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DME, a new energy carrier

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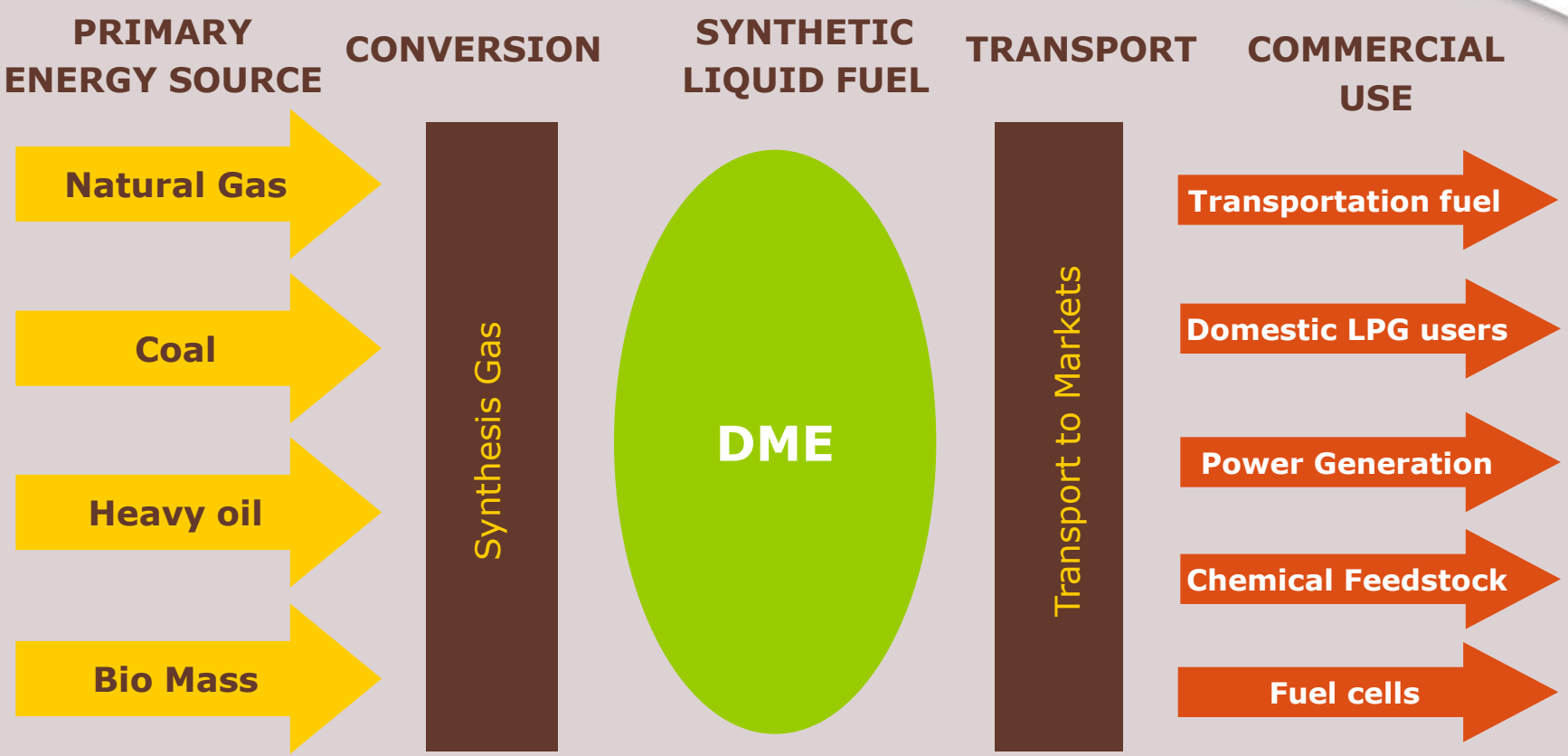
TOTAL

Plan

1. Some reminders on DME
2. Technical routes to DME
3. DME an emerging market
   - In China
   - In Japan
   - In South Korea
4. DME business models
5. Conclusions

1. DME an energy carrier for a sustainable development



- Most promising segments are Diesel Substitute and Petrochemical Feedstock
- LPG substitute is compulsory for the demand's ramp up.

1. Physical Properties of DME & Other fuels

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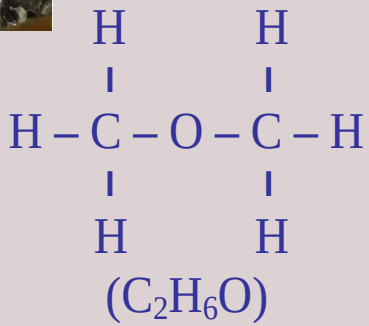
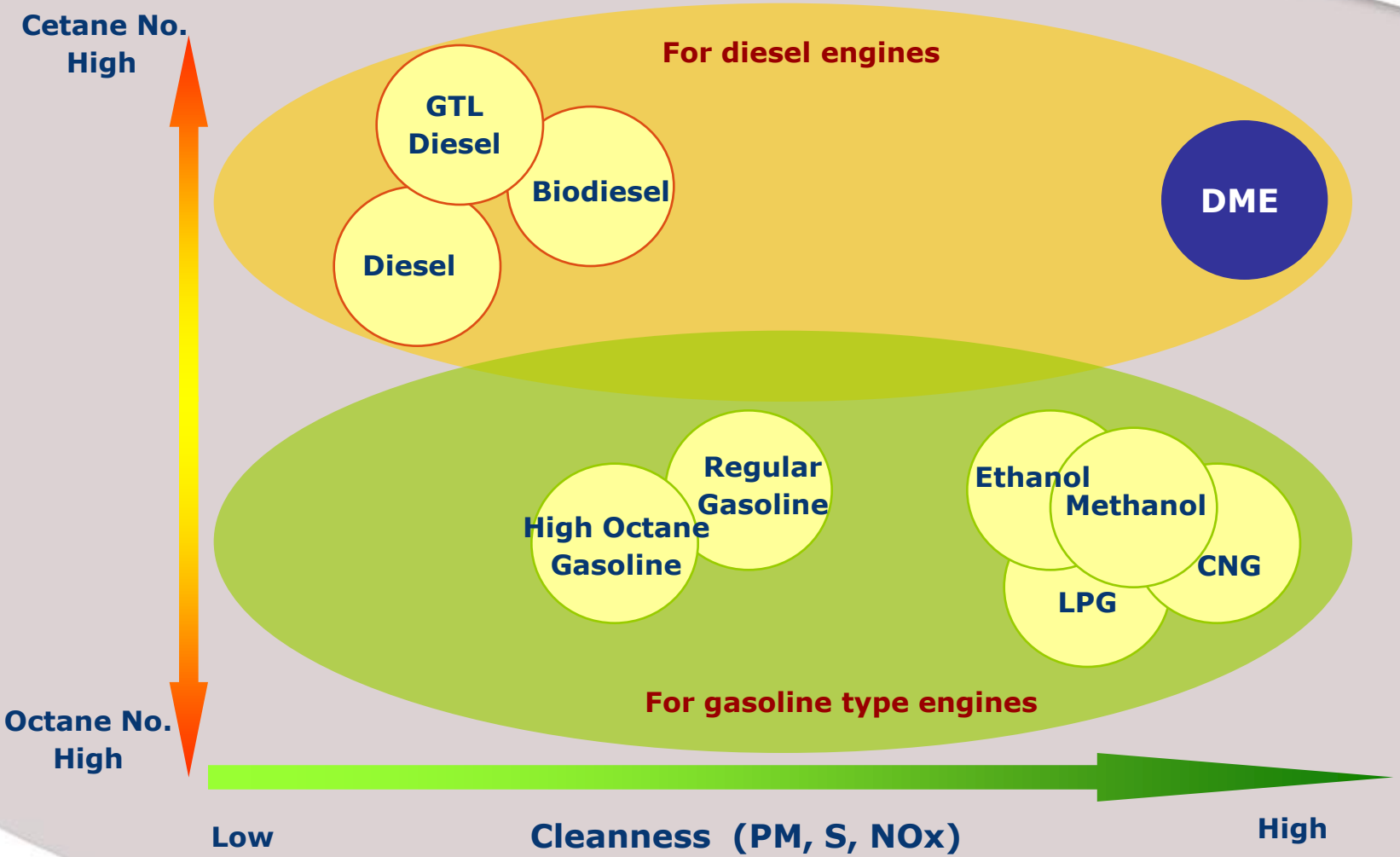


Easy to liquefy	Boiling point : -25°C at 1 bar Saturated vapor pressure : 6.1 bar at 25°C
Net calorific value	14,200 kcal/Nm^3 / 6900 kcal/kg
Cetane number	55~60
Hazard	Equivalent to LPG

Properties	DME	Propane	n-Butane	Methane	Methanol	Diesel Oil	Coal
Net calorific value (kcal/kg)	6,900	11,100	10,930	12,000	4,800	10,000	6400
Net calorific value (kcal/l)	4,620	5,440	6,230	5,040	3,790	8,400	-
Net calorific value (kcal/Nm^3)	14,200	21,800	28,300	8,600	n.a.	n.a.	-
Explosion limit (%)	3.4 ~ 17	2.1 ~ 9.4	1.9 ~ 8.4	5 ~ 15	5.5 ~ 36	0.6 ~ 6.5	-
Cetane number	55 ~ 60	5	10	0	5	40 ~ 55	-
Viscosity (kg/ms at 25°C)	0.12 ~ 0.15	0.2	0.2		0.7	2 ~ 4	-
Liquid density (kg/m^3 at 25°C)	0.67	0.49	0.57	0.42	0.79	0.84	-
Boiling point (°C)	-25	-42	-0.5	-162	65	180 ~ 370	-

1. DME as Cleanest Diesel Alternative



Source : R & D Group for Practical Use of DME Fuel Vehicle

2. Two main processes :
Total has joined DME-I consortium (with JFE)

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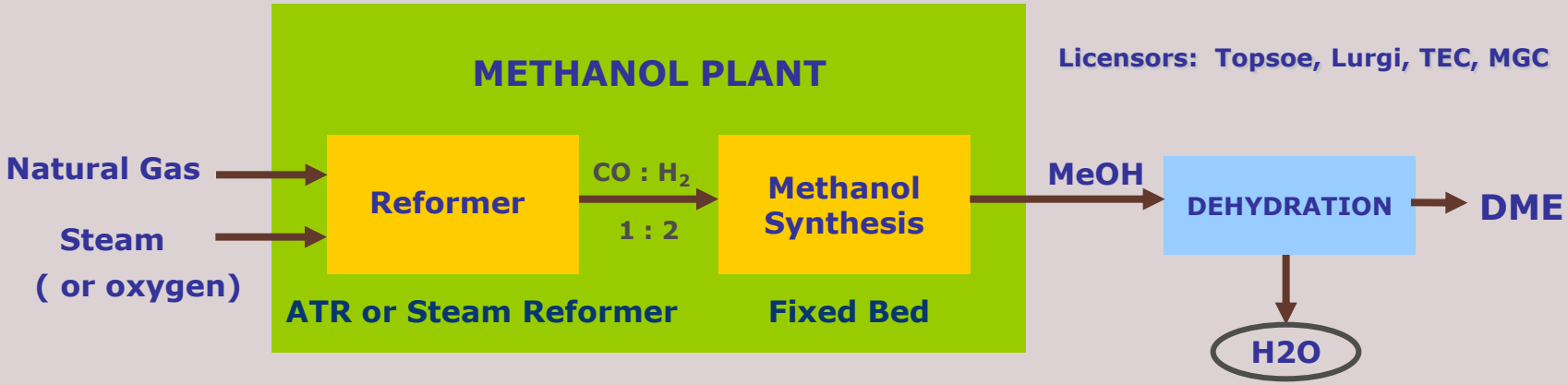
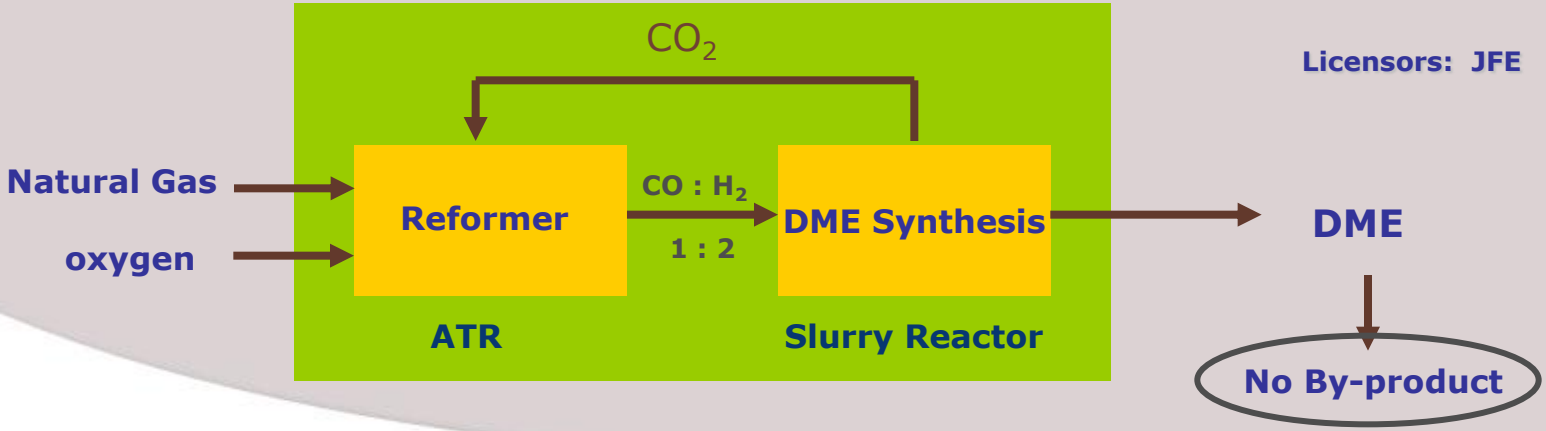
1.Methanol route is conventional technology



2.JFE Direct route has been demonstrated with a higher efficiency



2. Kushiro demo plant subsidized by METI

- Since Dec 2003, six series of run with a total duration of 342 days : DME production of 20 ktons
  - Objectives :
    - Validate the Direct Synthesis Process and specific reactors
    - Tests of new catalyst formulations
    - Prepare the scale-up to 6000 t/d commercial plant
  - End of tests in May 2006
- What has been demonstrated ?
  - All objectives have been reached and even surpassed
  - "Cold gas efficiency" : 68,7% ➔71% expected for commercial plant
  - DME purity : 99.8% *(international future standard : 99.6% for Diesel substitution)*
- Next step : feasibility study of a DME commercial plant in Qatar
  - Production of 2,2 Mtpa starting around 2012
    - JFE – DME synthesis is demonstrated
    - Scale-up to 2 trains of each 2 reactors of 1500 t/d is feasible

3 China : Strong Governmental Support & numerous projects

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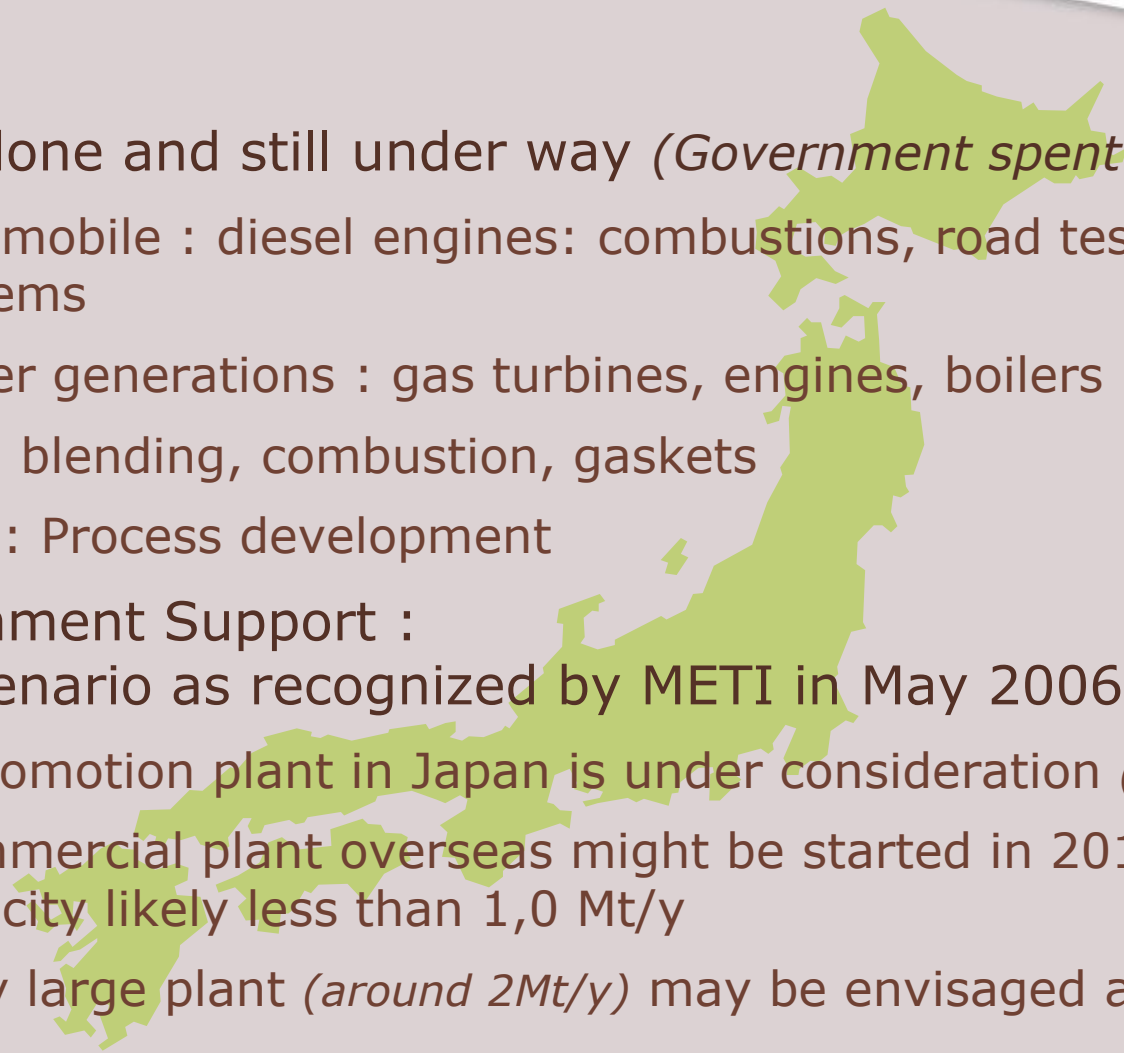
List of DME Plants and Projects in China (as of August 2006)*								
No.	Location		Owner	Capa. (Kt/y)	Feedstock	Technology	Usage	Status
	City	province						
1	Linyi	Shandong	Jiutai Group	100	Coal	in-house	LPG-blending	in operation
2	Guangzhou	Guangdong		200	Methanol			under construction
3	Ordos Reg.	I. Mongolia		700	Coal			preparation
4	Luzhou	Sichuan	Lutianhua	10	Natural gas	Toyo	LPG-blending & Propellant	in operation
5				100				test operation
6	Bengbu	Anhui	XinAo	10	Methanol	SWI**	LPG-blending	in operation
7				100	Coal			in preparation
8	Langfang	Hebei		100				
9	Yantai	Shandong		100				
10	Luoyang	Henan		100				
11	Yuci	Shanxi	Jiaxin	10	Methanol	SWI**	LPG-blending	in operation
12	Weihe	Shaanxi	Weihe	10	Natural gas	SWI**	Propellant	
13	Xinyang	Henan	Xinyang Fert.	10	Coal	SWI**	LPG-blending	
14	Zhongshan	Guangdong	Kaida	10	Methanol	SWI**	Propellant	
15	Kaiyuan	Yunnan	Jiehua	150	Coal	SWI**	LPG-substitute	in preparation
16	Yinchuan	Ningxia	Ningxia Coal	210	Coal	Toyo	LPG-blending	under construction
17	Ordos Reg.	I. Mongolia	Sinopec, etc	3000	Coal	N/A	Fuel	Just set up working team

**** with a capacity > 10 kt/yr***

***** SWI: China Southwestern Research & Design Institute of Chemical Industry***

- An existing production capacity of 370 kt/y and projects for 4,5 Mt/y mainly from coal in operation by 2010
- DME consumption : 2004 20 kt (56% FGDME) 2005 50 kt

3. DME promotion in Japan



- Tests done and still under way *(Government spent over $250 mil)*
  - Automobile : diesel engines: combustions, road tests, filling systems
  - Power generations : gas turbines, engines, boilers
  - LPG: blending, combustion, gaskets
  - DTP : Process development
- Government Support :
  The scenario as recognized by METI in May 2006
  1. A promotion plant in Japan is under consideration *(Niigata)*
  2. Commercial plant overseas might be started in 2010-2012 with capacity likely less than 1,0 Mt/y
  3. Very large plant *(around 2Mt/y)* may be envisaged around 2013

3. DME promotion in South Korea

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1. Korea DME Forum created in January 2003
2. KOGAS and TOTAL, DME promoters in South Korea since 2005
3. Third Asian DME conference success in October 2006

4. DME An option to diversify and increase natural gas outlets

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- Potential new outlet for methanol : Case of Methanex which has recently announced projects in China and Chile
- Potential new way of valorization in the GTL processes for portfolio diversification :
  - Higher thermal efficiency through direct synthesis and less investment than Fischer-Tropsch (FT)

	FT	DME	LNG
Thermal efficiency:	~ 55 %	**~ 68 %**	~ 86%

- Possible development of stranded gas fields or flared gas where large investment for LNG chain is not economically justified
  - 6000t/d DME plant would consume 2,6 Tcf of reserves for 25 years
- Direct synthesis process accept CO2 concentration in feed gas up to 25%

Conclusions

- After 2010-2015, DME would have a market in Asia and DME fired systems would be available on an industrialized scale
- DME has to be included in the possible gas valorization portfolio especially to reach countries with large, scattered or immature domestic energy markets as LPG substitutes, Diesel engine fuel or decentralized power generation fuel
- As DME is a clean fuel, its development may also improve human health not only in big cities but also in remote places

This explains Total's involvement in that route