7th Asian DME Conference, Toki Messe Convention Center, Niigata, 16-18 November 2011

DME in Japan

- Perspective in New paradigm after Fukushima -

Yotaro Ohno
Director
Japan DME Forum (JDF)

Japan DME Forum

Contents

- Japanese Government Energy Policies
- Introduction of Renewable Energy as DME
- DME Commercialization Update
- DME Utilization Technologies Update
- DME Standardization and Legislation
- DME Promoting Activities
- Conclusion

Japan DME Forum

Energy Policy Change relating to CO_2 emission

- Outlook of Long term energy supply/demand (revised) in August 2009

  CO_2 emission (vs.1990): - 6% in 2020, - 18% in 2030

- Law Concerning Promotion of the Development and Introduction of Alternative Energy has been amended in August 2009.

  Electricity, City gas and Petroleum industries are obliged to introduce non-fossil energy. It was extended to LP gas industry in 2010.

- PM Hatoyama announced in COP15 in September 2009.

  CO_2 emission (vs.1990): - 25 % in 2020

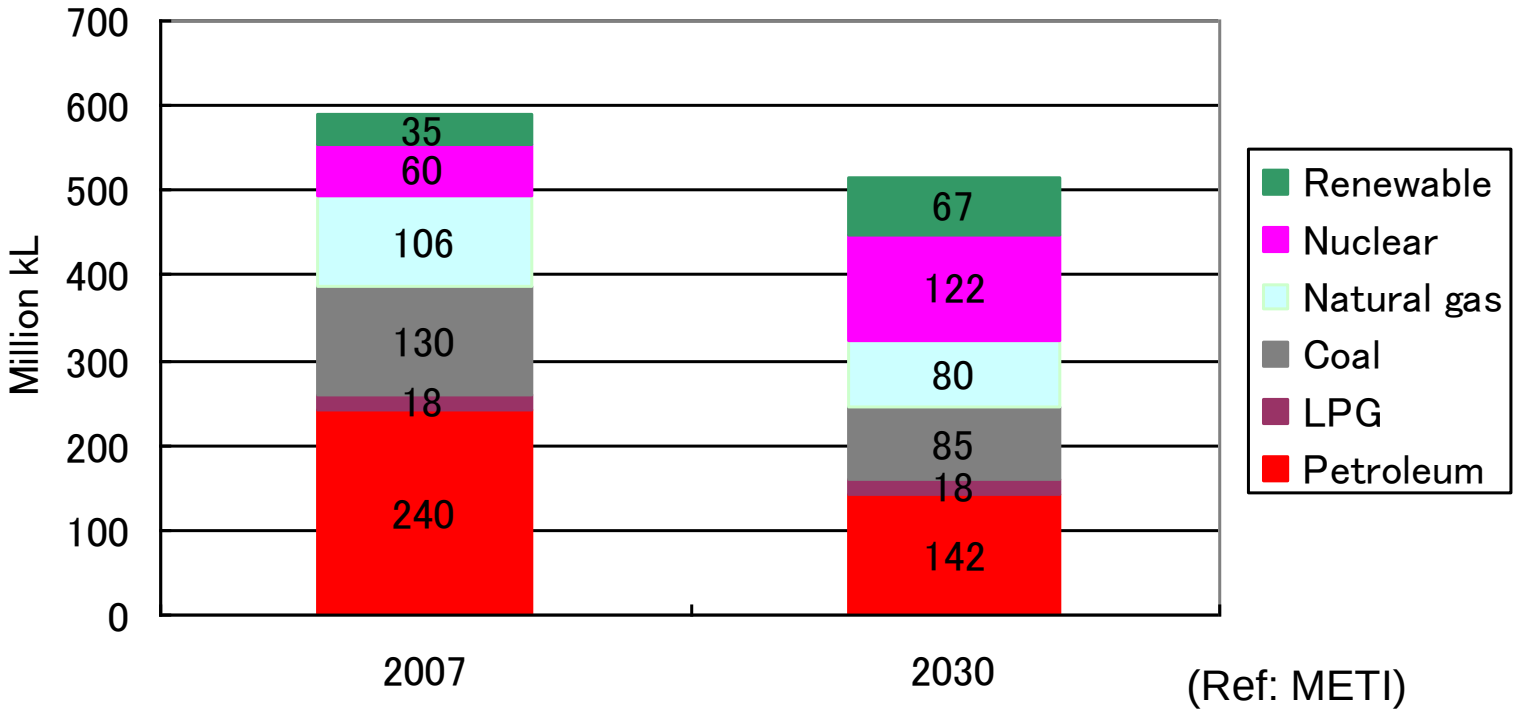
- Strategic Energy Plan was revised in June 2010.

  CO_2 emission (vs.1990): - 30 % in 2030

- After Fukushima, What is possible to secure energy supply and CO_2 emission reduction target ?

Long term energy strategy before Fukushima

- Strategic energy plan in June 2010 was decided to aim to realize CO_2 emission reduction target and higher self-sufficiency of energy in keeping economic growth.
- Additional 14 nuclear power plant and 90% operation rate of all plants, maximal introduction of renewable energy introduction and more efficient energy conservation were expected.



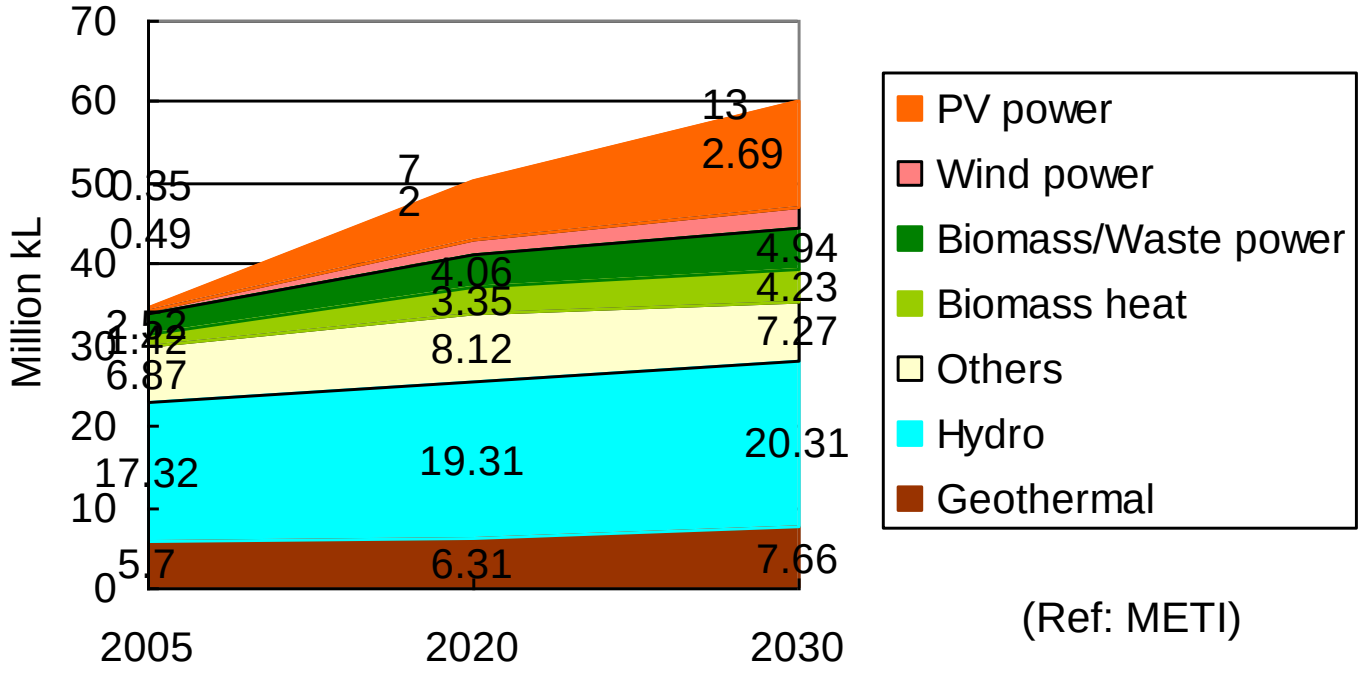
(Ref: METI)

Renewable energy introduction in Japan

• Maximal introduction of Renewable energy in “Outlook of long-term energy demand”(August 2009)　Renewable energy share in primary energy supply is projected 9.0% in 2020 and 11.6% in 2030.　Solar voltaic is expected to grow substantially.

• New Buyback program for PV started in October 2009.

Excess electricity from PV generation (mainly residential) is purchased by utility companies. Subsidy program is prepared for residential and non-residential system respectively.



(Ref: METI)

New direction of Energy policy after Fukushima

• Bill on Special Measures concerning Procurement of Renewable Energy sourced electricity by Electric Utilities(Law of Feed-in tariff on renewable energy) was passed by Diet in August 2011.(effective in July 2012).

• New PM Noda mentioned in his policy speech in September 2011 that Strategic Energy Plan shall be revised totally by the next summer 2012 with basic directions:

For primary energy supply side,

- Reduction of Dependence on Nuclear power
- More introduction of Renewable energy .

For demand side:

- More Energy conservation

• Renewable resources and room for energy conservation in Japan are limited.

▸ Innovative development of biomass utilization: Bio-DME for LP gas & vehicle

▸ Development & import of renewable DME in regions where renewable energy resources are abundant. Renewable DME could be supplied in local region and exported to consuming countries as Japan.

(In 2007, 96% of the primary energy is imported in Japan.)

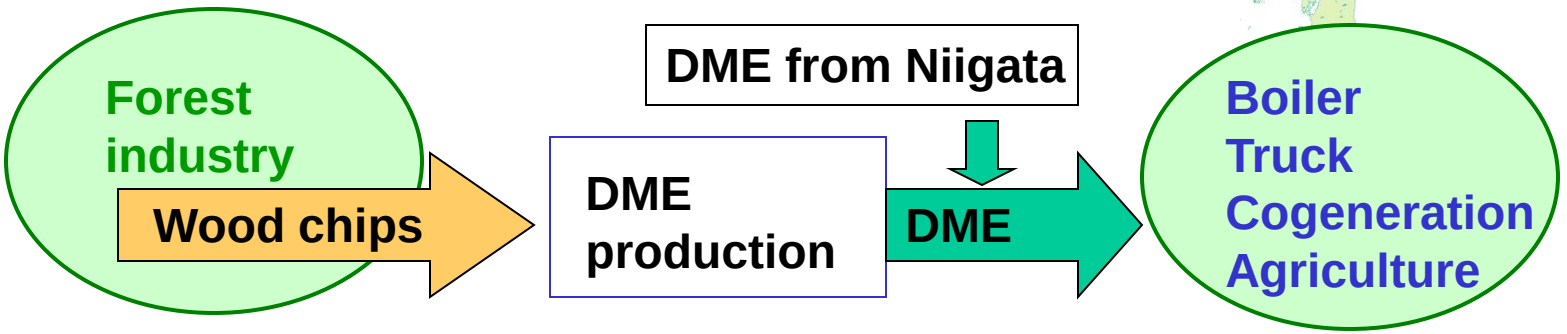
Bio-DME Business Development in Japan

• In order to expand utilization biomass to transportation and industrial sector, Biomass based DME is expected as a BTL.

Nagahama city model:

Local production of DME from biomass for local consumption with combination of fossil DME from Niigata.

- Promote forestry industry with DME as value added product.
- Secure stable woody biomass supply and its low cost
- Develop cost effective
  Bio-DME blended with fossil DME for low carbon alternative
- Secure stable DME supply by DME from Niigata
- Totally efficient use of DME in locally optimized scheme



Japan DME Forum

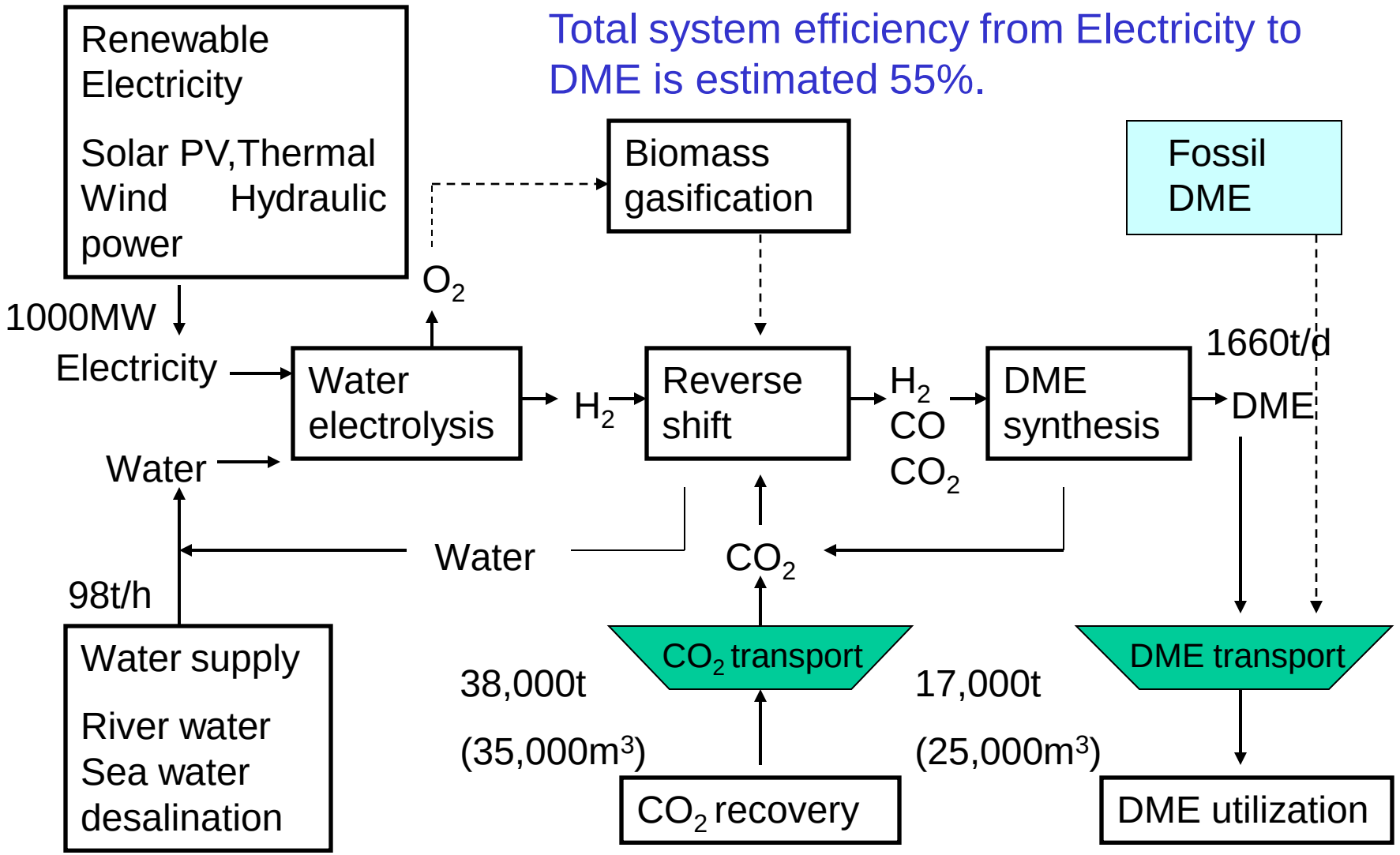
Potential of DME as Energy carrier

- DME is promising as Energy carrier from remote resource for high energy intensity by volume and safety aspect.

	Liquid H_2	Liquid Ammonia	Methanol	DME	CO_2
Formula	H_2	NH_3	CH_3OH	CH_3OCH_3	CO_2
Liquid density [kg/L]	0.07	0.7	0.795	0.67	1.1
Boiling point [℃] @0.1Mpa	−253	−33.4	64.4	−25	(−50)*1
Vapor pressure [Mpa] @25℃	−	1.02	0.0129	0.53	(0.7)*1
Energy density by Weight [MJ/kg]	120.8	19.2	21.1	28.8	−
Energy density by Volume [MJ/L]	8.5	13.4	16.8	19.3	−
Explosion limit [%]	4～75	15～28	6.7～36	3.4～27	−
Allowable limit of toxicity	−	25ppm	200ppm	−	−

*1: Marine transportation condition of liquid CO_2

Global Renewable DME Network



Japan DME Forum

DME Commercialization Update

- DME produced from imported methanol in Fuel DME product Co. is supplied to customers in near region.

-Boiler of Food industries (subsidized by METI)

Ichimasa Kamaboko Co. & Sato Shokuhin Co.

Thermal efficiency same as LP gas

-DME truck of Transportation companies (subsidized by METI)

Niigata Unyu Co. & Trinet logistics Co.

Drivability similar to Conventional Diesel, No smell, No smoke

Niigata plant [presented by Mr.Ishiwada]

Ichimasa's boiler [presented by Mr.Imura]

Niigata unyu's truck [presented by Mr.Murakawa]

DME Utilization technologies Update-1

Technical data for DME/LPG blend use (LPG Center of Japan)

- Gas composition vaporized from liquid DME/LPG mixture container
- DME concentration in gas is not constant and slightly increases with vaporization. In order to keep lower than 20% in gas, initial DME concentration in liquid should be less than 15%.
- Home appliances performance
- DME/LPG mixture combustion test by existing home appliances:

  Tabletop stove, Infrared stove, Hot-water unit, specified to LPG.
- Up to 20% DME in gas, DME/LPG mixture can be used as same as LPG and up to 40% with minor modification (Nozzle diameter, Air damper opening and so on).
- No degradation of performances for 1,000 hours (cumulative combustion time) on these appliances.
- Thermal efficiency is almost constant, independent on DME concentration of DME/LPG mixture, a little better than that with Propane.

DME Utilization technologies Update-2

DME resistant rubber materials (Nichiasu Co.)

• By blending low molecular weight Polyethylene in EPDM as base-rubber, a versatile rubber of low expansion with DME liquid was developed, which is excellent in DME resistance.

• Based on this basic finding, two kinds of practical blend-rate having different hardness were tested with actual equipment. Finally, it is confirmed that all these rubber materials can be used as DME sealing rubber without any problems.

Non Sulfur odorant (High Pressure Safety Institute of Japan)

• Primary evaluation conditions: strong discomfort odor, threshold level less than 1.0 ppm, boiling point lower than 120° C, stable at ambient temperature, negligible effect on human body.

10 candidates: iso-nitrile 3, hydrocarbon 4, oxygenate 2, cyclo-amine 1

• Secondary evaluation conditions: chemical stability, combustibility, corrosiveness, adsorption on soil, safety

2 selections: 1-penthyne, 2-hexyne has performance comparable with TBM which is actually used as odorant.

DME Utilization technologies Update-3

Durability of DME truck (ISUZU) [presented by Dr.Shimazaki]

• 2 ton light duty test truck with 4.8 litter engine run 100,000km on test course, high way and urban way without serious trouble from Dec.2006 to Sept.2009.

Engine Investigation was conducted after running test: Engine valve seat wear, injector nozzle seat wear were found, but not serious.

• Two 3.5 ton medium duty commercial tucks with 5.2 litter engine are running. The running distance today is 84,000km in Kanto area and 62,000km in Niigata area respectively since Nov.2009.

Fuel consumption: 3.8-3.9km/L-DME (equivalent to 7.0-7.2 km/L-Diesel)

DME vehicle fueling station [presented by Mr.Amemori]

• Development of DME high-speed filling system

Prototype of 80L/min filling capacity is developed, equivalent to diesel filling equipment.

• Technical assessment for safety distance of DME filling station

Tests and simulation analysis were conducted on diffusion of DME gas and flame propagation from small leakage and rupture of filling hose.

Safety distance of 5m is evaluated to be appropriate, as same as for CNG and LP gas.

Fundamental researches for DME Engine

Effect of lubricity improver and impurities on Nozzle Wear

- MPT-HFRR test (AIST) [presented by Dr.Oguma]
- Adding 100ppm of fatty acid based lubricity improver (LI) gives diesel level lubricity to DME.
- Excess adding fatty acid based LI increases fuel acid value which is a factor of corrosion.
- Water content impact on wear scar of fuel injection parts.
- There is no effect of methanol content on wear scar.
- Direct nozzle wear test (Denso CO., Ibaragi Univ. Toyotsu Chemiplas CO.) [presented by Mr.Kato]
- Actual nozzle tip wear is directly measured with newly developed test rig.
- Fatty acid type and polymer type lubricity improver were tested.
  300ppm is enough for reducing wear of nozzle seat.
- Water concentration should be lower than 300ppm.

Fundamental researches for various DME Use

Fundamentals of DME combustion

- Ignition at low temperature(Hokkaido Univ.)[presented by Dr.Giao]
- Low Nox combustion under high pressure(Kansai Univ.)
  [presented by Dr.Takeuchi]

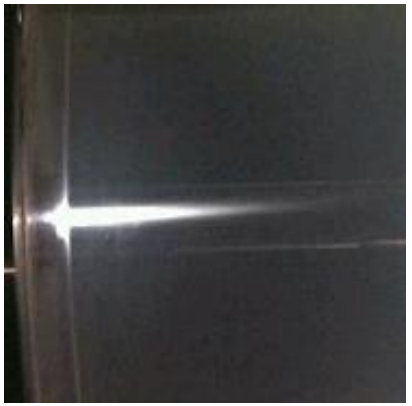
DME application to SOFC(AIST) [presented by Dr.Tanaka]

- SOFC with DME shows a similar high power generation efficiency to with propane.

Space rocket engine fuel(Kyushu Institute of Technology)

(http://www.mech.kyutech.ac.jp/combust/study_dme_thruster)

	Boiling point /Freezing point	Energy density by weight / by volume
DME	-25°C / -143°C	28.8MJ/kg / 19.3MJ/L
Hydrogen	-253°C / -259°C	120.8MJ/kg / 8.5MJ/L
Methane	-162°C / -183°C	50.2MJ/kg / 20.8MJ/L
Hydrazine	114°C / 1°C	16.7MJ/kg / 16.5MJ/L



Arc jet plume with DME

Standardization and legislation on DME Fuel

- Standardization in Japan

- TS(Technical Specification) for DME fuel was published in 2005, first in the world. This TS will be finalized as JIS with ISO's progress.
- Fuel standards for vehicle are under study in JSAE (Society of Automotive Engineers of Japan).

- International Standard

- New committee, "National Committee for DME Fuel Qualitative Standardization" has established to support PAJ (Petroleum Association of Japan) who is a domestic secretariat of TC28 in DME standardization field.
- In ISO committee, International chairman of TC28/SC5 is Dr.GOTO and Dr. OGUMA is Convener of TC28/SC4/WG13, both from AIST. Mr.Yoshihara is Convener of TC28/SC4/WG14 from MGC.

- Technical guidelines for DME vehicles

Technical guidelines required for mass production of DME vehicle is under study at MILT and expected to be published soon. Construction and use standard for DME vehicle is being studied by Bio-DME&DMEVPC and private companies to provide details.

Bio-DME Project for the Next generation vehicle

• International Standard Innovation Technology Research Association (IS-INOTEK) is established in 2011 as a part of the intellectual property strategy of the Japanese government. This project is promoted by IS-INOTEK and Isuzu Advanced Engineering Center, with AIST and Bio-DME&DMEVPC. (Schedule FY2011-2013)

1. Test & evaluation for standardization of DME supply unit

Safety evaluation for shortening the security distance, Development and evaluation of DME supply unit for vehicle (refueling port of DME vehicle, mechanical and electrical interface between DME vehicle and fueling unit, and measuring method of fueling amount)

2. Test & evaluation for standardization of Bio-DME fuel quality for vehicle

Evaluation of effect of impurity and additive such as odorant, Vehicle running test, Engine endurance test, and Assessment of quality control method practical in the market

3. Consensus-building among Asian countries

Opinion exchange and Workshop with related organizations of each countries

Public relations activities on DME

- DME Promotion Center made exhibitions for promoting popularity of DME among the common people.

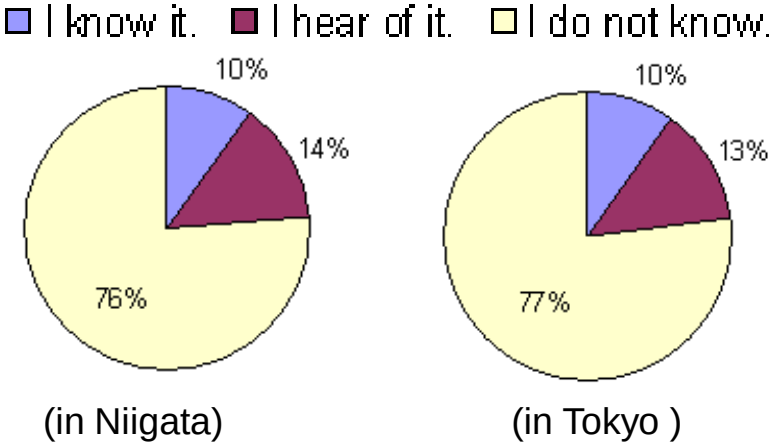
[Environment Fair] in Niigata (October 2011) visitors: 2000
[ECO-Products 2000] in Tokyo (December 2011) visitors: 5000

Popularity of DME is still weak, but promotion activity is efficient to raise understanding on DME.

[Questionnaire investigation on site]

>Before guidance on DME

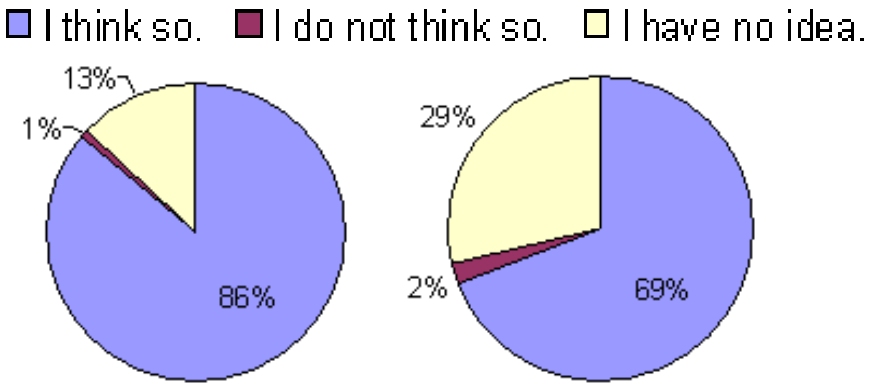
Do you know DME previously ?



(in Niigata) (in Tokyo)

>After guidance

Do you suppose DME is necessary as a future fuel ?



(in Niigata) (in Tokyo)

DME Handbook Supplement

• DME Handbook Supplement covers progress since DME Handbook was published in 2006 and its English edition in 2007.

Ch.1 DME production

Production system from various resources, Production technologies and Projects

Ch. 2 DME Household Use

LPG/DME blend use, Seal materials, Non-sulfur odorant, and Market development of household use

Ch. 3 DME Industrial Use

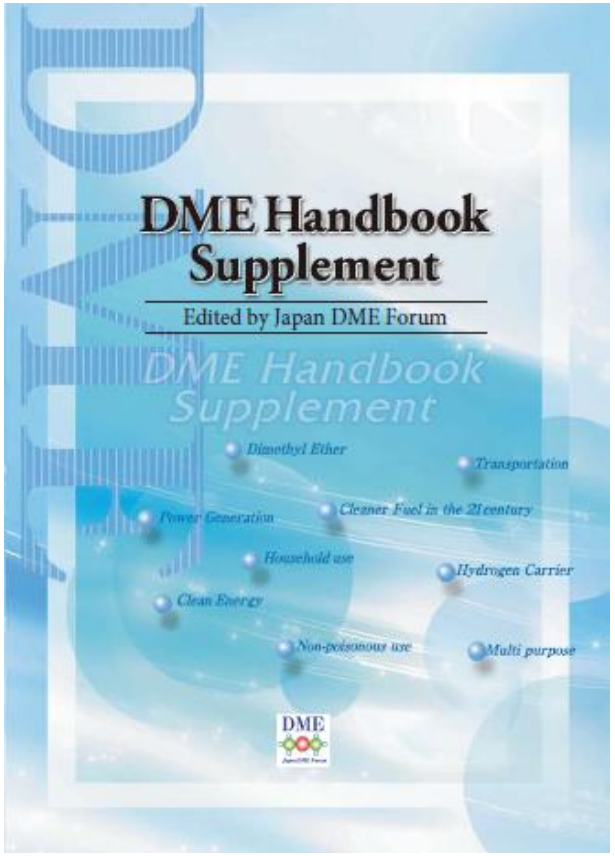
Distributed energy use and Chemical use

Ch. 4 DME Transportation Use

Vehicle performance, Effect of impurities, Lubricity improver and High-speed filing system for DME vehicles

Ch.5 DME Standardization and Legislation

Standardization of DME fuel quality and DME utilization /ancillary system



(288 pages, Price:JPY20,000)

Conclusion

Global DME Network will be a promising option in order to secure energy supply and environmental conservation including CO_2 emission reduction at the same time.

- For internationally tradable DME, International standardization is important.
- Combination of Renewable DME with Fossil DME is efficient to keep stable supply.
- Renewable DME is a key to open DME market in energy saturated countries as Japan.

Technology transfer is useful to prevent unnecessary troubles for DME use and to promote more efficient utilization of DME.

- Technical knowledge and know-how are accumulated in Japan.

International cooperation such as Standardization,Technology transfer and Project investment is requested to grow stronger in order to develop more DME market and realize “Low Carbon World”.