

DME as Alternative Fuel for CI Engine and Vehicle

- Progresses in China

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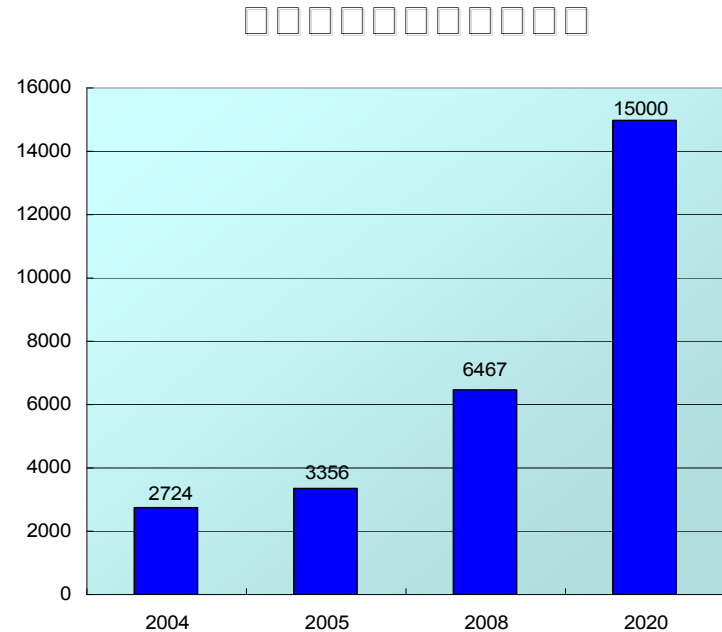
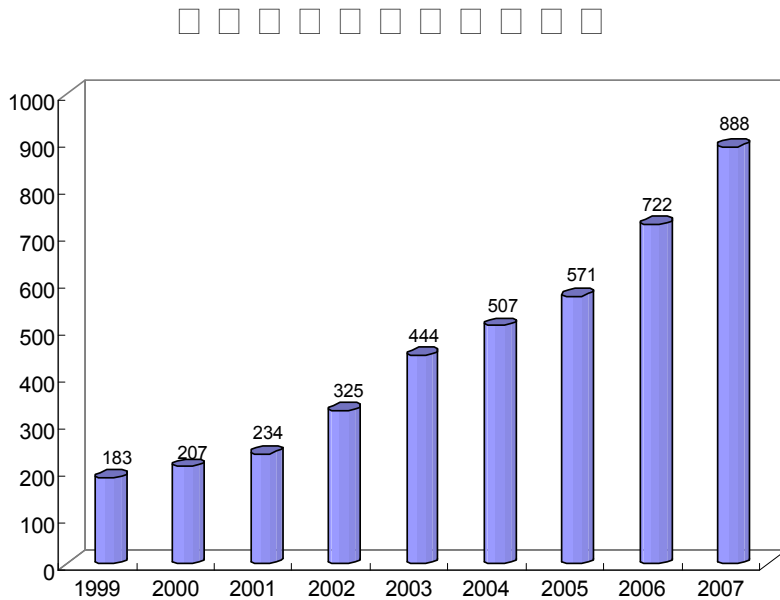


Presentation Outline

1. Energy Supply for Transportation in China
2. DME Production
3. SJTU's Efforts in DME Vehicle
4. Conclusions



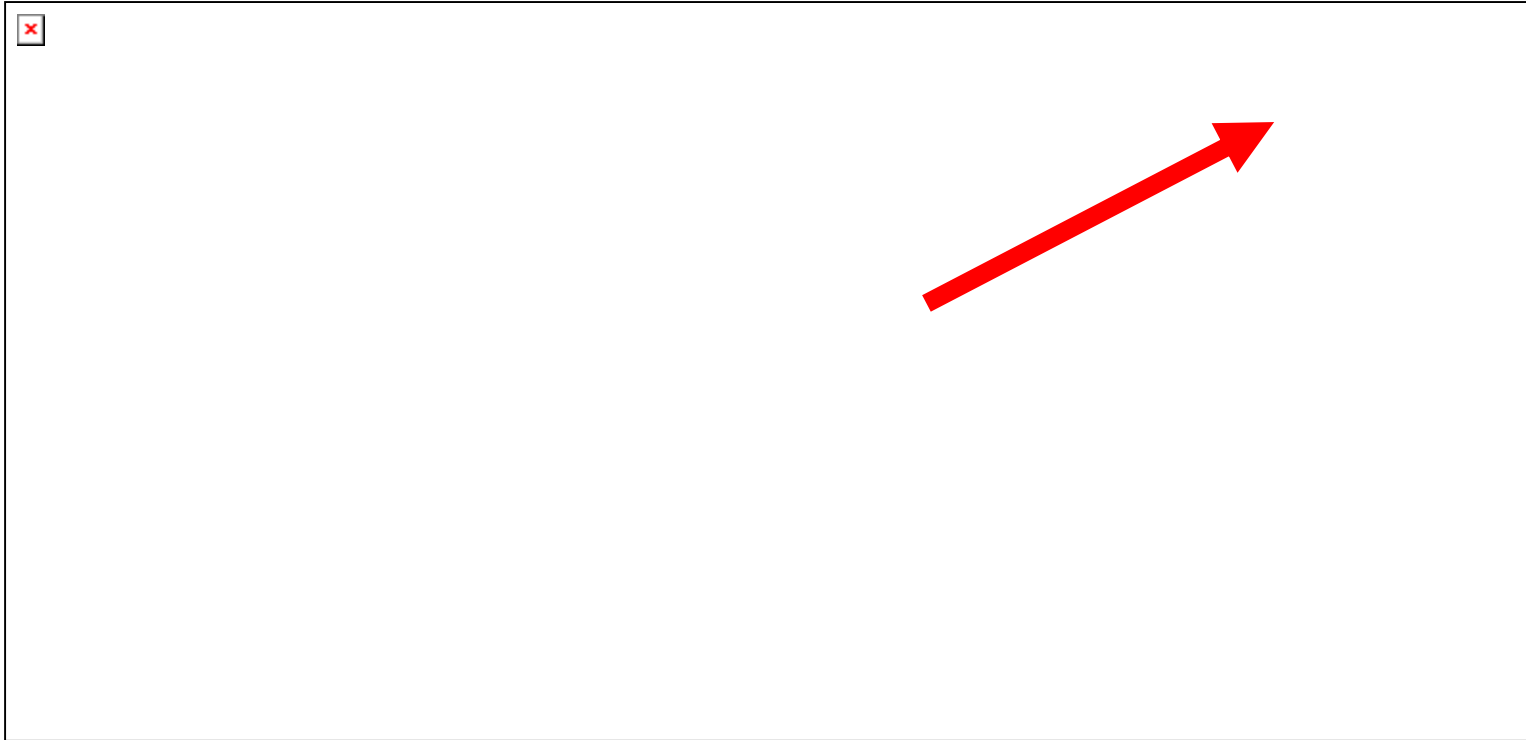
Vehicle Production and Population of China



- In 2008, motor vehicle production of China has reached 9.3 million ranked in world No.2.
- According to research center of state department's estimation, the total vehicle population of China will increase to 150 million by the year of 2020.



China's Oil Production, Consumption and Shortage



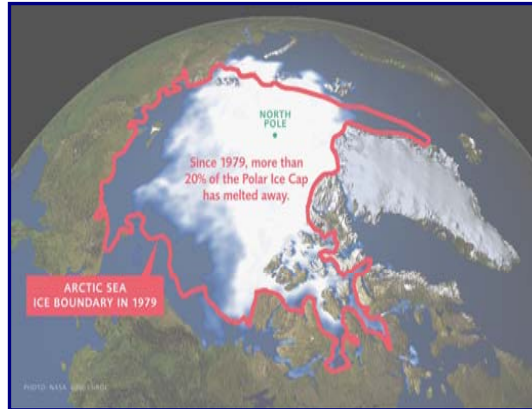
China has become a net oil importer from 1993. Over 51% of total oil consumption was imported from foreign countries in 2008.



China faces major challenges in meeting energy demand while minimizing environmental impacts.



Energy insecurity



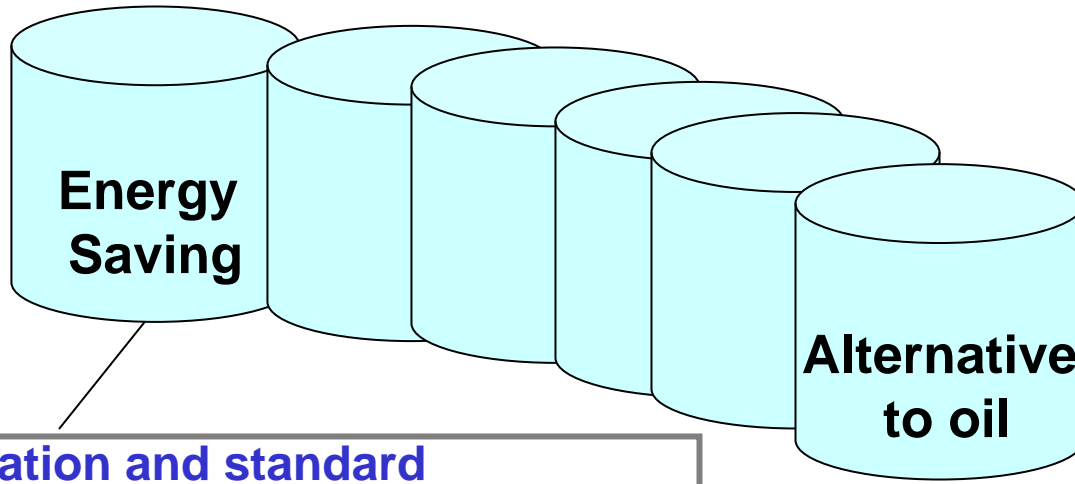
Global warming



Air pollution



Strategies of Energy Supply for Transportation

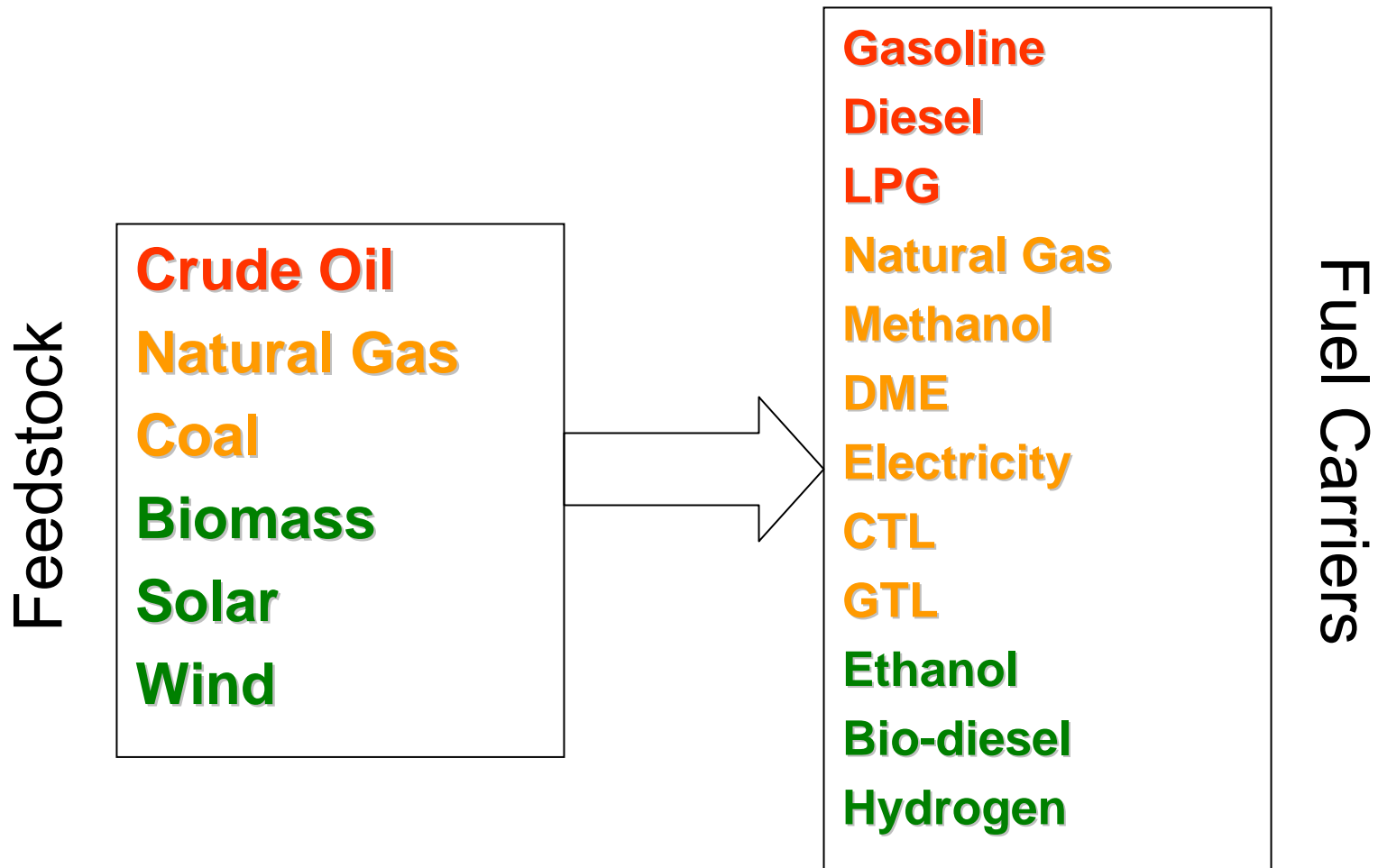


- Regulation and standard
- Fuel tax
- Promote of Diesel passenger car
- Encourage use of car with smaller cylinder volume
- Develop Hybrid vehicle

- Develop alternative fuel



Fuel Options in China

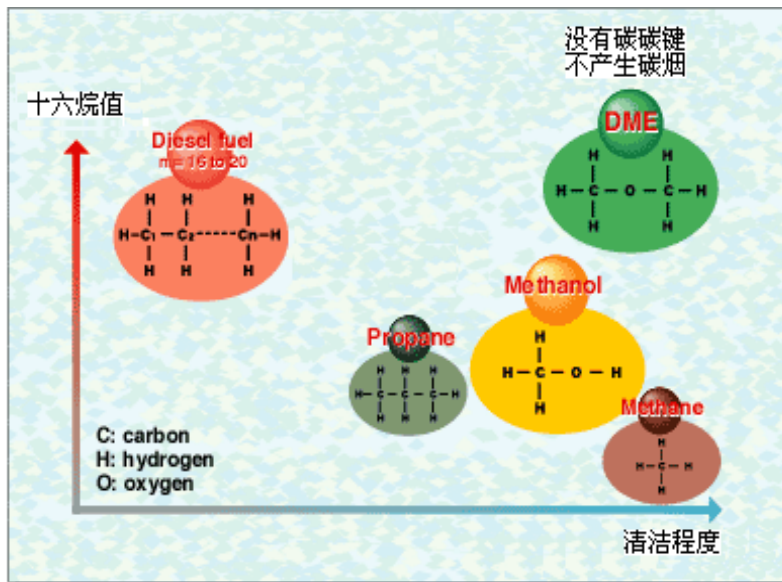
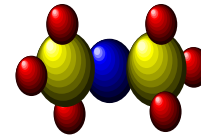


Strategies of alternative fuel for transportation

1. Local energy source
2. Low cost, competitive with diesel and gasoline, low influence by international oil price
3. Large scale production



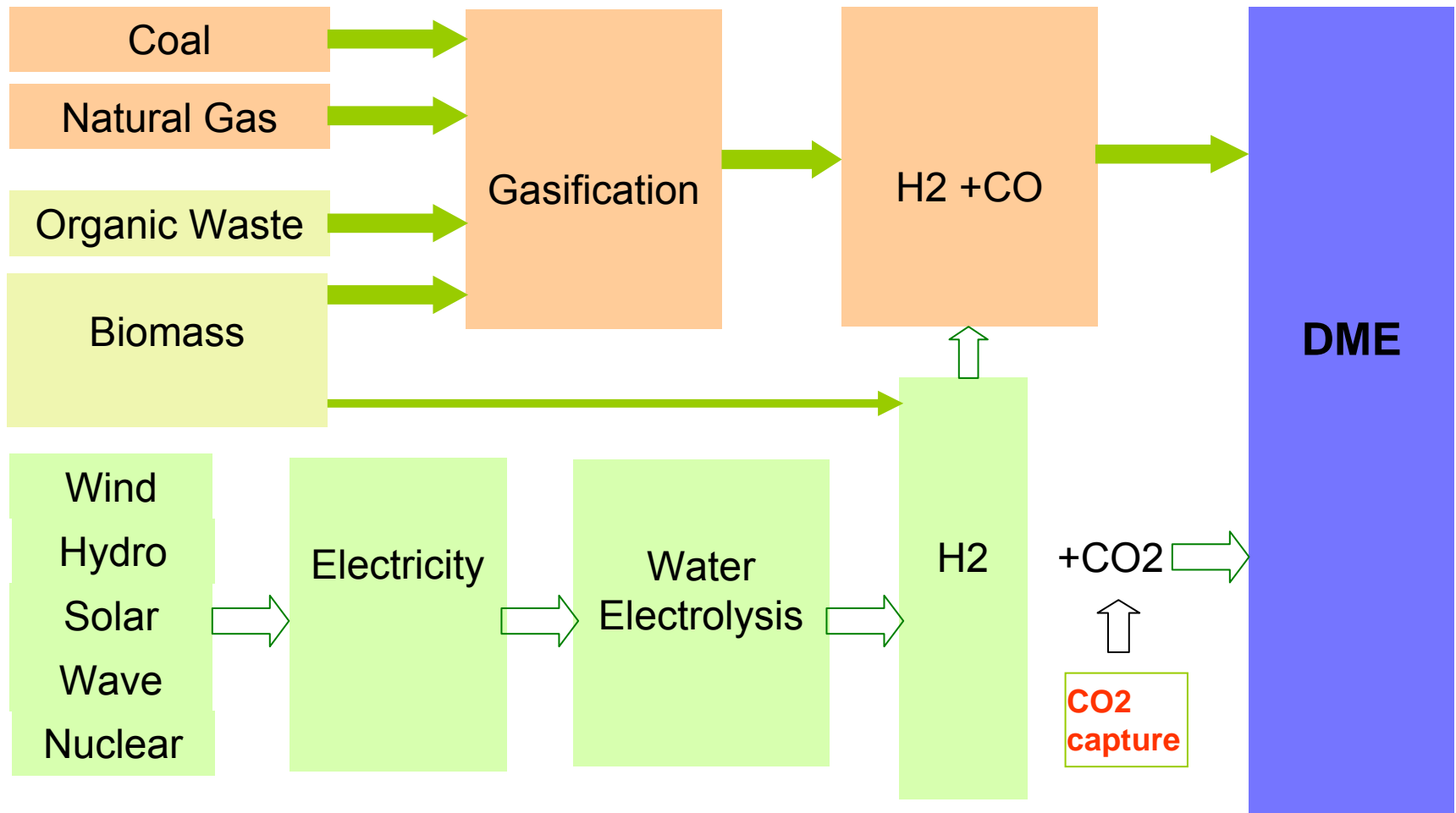
DME



- *both non-toxic and environmentally benign.*
- *high cetane number*
- *high oxygen content*
- *easy to store and transport*



DME Pathways

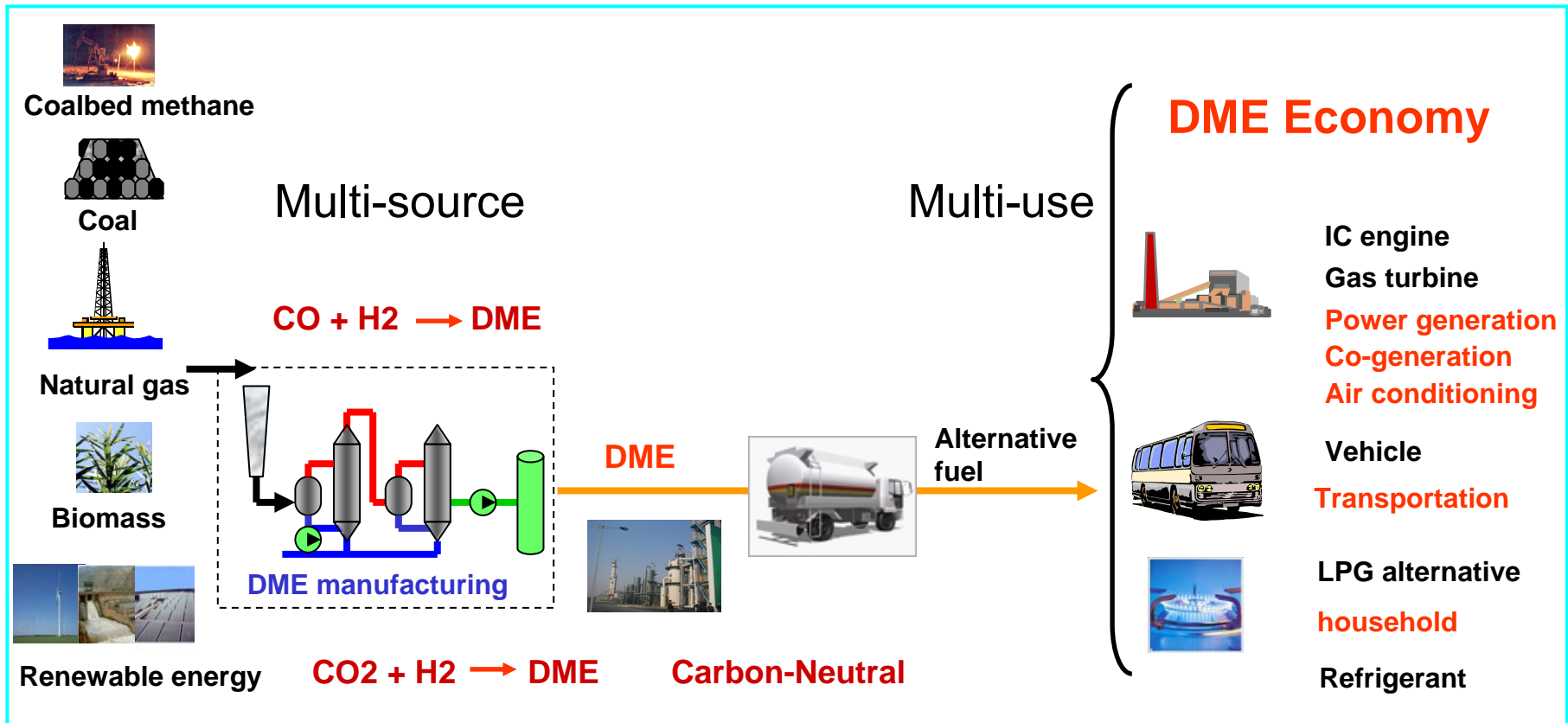
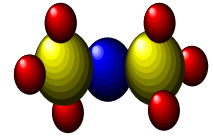


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DME - A Solution for Energy Security and Environmental Protection in China



DME Production in China

- In recent years, due to “hot” investment and construction of methanol and DME plants in China, DME production increases dramatically.
- Annual production capacity are only 31.8 thousand t/y in 2002 in China. They increased to 5 million t/y in 2008
- A 3 million t/y DME plant in Inner Mongolia has been approved by government and will put into production by year of 2010.
- DME production is ready for mass utilization and large-scale market operation in China.



DME Utilization - LPG Alternative



- China is the 3rd largest LPG consumption country, with LPG import volume ranks 2nd in the world.
- Due to attractive economics of DME, DME as alternative of LPG for cooking and heating has found his market in China.



DME Utilization - LPG Alternative

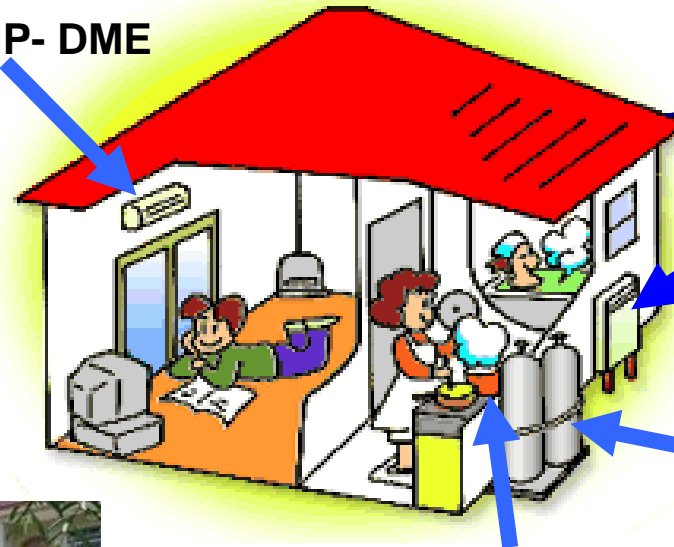
Energy supply



Urbanization



GHP- DME



Base load	Power grid
	DME
Auxiliary load	Solar energy

Water heater - DME

DME Tank

Cooking - DME



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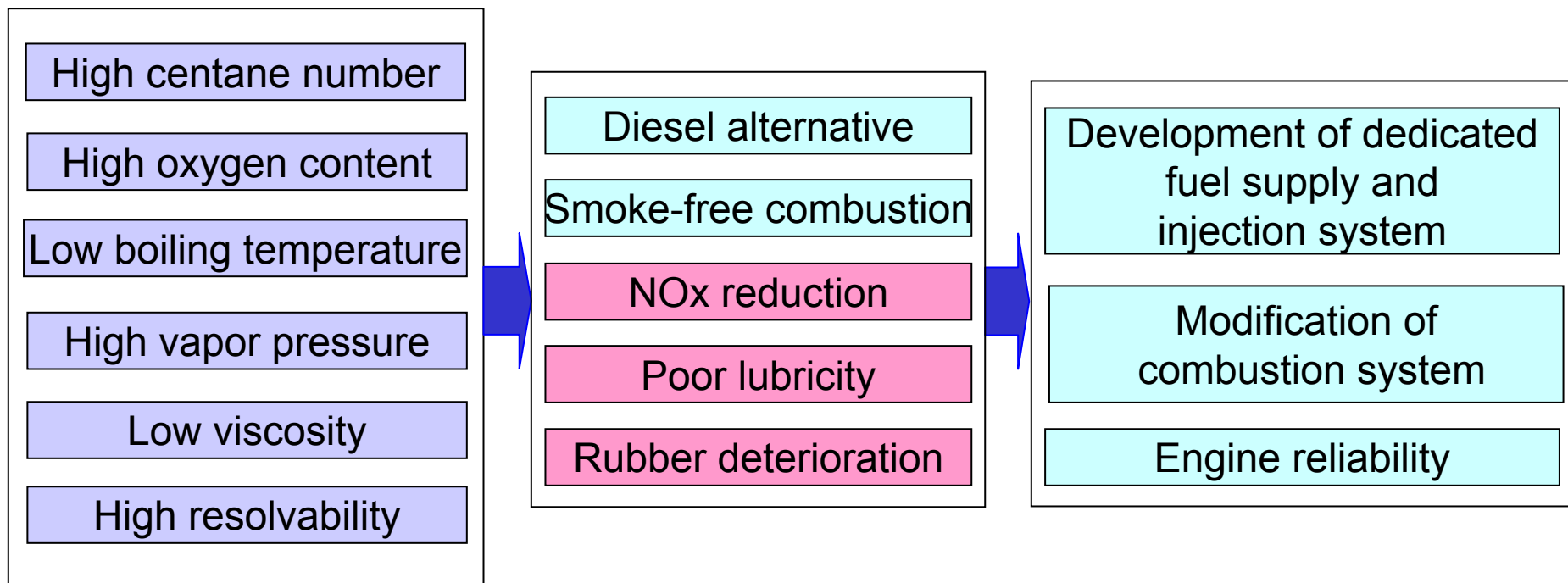
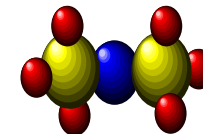


Properties of DME and Diesel Fuel

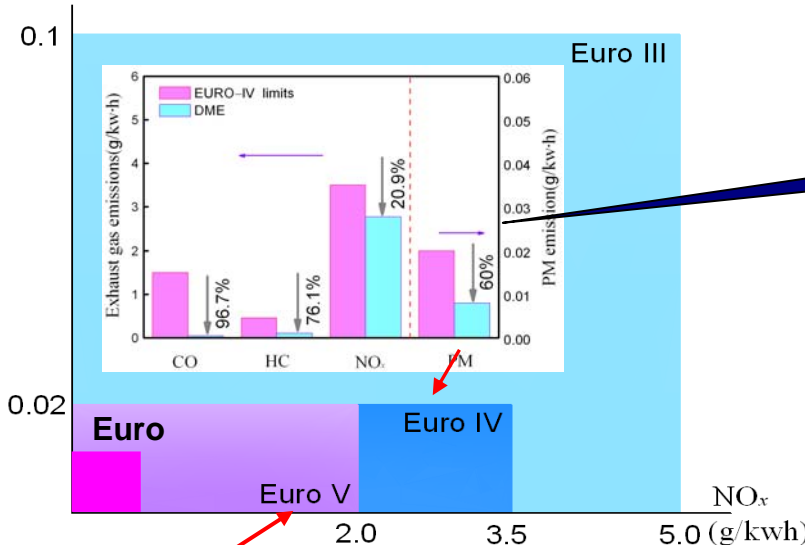
Property (unit/condition)	DME	Diesel fuel
Chemical formula	CH ₃ -O-CH ₃	—
Mole weight (g)	46.07	170
Boiling point (°C)	-24.9	180 360
Liquid density (g/cm ³)	0.668	0.84
Liquid viscosity (cP)	0.15	4.4-5.4
Low heat value (MJ/kg)	28.43	42.5
Ignition temperature (°C)	235	250
Cetane number	55-60	40-55
Stoichiometric air/fuel ratio (kg/kg)	9.0	14.6
%wt of carbon	52.2	86
%wt of hydrogen	13.0	14
% wt of oxygen	34.8	0
Modulus of elasticity (N/m ²)	6.37×10^8	1.486×10^9



DME Engine Technology



PM (g/kwh)



DME Engine Research

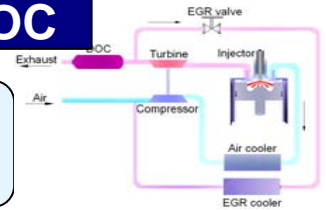
Inline-pump +EGR

- Combustion optimization
- Slight EGR rate



Inline-pump + EGR +DOC

- Combustion optimization
- Increase of EGR rate



Common rail + LTC +DOC

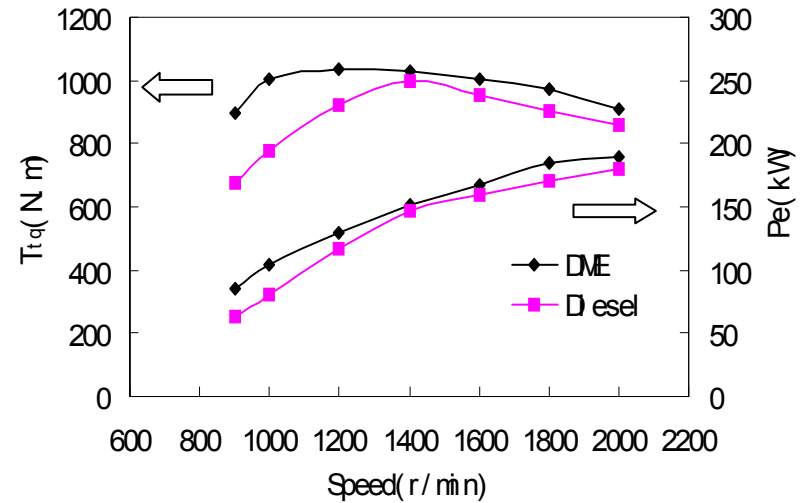
- Fuel injection strategy
- Low Temperature Combustion



Euro



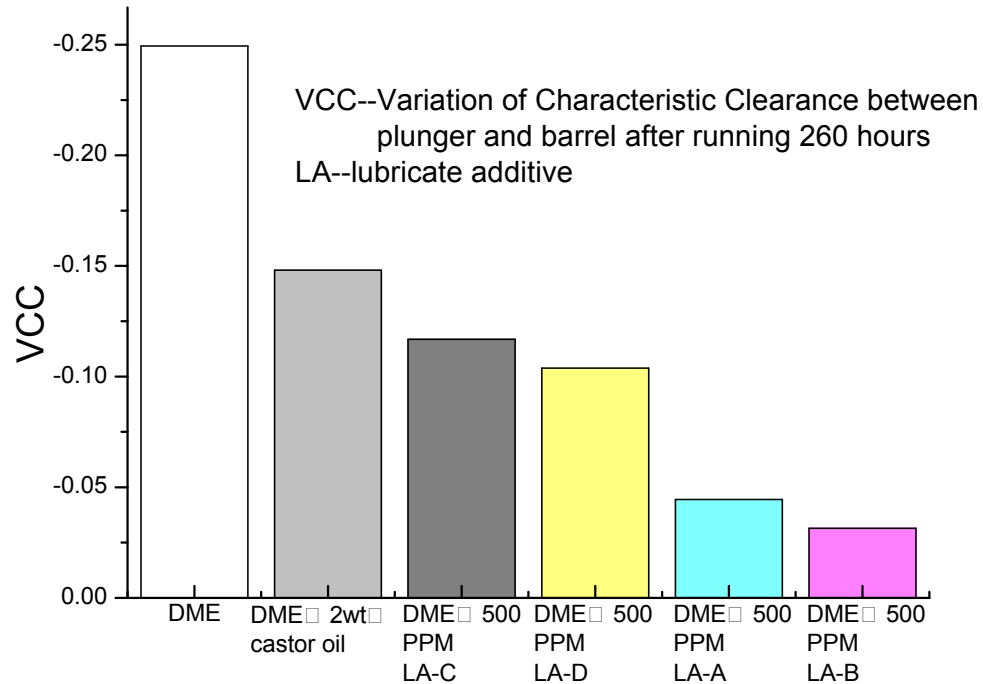
First DME City Bus in China (2005)



DME engine performance



Lubricity improvement



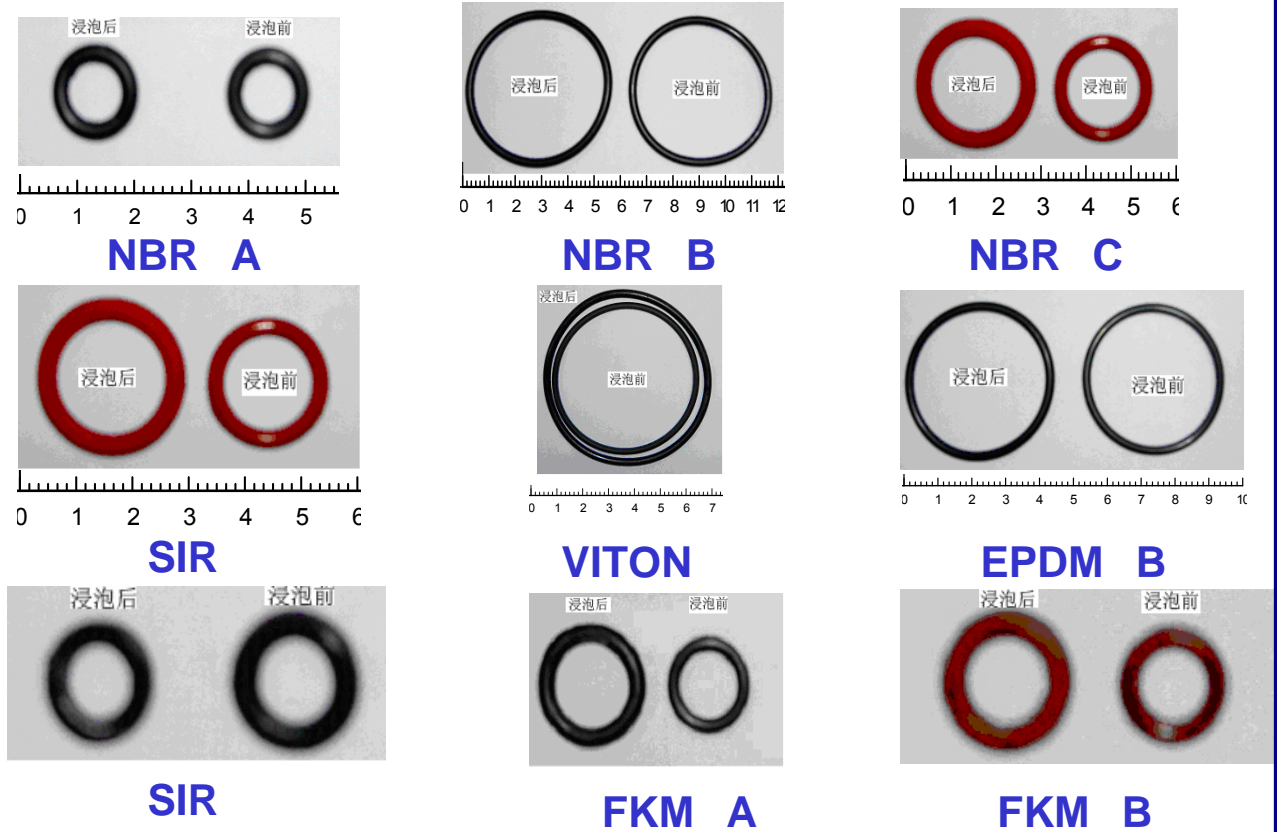
It can be seen that fuel additive could effectively decrease abrasion of the plunger in the fuel pump.



DME-tolerant seal material



Since high resolvability of DME, conventional rubber material are not chemically compatible and will deteriorate after exposure to DME.

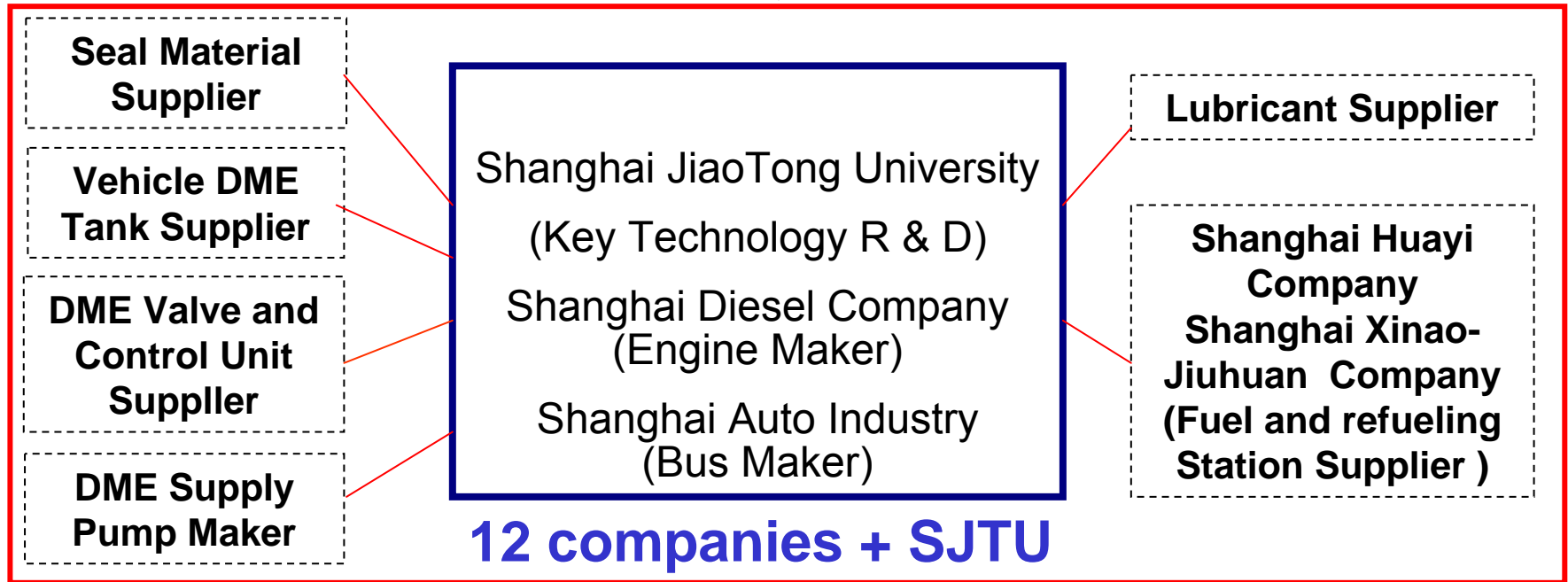


In this study, more than 15 kinds of rubber materials were selected and evaluated. As result, DME-tolerant rubber materials were developed.



Shanghai DME Bus Project

Ministry of Science and Technology
Shanghai Municipal Government



Local DME fuel, engine, vehicle,
tank, refueling station and
parts standards

Shanghai Bus Company
(No.147 City Bus)



Road Test Result of the DME Bus



	Test item	DME	National standard
1	Noise outside bus	80.8dB(A)	Satisfy
2	Noise inside bus	76.4 dB(A)	≤ 79 dB(A)
3	Acceleration smoke	Zero	
4	Maximum Speed	83.2km/h	≥ 80 km/h
5	25□60 km/h Acceleration time	34.9 s	≤ 50 s



Road Test Result of the DME Bus



Engine and bus road test:

- ✓ 1000 hours DME engine reliability test.
- ✓ 42000 Km DME bus road reliability test
- ✓ 3200 km routine road test in summer season



Shanghai DME Bus Demonstration



First DME refueling station was set up in Shanghai in Mar. 2007

DME Tank: 10 cubic meter

8500 Liter (DME)



Shanghai DME Bus Demonstration



The NDRC granted first licence to SAIC for DME bus manufacture and selling in 2008. A fleet of DME buses has been put into public use for demonstration this September.



Shanghai DME Bus Project

Engine R&D

Prototype bus

Road test

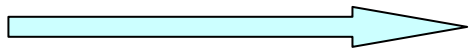
A Fleet of DME buses Demonstration

R&D

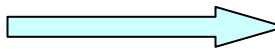
Demonstration

Volume applications

1997



2005



2008

2010



1st- G DMEV



2nd-G DMEV

3rd-G DMEV



Promotion of standard system of DME vehicle

Vehicle (4 items):

- ❑ The standard of DME city-bus
- ❑ Liquid DME cylinder of DME city-bus
- ❑ The technical requirement of DME city-bus dedicated parts
- ❑ The setting requirement of DME city-bus dedicated parts

Engine (3 items):

- ❑ Technical requirement of DME engine
- ❑ Technical requirement of the key part of DME engine
- ❑ Calculation method of DME engine emission

Refilling (2 items):

- ❑ The filling inlet of DME city-bus
- ❑ The requirement of structure, design and detection of DME filling station

Seal materials (2 items):

- ❑ Standard of EPDM for DME vehicle
- ❑ Standard of plastic for DME vehicle

Fuel (1 item)

- ❑ The DME standard for vehicle

Fuel tank (2 items):

- ❑ The valve of DME tank
- ❑ The system of DME tank



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Why DME ?

- DME could be made from multi-source, especially from coal.
- DME could be used for multi-purposes.
- DME production technology is mature and scalable.
- DME contributes to our National energy objectives

Energy Security

Environmental Protection



Way Ahead

- More industry involvement in R&D and demos
 - LPG alternative
 - DME buses. Trucks and trains
 - DME for countryside use
 - DME power generation
 - Government in role of early adopters
- Need for more DME users to stimulate market
- Government policies and incentives
- Universal set of standards.
- International cooperation.





Thank You!

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