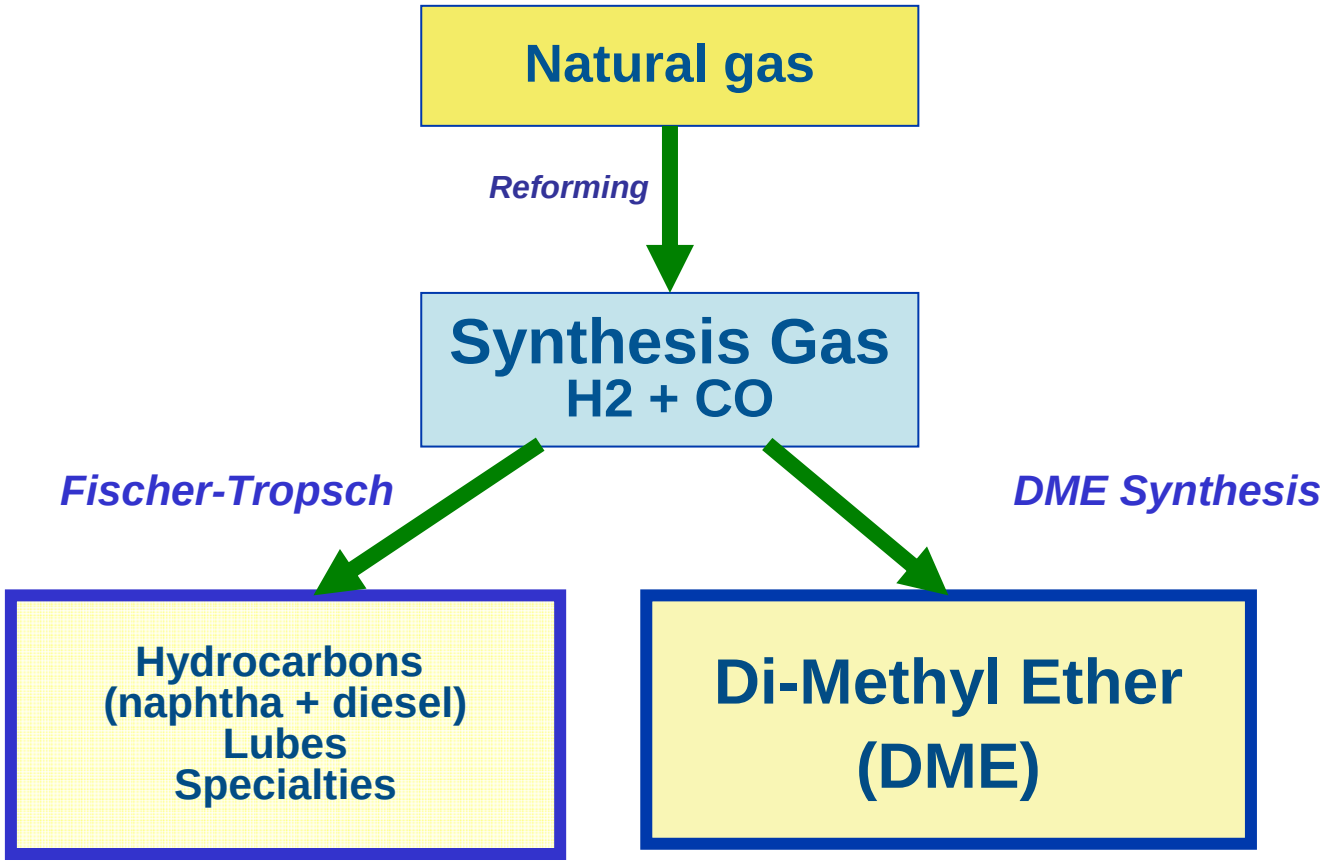
TOTAL

Future Prospective of DME

Hubert de Mestier du Bourg

23 rd World Gas Conference
Amsterdam 5 - 9 June 2006

DME is another option of GTL (Gas To Liquid)



Characteristics of DME

$DME = CH_3\text{-}O\text{-}CH_3$ *di-methyl-ether*

- ***handling as easy as LPG***
  - ***boiling at - 25℃, liquid under 5.1 bars at 20℃***
- ***calorific value / weight 60 % of LNG***
  / gas volume 150% of LNG
- ***low ignition temperature, high cetane number***
  - *suitable for diesel engine fuel*
- ***clean combustion – no Smoke at all***
  - *can meet extremely stringent control of PM emission without filter for diesel engine cars (<0.013g/kwh in 2010, Japan)*

Why TOTAL is interested in DME ?

- *An option to diversify and increase natural gas outlets,*
- *Economical for storage and transportation, especially where large investment for LNG is not economically justified,*
- *Future possibility as cleanest Auto-gas (diesel),*
- *Best thermal efficiency among all GTL processes, especially with direct synthesis solution.*

***TOTAL** participation in a Japanese Consortium (JFE group) since 2001 for Direct DME Technology Development and Feasibility Study of a large scale DME production Project*

Technical Challenges for DME Production as Fuel

- ***Existing DME plants are small, and sell DME in high price chemical market :***

Shell/RWE, Germany	~	60,000 t/y
Hamburg DME Co, Germany	~	10,000 t/y
AKZO, Holland	~	10,000 t/y
DuPont, West Virginia, USA	~	15,000 t/y
MGC, Sumitomo, Japan	~	10,000 t/y
Australia	~	10,000 t/y
Taiwan	~	15,000 t/y

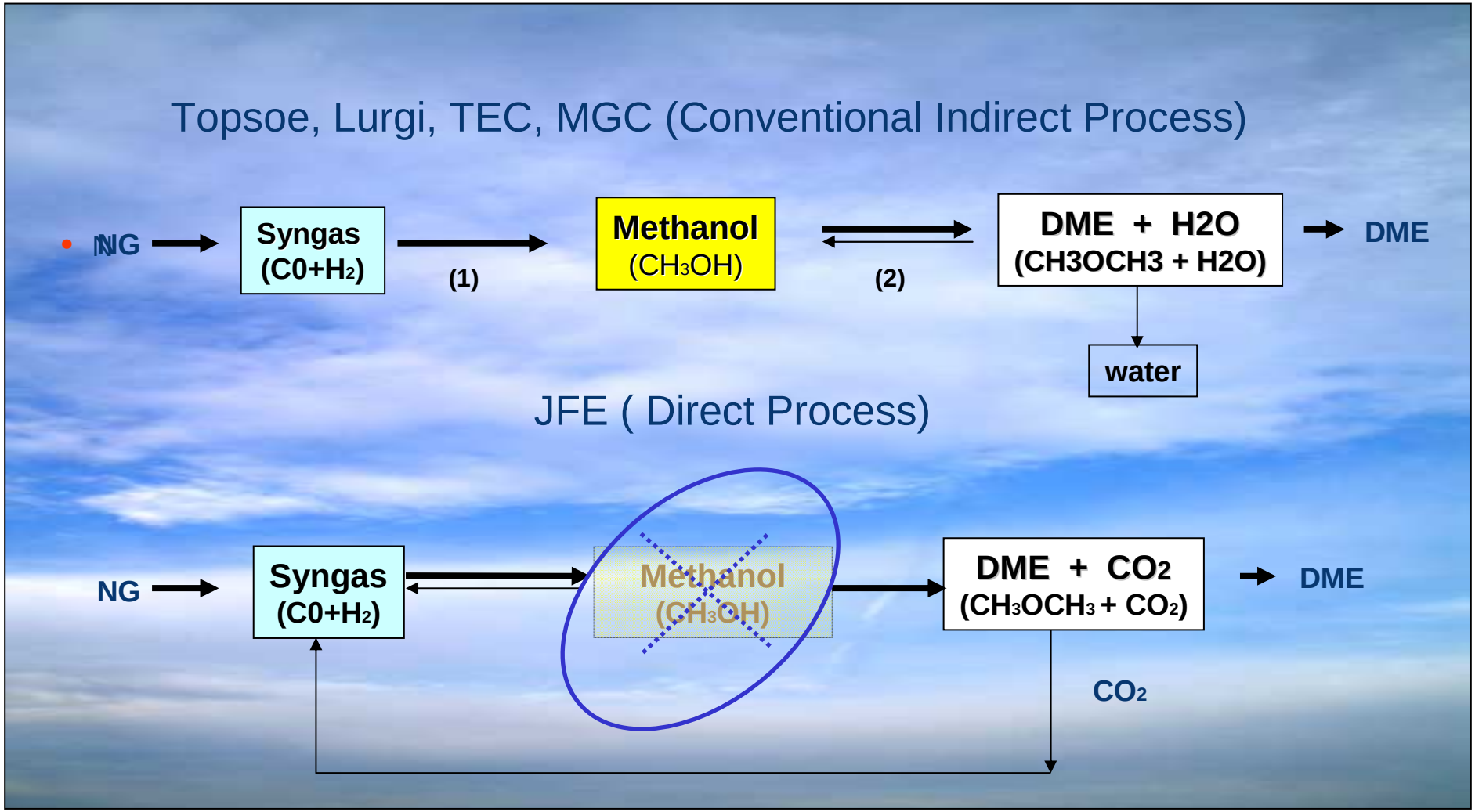
All of them use conventional methanol dehydration process

Luthianhua, China		110,000 t/y (s/u 1st Q, 2006) - for fuel
Jiutai etc. China	~	120,000 t/y ? - for fuel from coal
Ningxia Coal Group		210,000 t/y - for fuel from coal (s/u 2007)

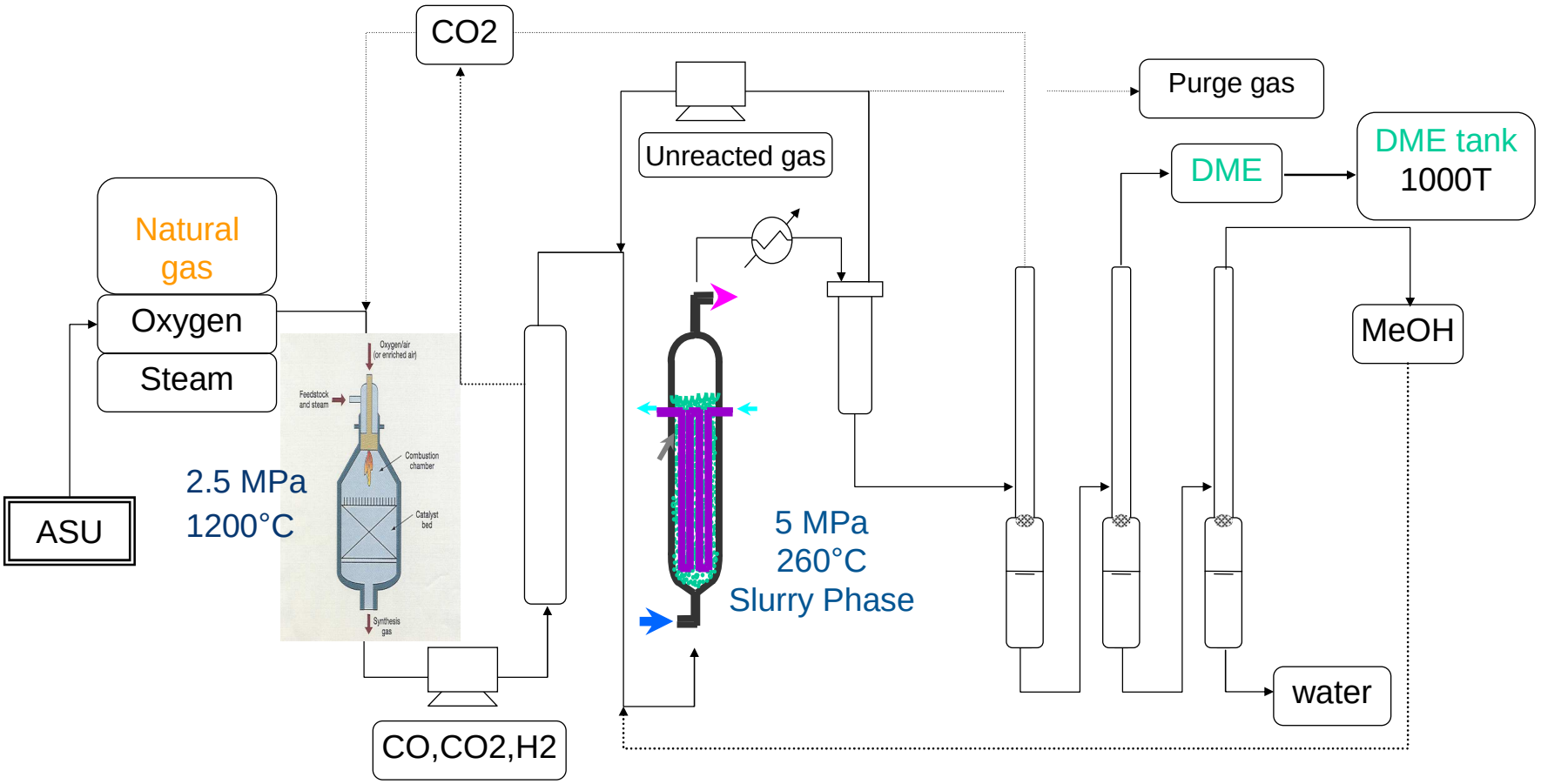
- ***To be cost competitive in Fuel market, at least 1 ~ 2 million t/y single plant capacity is necessary.***

Technical Challenges - Scale-up to 10 ~ 100 times capacity
- More economical process

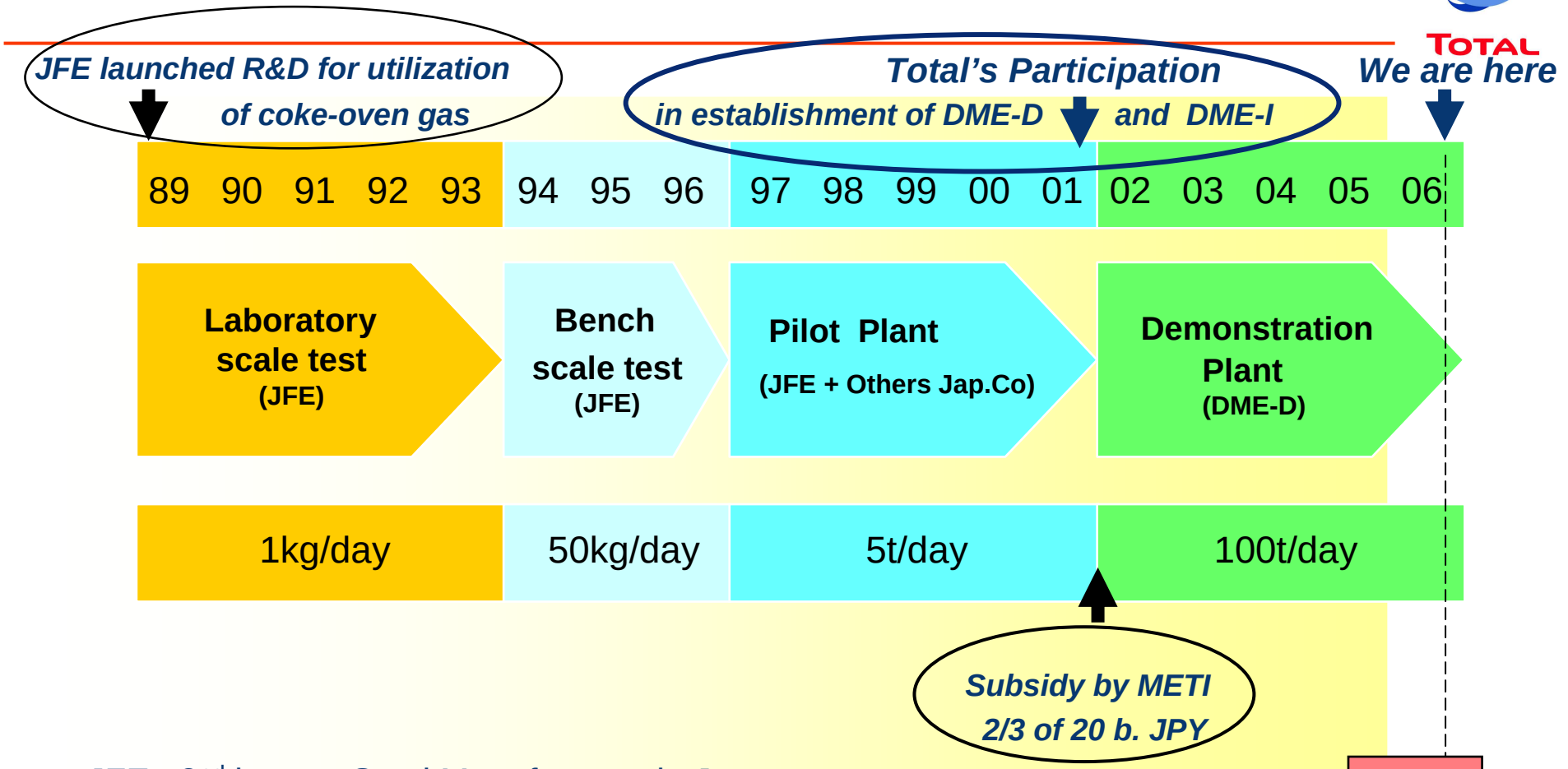
Technical Challenge for more Economical Process



JFE Direct DME Process Flow Diagram



JFE Process Development and TOTAL Participation



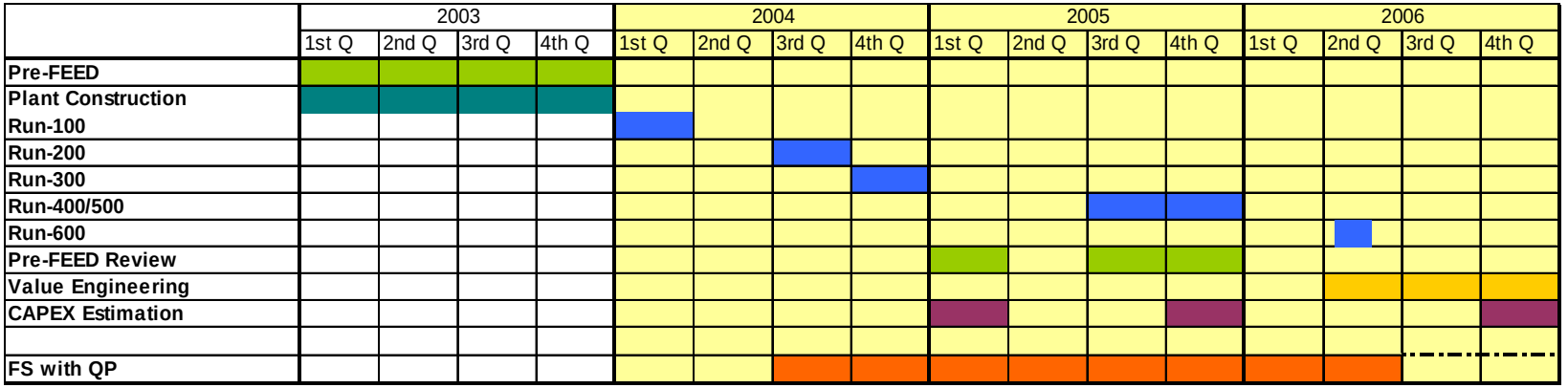
JFE: 2nd largest Steel Manufacturer in Japan

C

Partners in DME-D (DME Development) **and DME-I** (DME International)

JFE, Toyota-Tsusho, Hitachi, Idemitsu, INPEX, JAPEX, Marubeni, LNG Japan, Taiyo-Nissan, TOTAL

JFE Direct Process – Technical Validation Program



OBJECTIVE OF THE TEST RUNS

Run No.	Objective	Key test items	Duration (days)	DME produced (tons)
Run-100	Commissioning	Start-up/shut-down, operability etc.	43	1,240
Run-200	Performance data acquisition	ATR efficiency, CO2 effect on DME conversion, gas recycle ratio etc.	39	2,500
Run-300	Engineering data acquisition	Heat exchanger fouling rate, slurry reactor fluid dynamics, etc.	73	4,230
Run-400/500	Durability tests in a long steady state operation	Duration of equipment and catalyst	152	9,070
Run-600	Confirmation tests	ATR/Quencher Improved catalyst	40	2,500
		Total	347	19,540

100 t/d Demonstration Plant in Kushiro - Syngas Section

100 t/d Demonstration Plant In Kushiro – DME Synthesis and Purification Section

100 t/d Demonstration Plant in Kushiro – DME tank and Lorry

Fuel Grade DME Commercial Plant Projects around the world

- ***Japan***

  3 big groups (JFE, Mitsubishi, Mitsui) are separately conducting FS of 1 ~ 2 MM t/y DME production in Middle East, Australia or South East Asia, and importing DME to Japan.

- ***China***

  Liutianhua group started up 10,000 t/y DME plant in September 2003.
  The same group is constructing 110,000 t/y DME plant to be completed in 1st Q of 2006 in Sichuan Province.
  Ningxia Coal Group plans to start-up 210,000 t/y DME from coal in 2007
  Jiutai group plans to build 1 million t/y DME plant from coal in Mongolia

- ***Iran***

  Zagros Petrochemical is reported to construct 800,000 t/y DME plant in Bandar Assaluyeh. *(European Chemical News - June/July,2004)* ***although the current situation is not clear.***

DME Chain

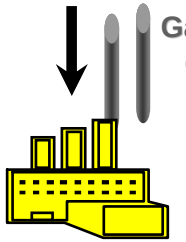
Natural gas reserves required

For DME 6,000 t/d (2.2 MMt/a or 33,000 bbloe/d)

~ 2.8Gm^3 / y or 2.0 TCF in 20 years

Gas consumption 7.7 Mm3/d

Gas pipeline gathering



Pre-treatment Units

(condensate, sulphur, heavy metals, …)

Plant located in Qatar

DME
Production Plant

Export Terminal

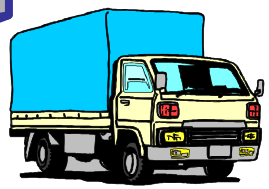
LPG carrier can be used

DME Carrier

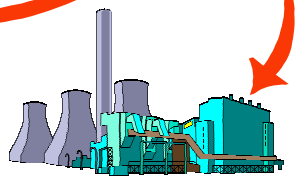
Existing LPG terminal can be used with minor modifications

Import terminals

DME sold in first instance on two markets : Residential and industrial LPG substitution/LPG blending and Power Generation



Diesel vehicules



Power plant

LPG market

DME Markets

Fuel markets

- **LPG market** - DME/LPG blend (up to 30%) appears promising
- **Power generation market** - often competing with other fuels (LNG, coal, nuclear)
- **Diesel market** - most promising, but might need more time to grow
- **Fuel cell market** - depends on fuel cell development

Other potential markets

- **Petrochemical feedstock**: - DME to Olefin (growing olefin market in Asia)
  - under development by Lurgi, UOP/Arkema (MTO), JGC, Idemitsu (DTO)
  - Idemitsu is interested in DTO development for their petrochemical plants
- **Refrigerant:** - Replacement of Fluoro-hydrocarbons for conservation of ozone layer
  - City of Moscow is actively testing
- **Resin foaming agent**: - Replacement of toxic chemicals
  - Kaneka in Japan announced use of DME for polystyrene foaming from September 2005

Prototype DME Vehicles in Japan

Year	2001	2002～2003						2004		
Photo-No	①	②	-	③	④	⑤	⑥	⑦	⑧	⑨
Displacement cc	3600	8266	4600	4214	4214	7166	7961	6925	4777	4777
Power k W	88	168	129	80	80	138	129	201		90
Govt Organization	-	MOLIT	MOLIT	JOGMEC			NEDO	MOLIT	ISUZU	JOGMEC
Manufacturer	JFE	ISUZU	Nissan	AIST	AIST	COOP	HINO	NTSEL	ISUZU	ISUZU

2001/ 2003

2004

MOLIT : Ministry of Land, Infrastructure and Transport

JOGMEC : Japan Oil ,Gas and Metals National Corporation

NEDO : New Energy and Industrial Technology Development Organization

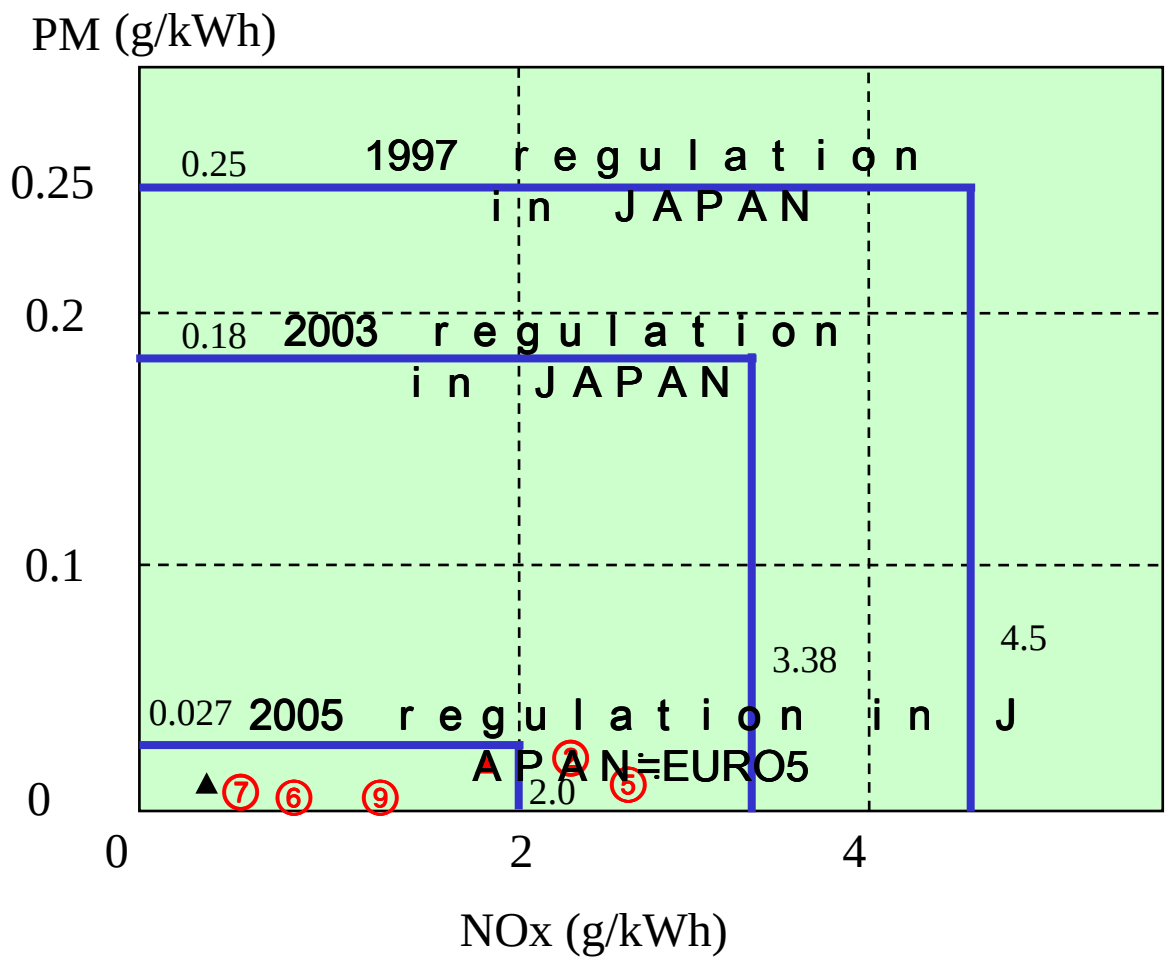
Nissan : Nissan Diesel Motor Co

COOP : Co-op EcoVehicle Development Co, Ltd

AIST : National Institute of Advanced Industrial Science and Technology

NTSEL: National Traffic Safety and Environment Laboratory.

Emissions of Proto-type DME vehicles



【 ~2003 】

②ISUZU/MOLIT BUS (PM0.026/NOx2.17)

⑤COOP/JOGMEC TRUCK (PM0.01/NOx2.48)

⑥HINO/NEDO BUS (PM0.008/NOx0.83)

【 2004~ 】

⑦NTSEL/MLIT TRUCK (PM≒0/NOx0.5) (NOx reduction catalyst+EGR)

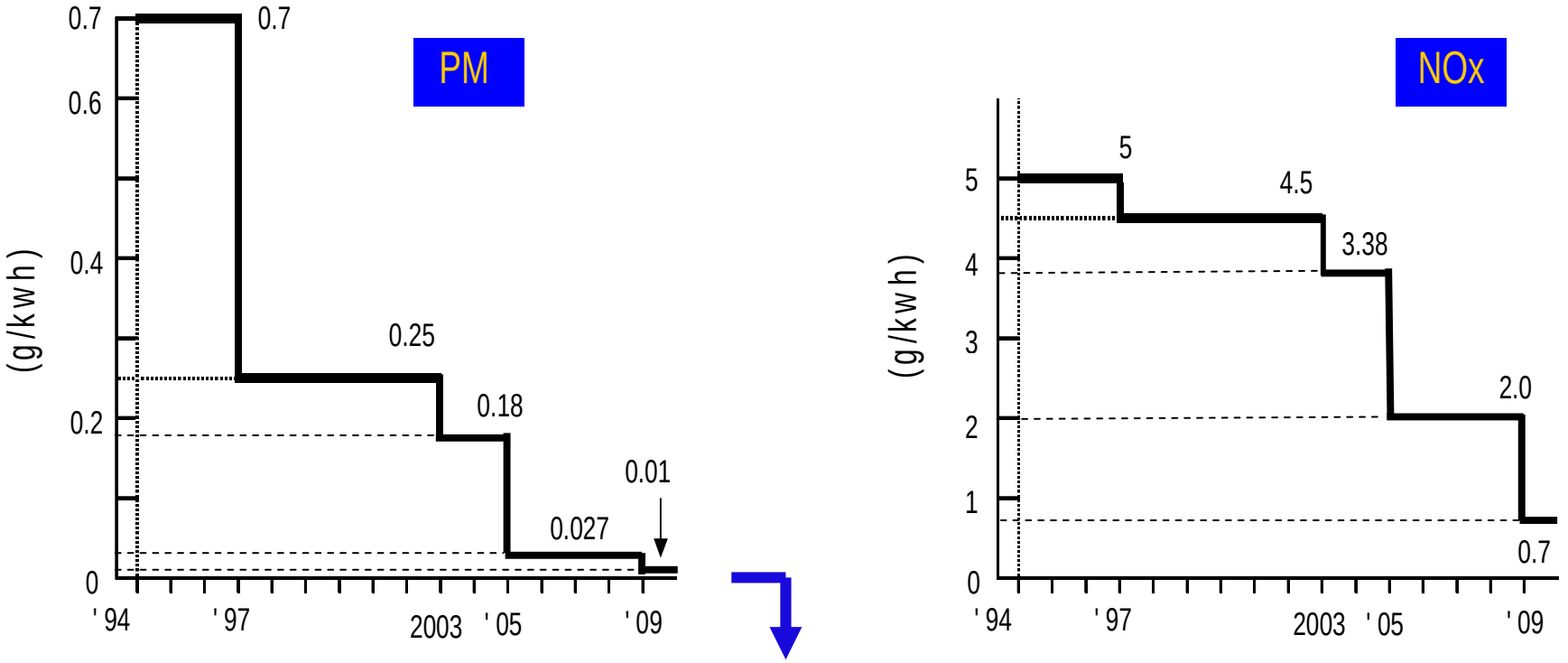
⑨ISUZU/JOGMEC TRUCK (PM0.005/NOx1.255) (only EGR for NOx)

▲VOLVO AFFORHD project

AFFORD : Alternative Fuel FOR

Regulation on Diesel Car Emission in Japan
(>3.5 ton heavy duty cars)

Advisory Committee for the Minister of Environment proposed in February 2005 a very stringent emission control from 2009.



Only DME can meet this level without DPF

Source: Nikkei Newspaper 2/22/2005