



**Bunker Fuels, Marine Engines and Ships  
A Future Scenario**  
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## CONTENTS

THIS PRESENTATION WILL BE IN THREE PARTS DEALING WITH:

- ▶ PART 1 – R&D IN MARINE FUELS
- ▶ PART 2 – R&D IN MARINE ENGINES
- ▶ PART 3 – R&D IN SHIPS
- ▶ PART 4 – OTHER R&D

## PART 1 – R&D WITH REGARD TO BUNKER FUELS

- ▶ DE-SULPHURIZATION TECHNOLOGY
- ▶ SYNTHETIC FUEL DME
- ▶ ETHANOL PRODUCTION – NON CORN SOURCES
- ▶ ETHANOL PRODUCTION – DOUBLING USING GM YEAST
- ▶ FUELS FROM JATHROPHA
- ▶ FUEL FROM ALGAE
- ▶ RENEWABLE DIESEL FROM E.COLI POOP

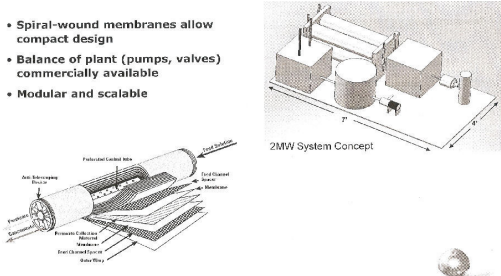
## DE-SULPHURIZATION TECHNOLOGY

- SULPHUR EMISSIONS CAUSE ACID RAIN AND OTHER HEALTH HAZARDS
- DESULPHURIZATION – REMOVAL OF SULPHUR FROM FUEL
- MEMBERANE BASED TECHNOLOGY TO HARVEST A LOW SULPHUR FUEL STREAM FROM BULK FUEL FEED
- OXIDATION BASED CHEMICAL SEPARATION SYSTEM ALSO REMOVES SULPHUR FROM BULK FUEL FEED

## DE-SULPHURIZATION TECHNOLOGY

### Membrane System Characteristics

- Spiral-wound membranes allow compact design
- Balance of plant (pumps, valves) commercially available
- Modular and scalable



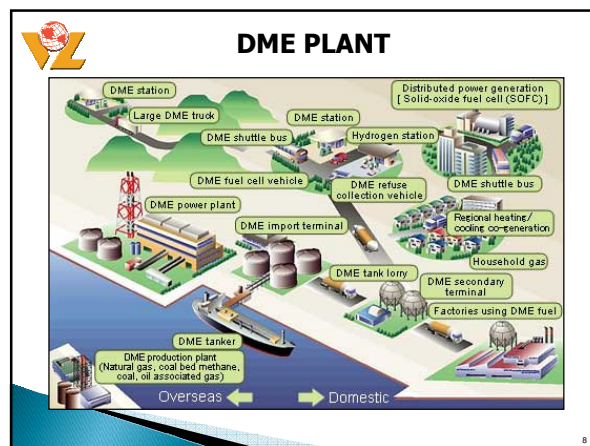
## Synthetic Fuel – Dimethyl Ester (DME)

- ▶ Coal to methanol to DME
- ▶ Bio mass to methanol to DME
- ▶ Natural gas to methanol to DME
- ▶ Five bars pressure liquid
- ▶ Easy transportation
- ▶ Easily supplements or replaces LPG which costs 2–3 times

### Synthetic Fuel – DME (Contd...)

- ▶ China scenario – Total commitment to DME – From coal and gas
- ▶ Over 30 existing plants
- ▶ Advantages of plant at coal pit head

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### MORE ETHANOL FROM GM YEAST

- Yeast decides what it will eat
- They like glucose- Which is present in corn and also the cellular of plant
- They don't like xylose, also present in basic plant
- Genetically modified (GM) yeast will eat xylose as well and produce 2 times more ethanol
- No need for corn
- Yield of ethanol 100% more

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### FUEL FROM JATHROPA

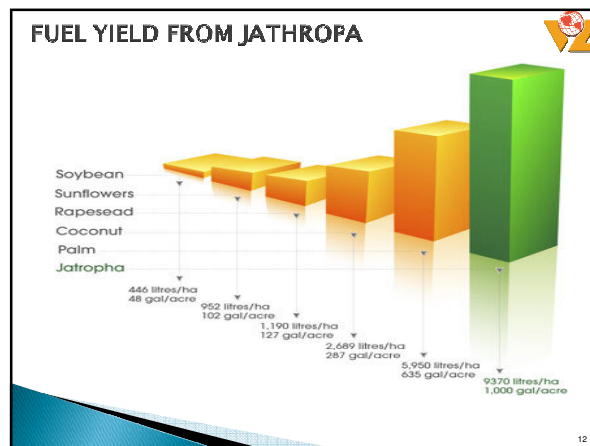
- ▶ IT CAN GROW IN ARID LAND
- ▶ NEED NOT USE CURRENTLY CULTIVATED LAND
- ▶ YIELDS IN THREE TO FOUR YEARS
- ▶ YIELD 1000/GALLONS PER ACRE
- ▶ 3 MILLION ACRES IN INDIA ALREADY ON JATHROPA

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### FUEL FROM JATHROPA

#### Pictures of Jatropha

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### Fuel from Algae—Bill Gates invests in this technology

- Algae creates fats using energy from Sun and CO<sub>2</sub> and air
- Genetically engineered Algae produce more fat; Contain up to 70% oil—can be refined into Biodiesel
- 25 times more than rapeseed oil
- Low content of Sulfur and Greenhouse gases
- Can also produce gasoline
- Cruise ships already using part Biofuel

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### Renewable Diesel from *E. coli* poop

- Biotech labs use bacteria to create diesel oil
- Genetically altered bacteria feed on plant material (type of sugar)
- They digest and excrete equivalent of diesel fuel
- Bacteria produce yeast, beer, ethanol, and now diesel fuel
- These harmless *E. coli* microbes can be programmed to produce gasoline or jet fuel
- Now only produced in labs – to be scaled up

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### PART 2 – R&D IN MARINE DIESEL ENGINES

- ▶ COMMON RAIL SYSTEM
- ▶ ADVANCED TURBO CHARGER TECHNOLOGY
- ▶ NANO PARTICLES IN LUBE OIL
- ▶ NANO PARTICLES IN FUEL
- ▶ THERMO ELECTRICS
- ▶ FILTRATION TECHNOLOGY
- ▶ CONDITION MONITORING (SCUFFING)

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### R&D TRENDS at 2007 CIMAC

- ▶ More emphasis on emission than fuel efficiency.
- ▶ More concern about CO<sub>2</sub> and NO<sub>x</sub> than other types of emissions.
- ▶ An introduction to alternate fuels and synthetic fuels such as Di Methyl Ether (DME).
- ▶ Common rail fuel system two stage turbocharger to enable running at low loads, reducing NO<sub>x</sub> emissions and SFOC (Specific Fuel Oil Consumption).
- ▶ Advanced Condition monitoring

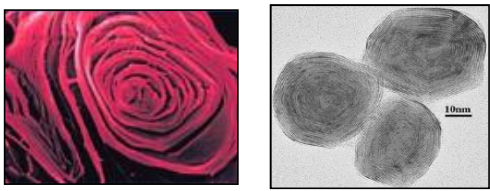
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### NANO PARTICLES BASED SOLID LUBRICANTS

- ▶ Inorganic fullerene nano particles. Tungsten Disulphide
- ▶ 15–300 nano meter size onion like structure. Can withstand shock pressures upto 3.5 giga pascals.
- ▶ Coefficient of friction – hardly increases even when load increased several times
- ▶ 1% of nano particles added to lubricating oil
- ▶ Significant increase in lubricity. Improved seizure point by 13%, Weld point by 20%
- ▶ **Oil renewal maybe once in one million miles!**

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### NANO PARTICLE TECHNOLOGY (Contd....)



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## NEW ISRAELI NANO TECH – NO OIL CHANGE!

- ▶ NanoLube–synthetic lubricant, spherical inorganic Nano particles
- ▶ Friction and wear between moving objects reduced
- ▶ Nano spheres act like mini ball bearings, keep rubbing surface cool
- ▶ Lubrication very efficient even if surface not smooth
- ▶ Extended fuel mileage is a greener technology since lube oil not dumped

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## IGNITION IMPROVEMENT USING NANO PARTICLES

- ▶ AZ State University research carried out on Diesel fuels
- ▶ Aluminum Oxide ( $Al_2O_3$ ) Nano particles 15 and 50 nm, 0.1% and 0.5% by volume
- ▶ Significant improvement in Ignition–droplets ignited at lower temperature and in greater numbers
- ▶ Heat and Mass Transfer properties enhanced

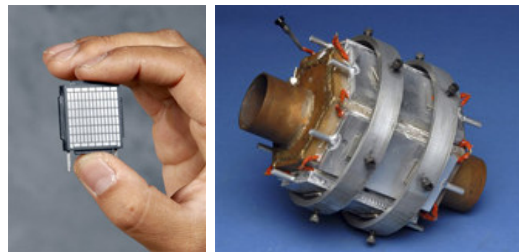
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## Thermo Electrics

- Using temperature difference to generate electricity
- Metal plated device fitted around exhaust pipe – save 10% fuel
- When a material is heated excited electrons move to the cold side. This movement is current
- Thermo electric can also provide cooling.
- With nearly 50% of heat wasted in cooling and exhaust, thermo electric can save a lot.
- All car companies are racing to produce thermo electrics
- May become a standard fitting in a car in 3 years
- Over 500 million gallons of fuel will be saved per year in three years from now

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## Thermo Electrics



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## Achieving Energy Efficiency on Ships

- Variable frequency motors for cooling pumps, vent fans, circulating pumps, air-conditioning and refrigerator compressors
- Changeover controls to electric linear motors from pneumatic control systems
- Changeover lighting to CCFL lamps–60% saving
- Use LED lighting 50% saving

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## Achieving Energy Efficiency on Ships (Contd..)

- Motion detection lighting to save energy
- Electronic power factor correctors
- Better insulation
- Reduce part load generator operation, fit one reduced power generator for port
- Silicone Slick paint coated propellers and rudders
- Adjusting auto pilot parameters to reduce rudder oscillations

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### PART 3 – R&D ON SHIPS

- ▶ ONSHORE CONTROL OF NAVIGATION
- ▶ HULL TREATMENT, PROPELLER DESIGN
- ▶ WIND TECHNOLOGY (SKY SAILS)
- ▶ FUEL CELL
- ▶ SOLAR
- ▶ FLOATING WIND TURBINE
- ▶ CLEANING SHIP HULLS WITH ROBOTS
- ▶ CORROSION PROOFING OF ALLOY METALS
- ▶ ACHIEVING ENERGY EFFICIENCY ON SHIPS
- ▶ NEW TYPES OF SHIPS

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### Wind Assisted Ships

- ▶ Kite flying at 500m altitude,
- ▶ Inflatable kite fitted on Beluga Ships
- ▶ 2000 to 5000 sq m area
- ▶ 15 to 20% speed increase
- ▶ Fuel saving 50%

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### USING WIND POWER

#### HARNESSING THE WIND

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### FUEL CELLS

- ▶ Chemical Energy direct conversion to electrical energy – more efficient than heat engines
- ▶ Avoids conversion to mechanical – thermal and then to electrical
- ▶ Not Subject to limitation of Carnot cycle  $T_1 - T_2/T_1$
- ▶ Water is the exhaust emission

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### FUEL CELLS (Contd..)

- ▶ Hydrogen gas flows into anode side. Catalyst (Pt) separates gas into electron and protons (Hydrogen ions). Ions pass through the membrane (center of fuel cell) combines with oxygen and electrons on the cathode side to produce water.
- ▶ Electrons which cannot pass through the membrane flow from the anode to the cathode through an external circuit where they can supply an electric load.

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### FUEL CELL DESIGN

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### Near Zero Emission Tug

- Fuel cells & Hydrogen
- 98% of NO<sub>x</sub> SO<sub>x</sub> emission & 30% CO<sub>2</sub> are cut.
- 50 ton Bollard pull
- H<sub>2</sub> tanks (storing at 430 bars)
- Normal tug operation
- Fuel cells can do the job
- Substantial Bollard pull  
–then, diesel sets are commissioned
- Efficiency 34% for fuel cells
- 30 meter long, 9.5 meter beam with 2 electric propulsion units, 1300kw each.  
4 X 650 KW gen. set for max Ballard pull

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### Near Zero Emission Tug

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### Cleaning Ship hulls with Robots

- ▶ Exhibit in SMM 2008 Germany—a project by Hismar—European funded
- ▶ Moves at 0.48m per second along the hull
- ▶ Magnetically attached to hull
- ▶ Keeps cleaning whether ship is stationary or in motion
- ▶ Huge saving in fuel by reducing hull resistance

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### Cleaning Ship hulls with Robots (Contd..)

	<b>Nylon Brushes:</b> - used to remove light/medium fouling
	<b>Soft Steel Brushes:</b> - used to remove medium/heavy fouling
	<b>Hard Steel Brushes:</b> - used to remove heavy/extreme fouling

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### NEW SHIPS

PENTAMARAN – FUTURE SHIP DESIGN

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### SHIPS

- 2006 NEW ship buildings – 52 million GRT
- 2008 NEW ship buildings – 64 million GRT
- Number of ship deliveries per year 2000 TO 2004 was 1700 ships
- Number of ship deliveries in 2006 was 2500

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## SHIPS

- The manpower demand for the marine industry in 2005 was 500,000 and the supply was only 400,000. Shortage of 100,000 is expected to increase to 150,000 in the year 2010.
- ▶ Nearly 40% of problems experienced by ships, are related to marine machinery.
- ▶ Focus on better quality manufacture

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## PART 4- OTHER R&D-CAN BE USED FOR SHIPS

- SOLAR ENERGY
- WIND TECHNOLOGY
- GEO THERMAL ENERGY
- WAVE ENERGY
- BATTERY
- OFFSHORE FLOATING POWER OPTIONS
- SOLAR THERMAL ENERGY

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## CONCLUSION

- ▶ R&D efforts moving ahead in many spheres and many countries
- ▶ Recognition that oil prices will never come too low, present low price is temporary
  - (300 K to 11 million cars in China in 11 years)
- ▶ Fossil fuels used as fuels will be very expensive
  - Mainly petro-chemicals
- ▶ Expenditure on R&D will yield results that will justify the investments

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## CONCLUSION (Contd...)

- ▶ Many governments penalizing fossil fuel usage and supporting renewable fuel usage
- ▶ **As long as alternate energy cost is less than fossil fuel cost, alternate energy will be preferred** -this is happening now
- ▶ There are enough resources in nature
- ▶ Therefore pollution reduction, meeting increasing demands, cost reduction in power generation all are possible. No need for pessimism

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PRESENTATION BY DR.R.VIS

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