

# ***Enabling Production of Remote Gas***

***a cross disciplinary competence building project***

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# Outline of presentation

- Remote gas perspectives
- Challenges
- The project
- Results
- Summary

# Natural gas perspectives

- IEA, Natural Gas Market Review 2007 – *Security in a globalising market to 2015:*

“Natural gas is becoming an increasingly global commodity; developments in previously separate regional gas markets can no longer be considered in isolation”

- IEA, Natural Gas Market Review 2009 – *Developments in the LNG markets:*

“The 2009-13 period will see liquefaction capacity increase from 280 bcm as of end 2008 to 373 bcm by end 2010 and 410 bcm by end 2013, almost a 50% increase within five years”

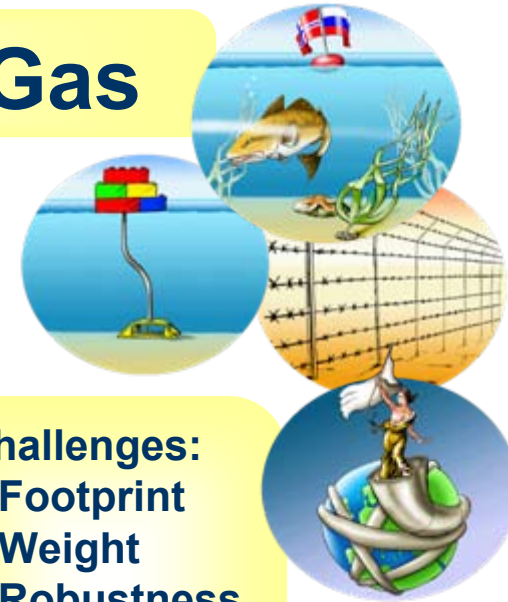
# Many concepts for offshore LNG, GTL and Methanol have been developed, but not implemented

- The reason for not being realized might be insufficient economical margin to bear the risk related to the following issues:
  - Technical
  - Operational
  - Safety
  - Regulations
  - The number of stake-holders involved along the gas chain
- These issues lead to the hypothesis that future floating gas conversion concepts would benefit from more compact equipment
- Further, that these challenges also requires an interdisciplinary approach

# Enabling Production of Remote Gas

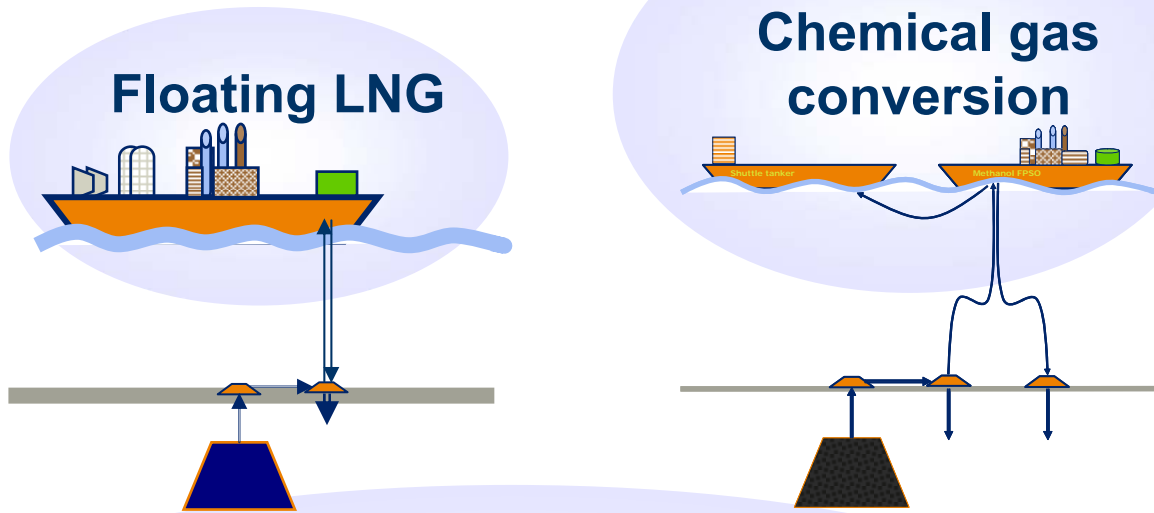
## Objective:

Enable competitive natural gas production from remote fields by addressing critical technology barriers through a coordinated effort by industry and research institutions



## Challenges:

- Footprint
- Weight
- Robustness
- Safety
- Tilting



## Whole-system Issues

HSE

Reliability and operability

Power supply

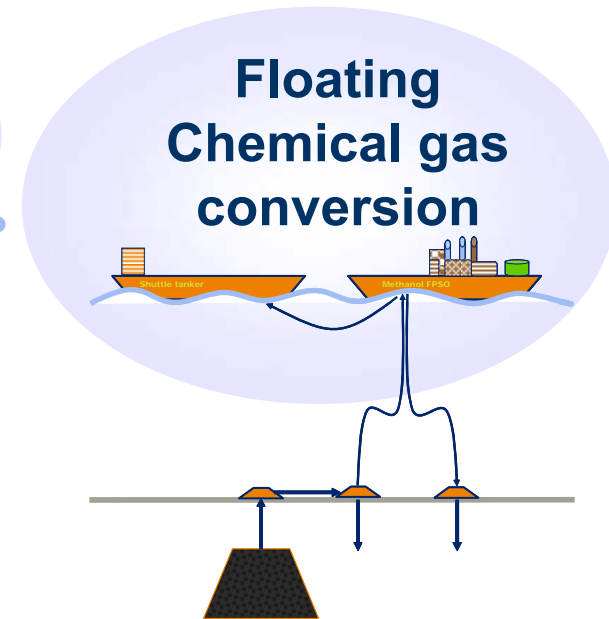
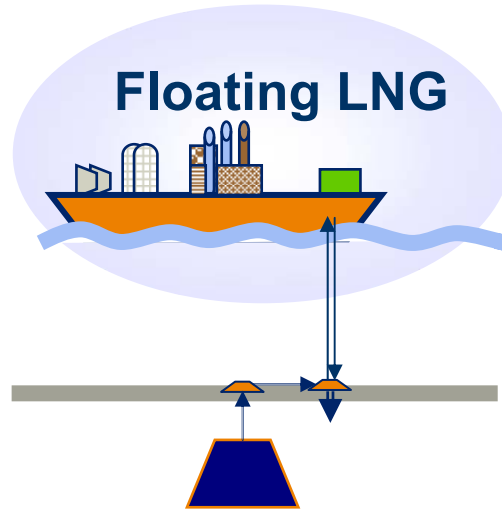
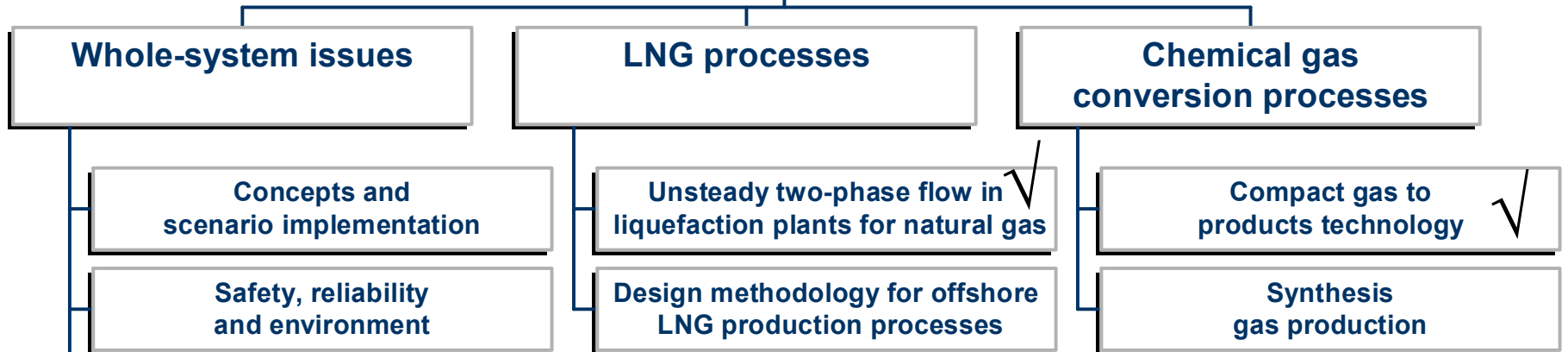
Techno-economical analysis



2005-2009



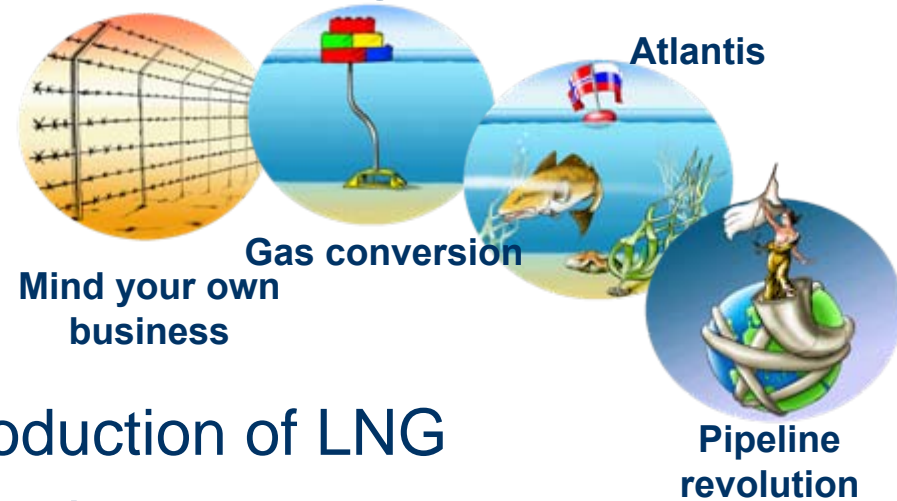
# Enabling Production of Remote Gas



✓ - to be presented in this conference

# Developing scenarios for Remote Gas production as a tool for directing multidisciplinary research

- 4 scenarios for Remote Gas



## Recommendations:

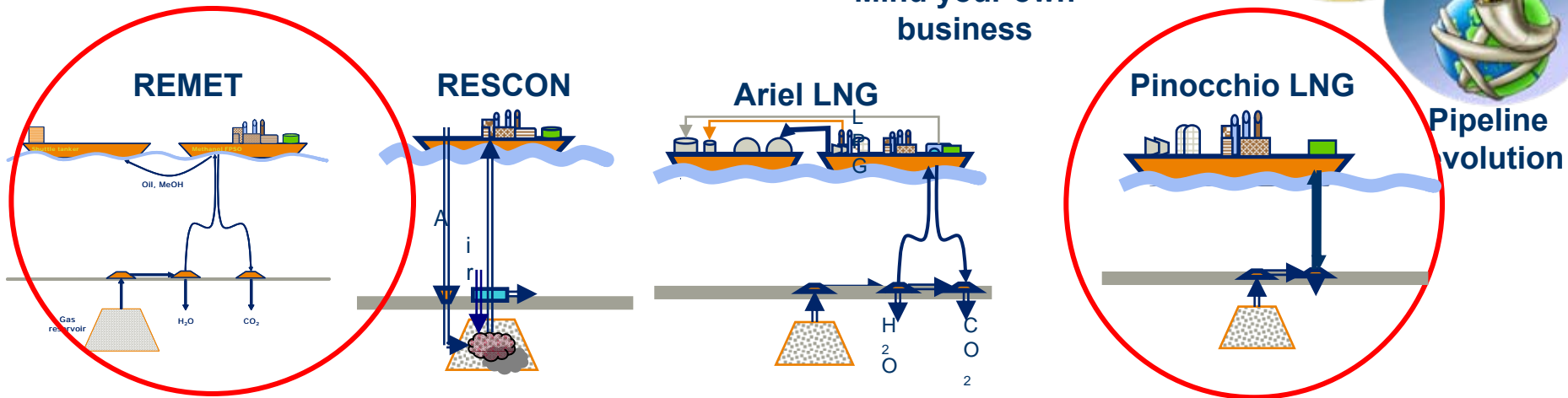
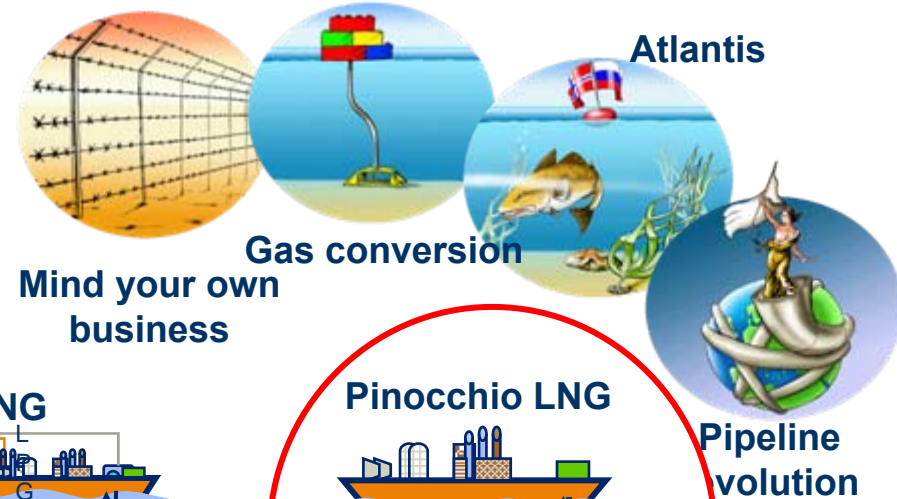
- Floating gas conversion and production of LNG
- Mobile production / processing units
- Production / processing in arctic areas
- Sustainability of remote gas production
- Sub-sea production and gas processing
- Modular design and scalability of processes

Grethe Tangen and Mona Mølnevik, Scenarios for remote gas production, Applied Energy, Volume 86, Issue 12, December 2009, Pages 2681-2689.



# Developing scenarios for Remote Gas production as a tool for directing multidisciplinary research

- 4 scenarios for Remote Gas
- 4 concepts for Remote gas



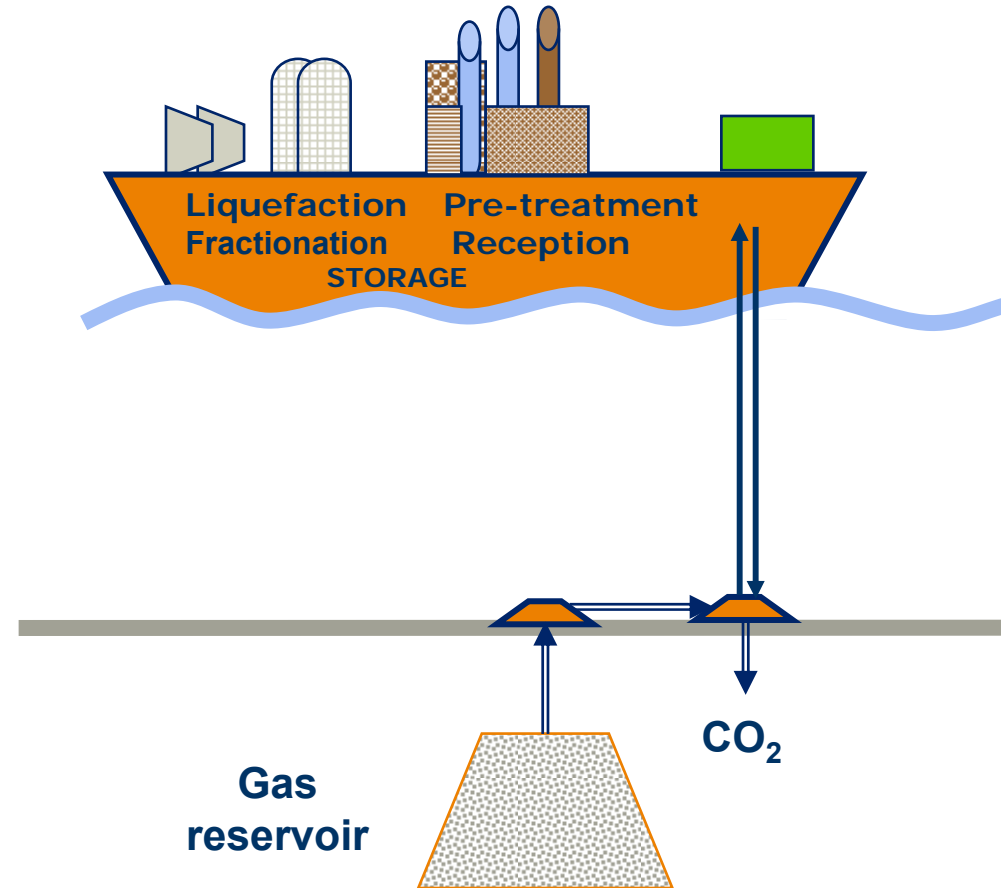
A common basis was provided for studies related to:

- Whole-system issues: ReMET and Pinocchio LNG
- LNG processes: Pinocchio LNG
- Chemical gas conversion processes: ReMET



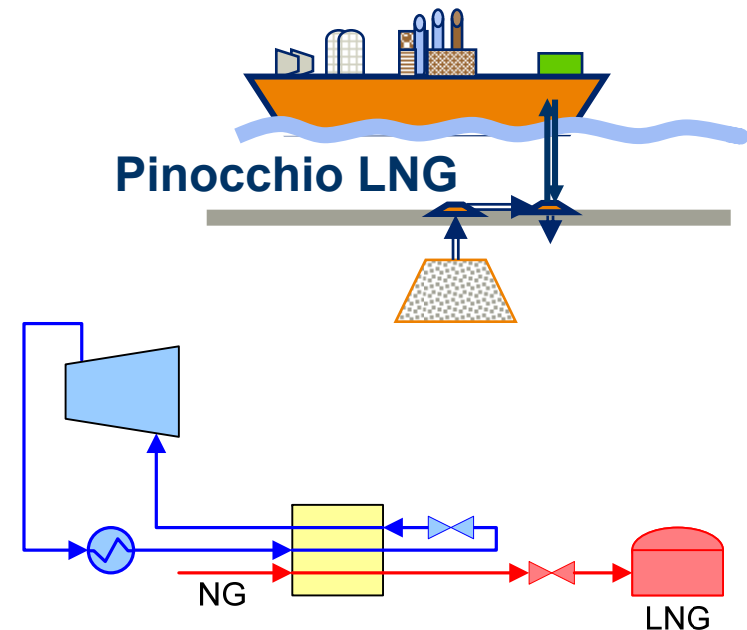
# Pinocchio LNG

- Modularized offshore LNG plant
- Standardized processes
- Scalable processes
- Process reuse
- Local power generation
- Zero emissions of hazardous chemicals
- Ultra-low emissions of CO<sub>2</sub>
- Fast-track manufacturing and process installation
- Low operation costs
- Suited for remote operation



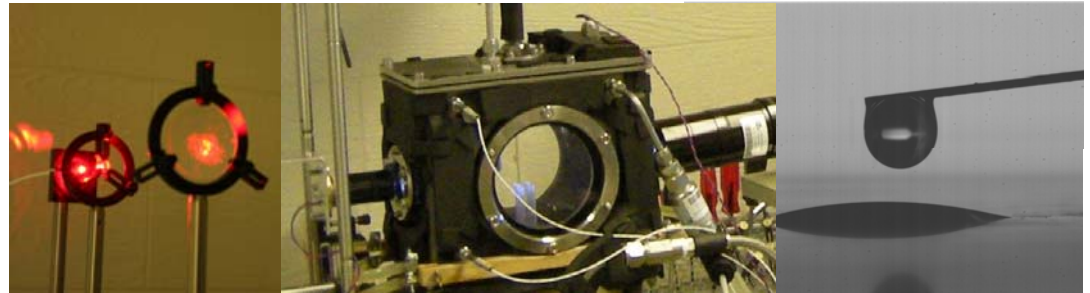
# LNG process for Pinocchio LNG

- **Criteria for selection of LNG process:**
  - From literature
  - From description of the Pinocchio LNG concept
  - From the project partners
- **Evaluation and selection of LNG process:**
  - Prico (reference)
  - Tealarc
  - Expansion process
- **Energy analysis**
- **Improved understanding of the LNG process optimization problem and formulation of restrictions**
- **SQP and Evolutionary search methods researched**
- **The impact of process design decisions on operability and control of an LNG process**

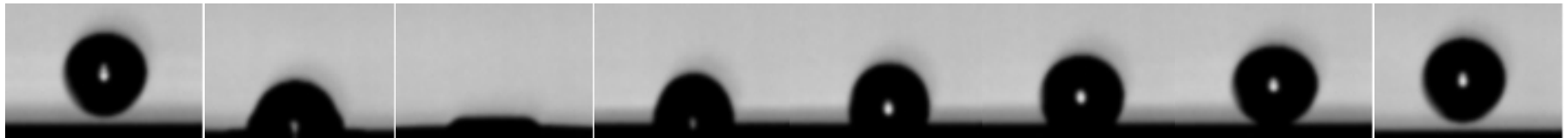


# Fundamental aspects of flow behavior in LNG heat exchangers

Modeling and experimental work to gain insight into fundamental phenomena occurring in heat exchangers in liquefaction plants.



- Droplet – film interaction studies carried out at relevant conditions
- Phenomena modeling for supporting future LNG heat exchanger model development

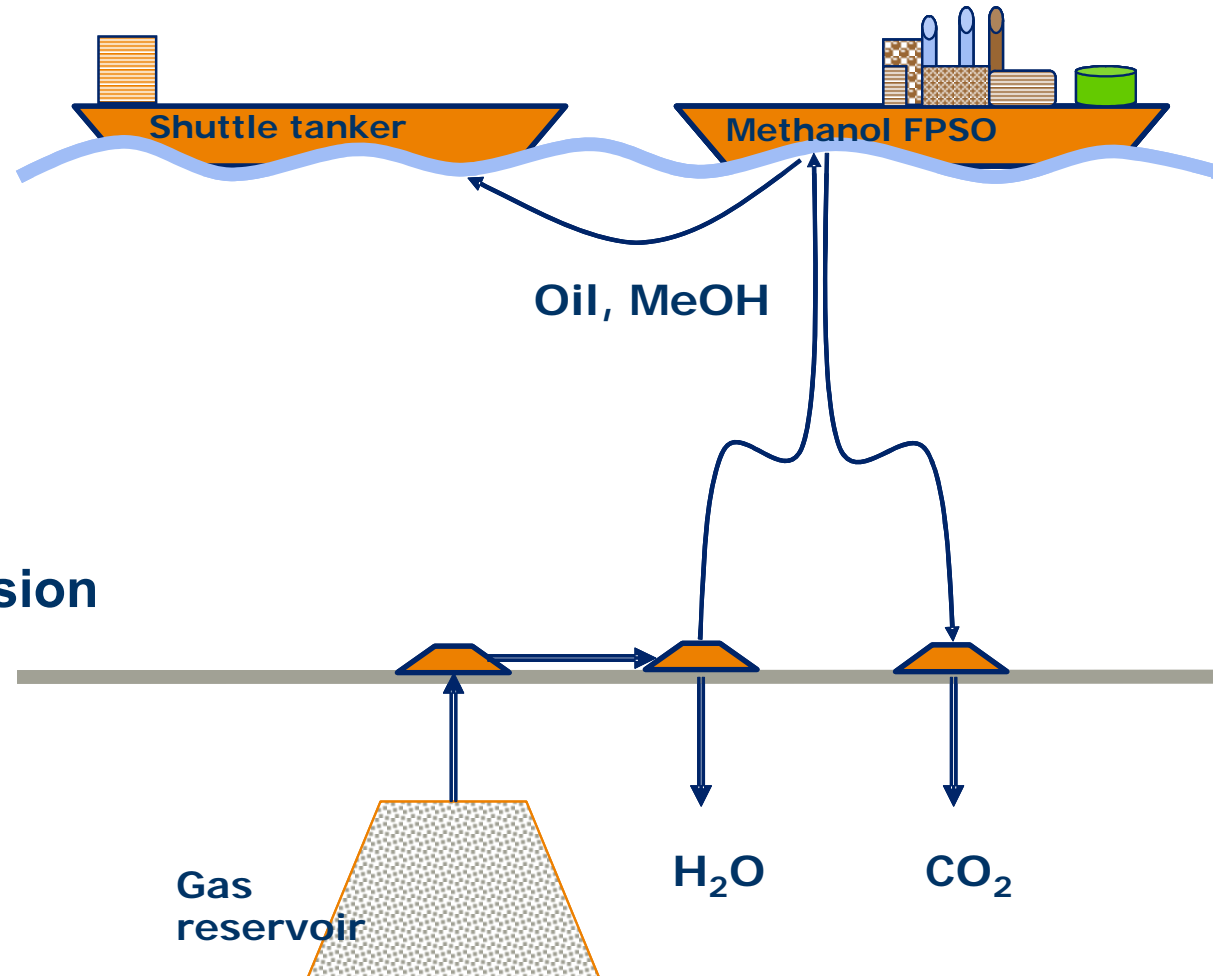


Bouncing of a 1-propanol droplet: diameter 0.23 mm impinging velocity 1.14m/s  
bouncing velocity 0.29 m/s

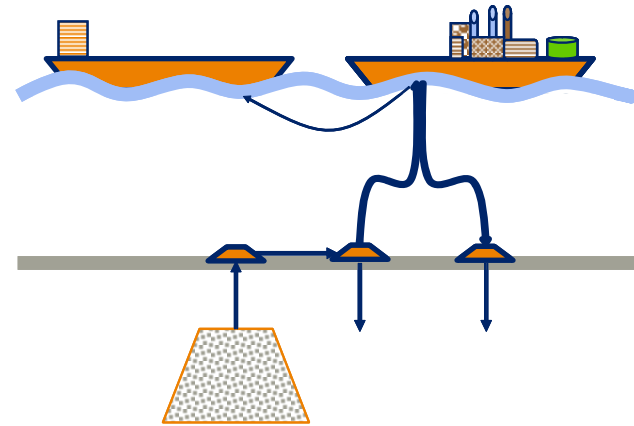
# ReMET - Remote Methanol

## Characteristics

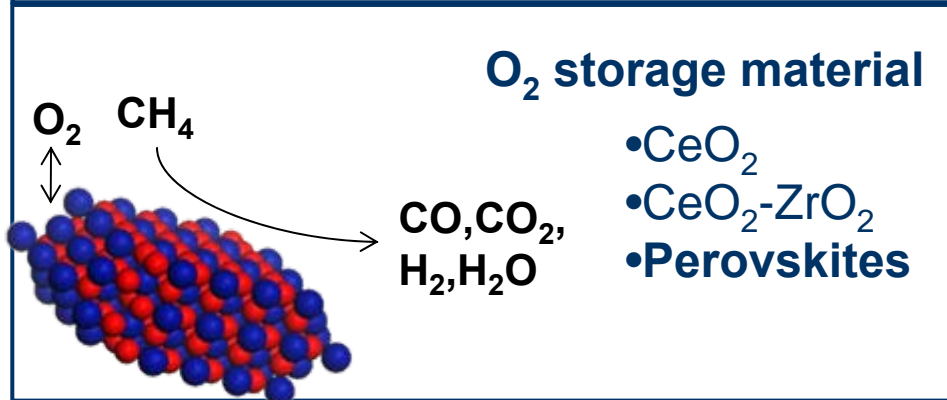
- Associated fields of relatively small size
- Deep water (2000m+)
- Reuse of installations
- New gas conversion technology
- Modular design
- Possibility for conversion of existing ship



# Methanol process for ReMET



**Syngas production by catalytic partial oxidation (CPO)**



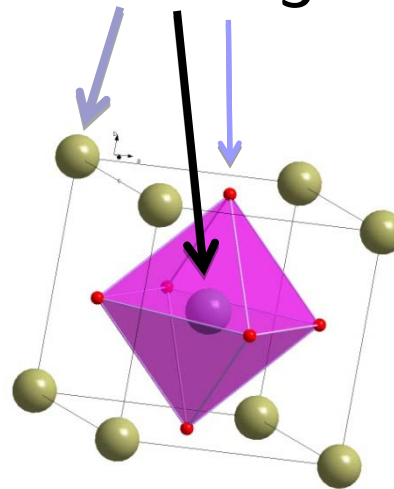
**Microstructured packed reactor for methanol synthesis**



# Synthesis gas production by catalytic partial oxidation (CPO)

- Partial oxidation of  $\text{CH}_4$  to syngas
- Oxidizing  $\text{CH}_4$  by the framework oxygen of an reducible oxide at  $500\text{-}600^\circ\text{C}$
- Cyclic process
- Regeneration by air
- No steam or pure oxygen is needed
- Perovskite based materials have been studied
  - Pure perovskites
  - Supported perovskites

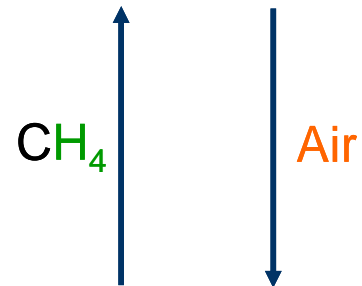
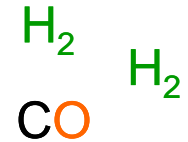
Ideal perovskite unit cell structure



A atoms

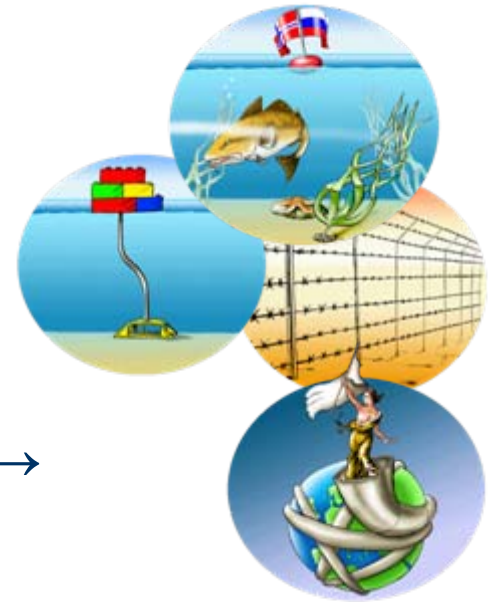
B atoms

Process principle



# Summary

- 50% of stranded gas is located off-shore
- Improved gas conversion technologies gives stranded gas access to the market → remote gas
- The Remote Gas project carries out in-depth research within LNG and chemical gas conversion
- Scenarios and concepts have been developed to direct the research within common issues, LNG and chemical gas conversion



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