

CO₂ Separation and Capture Technologies

**Indonesia-Japan CCS Workshop in Jakarta
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JGC



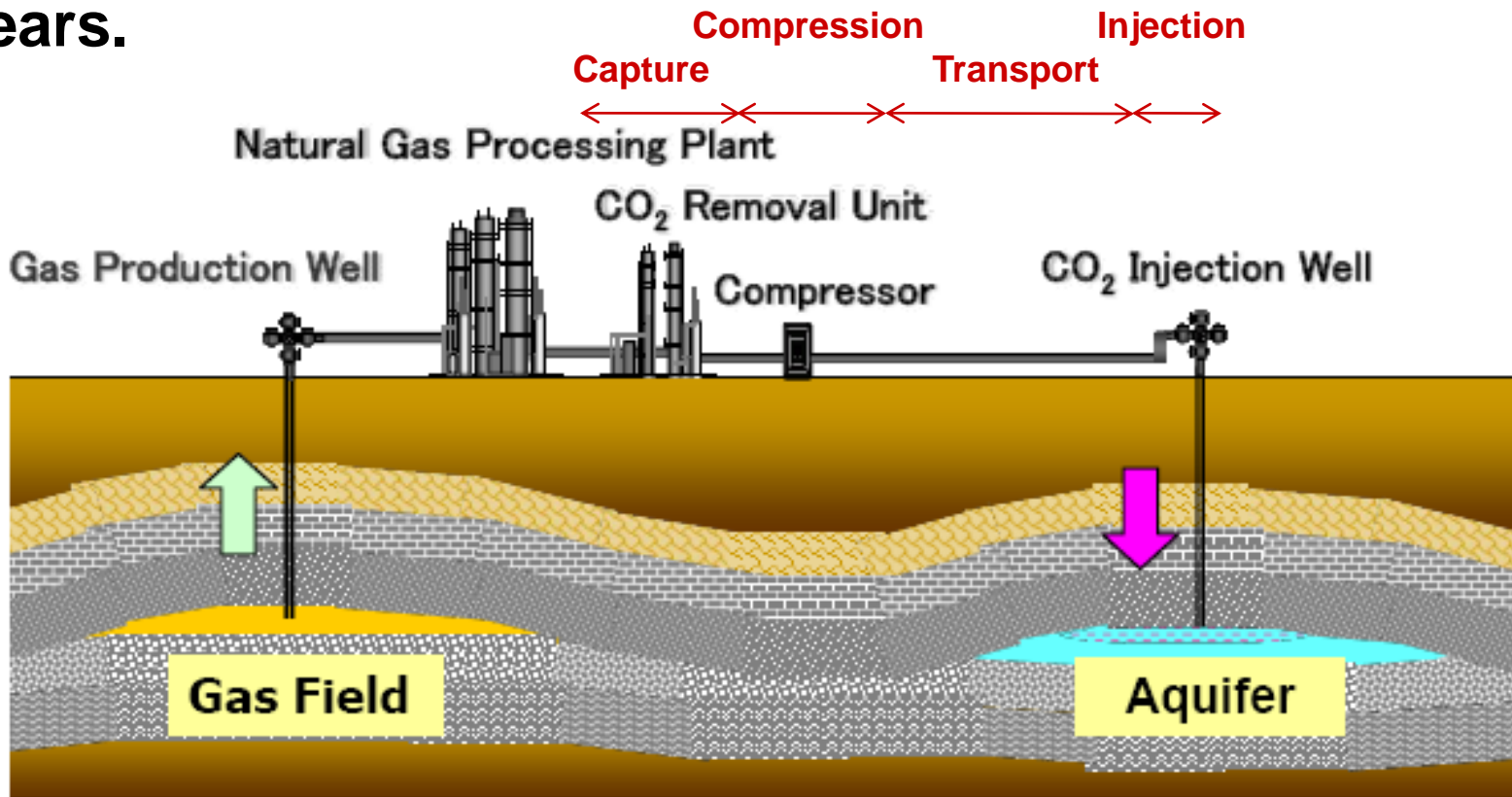
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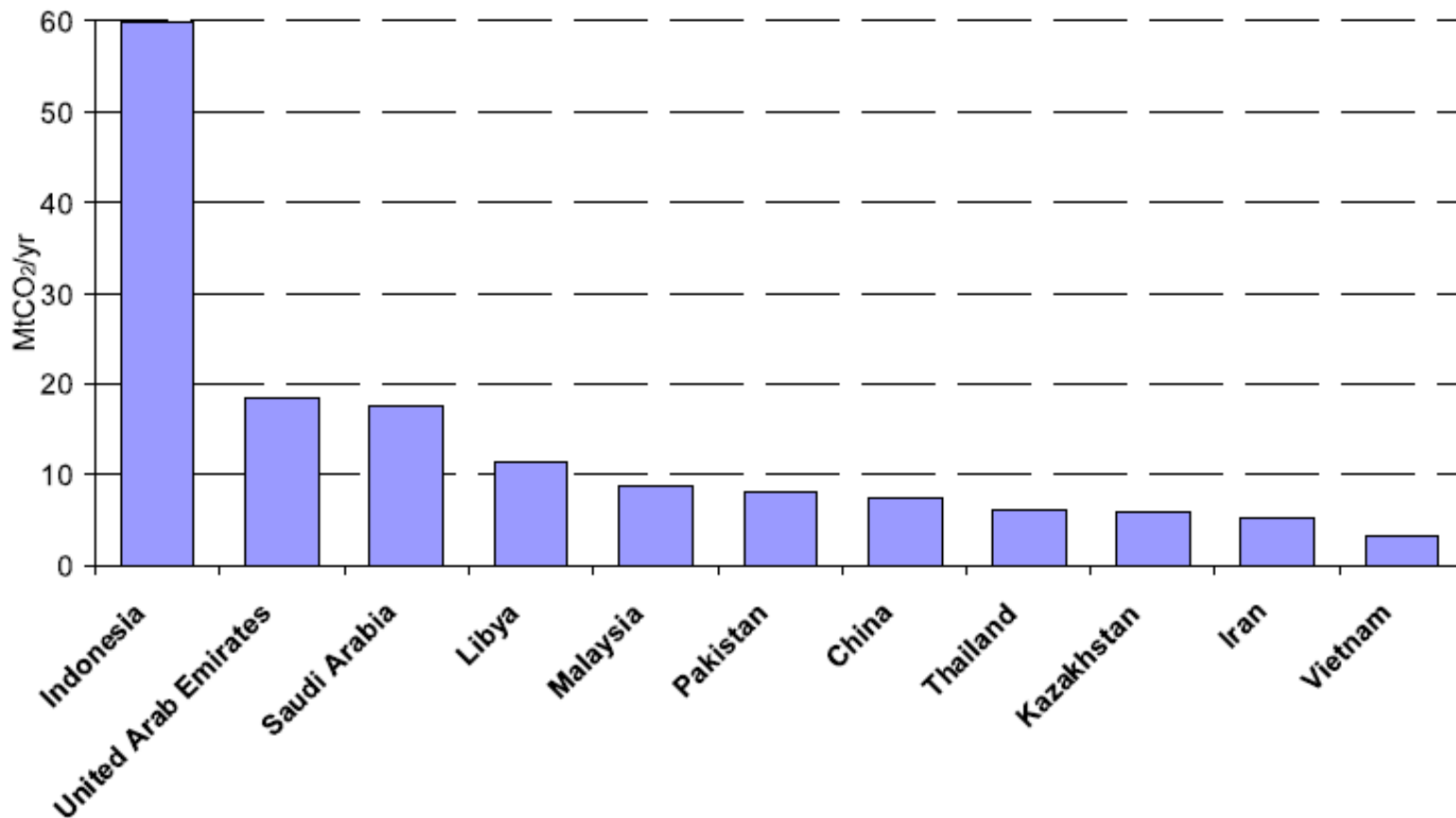
CCS in Natural Gas Exploration

- Raw natural gas usually contains considerable amounts of CO₂ which are captured at the processing plant.
- CCS in natural gas exploration has gained in importance: CCS commercial operations are implemented in recent years.





CCS Potential in Natural Gas Processing



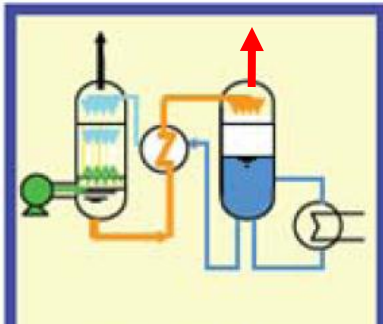
Mitigation potential for CCS in natural gas processing in non-Annex I countries in 2020

Stefan Bakker, et al. "Progress on including CCS projects in the CDM: Insights on increased awareness, market potential and baseline methodologies," GHGT-9



CO₂ Capture Technologies

Category

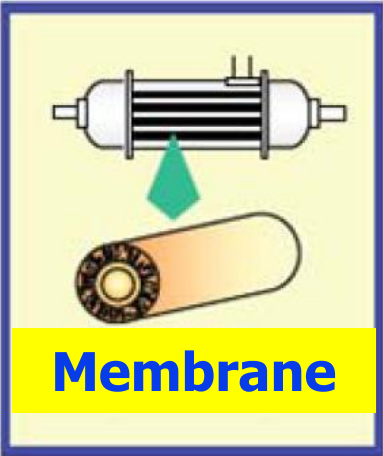


Absorption

Chemical Absorption

-> *Deep CO₂ removal*

Physical Absorption



Membrane

Membrane

-> *Bulk CO₂ removal*

Energy
consumption

Product loss
in CO₂ stream

HIGH

LOW

LOW

HIGH

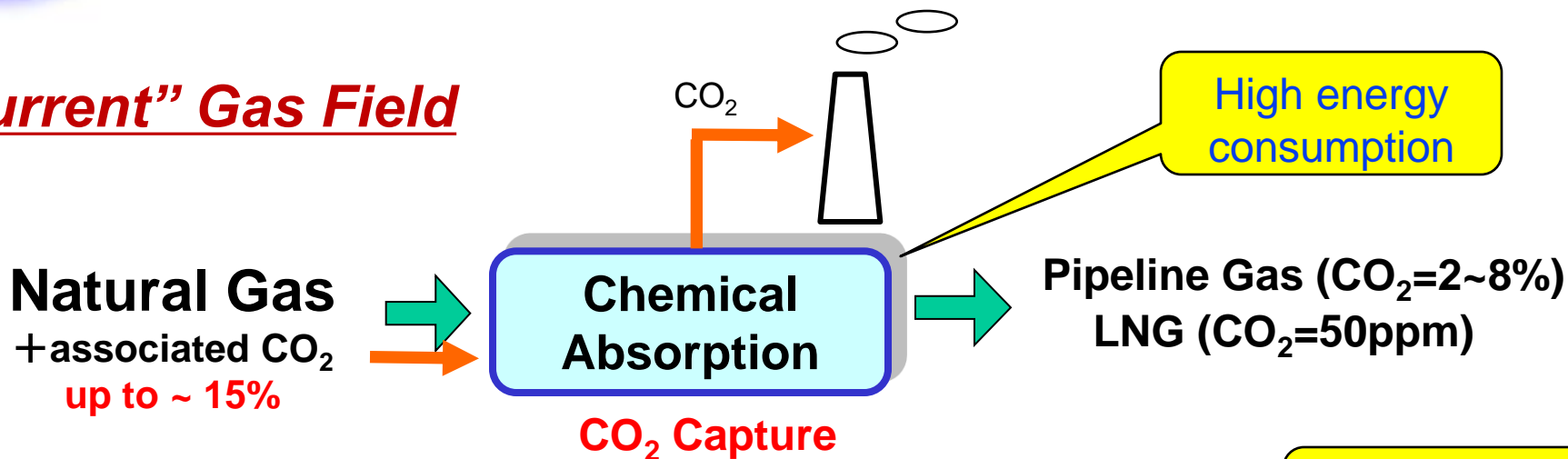
Adsorption, Cryogenic -> not suitable for natural gas



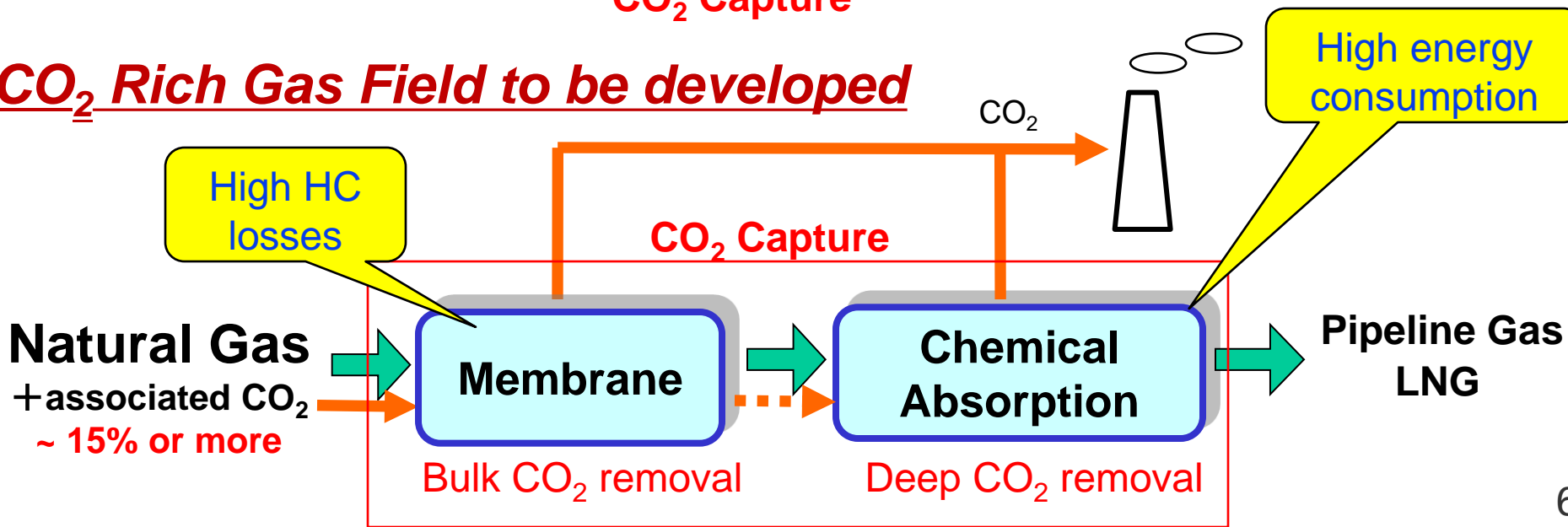
CO₂ Capture Technologies

Selection of technology so far...

"Current" Gas Field



CO₂ Rich Gas Field to be developed

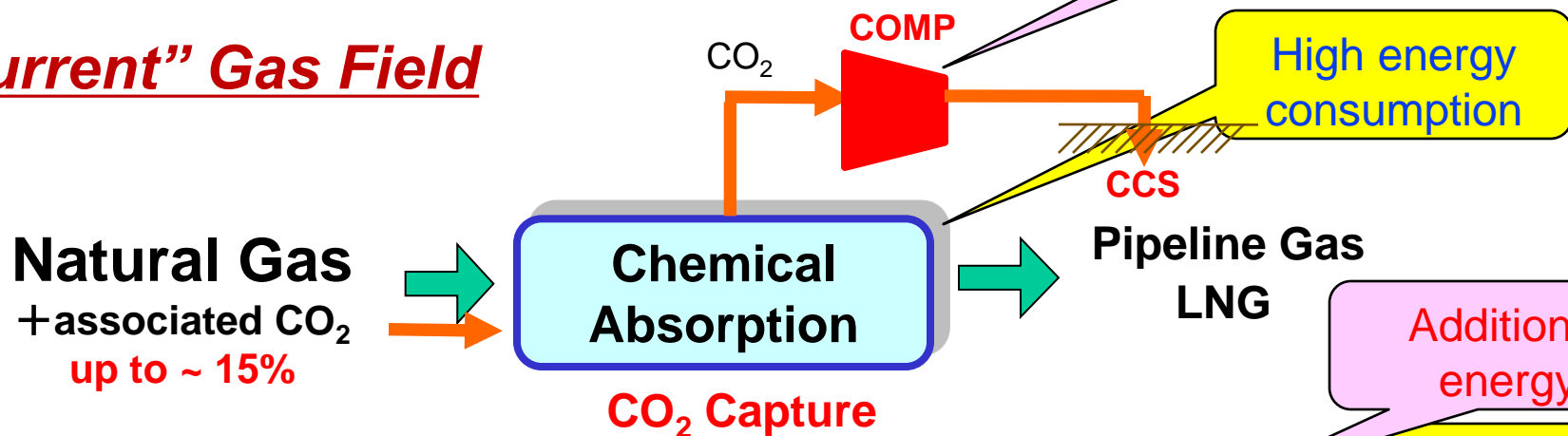




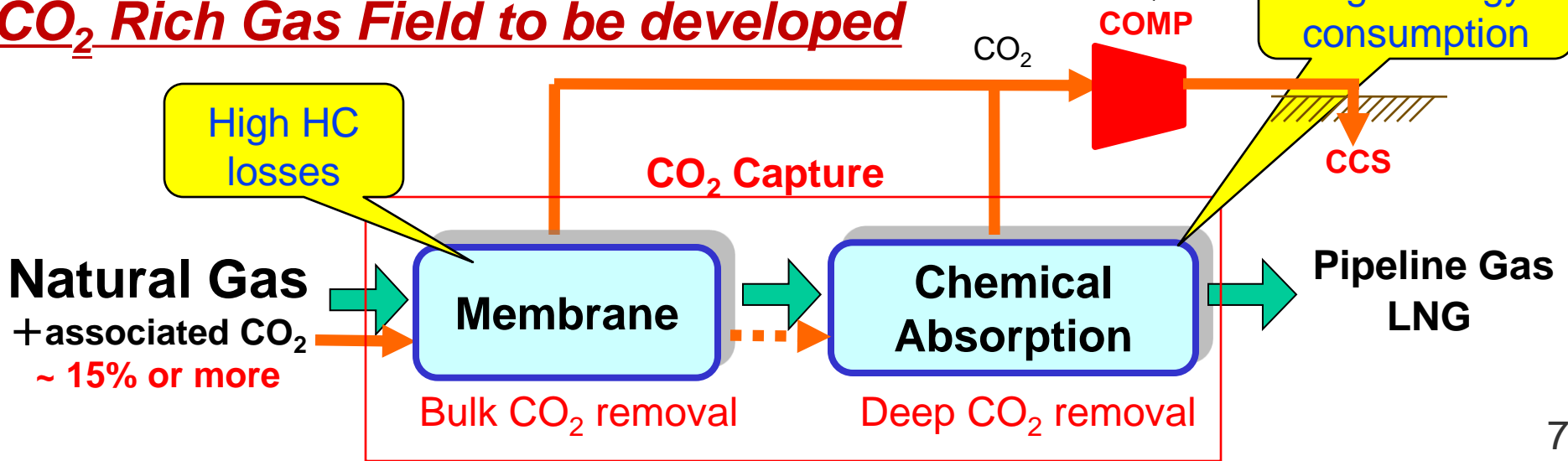
CO₂ Capture Technologies

When it comes with CCS...

"Current" Gas Field



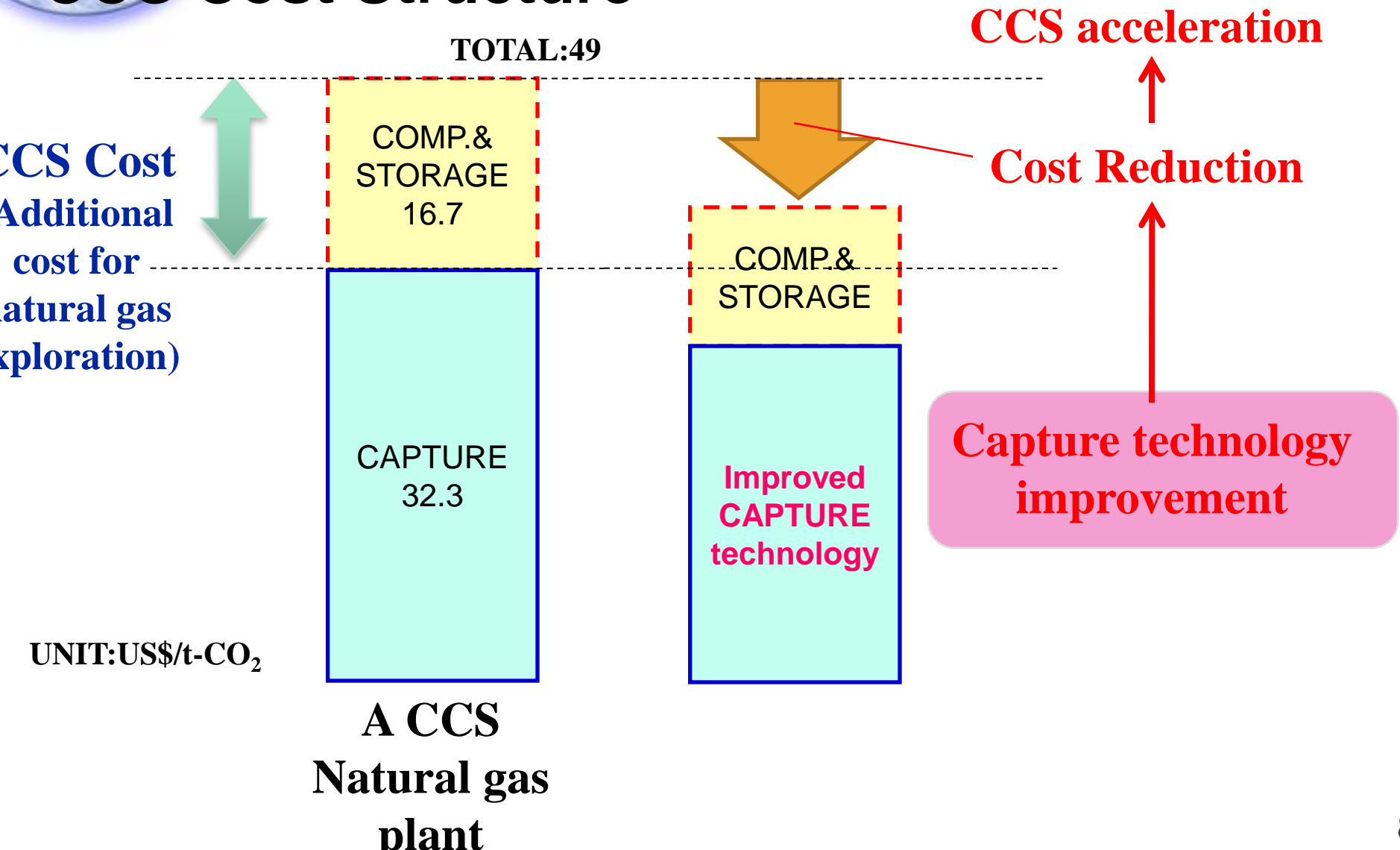
CO₂ Rich Gas Field to be developed





CO₂ Capture Technologies

CCS Cost Structure





Improved Technology - HiPACT -

Chemical Absorption CO₂ Capture

Natural Gas + associated CO₂



Pipeline Gas LNG

JGC **BASF**
The Chemical Company
Joint Development Program

CO₂ stripping pressure

Existing technology **1.2** Bar(a) → **HiPACT** **3 - 8** Bar(a)

CO₂



Compression ratio
200/1.2 = **166** → 200/3 = **66**
200/8 = **25**

CO₂ injection pressure

200 Bar(a)



Key features of HiPACT solvent

<p>High stability against thermal degradation</p> <p>↓</p> <p>- High CO₂ stripping pressure</p> <p>↓</p> <p>- Reduce comp. ratio</p> <p>↓</p> <p>- Reduce comp. energy</p> <p>↓</p> <p>- Reduce comp. size</p>	<p>High performance of CO₂ absorption</p> <p>↓</p> <p>- Low solvent rate</p> <p>↓</p> <p>- Reduce capture energy</p> <p>- Reduce capture size</p>
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Reduce CAPEX and OPEX for CCS



HiPACT Development Program

Pilot Test

- ✓ More than 14,000 hours operation with simulated gas
- ✓ METI Program
- Thermal stability was demonstrated
- Solvent characteristics data was obtained for process modeling

HiPACT pilot plant
(JGC's laboratory in Japan)





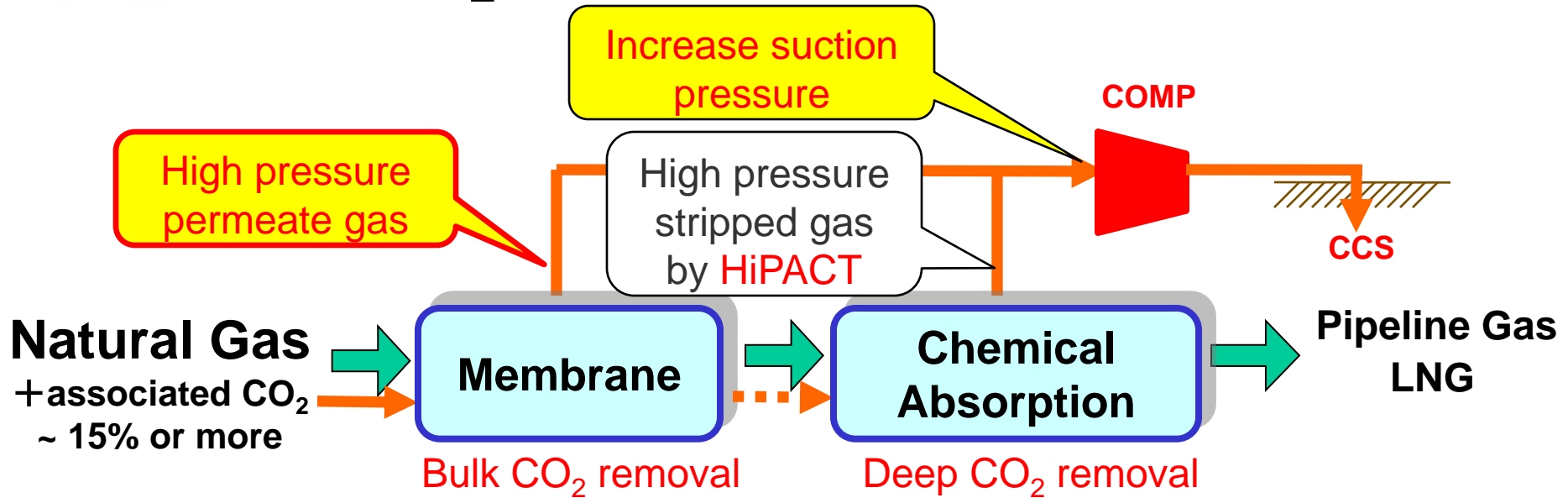
■ Demonstration Test

- ✓ Tests were implemented through the commercial operation in INPEX's Koshijihara natural gas plant in August, 2010, by replacing with HiPACT solvent.
- **Excellent energy saving performance was demonstrated**
- **Applicability of actual natural gas service was confirmed**

Now on marketing stage



Return to CO₂ Rich Gas Treatment...



Setting permeate gas from membrane at high pressure

causes...

- ◆ Larger membrane area
- ◆ Therefore more hydrocarbon product losses

Long for highly selective membrane



Summary

CO₂ Capture Technologies

Overview

- Chemical absorption – widely used but energy intensive
- Membrane – low energy but high product loss
- CCS implementation requires additional energy

New Technologies

- HiPACT, a new chemical absorption technology, improves natural gas production economics with CCS
- Breakthrough for CO₂ rich gas development – highly selective membrane