



Natural Gas Transportation in form of Hydrate

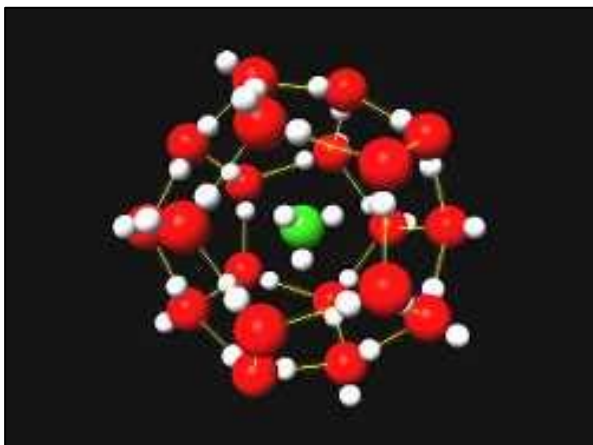
Tatsuya Takaoki

Mitsui Engineering & shipbuilding Co., Ltd.

Natural Gas Hydrate (NGH)

Crystal

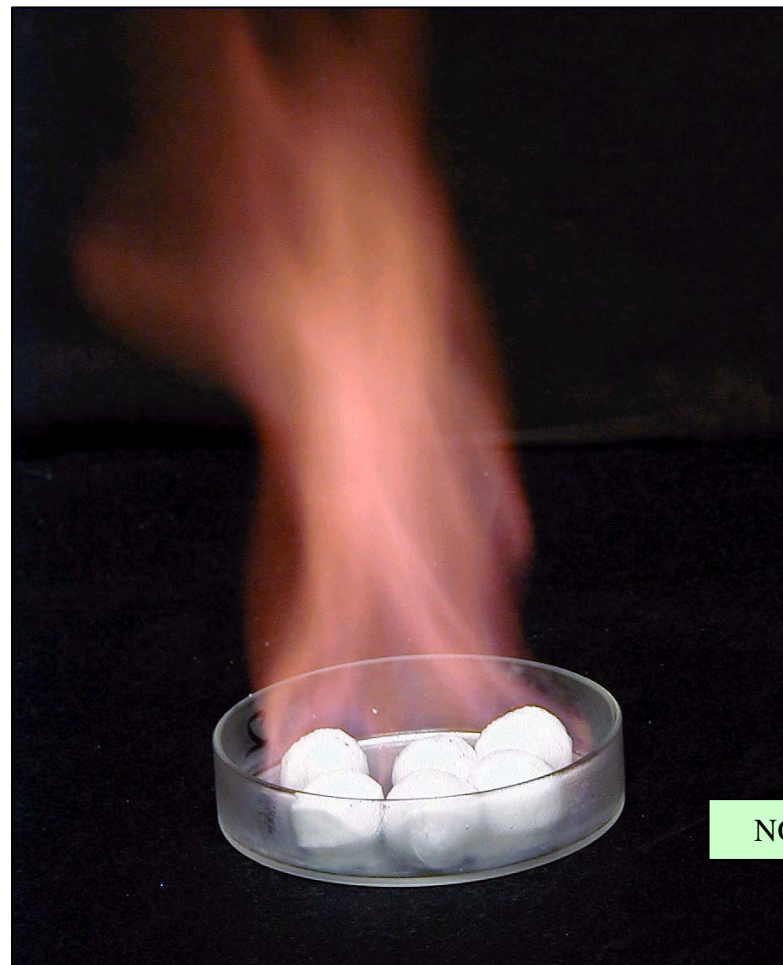
Gas
Molecule
+
Water
Molecule



Powder



Hard to ignite



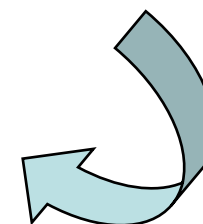
NGH Pellet

Easily to handle

Process Developing Plant with Capacity of 600kg/day in Chiba

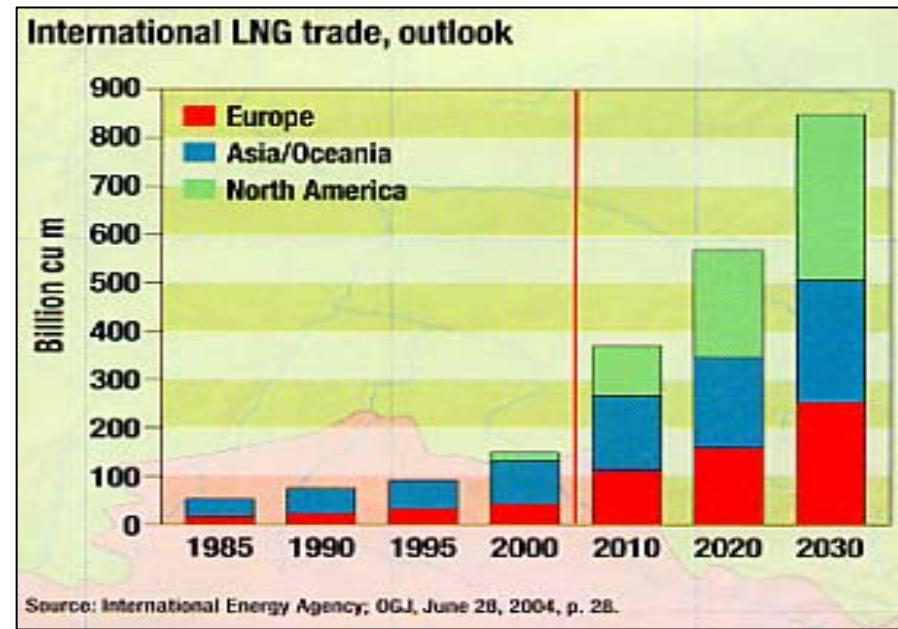
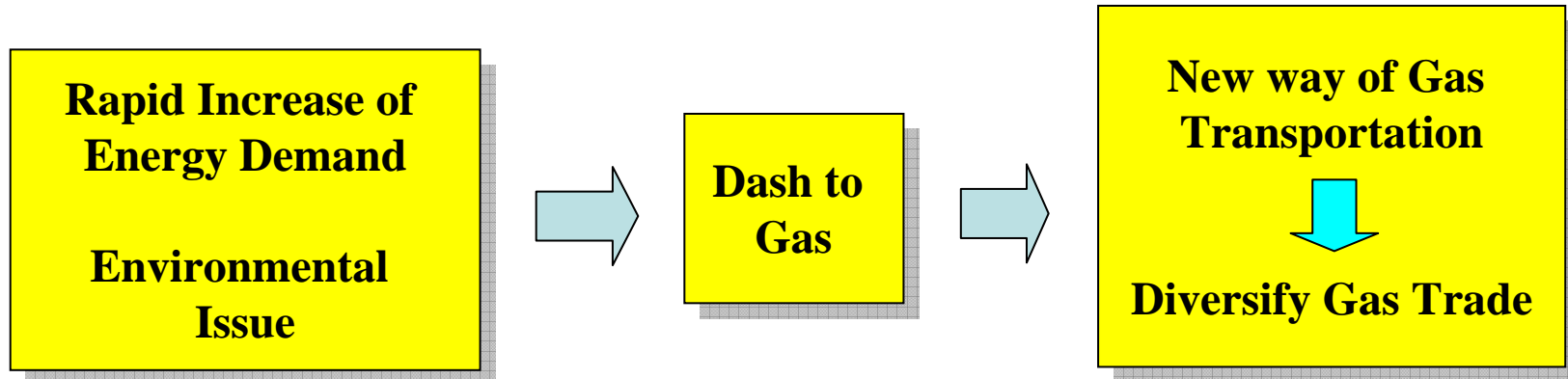


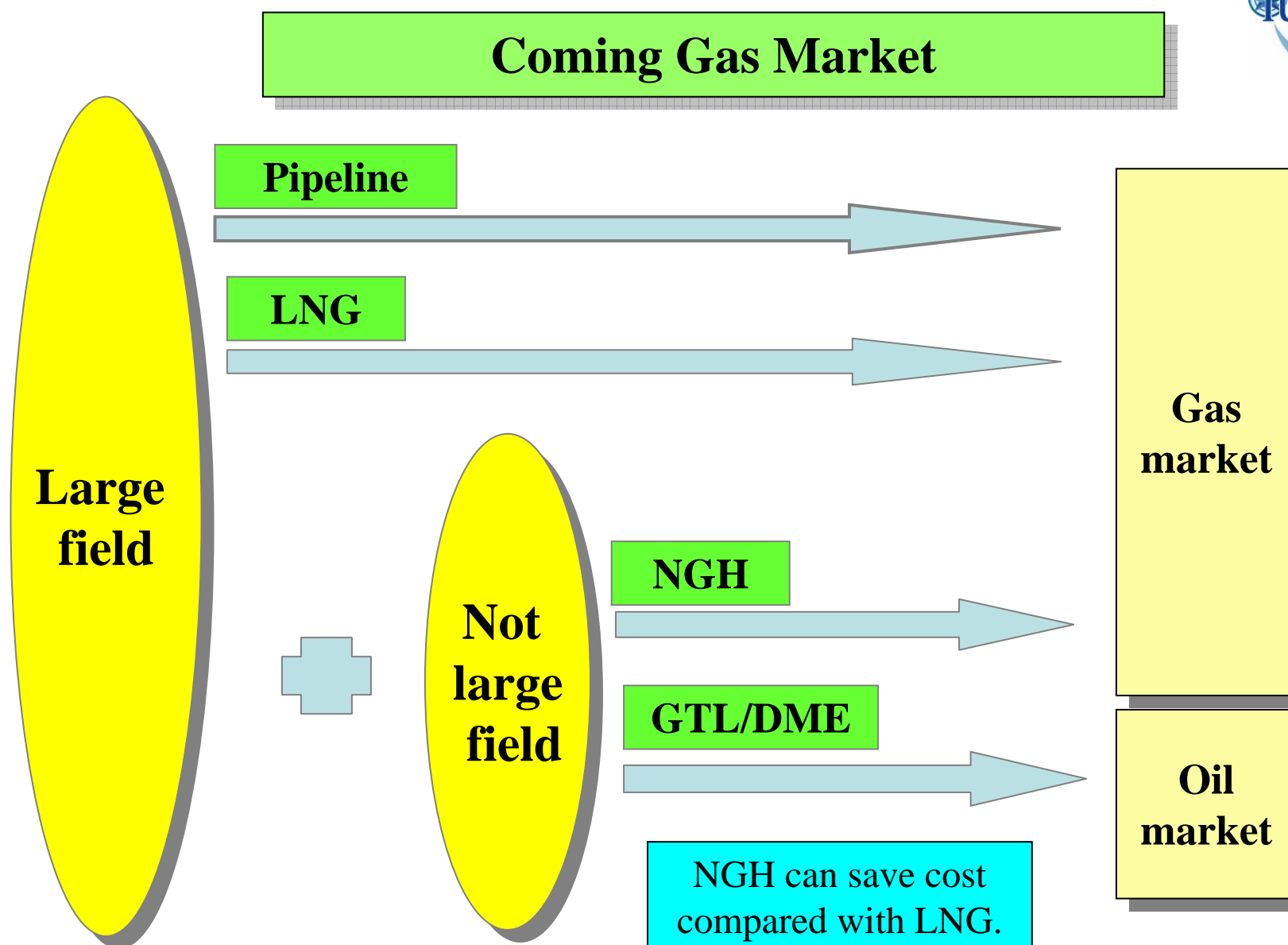
NGH Powder



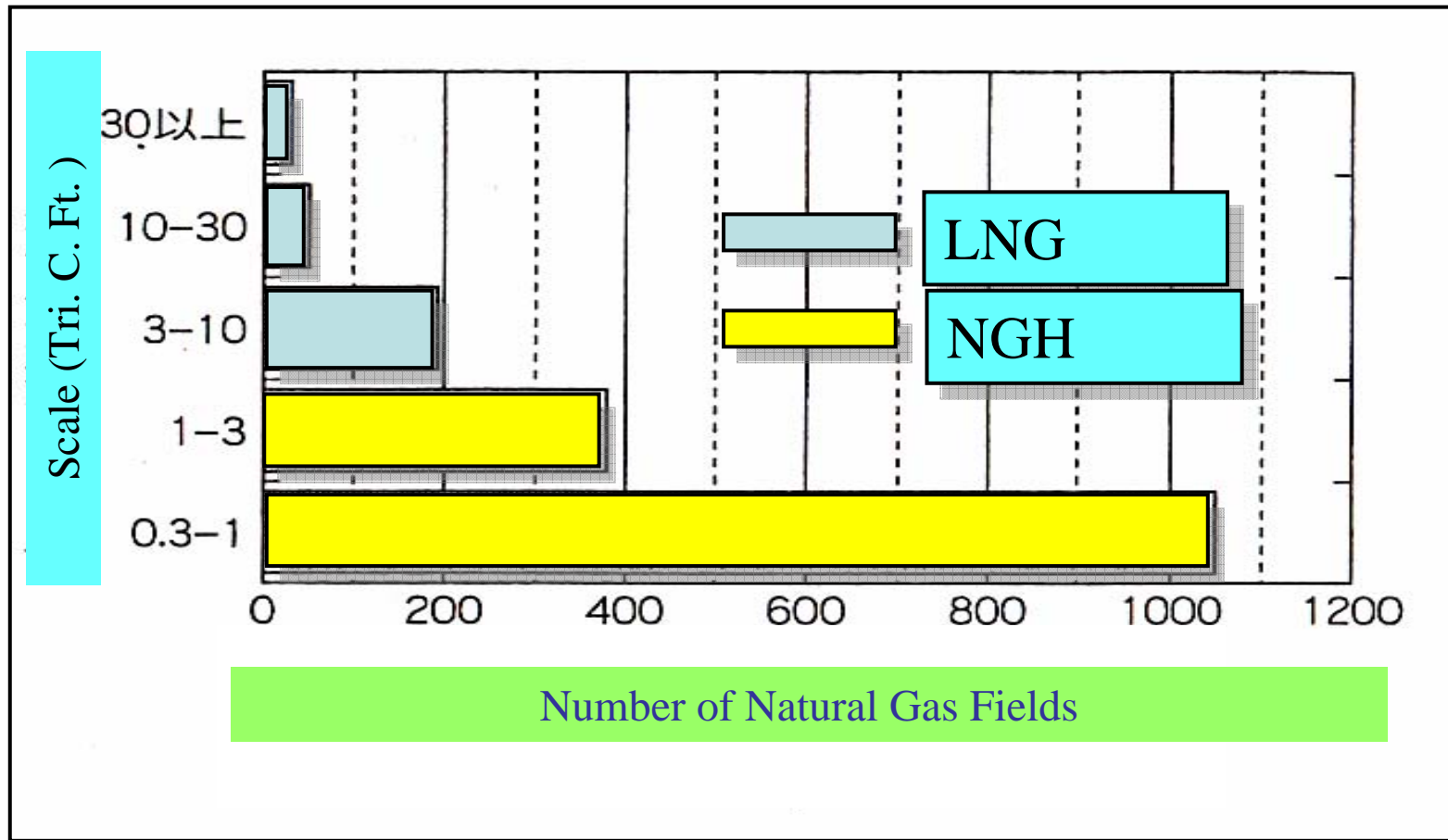
NGH Pellets

Background of NGH Development





Scale vs. Number of Natural Gas Fields



**South E.
Asia**

**Offshore
field**

**80% in
Number**

**40% in
Volume**

Specification of NGH compared with LNG

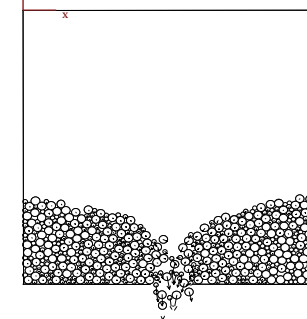
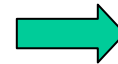
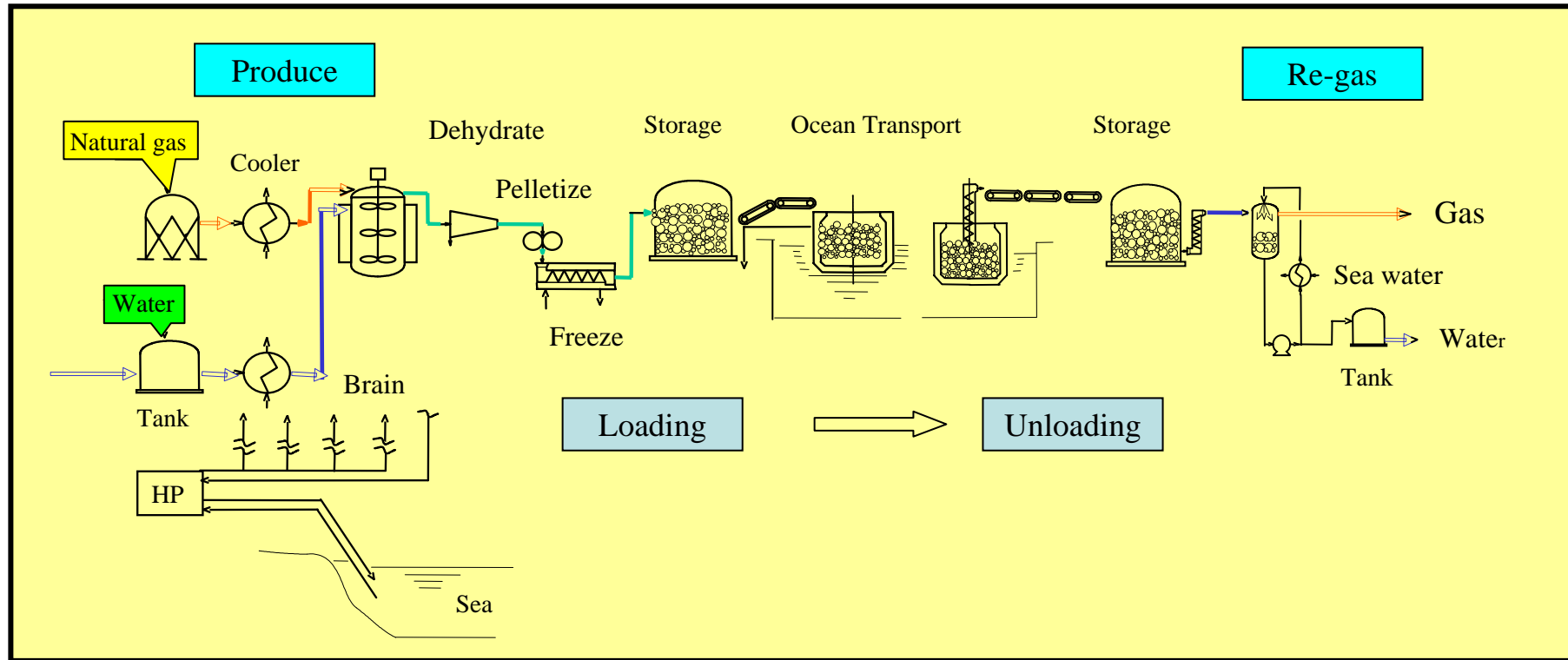
Items	NGH	LNG
State	Solid	Liquid
<u>Temperature</u>	<u>-20 degree C</u>	<u>-162 degree C</u>
In 1m3	165Nm3 gas plus 0.8m3 water	600Nm3 gas
Specific Gravity	0.85-0.95	0.42-0.47

NGH can be transported under “milder” temperature than LNG



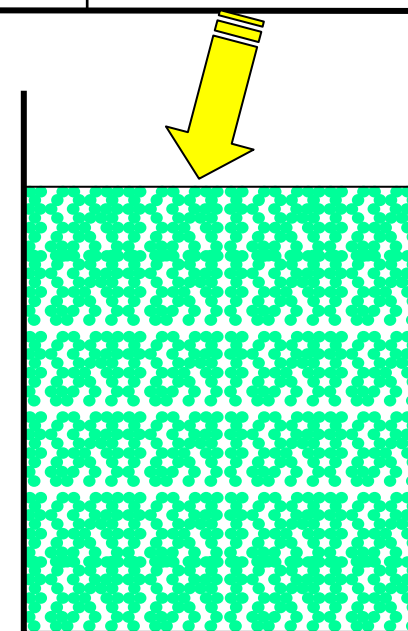
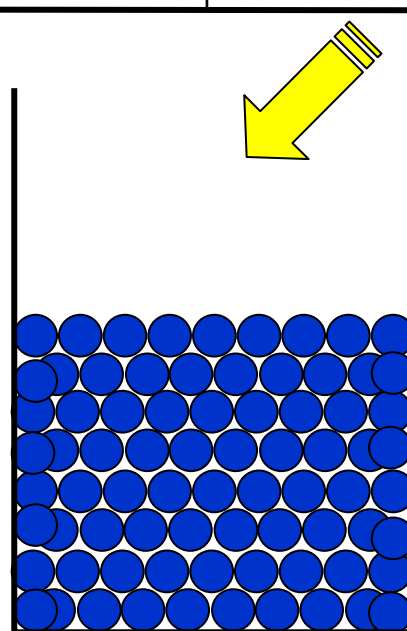
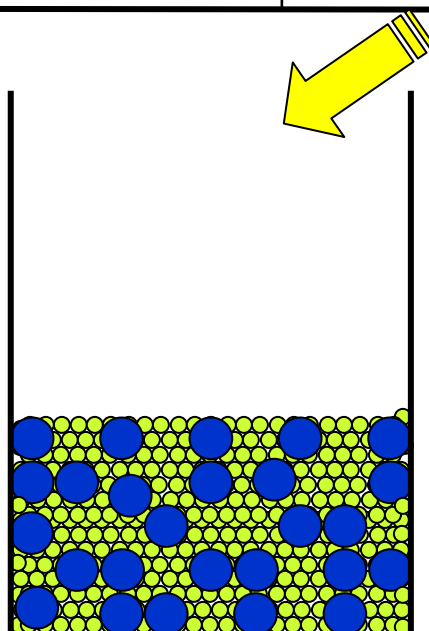
NGH saves cost and is eco-friendly

NGH Transportation Chain



Filling Efficiency

	M u l t i S	O n e S i	P o w d e r
F i l l i n g	i z e	z e	
E f f i c i e n	0.78	0.56	0.40
S t r a g e V o	1.0	1.4	1.8
l u m e			



Self-preservation (powder vs. pellet)

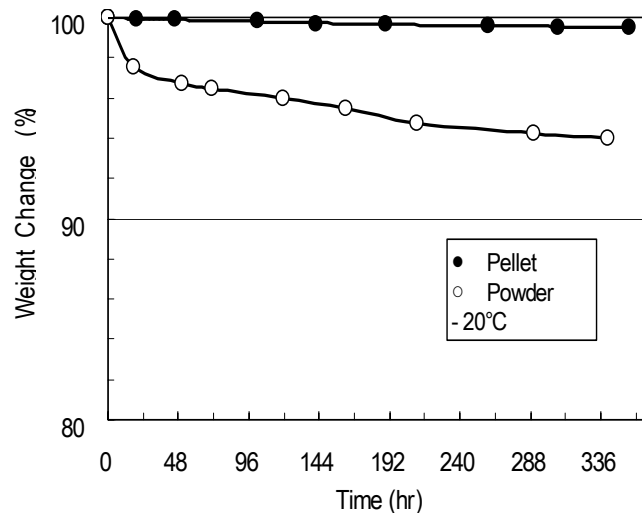


Figure 3 Dissociation Curve of Pellet and Powder at -20°C

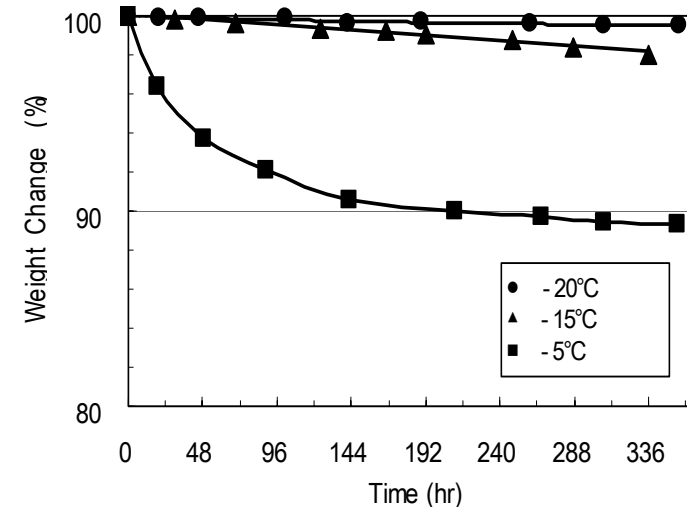


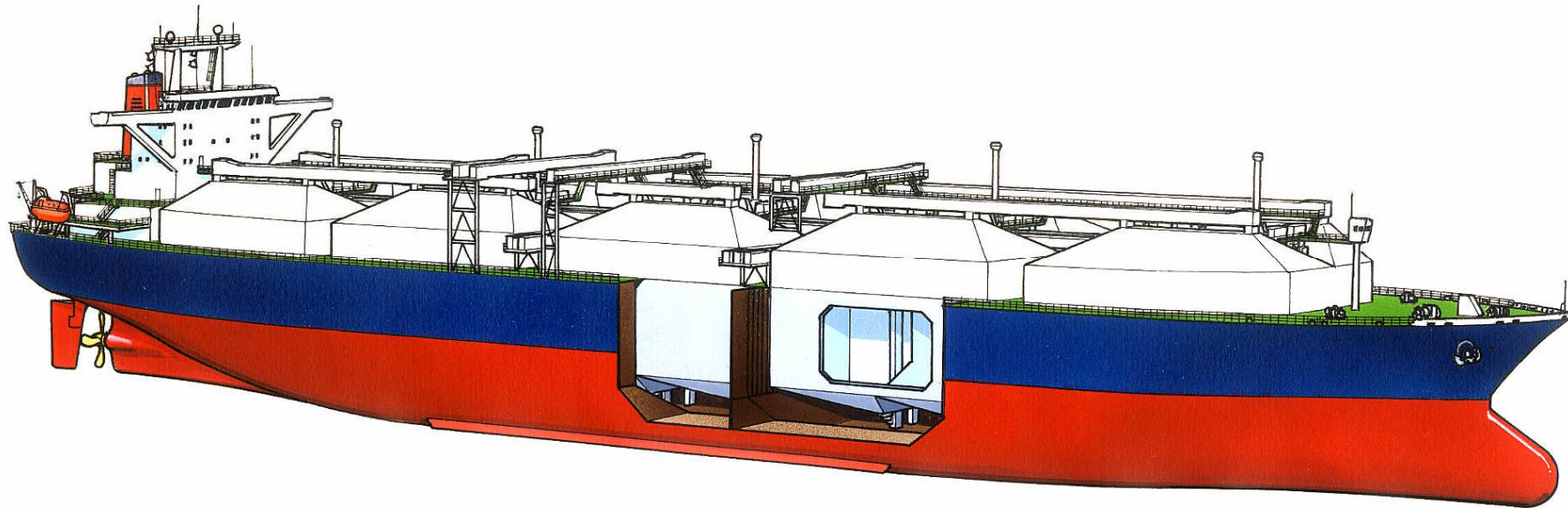
Figure 4 Dissociation Curve of NGH Pellet



Photo 7 Storage Image of Two Size pellet

**Multi-Dia. Pellet
(20 mm 5 mm)**

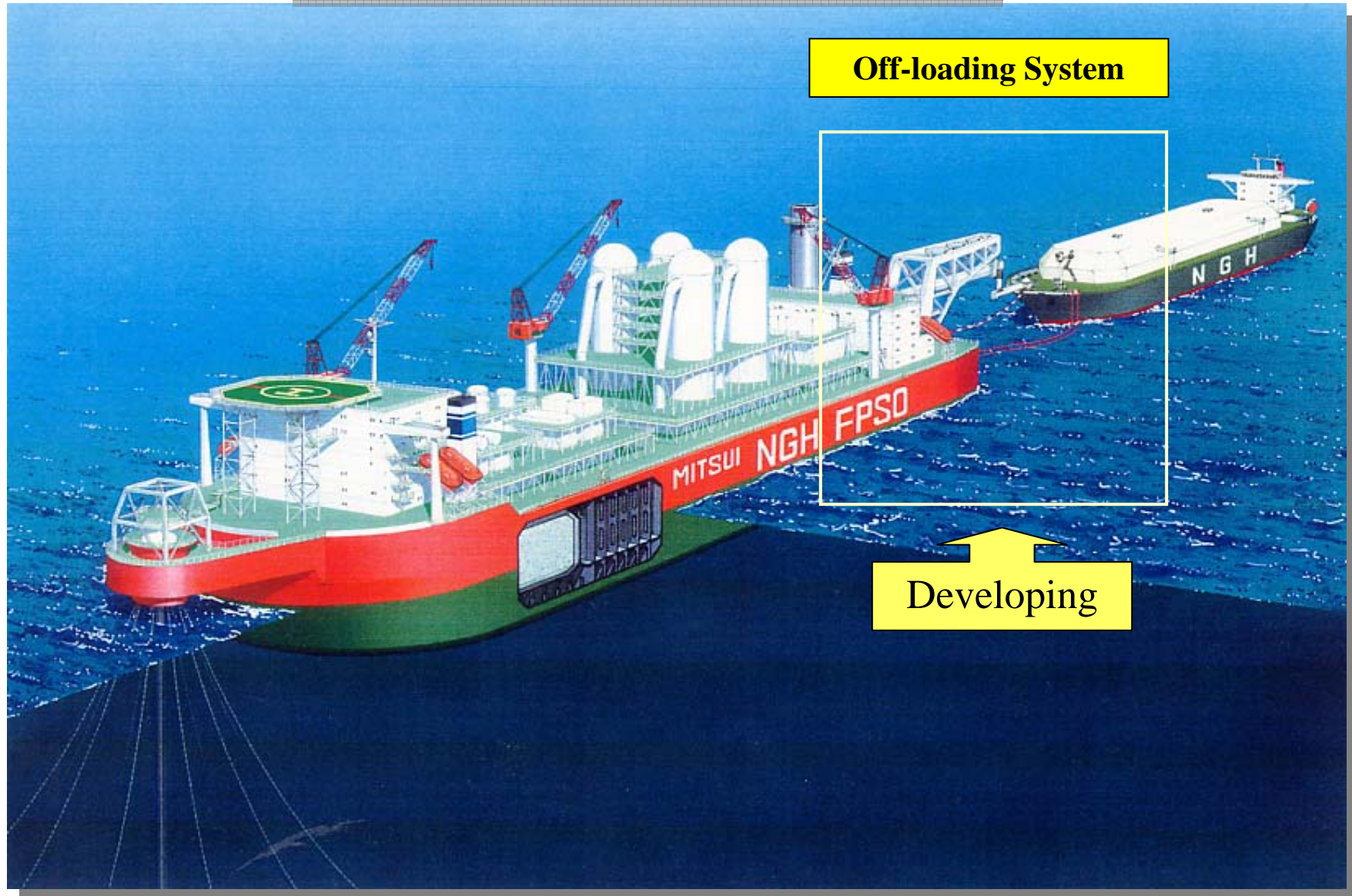
100,000DWT NGH Carrier



Length, p.p. : 275.0m
Breadth, mld. : 46.0m
Depth, mld. : 25.5m
Draft, design : 14.0m
Cargo capacity: abt. 160,000m³
Speed, service : abt. 17.0kt

NGH-FPSO (Image)

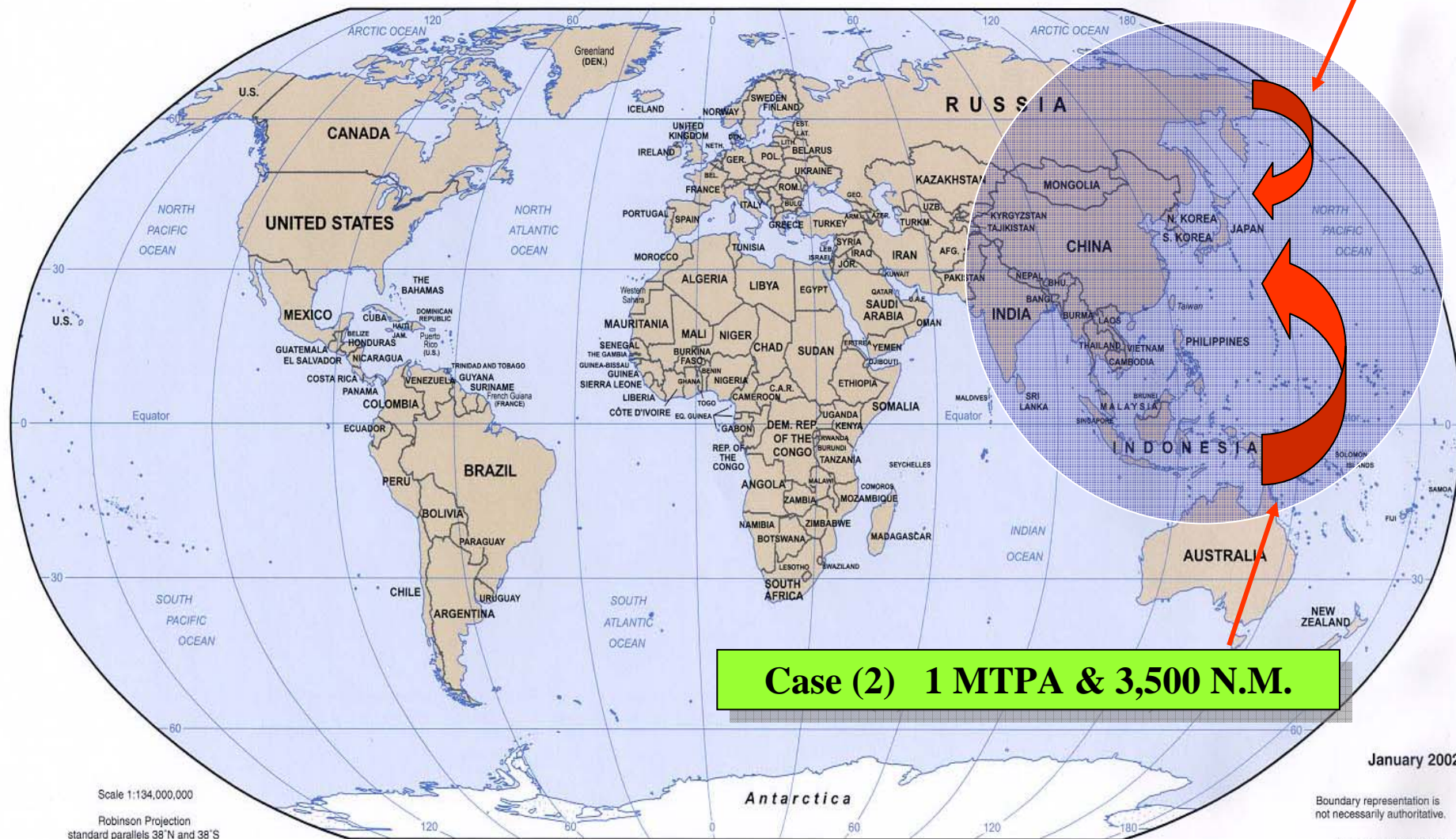
Off-loading System



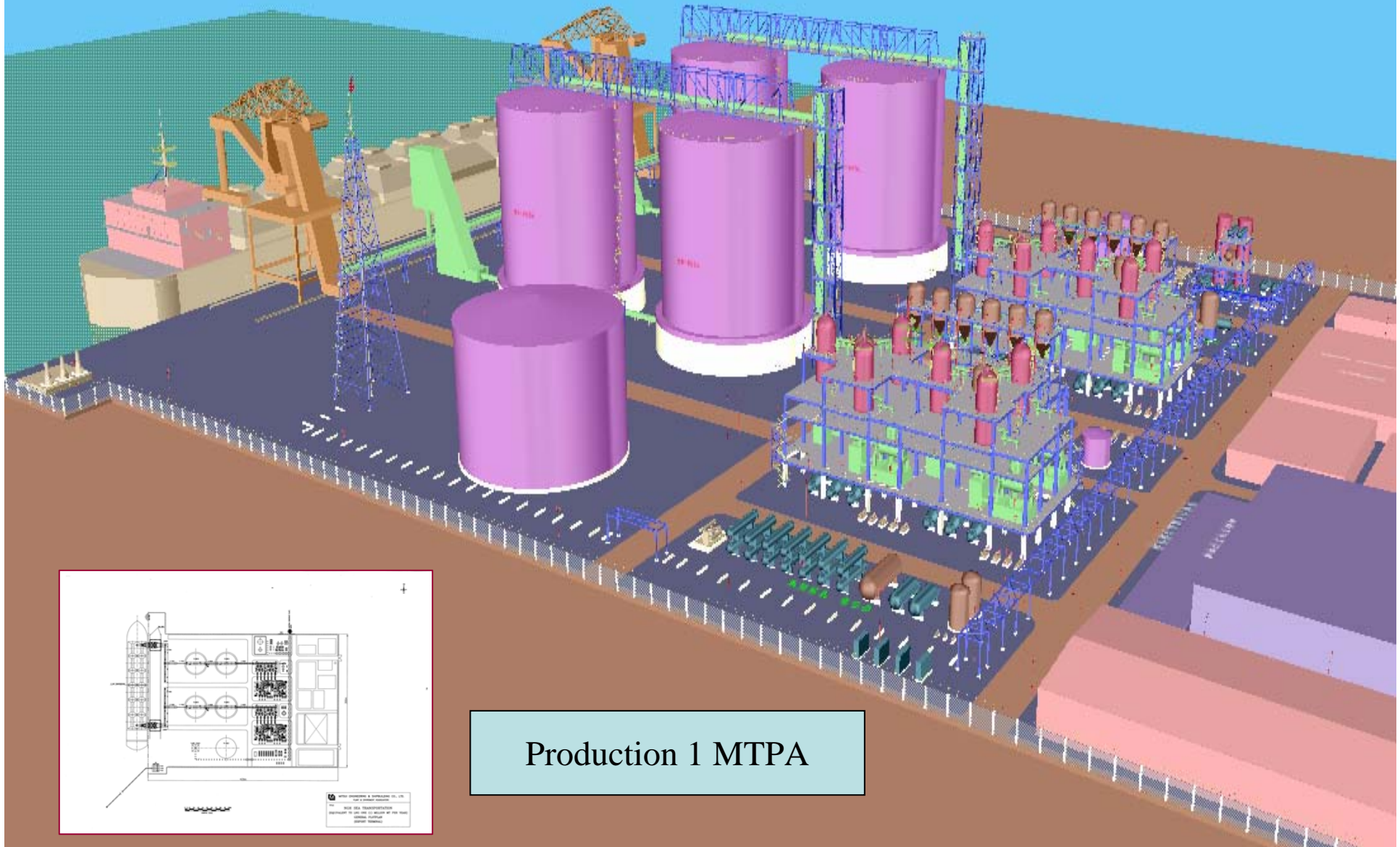
Developing

Distance of 3,500N.M (Market of NGH system)

Case (1) 0.4 MTPA & 1,500 N.M.

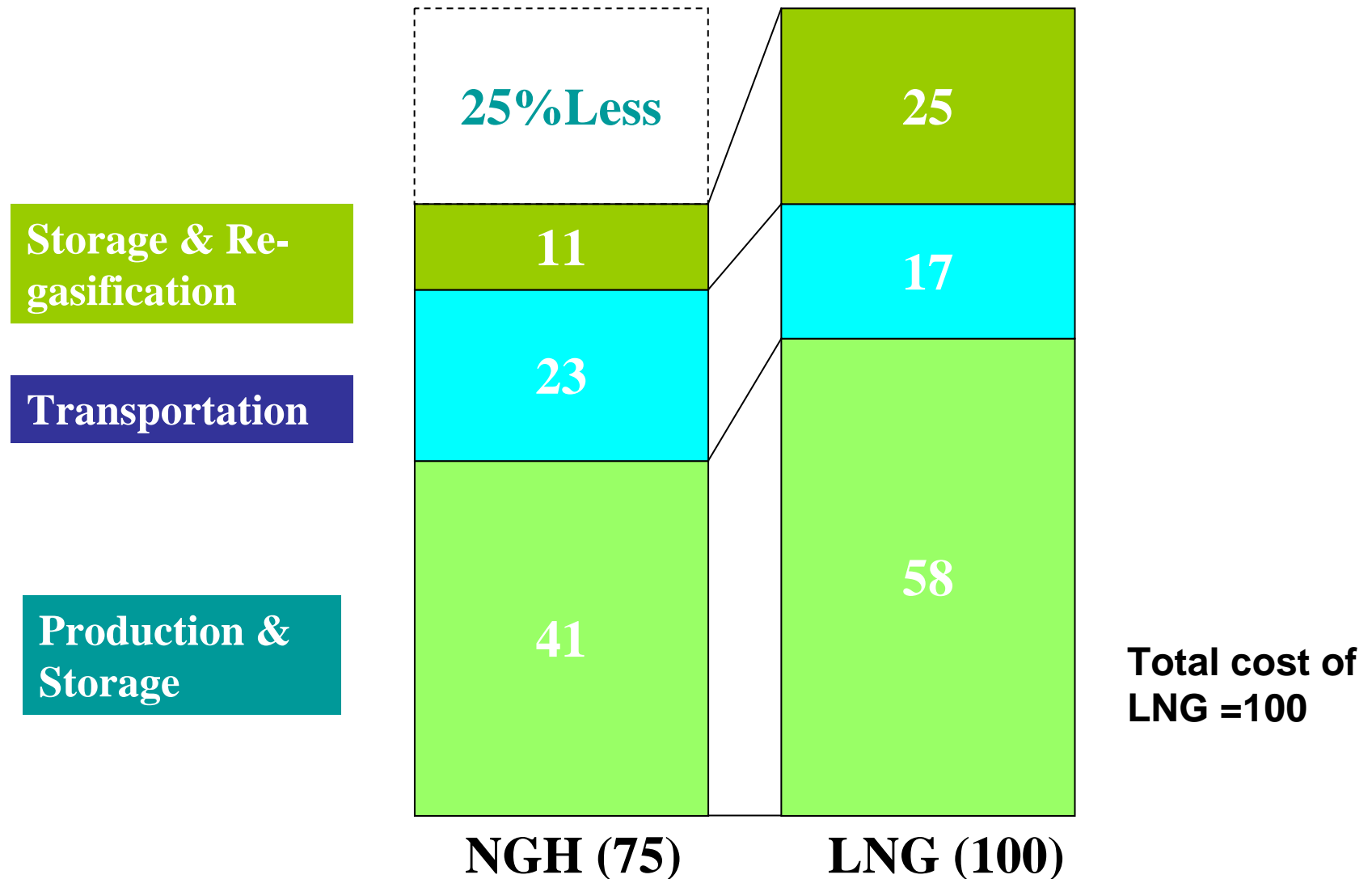


NGH Plant & Export terminal

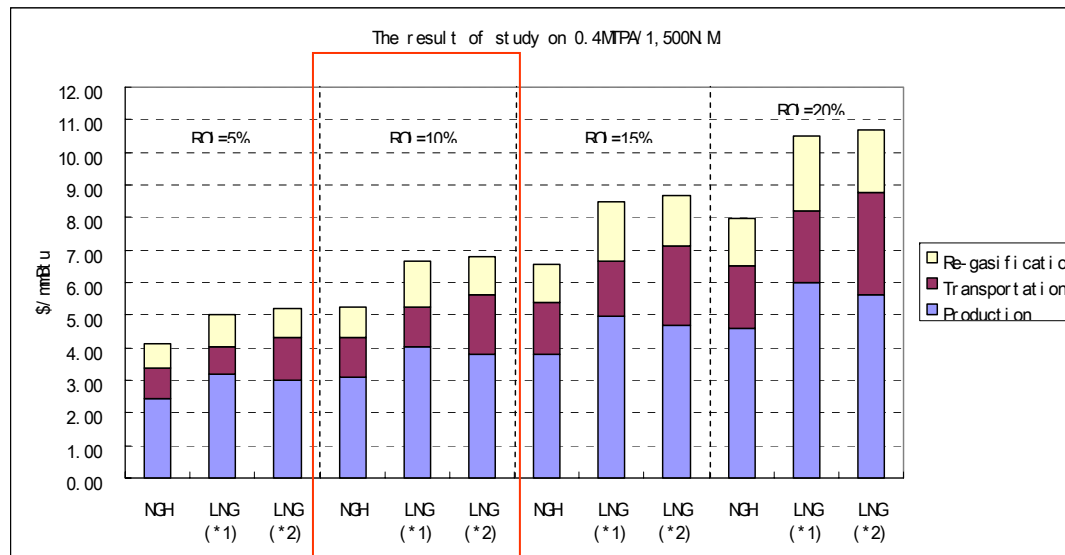


Production 1 MTPA

Capital cost by MES' rough study in case that 1MTA/6,000km gas is transported

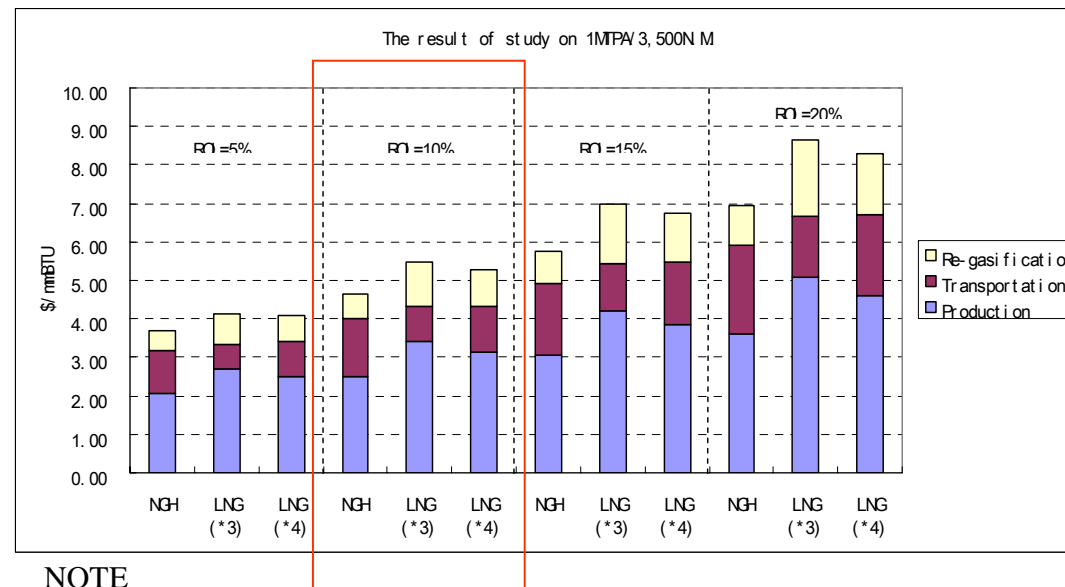


Total Cost (Capital cost + Operation cost)



**0.4 MTPA
1,500 N.M.**

ROI=10%
NGH 25% less



**1 MTPA
3,500 N.M.**

ROI=10%
NGH 18% less

NOTE

1. Natural gas is supplied to NGH production plant for \$1/mmBTU.
2. Figures described in () shows the number of ship.

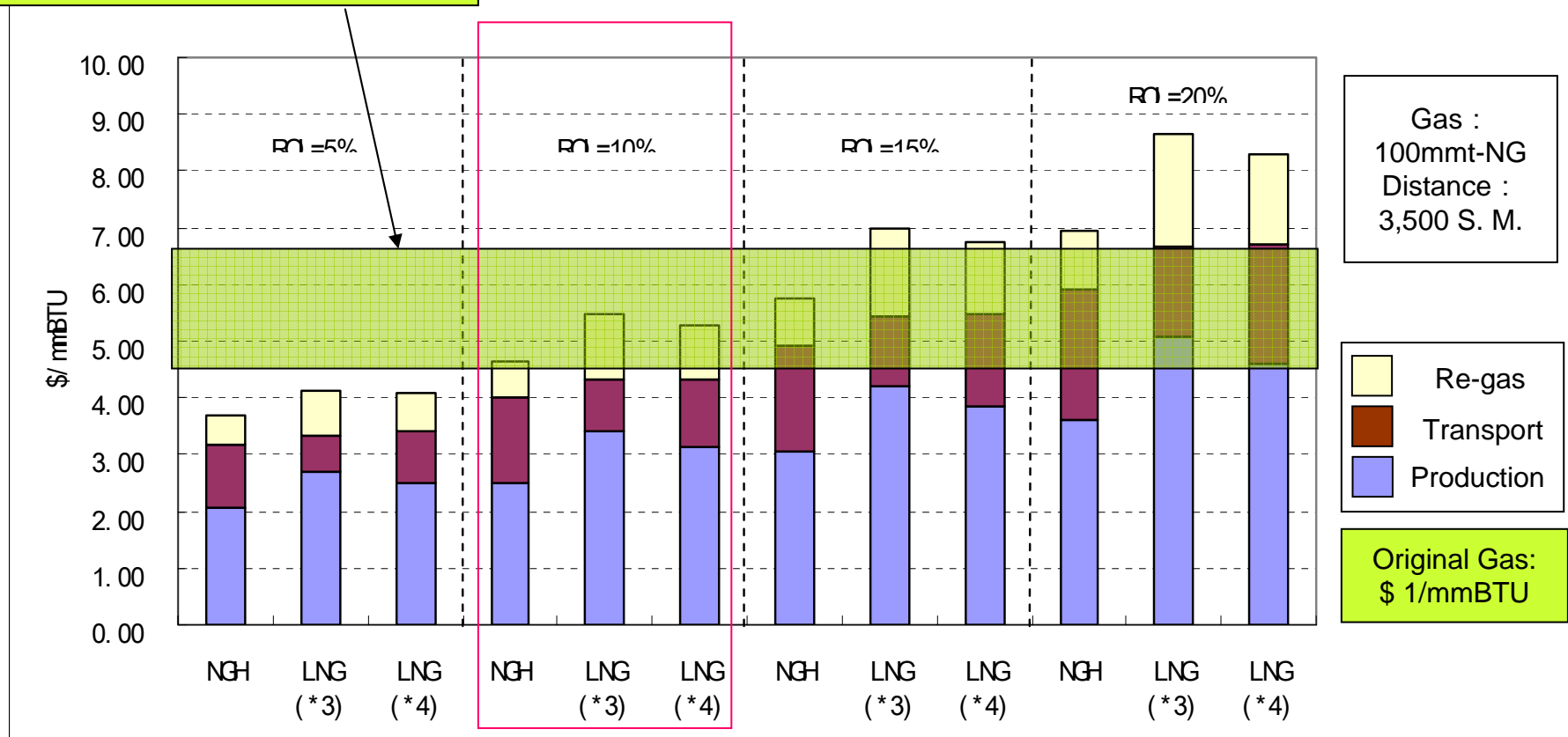
Compared with Market Price



ROI=10%
Gas cost at consumption area is 18% less than that of LNG

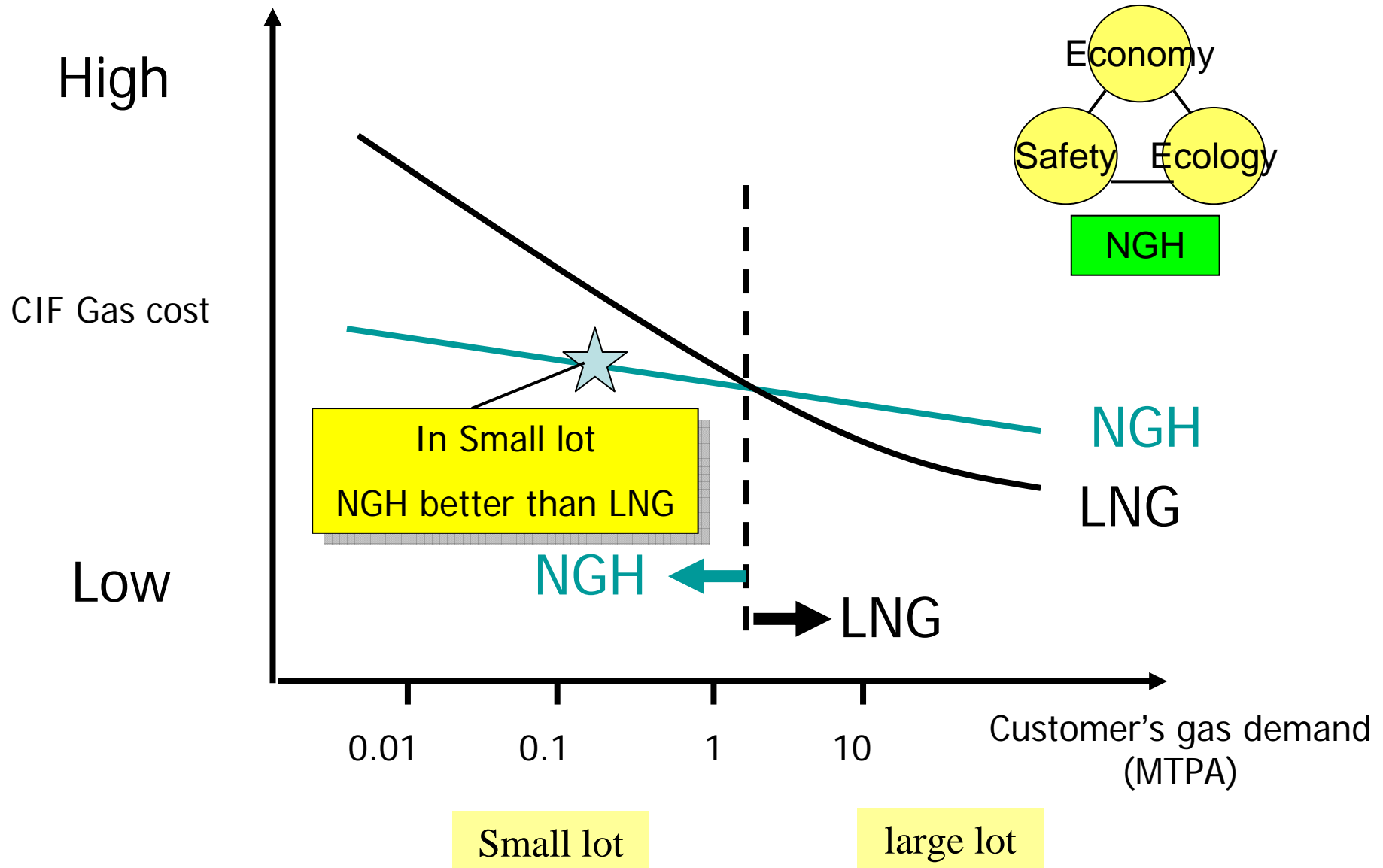
Market Price in Japan 4.5—6.5 \$

The result of study on 1MPa/3, 500N M



Note : (*3) LNG Carrier : 1, (*4) LNG Carrier : 2

Basic concept on economics of NGH



Distance of 3,500N.M (Market of NGH system)



**3,500N.M. distance one way
from middle east.**

**3,500N.M. distance one way
from Gulf of Mexico.**

**3,500N.M. distance one way
from West Africa.**

**Circle of 3,500N.M. distance
one way from Japan.**

Scale 1:134,000,000
Robinson Projection
standard parallels 38°N and 38°S

January 2002

Boundary representation is
not necessarily authoritative.

802804A1 (R00352) 12-01

NGH Domestic Transportation



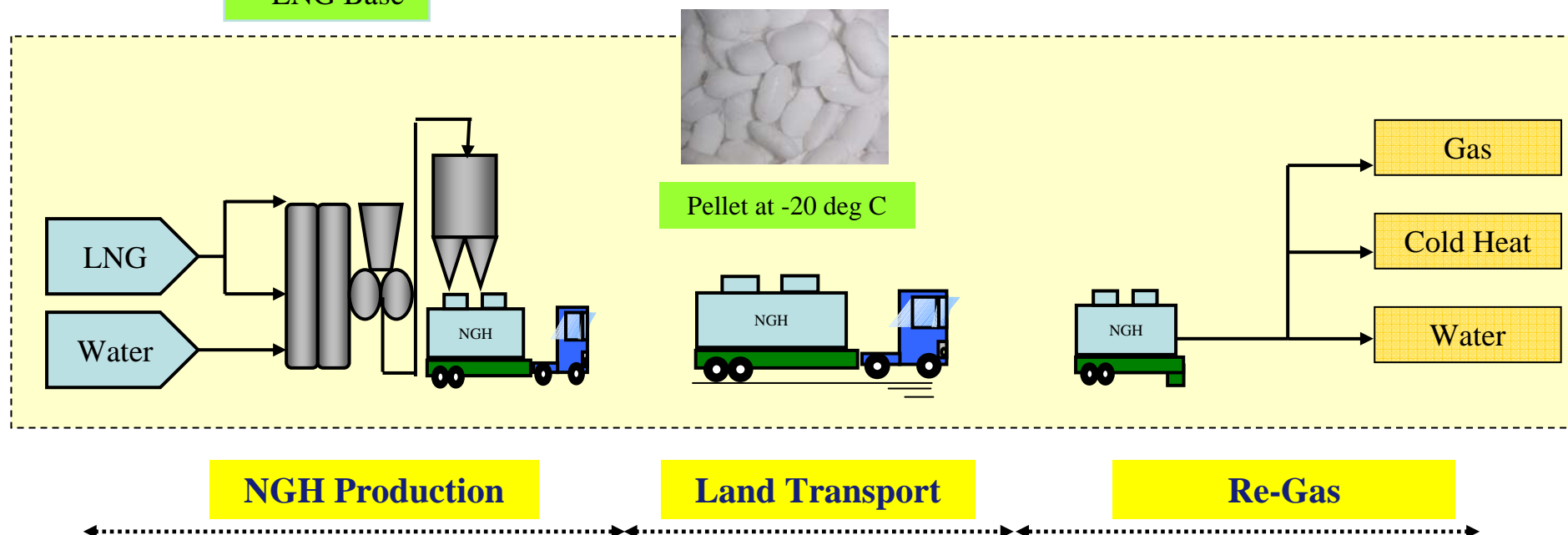
LNG Base



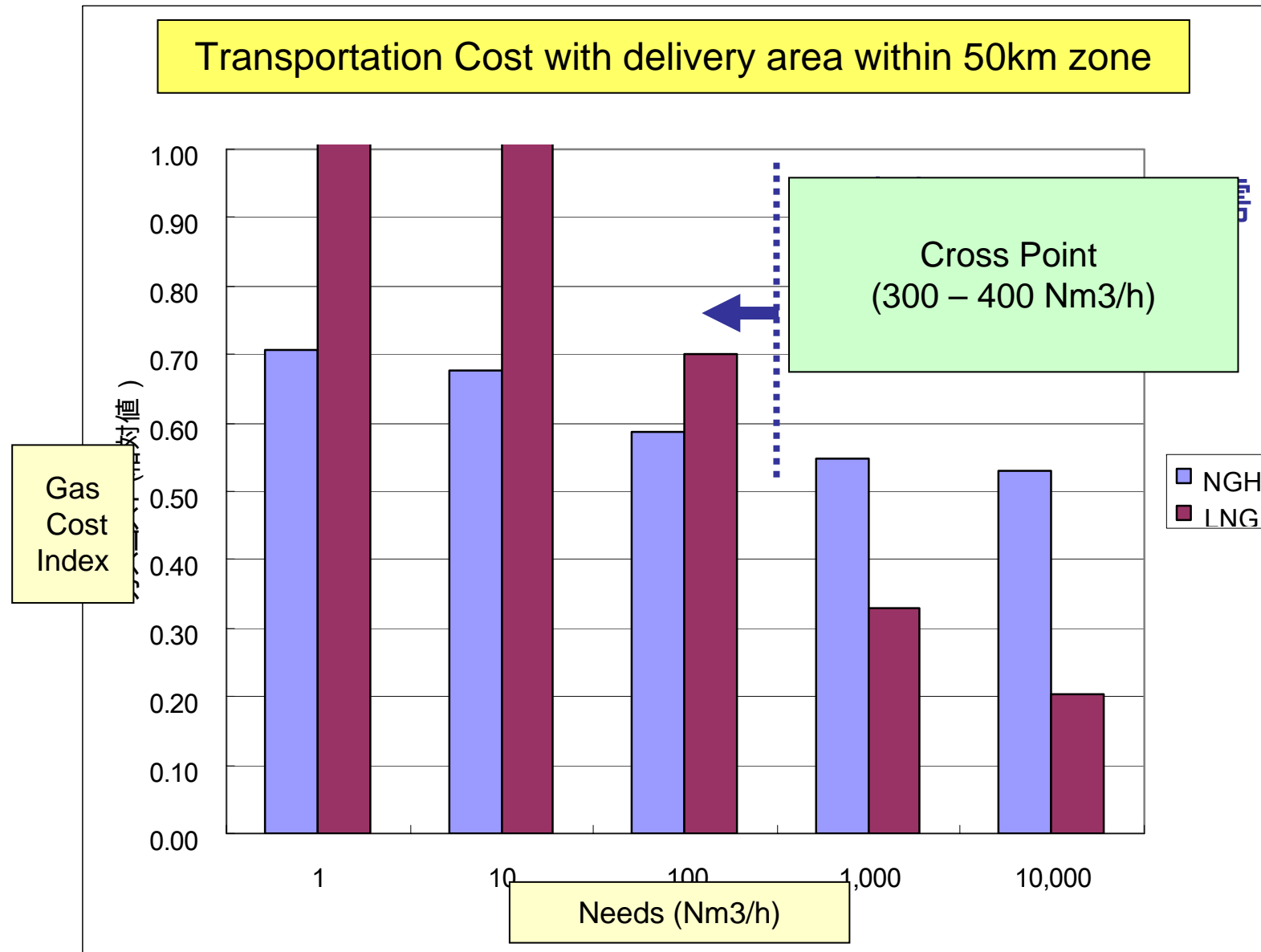
Shopping Center



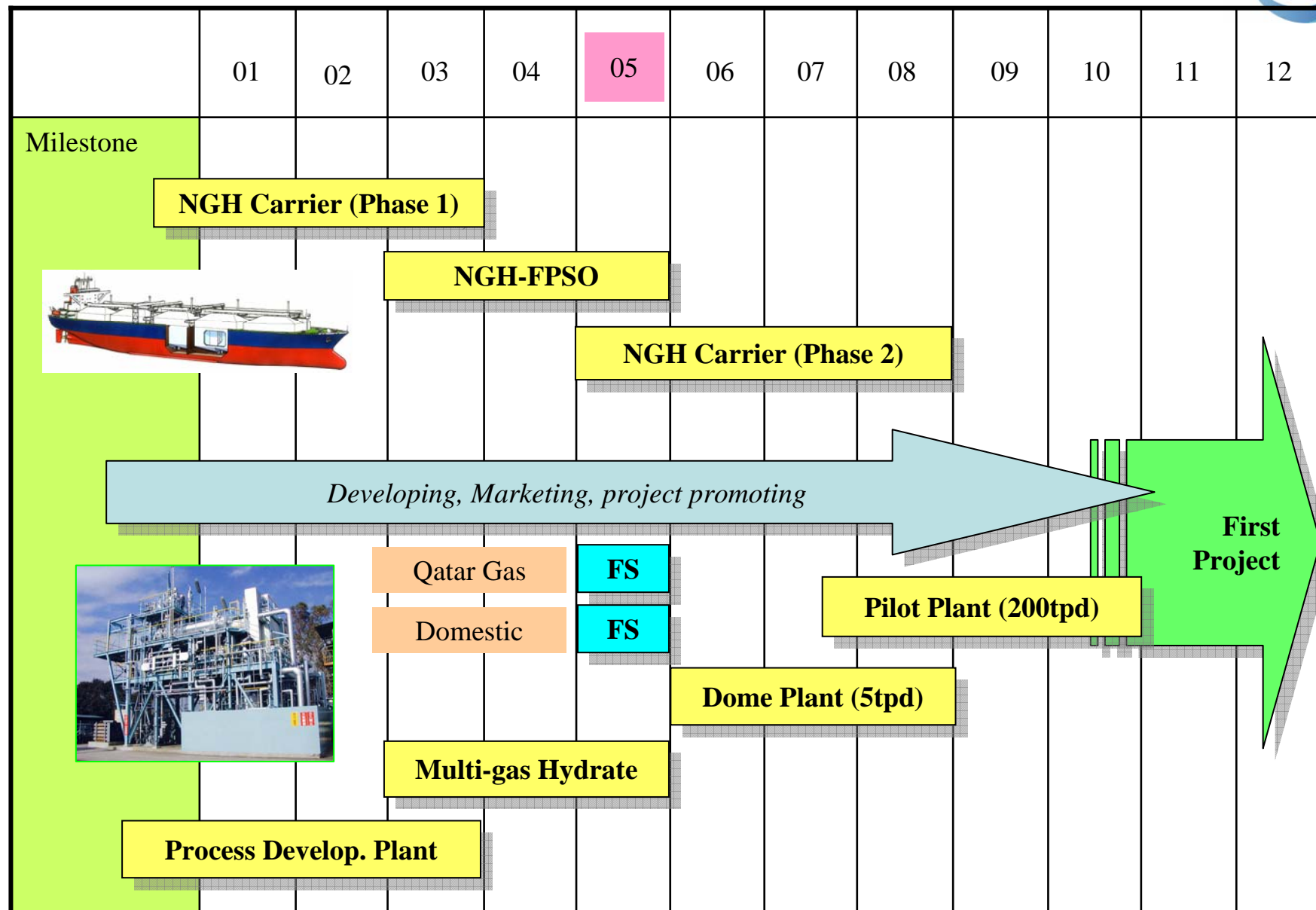
Medical Center



Operation Cost in Domestic Inland Transportation



NGH Project Milestone

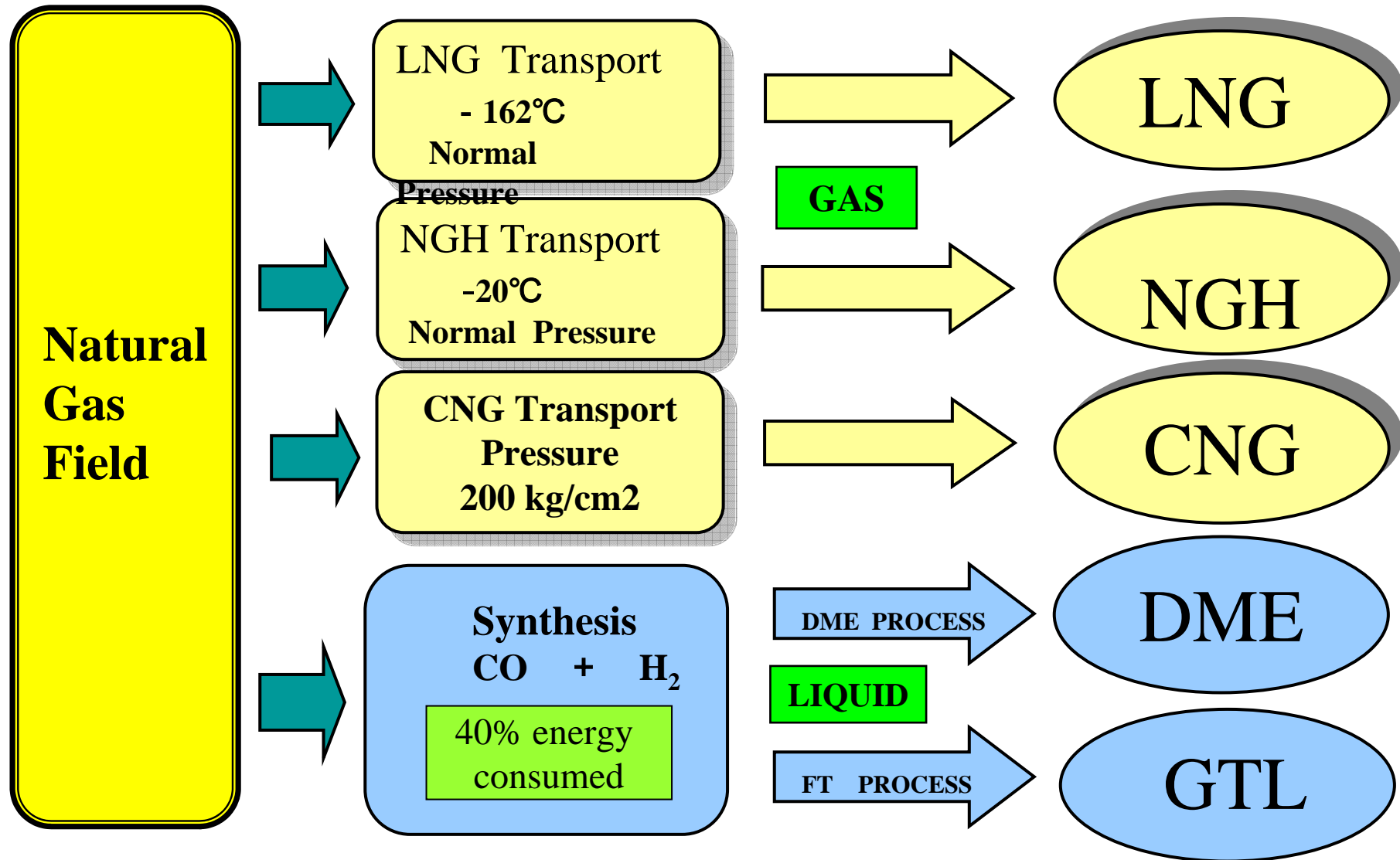


Joint Study Funded by Government

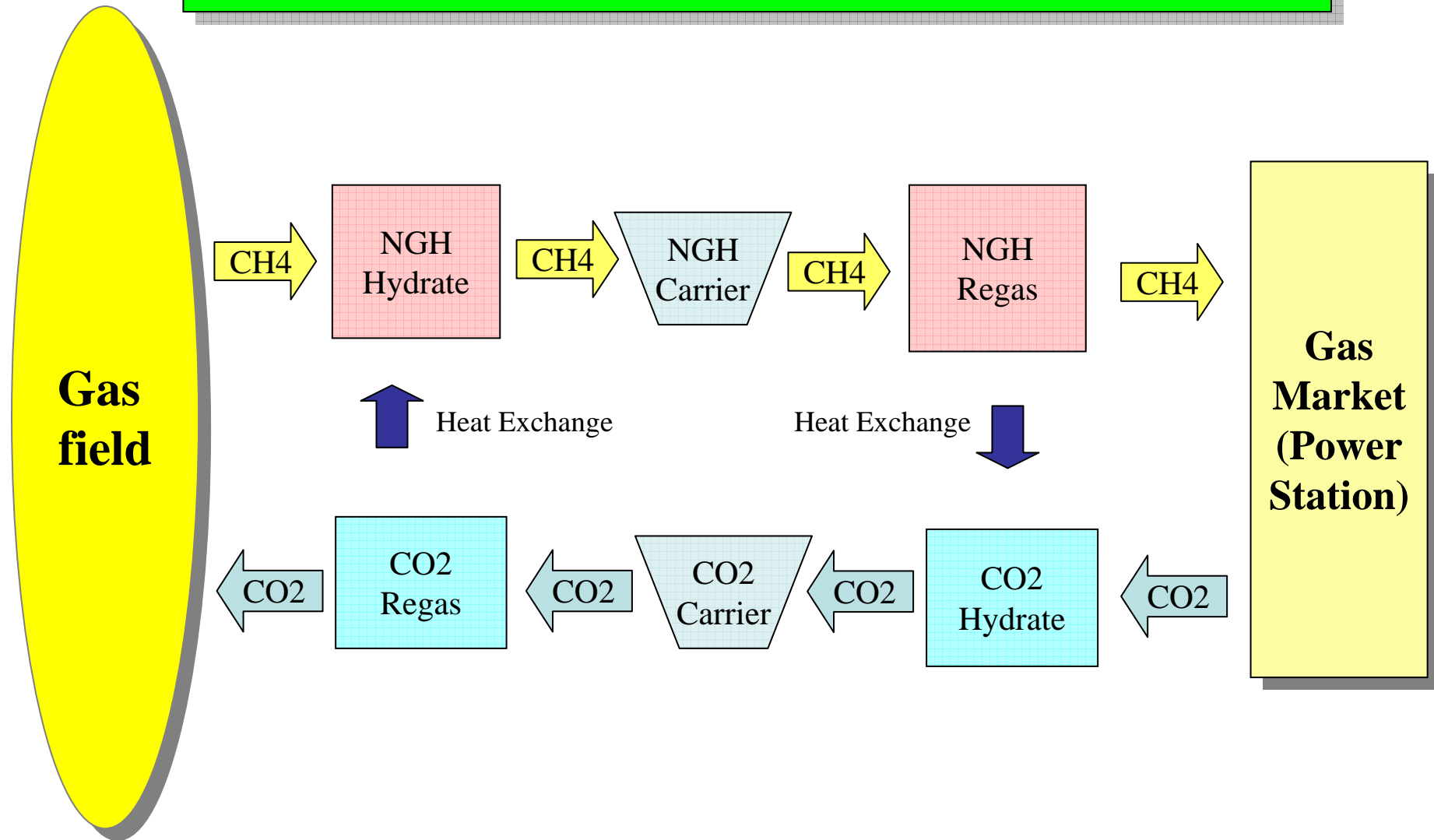


	S&O (Ship & Ocean Foundation)	JRTT (Japan Railway construction, Transport and Technology Agent) MITC	JOGMEC (Japan Oil, Gas and Metals national Corporation)	JETRO (Japan Export Trade Organization)	NEDO (New Energy Development Organization)
Ministry	S&O Foundation	MITC	MTI	MTI	MTI
Research	Off-loading System of NGH· FPSO	Development of NGH Carrier (Phase2)	Study of Mixed Gas Hydrate	F.S of NGH Sea Transportation from Qatar	Demonstration Domestic Transportation in Japan
Member	Mitsui NMRI NK	Mitsui NMRI, NYK, MOL, NK,MOECO	Mitsui Osaka University	Mitsui CUSE NRI, MBK JOGMEC	Mitsui Chugoku Power co.
Period	2003 ,2004, 2005	2005, 2006 2007, 2008	2004, 2005	2005	2006, 2007 2008
Job	Experiment Paper Work	Experiment Paper Work	Experiment Paper Work	Report	Plant Build NGH - Rory

Natural Gas Transport



Circulation of Energy in Form of Hydrate





END