

What are gas hydrates?

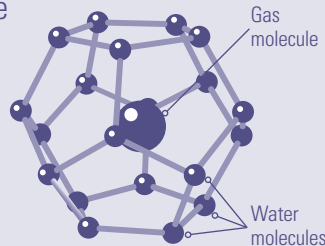
Gas hydrates are in the family of unconventional gas resources, along with shale gas, tight gas, and coalbed methane



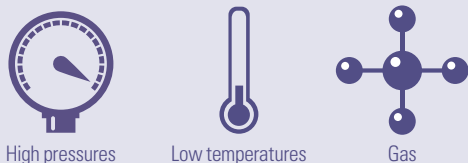
Shale gas Tight gas Coalbed methane Gas hydrates

Gas hydrates are chemical compounds resembling ice

Molecules of water-ice form a solid lattice around a molecule of gas



They require high pressures or low temperatures and sufficient quantities of gas to form and remain stable



High pressures

Low temperatures

Gas

Historically, gas hydrates have mostly been viewed as a threat to oil and gas operations

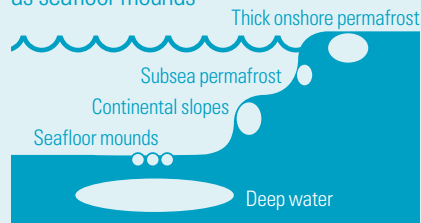


Gas hydrate blockage

Exploration

Gas hydrates form primarily within permafrost and below the seafloor

They can be hosted in sands, clay, or grow as seafloor mounds



- Sand-rich sediments stand out as the most feasible source in the near term
- Gas hydrate resources in sand sediments are plentiful

Notable exploration campaigns have already occurred around the world



Production

There are four main ways to produce gas hydrates:

Depressurization



Thermal stimulation



CO₂ / Methane exchange



Chemical injection



Depressurization is the most efficient method for sand-rich reservoirs. Impact on geomechanical stability from prolonged production is still unknown

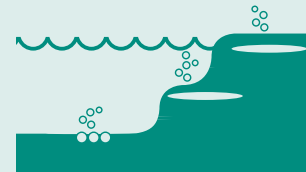


Short duration production tests have been carried out in the North American arctic and offshore Japan

Challenges to production include (secondary) reformation of hydrates during extraction and high levels of by-products (sand and water)

The man-made production of gas hydrates is not expected to impact naturally occurring gas hydrate emissions, which occur independently

Climate change-driven methane emissions should be long-term rather than explosive, as was once assumed



Economics

Economics for production is still highly speculative and will be impacted by certain key factors:

- Well spacing requirements



- Production profiles



- Recovery factors

%

Prolonged production tests (6-12 months) will help refine assumptions and factors in economic models

Early commercial production is likely to come from Asia, where drivers are favourable:

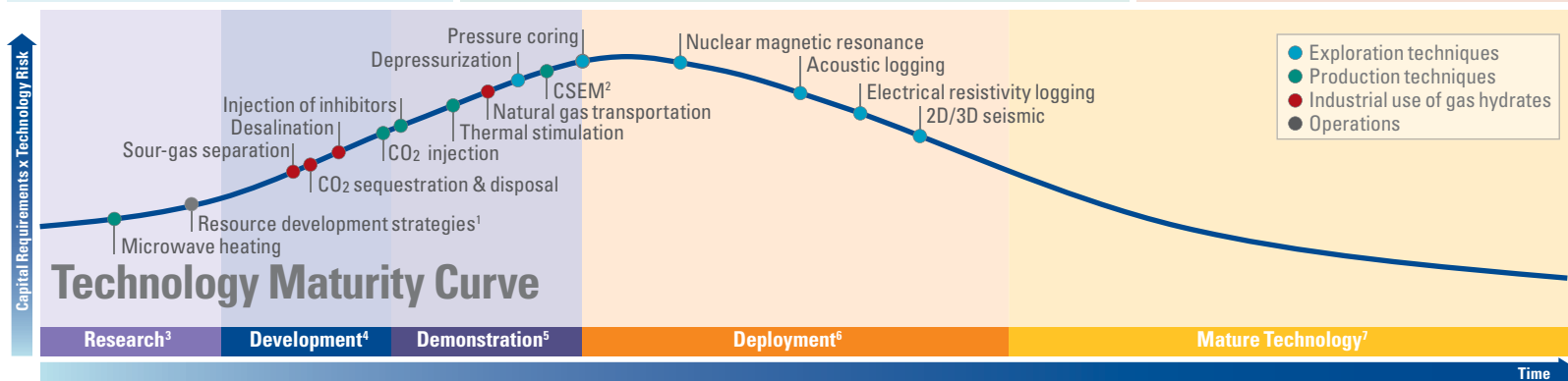
- less natural gas availability (vs North America)
- higher gas prices



Less availability



Higher prices



Note:

1 Addressing issues relating to operations, e.g. number and type of wells, and size of drilling vessels; 2 Controlled-Source Electromagnetic Methods; 3 Lab work / theoretical research; 4 Bench-scale; 5 Pilot-scale; 6 Proved commercial-scale process, with optimization work in progress; 7 Commercial-scale, widely deployed, with limited optimization potential.

Source:

A.T. Kearney Energy Transition Institute analysis