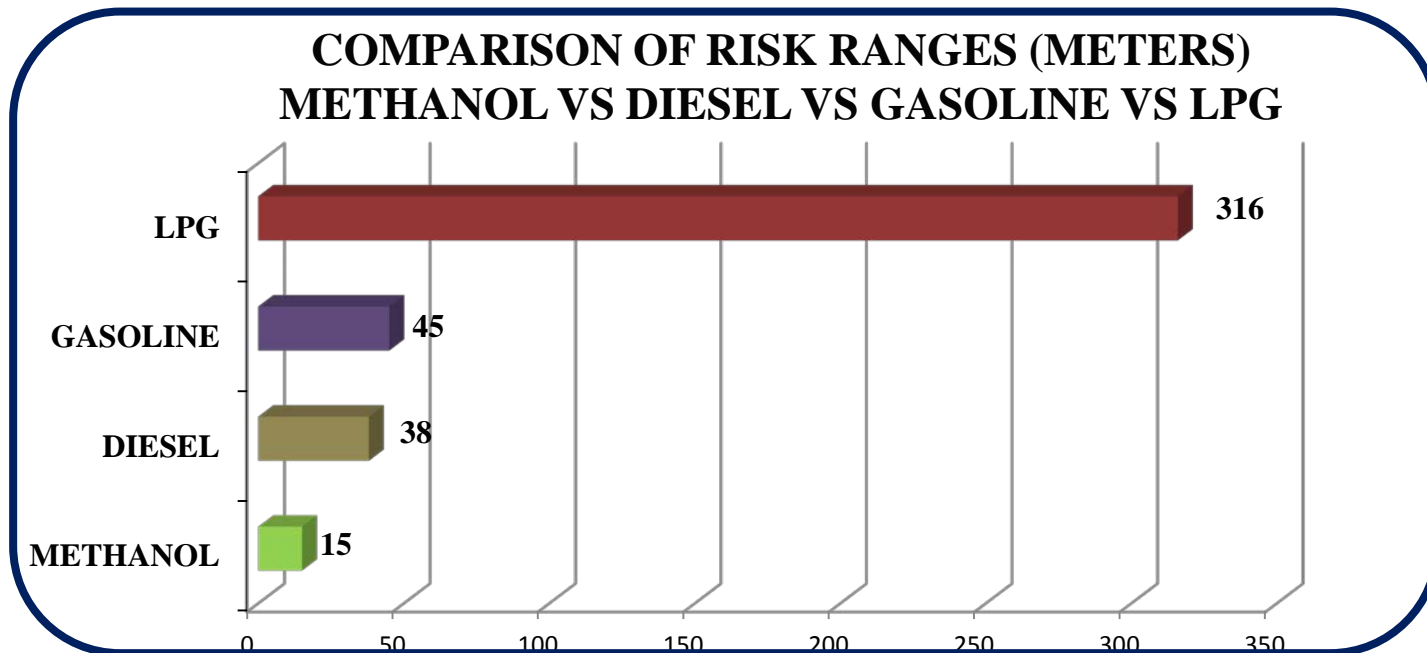
**Economic
Growth**

Methanol vs Diesel vs Gasoline vs LPG

Scenario:

Methanol, Diesel, Gasoline -leakage from a tank creating a pool fire in an area of 100 sq. meters .

LPG – leakage develops to tank explosion (BLEVE).



The Dor Group Experience

~Research and Development~

Methanol as a Clean & Green Alternative Fuel for

- Transportation
- Power Plants
- Steam Boilers

Methanol for Transportation



Existing EU Regulation – 3% Methanol

Table 1 — Requirements and test methods for unleaded petrol with a maximum oxygen content of 3,7 % (m/m)

Property	Units	Limits		Test Method ^a (See 2. Normative references)
		Min	Max	
Research octane number, RON		95,0	--	EN ISO 5164 ^b
Motor octane number, MON		85,0	--	EN ISO 5163 ^b
Lead content	mg/l	--	5,0	EN 237
Density (at 15 °C) ^c	kg/m ³	720,0	775,0	EN ISO 3675 EN ISO 12185
Sulfur content ^c	mg/kg	--	10,0	EN ISO 13032 EN ISO 20846 EN ISO 20884
Manganese content ^d until 2013-12-31 from 2014-01-01	mg/l	-- --	6,0 2,0	EN 16135 EN 16136
Oxidation stability	minutes	360	--	EN ISO 7536
Existent gum content (solvent washed)	mg/100 ml	--	5	EN ISO 6246
Copper strip corrosion (3 h at 50 °C)	rating	class 1		EN ISO 2160
Appearance ^e		clear and bright		Visual inspection
Hydrocarbon type content ^{e,f}	% (V/V)			EN 15553 EN ISO 22854
- olefins		--	18,0	
- aromatics		--	35,0	
Benzene content ^c	% (V/V)	--	1,00	EN 238 EN 12177 EN ISO 22854
Oxygen content ^{c,k}	% (m/m)	--	3,7	EN 1601 EN 13132 EN ISO 22854
Oxygenates content ^c - methanol ^g - ethanol ^h - iso-propyl alcohol - iso-butyl alcohol - tert-butyl alcohol - ethers (5 or more C atoms) - other oxygenates ⁱ	% (V/V)	-- -- -- -- -- -- --	3,0 10,0 12,0 15,0 15,0 22,0 15,0	EN 1601 EN 13132 EN ISO 22854

NOTE Requirements in bold refer to the European Fuels Directive 98/70/EC [1], including subsequent Amendments [2], [3] and [4]

Table 2 — Requirements and test methods for unleaded petrol with a maximum oxygen content of 2,7 % (m/m)

Property	Units	Limits		Test Method ^a (See 2. Normative references)
		Min	Max	
Research octane number, RON		95,0	--	EN ISO 5164 ^b
Motor octane number, MON		85,0	--	EN ISO 5163 ^b
Lead content	mg/l	--	5,0	EN 237
Density (at 15 °C) ^c	kg/m ³	720,0	775,0	EN ISO 3675 EN ISO 12185
Sulfur content ^c	mg/kg	--	10,0	EN ISO 13032 EN ISO 20846 EN ISO 20884
Manganese content ^d until 2013-12-31 from 2014-01-01	mg/l	-- --	6,0 2,0	EN 16135 EN 16136
Oxidation stability	minutes	360	--	EN ISO 7536
Existent gum content (solvent washed)	mg/100 ml	--	5	EN ISO 6246
Copper strip corrosion (3 h at 50 °C)	rating	class 1		EN ISO 2160
Appearance ^e		clear and bright		Visual inspection
Hydrocarbon type content ^c	% (V/V)			EN15553 EN ISO 22854
- olefins		--	18,0	
- aromatics		--	35,0	
Benzene content ^c	% (V/V)	--	1,00	EN 238 EN 12177 EN ISO 22854
Oxygen content ^c	% (m/m)	--	2,7	EN 1601 EN 13132 EN ISO 22854
Oxygenates content ^c - methanol ^g - ethanol ^h - iso-propyl alcohol ^h - iso-butyl alcohol ^h - tert-butyl alcohol ^h - ethers (5 or more C atoms) ^h - other oxygenates ^{h,i}	% (V/V)	-- -- -- -- -- -- --	3,0 5,0 12,0 15,0 15,0 22,0 15,0	EN 1601 EN 13132 EN ISO 22854

NOTE Requirements in bold refer to the European Fuels Directive 98/70/EC [1], including subsequent Amendments [2], [3] and [4]

Methanol Solution for Transportation



M15 & The Future of Automotive

- Joint Venture with ***Fiat Chrysler*** on M15.



FIAT CHRYSLER AUTOMOBILES



FCA Emission Test Results

Average Emissions - FIAT			
Type	95 RON	M15	Improvement %
HC mg/km	37	24.5	33.78
CO mg/km	241.5	228.5	5.38
CO2 g/km	134	132	1.49
Nox mg/km	19	18.5	2.63
NMHC mg/km	10	6	40.00
PM mg/km	1.36	1.1	19.12

Methanol Solution for Transportation



FFV- Flexible Fuel Vehicle

GEM – Gasoline, Ethanol & Methanol mixtures

- FFV Vehicles can use up to 85% Ethanol / Methanol.
- FFVs are marketed worldwide.
- M70 blends tested in Flexible Fuel Vehicle (FFV).



Methanol Solution for Transportation



<u>Type</u>					
95RON					
E10					
M56					

Methanol for Transportation



M15 & Existing Restrictions

Chevrolet– Car Owner's Manual

BMW – Car Owner's Manual

9-32 Driving and Operating

To check the fuel availability, ask an auto club, or contact a major oil company that does business in the country where you will be driving.

Fuel Additives

To provide cleaner air, all gasolines in the United States are now required to contain additives that help prevent engine and fuel system deposits from forming, allowing the emission control system to work properly. In most cases, nothing should have to be added to the fuel. However, some gasolines contain only the minimum amount of additive required to meet U.S. Environmental Protection Agency regulations. To help keep fuel injectors and intake valves clean and avoid problems due to dirty injectors or valves, look for gasoline that is advertised as TOP TIER Detergent Gasoline. Look for the TOP TIER label on the fuel pump to ensure gasoline meets enhanced detergency standards developed by the auto companies. A list of

marketers providing TOP TIER Detergent Gasoline can be found at www.toptiergas.com.

For customers who do not use TOP TIER Detergent Gasoline regularly, one bottle of GM Fuel System Treatment PLUS, added to the fuel tank at every engine oil change, can help clean deposits from fuel injectors and intake valves. GM Fuel System Treatment PLUS is the only gasoline additive recommended by General Motors. It is available at your dealer.

Gasolines containing oxygenates, such as ethers and ethanol, and reformulated gasolines might be available in your area. We recommend that you use these gasolines, if they comply with the specifications described earlier. However, E85 (85% ethanol) and other fuels containing more than 15% ethanol must not be used in vehicles that were not designed for these fuels.

Notice: This vehicle was not designed for fuel that contains methanol. Do not use fuel containing methanol. It can corrode metal parts in the fuel system and also damage plastic and rubber parts. That damage would not be covered under the vehicle warranty.

Some gasolines that are not reformulated for low emissions can contain an octane-enhancing additive called methylcyclopentadienyl manganese tricarbonyl (MMT); ask the attendant where you buy gasoline whether the fuel contains MMT. We recommend against the use of such gasolines. Fuels containing MMT can reduce spark plug life and affect emission control system performance. The malfunction indicator lamp might turn on. If this occurs, return to your dealer for service.

Notes

Your individual vehicle

On purchasing your BMW, you have decided in favor of a model with individualized equipment and features. This Owner's Manual describes all models and equipment that BMW offers within the same group.

We hope you will understand that equipment and features are included that you might not have chosen for your vehicle. You can easily identify any differences with the aid of the asterisk * used to identify all optional equipment and accessories.

If your BMW features equipment which is not described in this Owner's Manual such as a car radio or telephone, Supplementary Owner's Manuals are enclosed. We ask you to read these manuals as well.

Status at time of printing

BMW pursues a policy of continuous, ongoing development conceived to ensure that our vehicles continue to embody the highest quality and safety standards combined with advanced, state-of-the-art technology. For this reason, the features described in this Owner's Manual could differ from those on your vehicle. Nor can errors and omissions be entirely ruled out. You are therefore asked to appreciate that no claims can be recognized on the basis of the data, illustrations or descriptions in this Owner's Manual.

For your own safety

Fuels

A Use unleaded gasoline only. Fuels containing up to and including 10% ethanol or other oxygenates with up to 2.8% oxygen by weight – that is, 15% MTBE or 3% methanol plus an equivalent amount of co-solvent – will not void the applicable warranties respecting defects in materials or workmanship. Field experience has indicated significant differences in fuel quality – volatility, composition, additives, etc. among gasolines offered for sale in the United States and Canada. The use of poor-quality fuels may result in drivability, starting and stalling problems, especially under certain environmental conditions, such as high ambient temperature and high altitude. Should you encounter drivability problems which you suspect could be related to the fuel you are using, we recommend that you respond by switching to a recognized high-quality brand. Failure to comply with these recommendations may result in unscheduled maintenance. Obey all applicable safety rules when handling gasoline.

Notice: This vehicle was not designed for fuel that contains methanol. Do not use fuel containing methanol.

Fuels containing up to and including 10% ethanol or other oxygenates with up to 2.8% oxygen by weight – that is, 15% MTBE or 3% methanol plus an equivalent amount of co-solvent – will not void the applicable warranties respecting defects in materials or workmanship.

Replacing Traditional Fuels



Methanol Solution for Transportation



M100 – The Future for Diesel Trucks

**M100 – a 100% methanol solution
to replace diesel fueled trucks**



Gas Turbine (GT) Methanol firing

Methanol for Gas Turbines



Dor and Israel Electric Company (IEC) developed
Methanol application for power plants

Converted a Pratt & Whitney 50 MW Gas Turbine Unit in Eilat
from Diesel to 100% Methanol firing.



Methanol for Gas Turbines

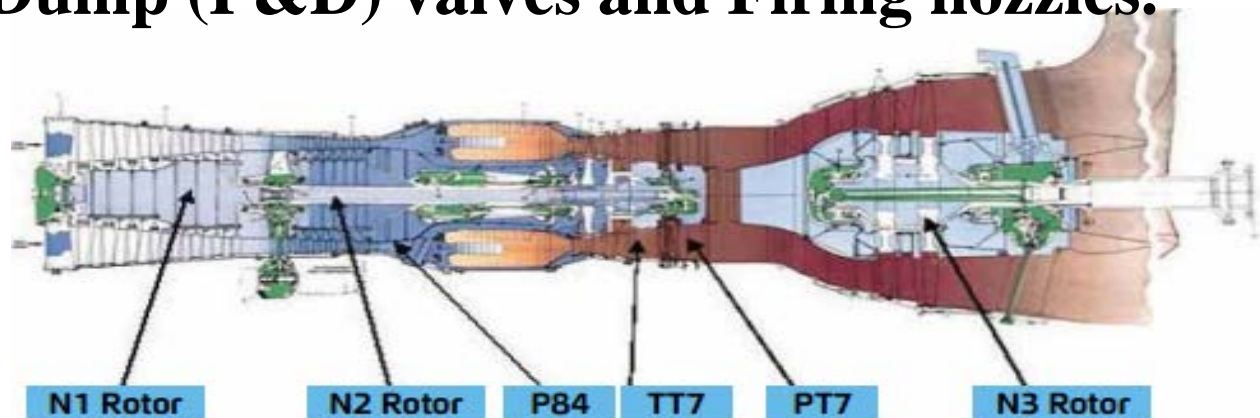


The Objective

Restoring the full capacity of the machine and gaining long-term operating experience of working with methanol-fueled GT.

The Process

Minor additions, replacements and modifications required to HP pumps (Gear Box Driven), Modulating Valve, Pressure & Dump (P&D) valves and Firing nozzles.



FT4 – Engine & Power Turbine

Methanol for Gas Turbines



Advantages

Significant reduction of emissions

NO_x - by **75%**

SO_x - by **100%**

Particle by **80%**

Results

- Comply with “clean air law” requirements.
- Performance not effected.
- Low cost fuel system retrofit methanol firing.
- Economically favorable where natural gas is not available.
- Utilizing existing infrastructure.

Steam Boilers Converted to the use of Methanol

Methanol as a Clean & Green Alternative Fuel for
Dor's Steam Boilers

Methanol for Steam Boilers



Filter Comparison

Diesel

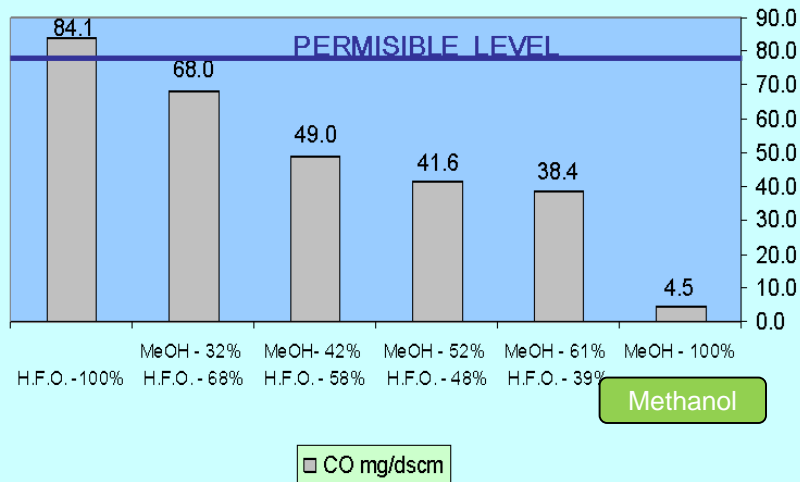
Methanol



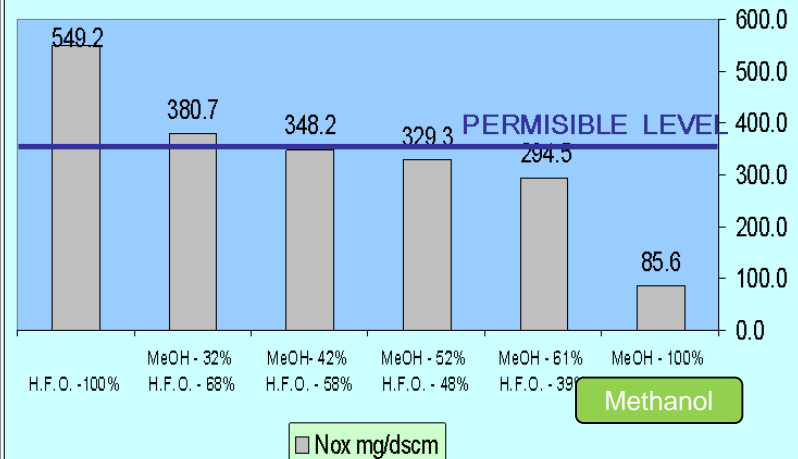
Methanol for Steam Boilers



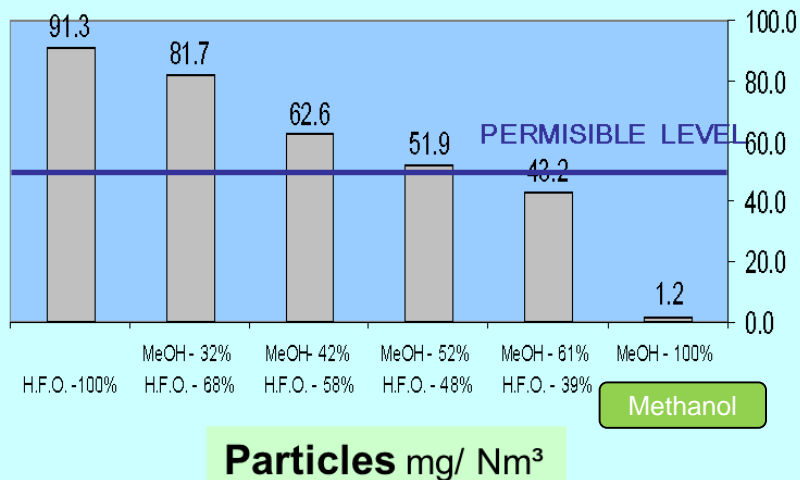
CO mg/dscm



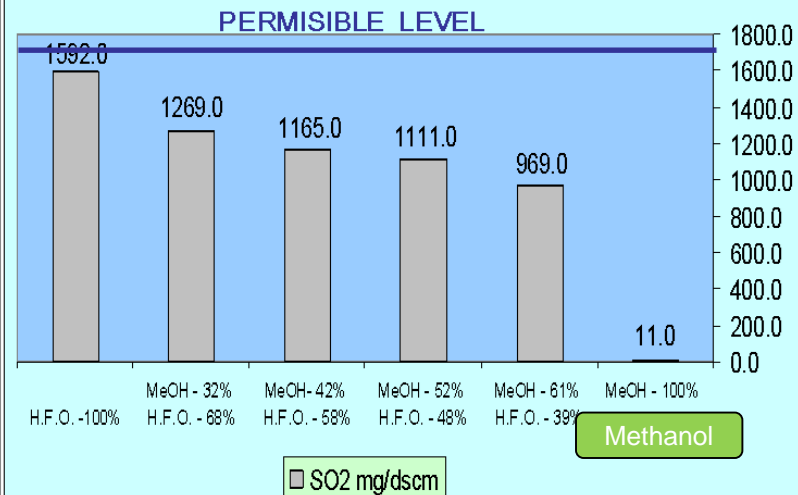
Nox mg/dscm



Total Particles mg/ Nm³



SO₂ mg/dscm



Recognition & Legitimization

- **Acknowledgement of Methanol as a fuel.**
- **Introduction and addition to existing regulation.**
- **Approval of use by automakers.**

Thank you!

