

About Gas Valorisation Routes

J-M Seguireau, TOTAL (Exploration & Production)

GGFR

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Presentation's topics

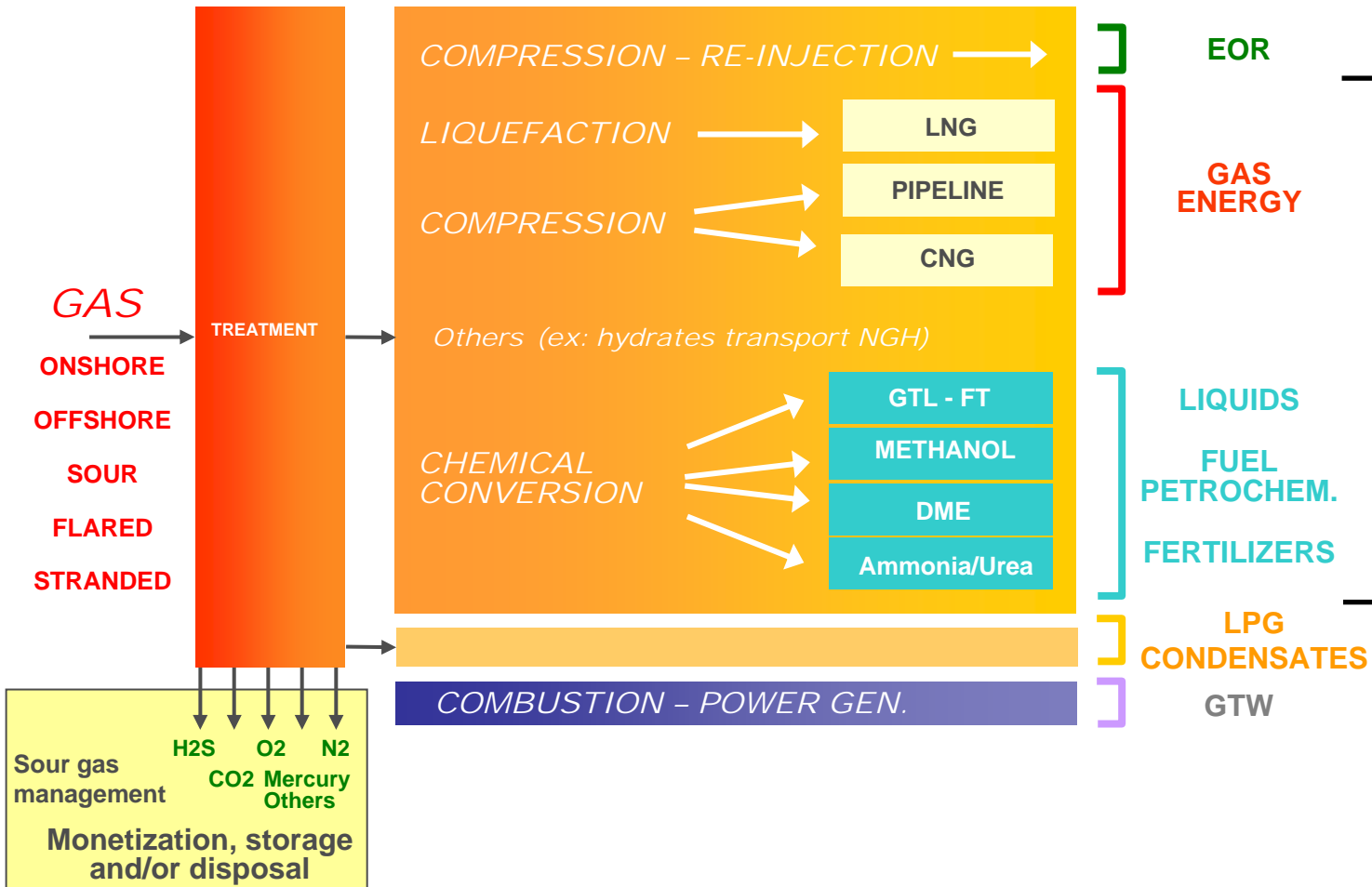
Share Total's view about gas utilisation

- ▶ Technologies description, including on site
- ▶ Reserves vs Products vs Markets
- ▶ Technologies comparison
- ▶ Conclusions

Gas utilization & monetization routes

Connecting (new) producing areas and consumer countries

TREATMENT *CONDITIONING & TRANSPORT* *MARKETS*



Gas re-injection context for Total

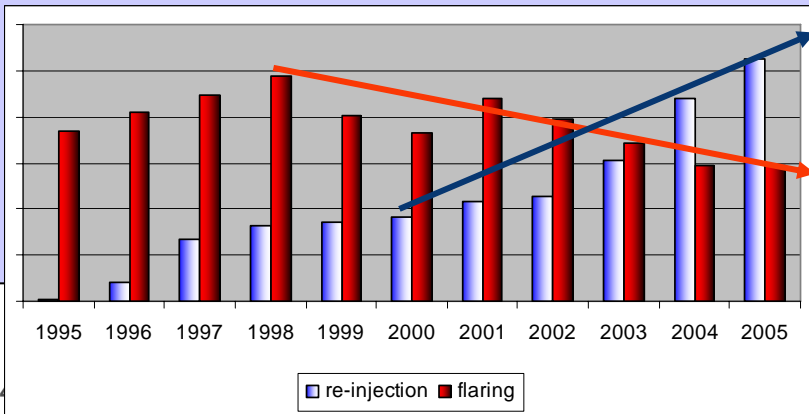
► Total commitment:

- No continuous flaring on new development (implemented since 2000)
- Flaring Reduction on existing fields

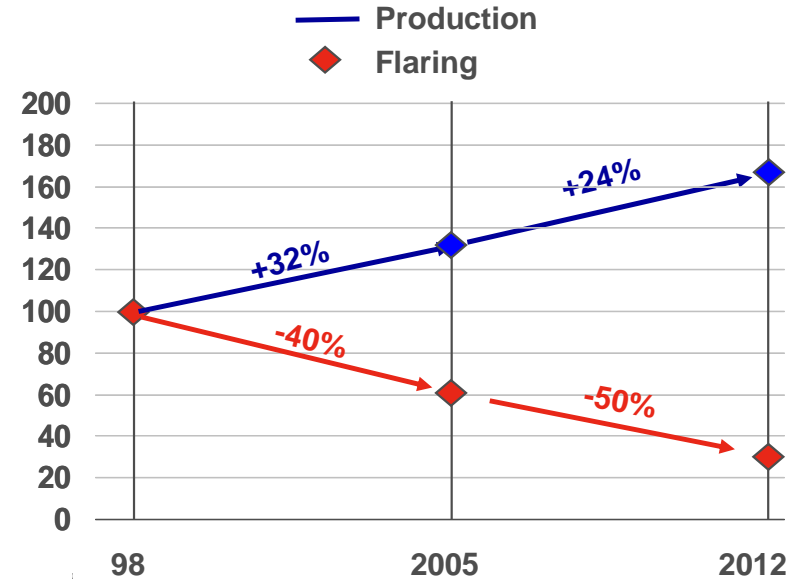
➔ Target: -50% 2005 - 20012

► Re-injection is part of long term asset management:

- Temporary storage before blow down
- Pressure maintenance
- EOR
- Ready for emerging gas value chains



Total's operated fields

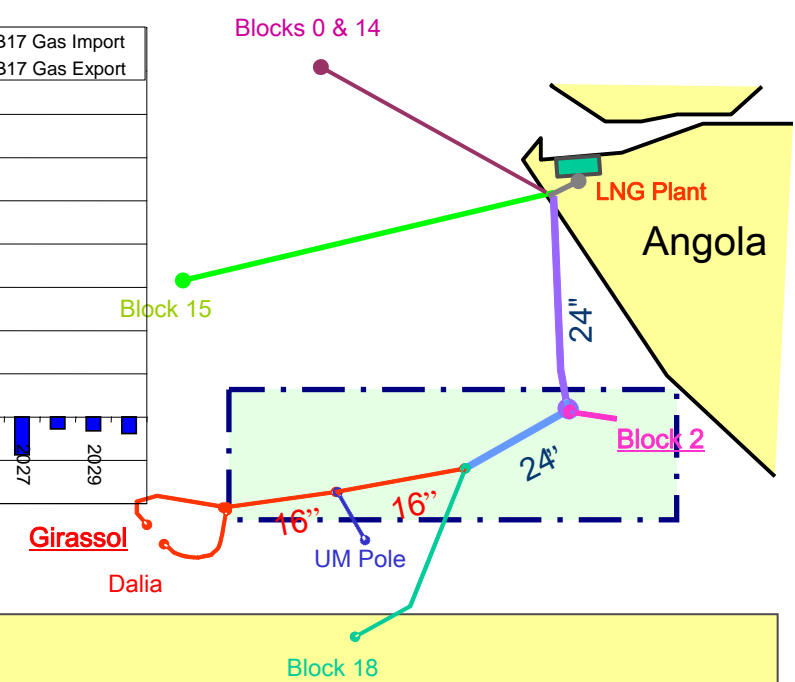
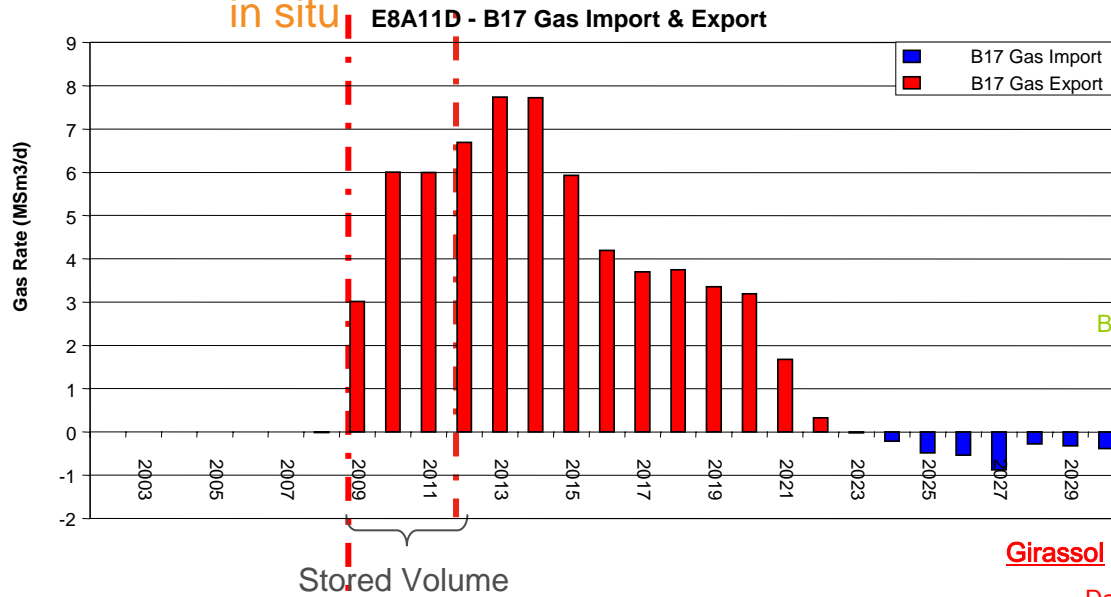


A steady decreasing flaring trend is observed since late '90s.

As from 2004, amount of re-injected gas is significantly higher than flared gas.

Block 17 – Gas External Storage: second step of global gas management

2009: Gas injection in situ
2012: ALNG Plant start-up



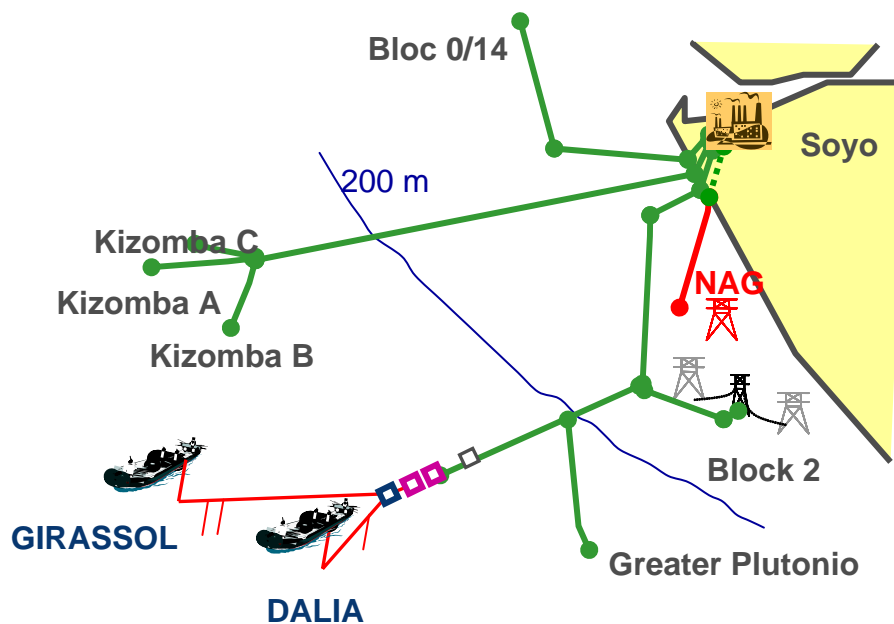
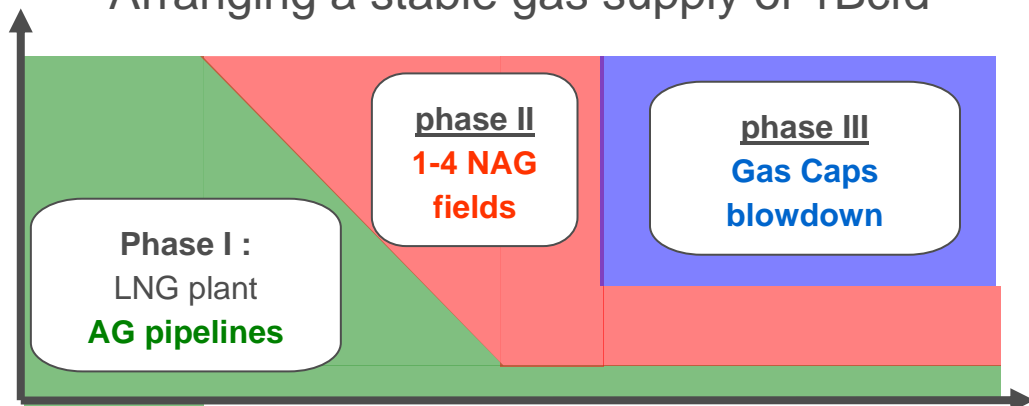
- ➔ Screening of potential storage candidates
Main criteria: seal, homogeneous depletion, well integrity, 0.4 tcf storable
- ➔ Block 2 fields Lombo-East & Tubarao identified as best candidates for external storage
- ➔ Multiple stakeholders (Block operators, Angola LNG)
Investments of main pipes brought forward, new platform on Block 2



Angola LNG mindset: third step of global gas management from a gas flaring concern to a gas valorization scheme

- ▶ **Common Goal** : ensure sustainable oil developments & address gas flaring concerns through a gas valorization scheme
- ▶ **Strong Commitment & Alignment of all Stakeholders** : partnership Sonangol - Oil companies
- ▶ **Pooling of gas resources**
- ▶ **Legal & Commercial Framework** suiting the project characteristics
- ▶ **Strong partners to overcome commercial and technical challenges**
- ▶ **Start-up : 2012**

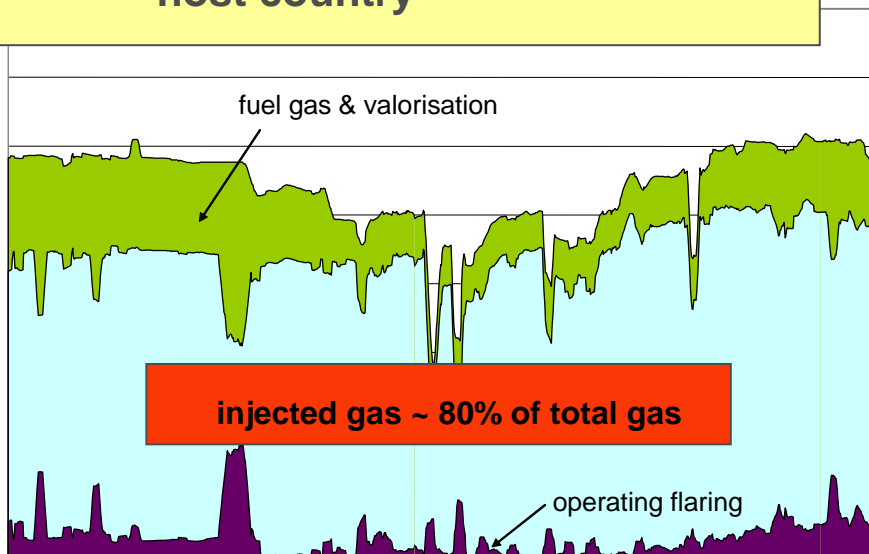
Arranging a stable gas supply of 1Bcfd



Gas injection for pressure maintenance

- ▶ **Liquid production increase:**
 - Oil recovery (pressure maintenance)
 - C3/C4 recovery in gas before re-injection
- ▶ **No continuous flaring**
- ▶ **The future: blowdown of the field**

⇒ **Gas valorization stake for the host country**



▶ **FID: December 1992**

▶ **First oil: June 1996**

Gas injection @ 420 bars since first oil

Cumulative gas injected:

- 30 Gm³ (10 years)
- 71 MTCO₂eq

Gas Transport routes:

BY LIQUEFACTION: LNG

Transport @ atmospheric pressure and $T = -160^{\circ}\text{C}$

Regasification

Mature technology → large single train capacity

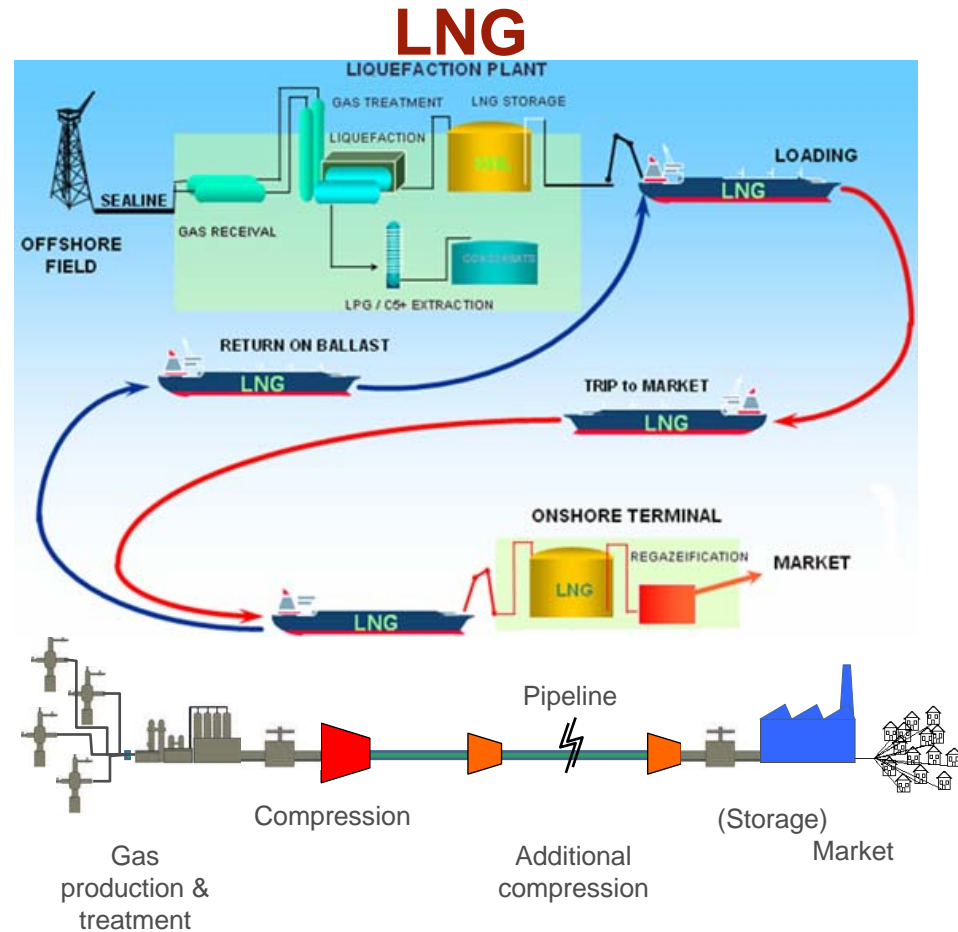
BY COMPRESSION: PIPELINE

Standard technology, but international gas pipelines require huge investments and political backing

BY COMPRESSION (& REFREGERATION): CNG

Transport in dense phase @ 120-250 bar and $T = -30^{\circ}\text{C} + 20^{\circ}\text{C}$

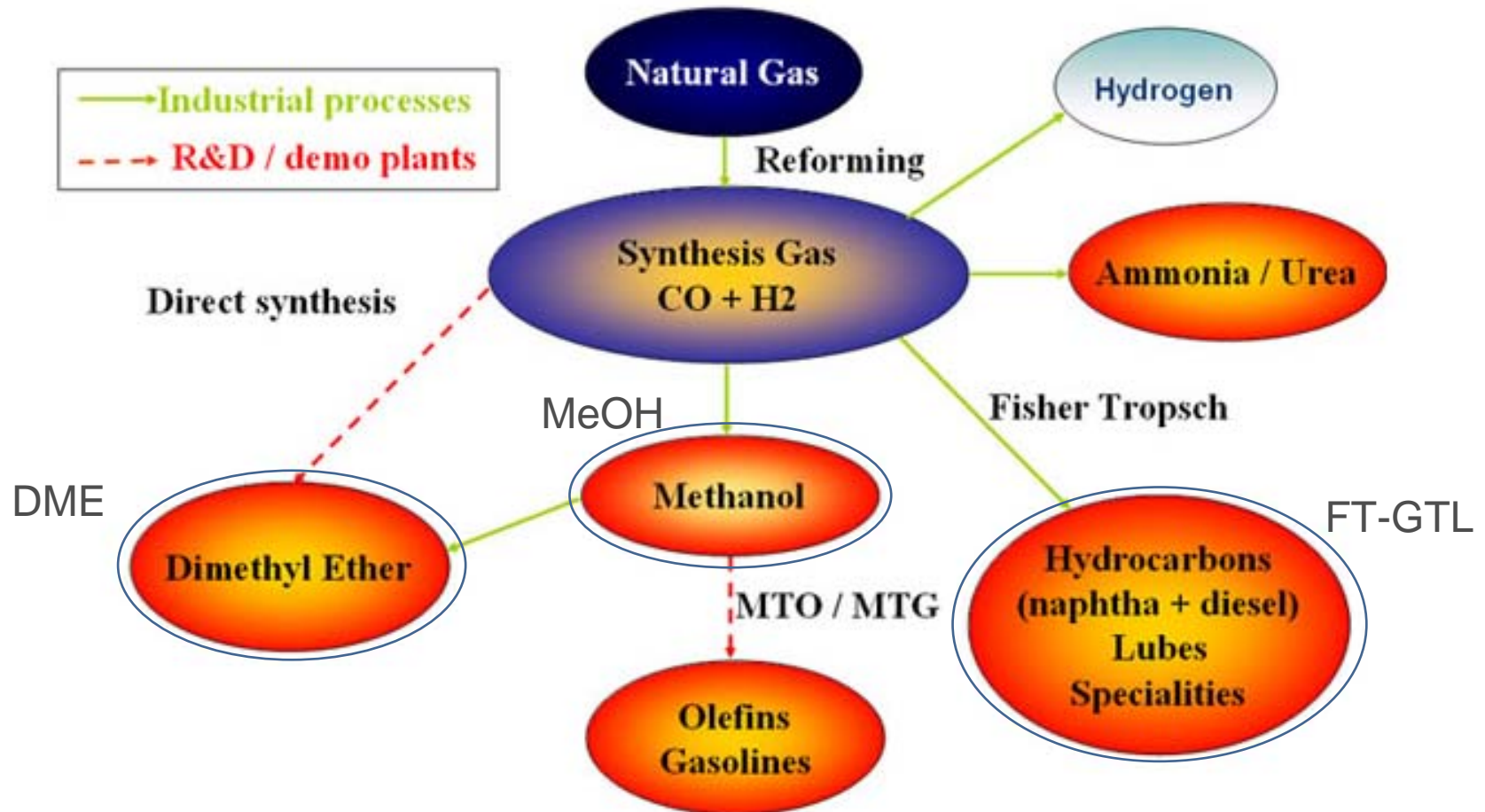
on-shore trucks, off-shore boats



CNG



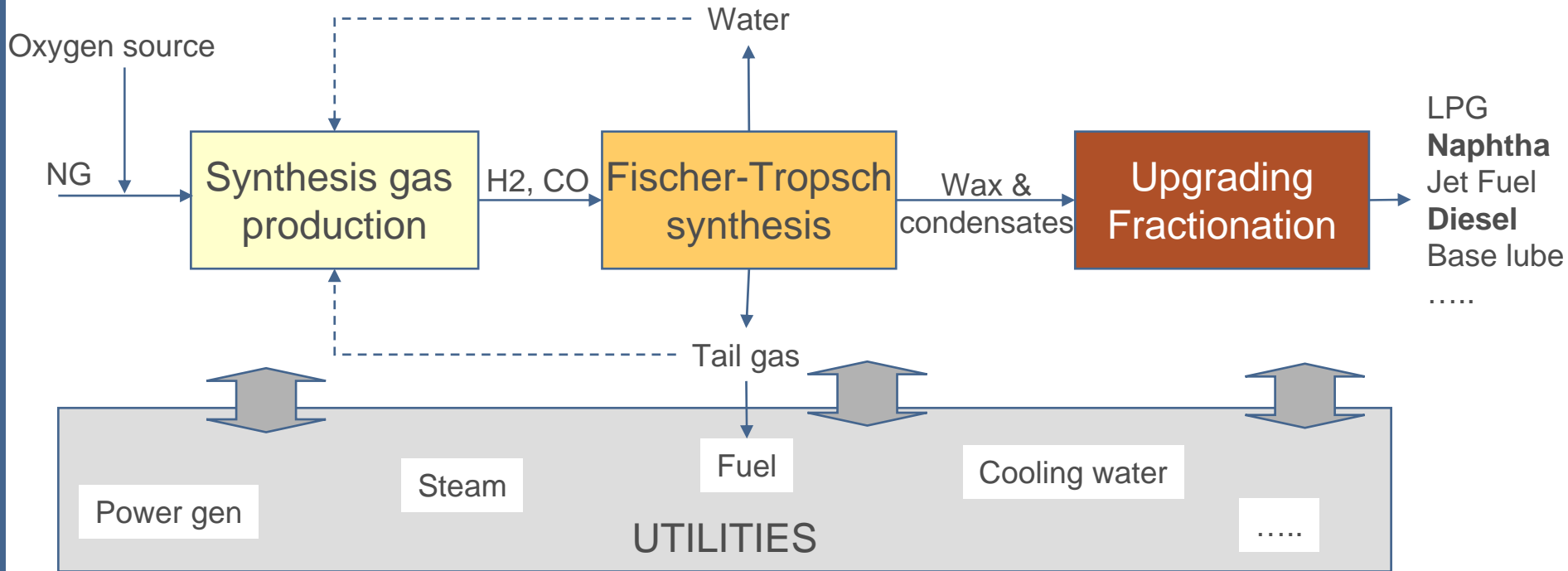
Chemical conversions routes:



Syngas generation: common step towards products diversification

Fischer-Tropsch Gas to Liquids process:

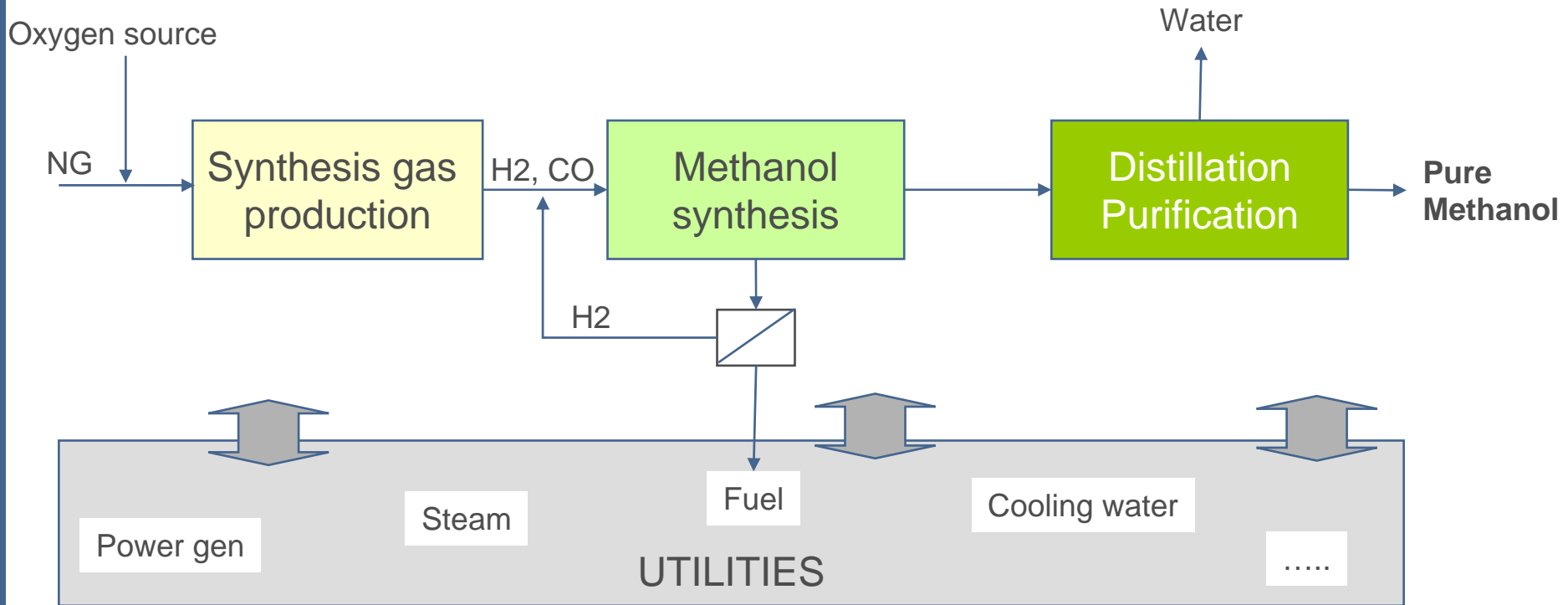
Production of liquid hydrocarbons from Natural Gas in 3 steps:



Markets:

- **Liquid fuels: Premium Diesel, Jet fuel (added value)**
- **Petrochemical feedstock: Naphtha**
- **Specialties**

Methanol process:



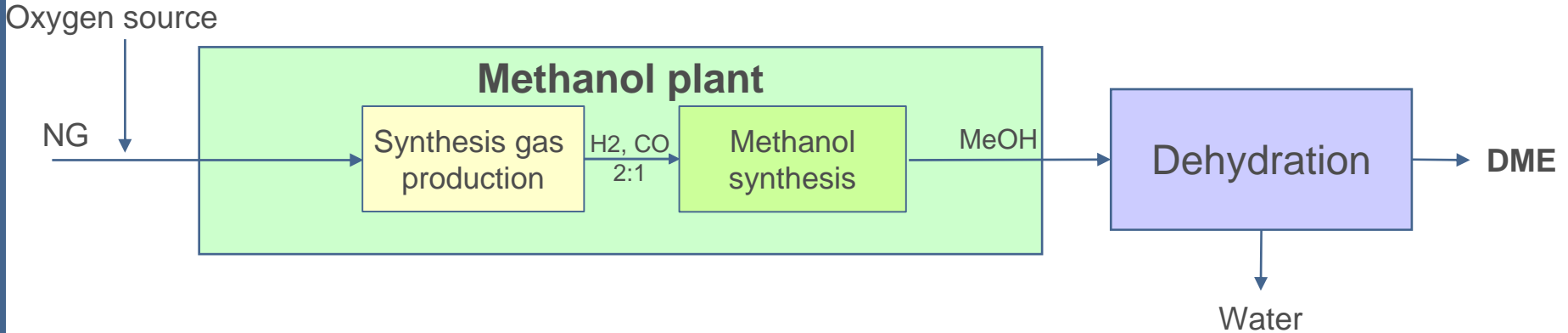
Main chemical markets:

- Formaldehyde,***
- Acetic Acid***
- MTBE (banned component, decreasing consumption)***

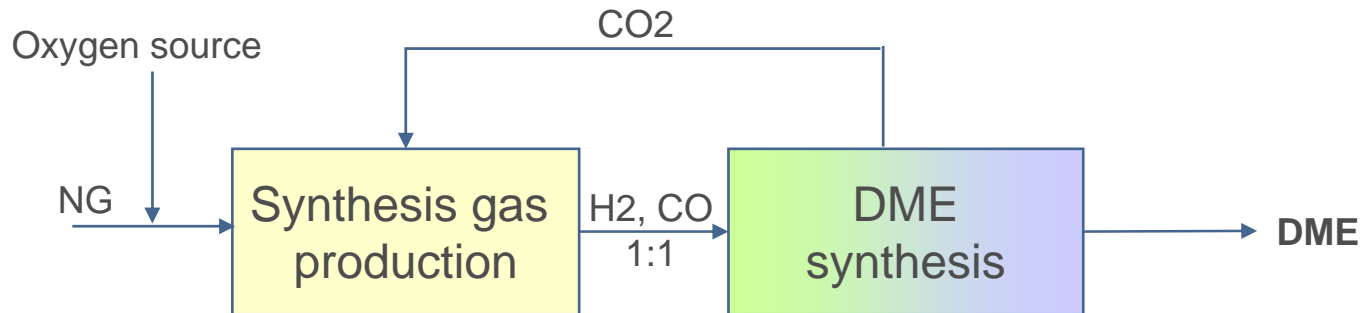
New applications: Biodiesel, Olefins

Di-Methyl Ether process: two routes

Indirect process: Industrial (small scale plants)



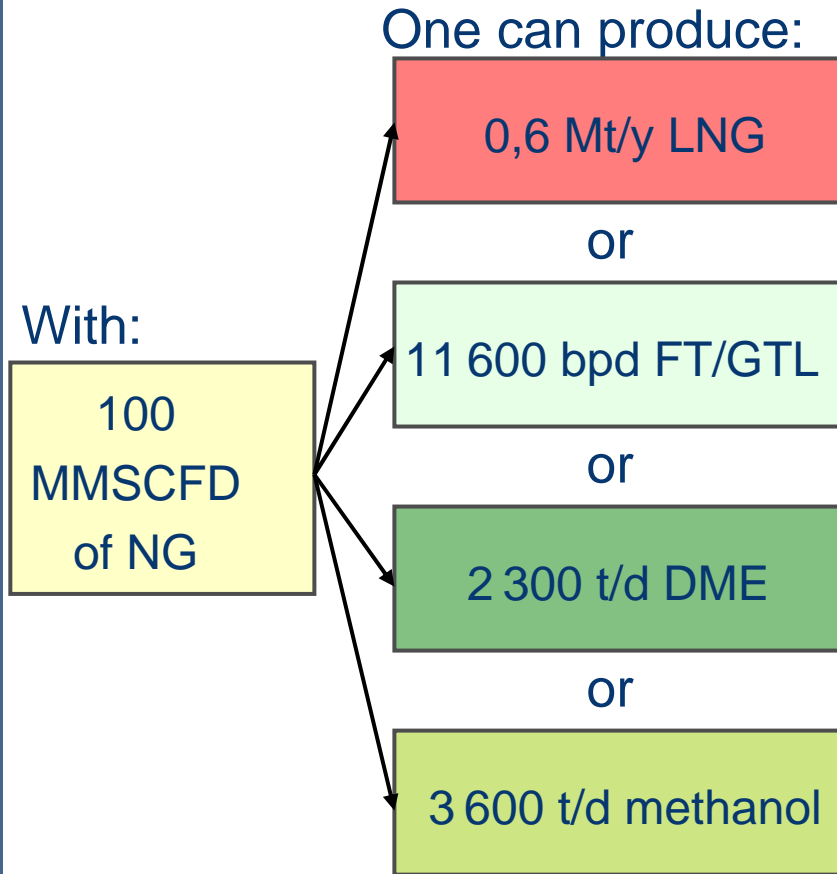
Direct process: Demo plant Kushiro (Japan) – 100 t/d



Current market: aerosol propellant

Great potential as: LPG alternative (DME/LPG blend), Transportation fuel (diesel LPG), chemical feedstock (to olefins), Power generation

Production & reserves: *order of magnitude*



Maximum capacity:

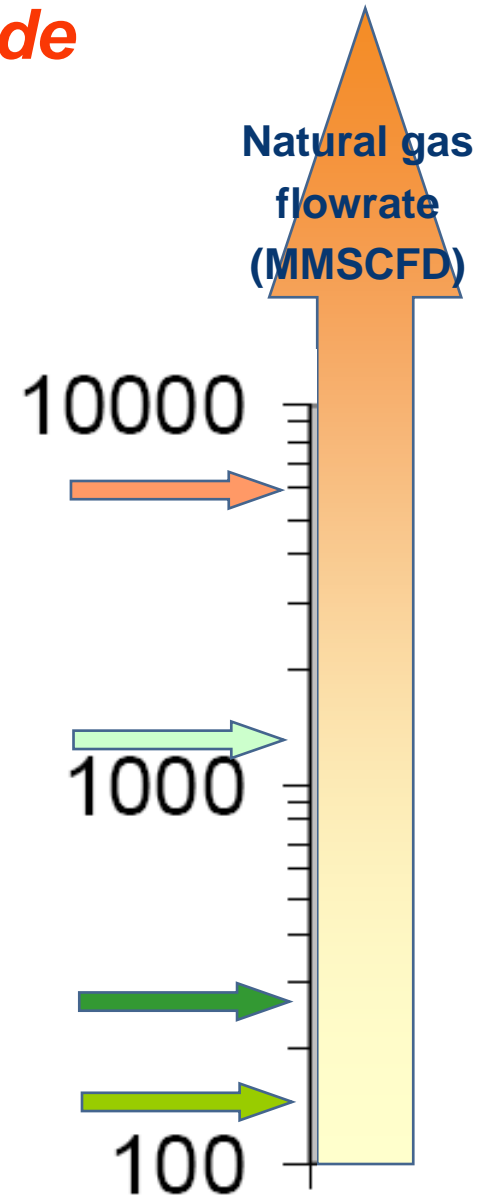
(in operation or under construction)

RasGas (Qatar):
36 Mt/y

Shell « Pearl »
(Qatar): 140 000 b/d

*DME**:
6000 t/d

Methanex/BP
(Trinidad): 5000 t/d



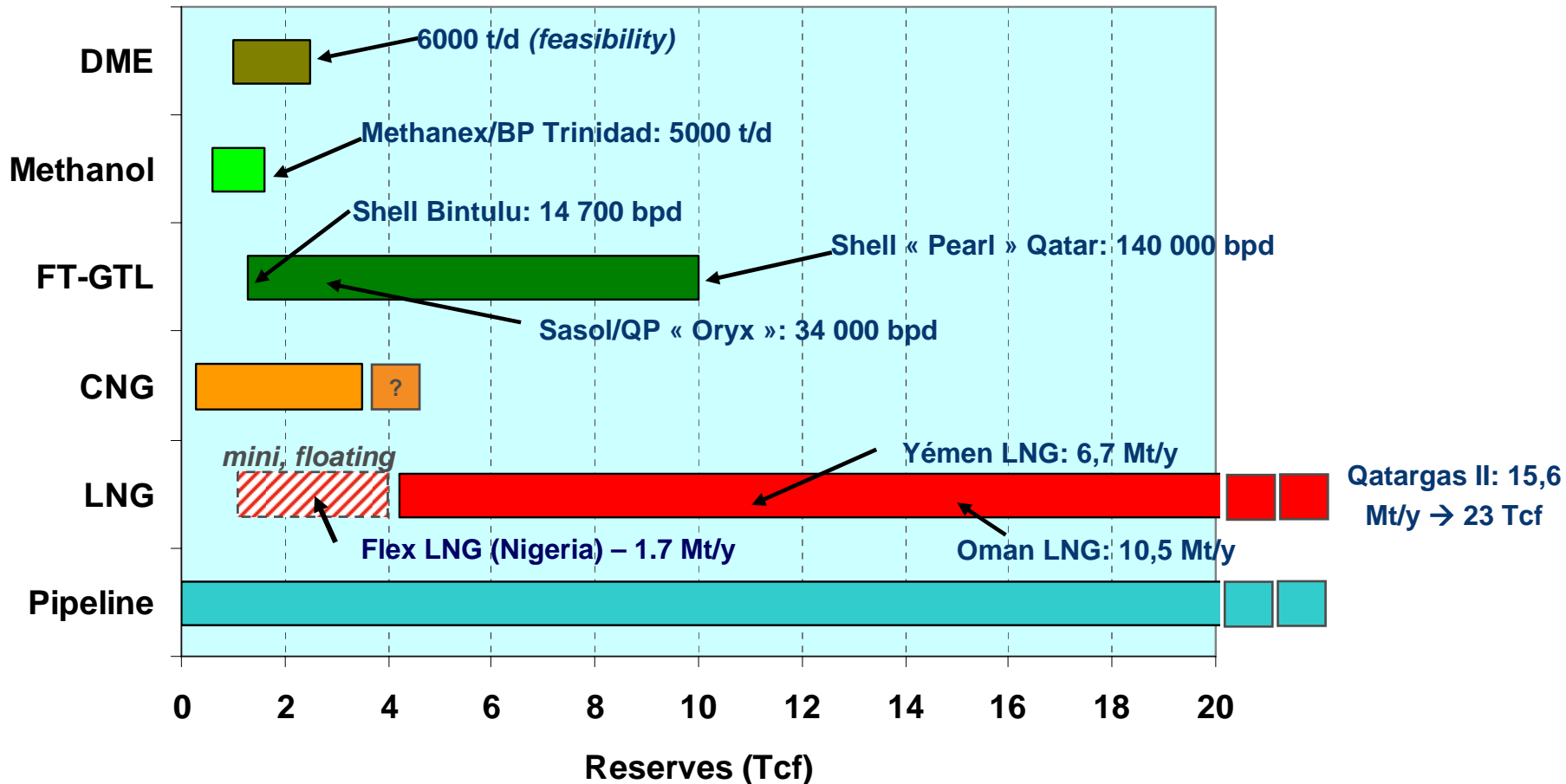
MMSCFD = Millions of Standard Cubic Feet per day

* Feasibility study only



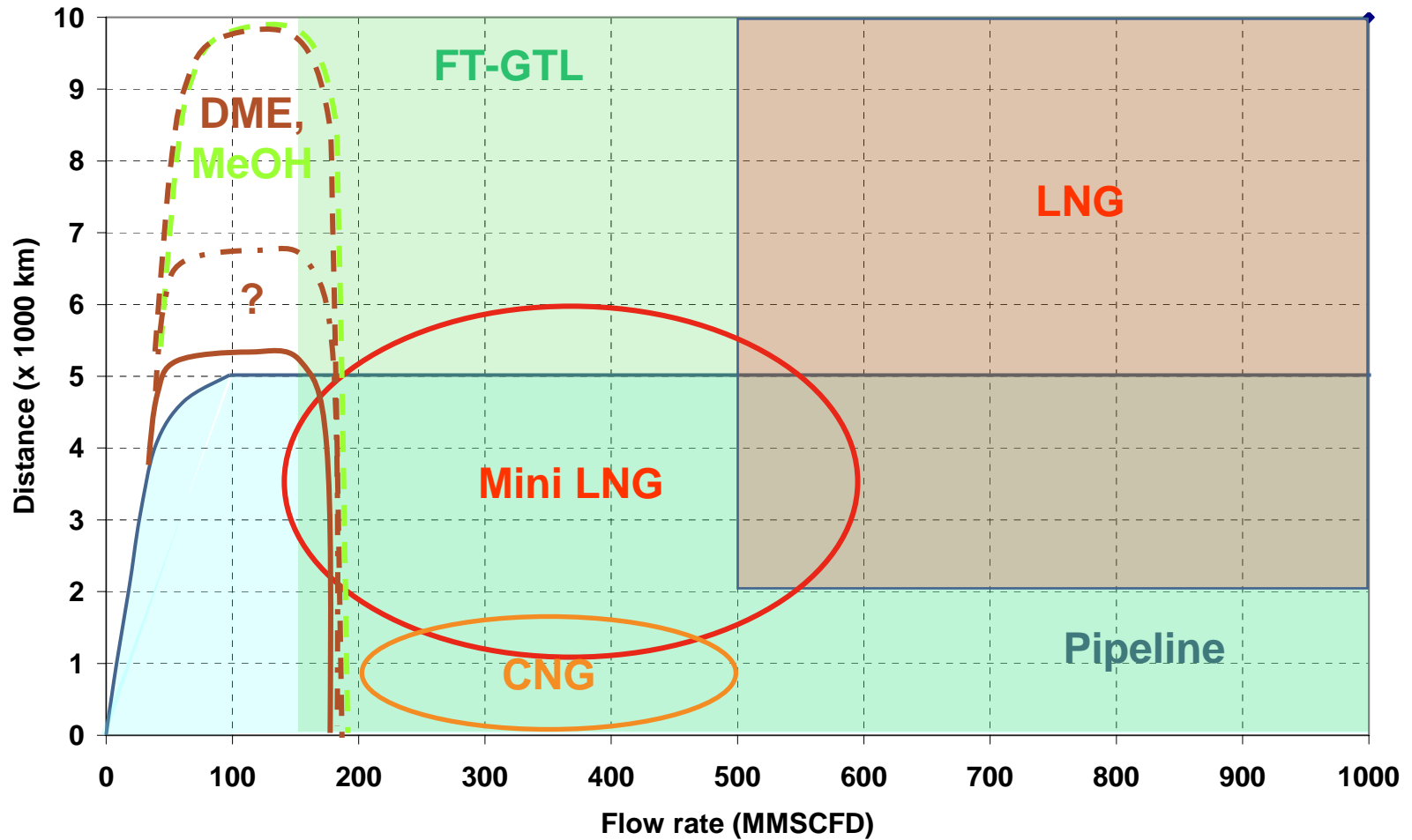
Reserves* vs Products

Natural Gas reserves

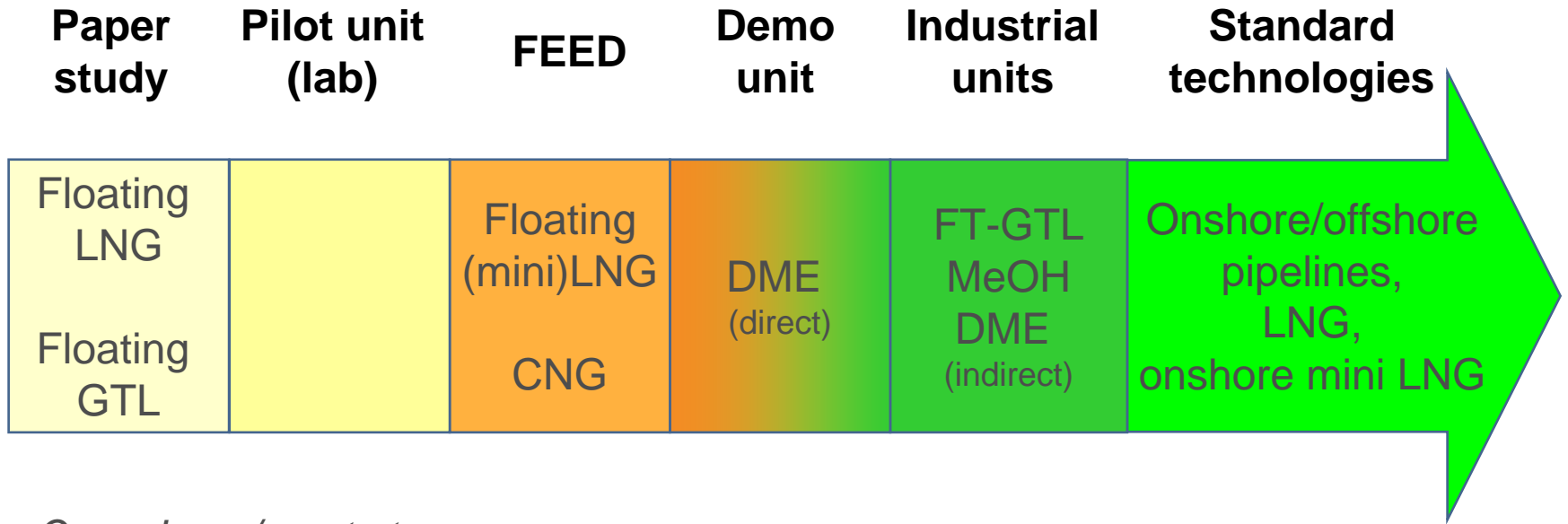


* 25 years production

Distance to markets



Maturity



On-goings / next steps:

- LNG: Mini, Floating
- CNG: ready for off-shore applications
- FT-GTL: breakthrough technologies, compact units
- DME: Nigata (Japan) first industrial plant (MeOH feedstock, 80,000 to 100,000 tpa) to fuel market in Japan

Technologies comparison

	LNG	CNG	FT-GTL	Methanol	DME
Maturity	Standard technology		Few industrial units	Several industrial units	
Efficiency	~ 80-85% (ex:10,000 km + regas)	~ 90% (ex:1700km) f(distance)	~ 55-60%*	~ 65%*	~ 62%*
CO₂ emissions (kt/Mboe inlet)	~ 50 (ex:10,000 km + regas)	~ 30 (ex:1700km) f(distance)	100*	70*	77*
Markets	150 Mt/y (Regasification)	Regional	1100 Mt/y (Diesel)	40 Mt/y	Great potential
CAPEX	First train, added trains	Leasing/service contract	Multiple trains		
OPEX (incl. CO₂)		OPEX = Transport			
Transport	f(distance)	f(distance, capacity, gas composition)			
Prices (relative)	Gas market	Gas market	Premium diesel	?	[LPG, +20% LPG]





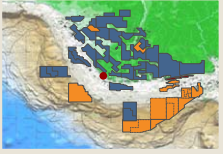

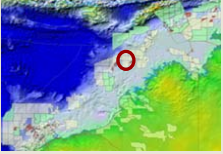
* Transport excluded

**Natural gas
Net-back value**

Conclusions:

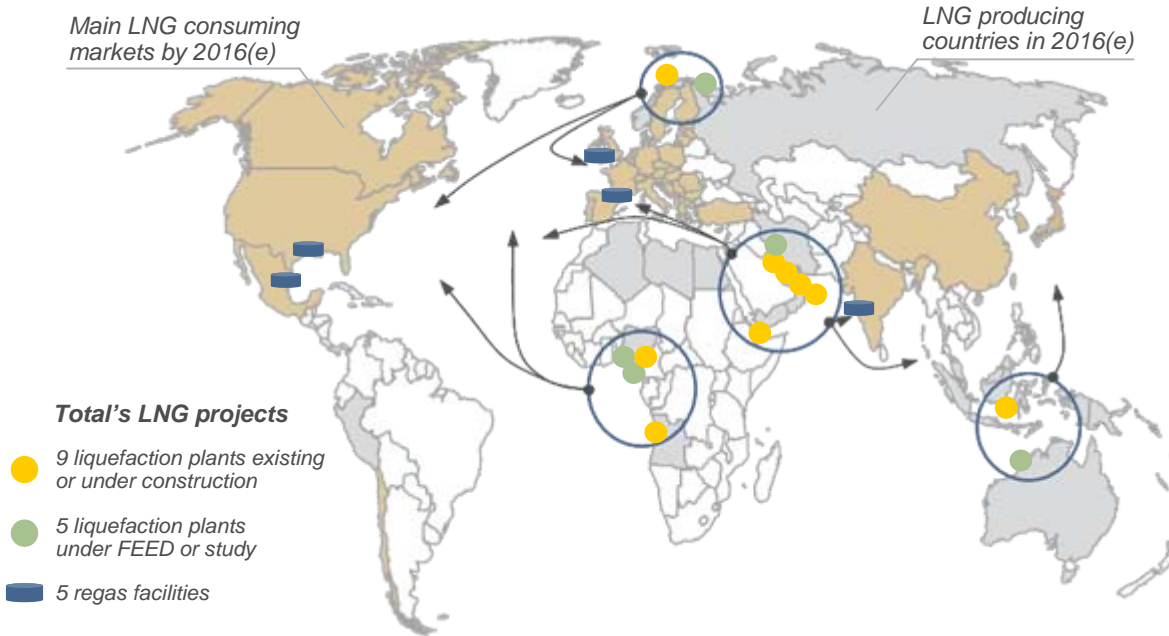
- ▶ On site use is always considered (energy needs, reservoir pressure maintenance, EOR, storage).
- ▶ When there is no local market or existing pipeline system, **LNG remains the preferred monetization option** ⇒ effort to improve its efficiency and profitability at smaller capacities (mini-LNG, Floating-LNG)
- ▶ CNG represents a viable niche for small capacities and short transport distances (provided regional markets)
- ▶ Gas conversion technologies produce added value products, especially in a high oil price scenario, but different challenges still to be tackled:
 - FT-GTL: high investment costs, efficiencies & CO₂ management
 - Methanol: relative price fluctuations, single large plant impact on world scale production
 - DME: new market ⇒ commitment in future development
- ▶ Methanol and DME ⇒ feedstocks for (poly)olefins production
 - MTO demonstration plant in Feluy

TOTAL, a major LNG player

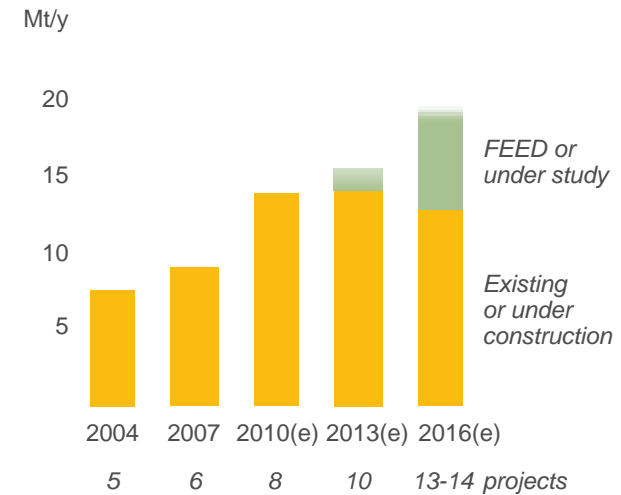
Yemen LNG (39.6%)	Qatargas II TrB (16.7%)	Angola LNG (13.6%)	NLNG T7 (15%)	Brass LNG (17%)	Shtokman (25%)	Ichthys LNG (24%)
						
<ul style="list-style-type: none"> > Capacity : 6.7 Mt/y > Start-up early 2009(e) > US, Asia* 	<ul style="list-style-type: none"> > Capacity : 7.8 Mt/y > Start-up 2009(e) > Europe, US* 	<ul style="list-style-type: none"> > Capacity : 5.2 Mt/y > Start-up 2012(e) > US* 	<ul style="list-style-type: none"> > Capacity : 8.5 Mt/y > FID 2009(e) > US* 	<ul style="list-style-type: none"> > Capacity : 10 Mt/y > FID 2009(e) > Europe, US* 	<ul style="list-style-type: none"> > Capacity : 7.5 Mt/y > FID 2009(e) > Europe, US 	<ul style="list-style-type: none"> > Capacity : 8.4 Mt/y > FID 2010(e) > Asia

Main LNG consuming markets by 2016(e)

LNG producing countries in 2016(e)



Total's LNG sales**



Close to 20% of Total's production by the middle of the next decade

* base case destinations

** Group share of LNG sales by affiliates and participations, including FAS69 production equivalent on Bontang sales and excluding trading