

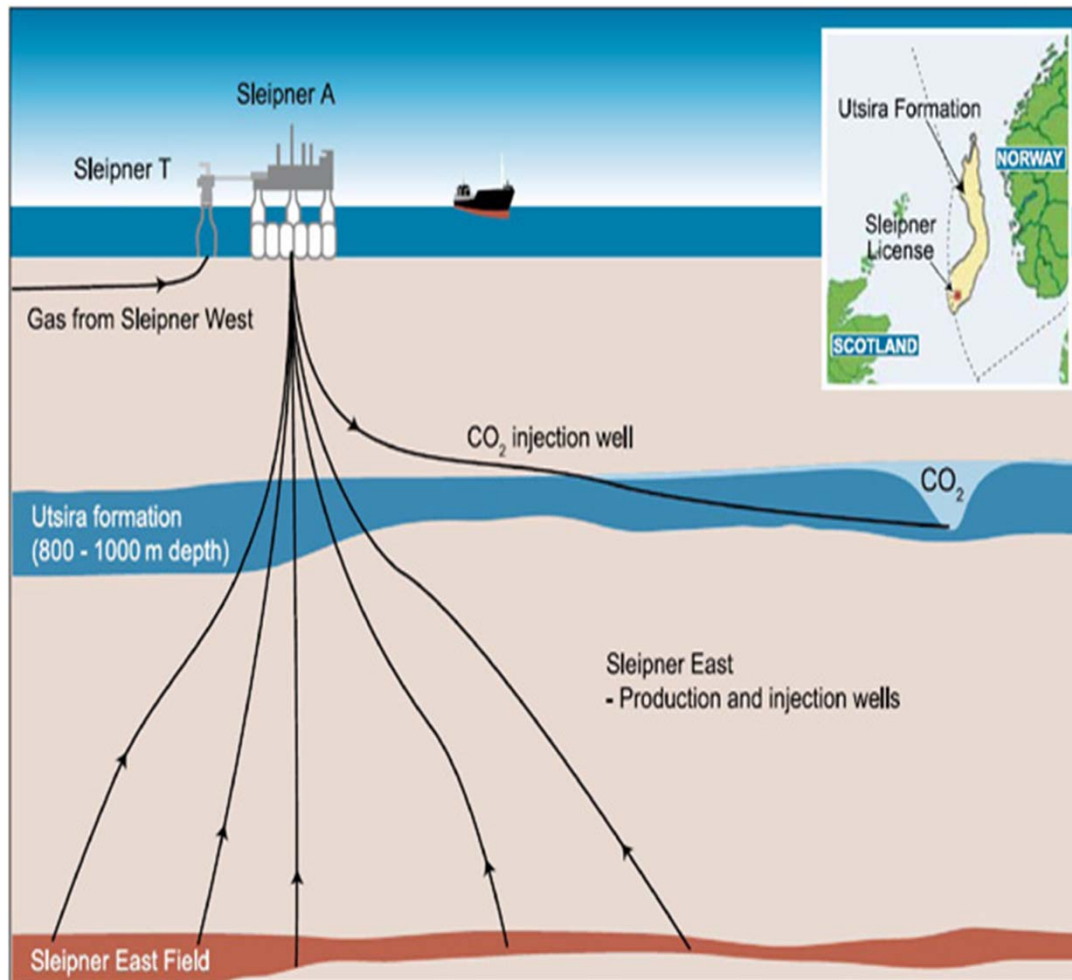
CCS/CCUS: The Way Forward in Asia

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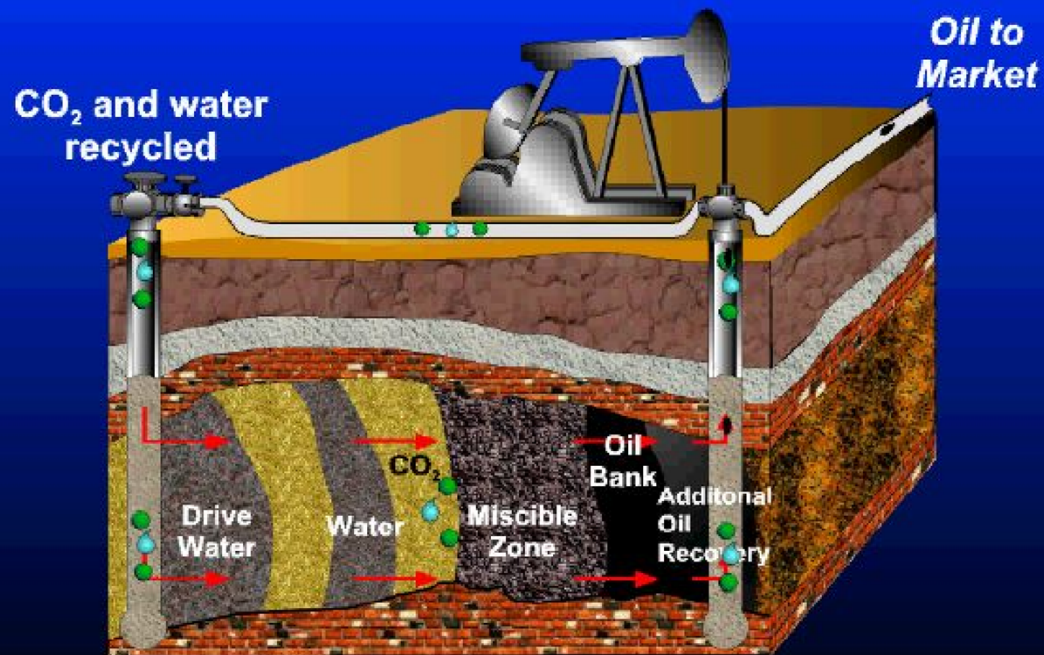
The World's 1st CCS Project: Sleipner, Norway, North Sea



- CCS part of gas field development
- Amine capture from natural gas
- **0.9 Million tonnes** stored per year
- Injection started in Sept. 1996
- **23 years** assurance monitoring

Weyburn CO₂ Miscible Flood Project

CCUS (Enhanced Oil Recovery)



▶ 40-70% of CO₂ injected stays in reservoir

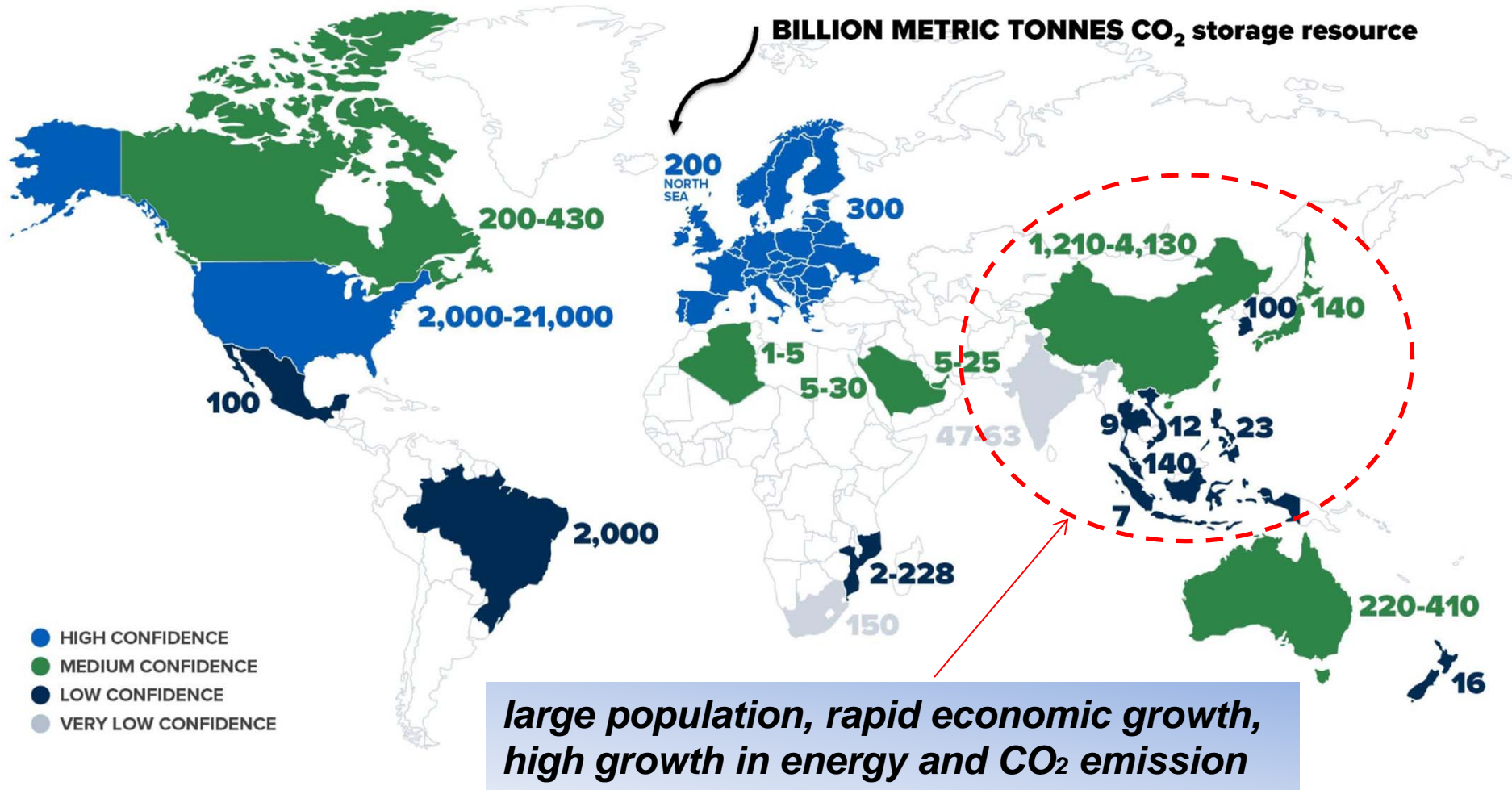
• CO₂ from Dakota Gasification Co., North Dakota

• Pipeline, 325 km, delivers 5000 t/d of CO₂

3 million ton/y
(CO₂ injection)

GLOBAL STORAGE RESOURCES

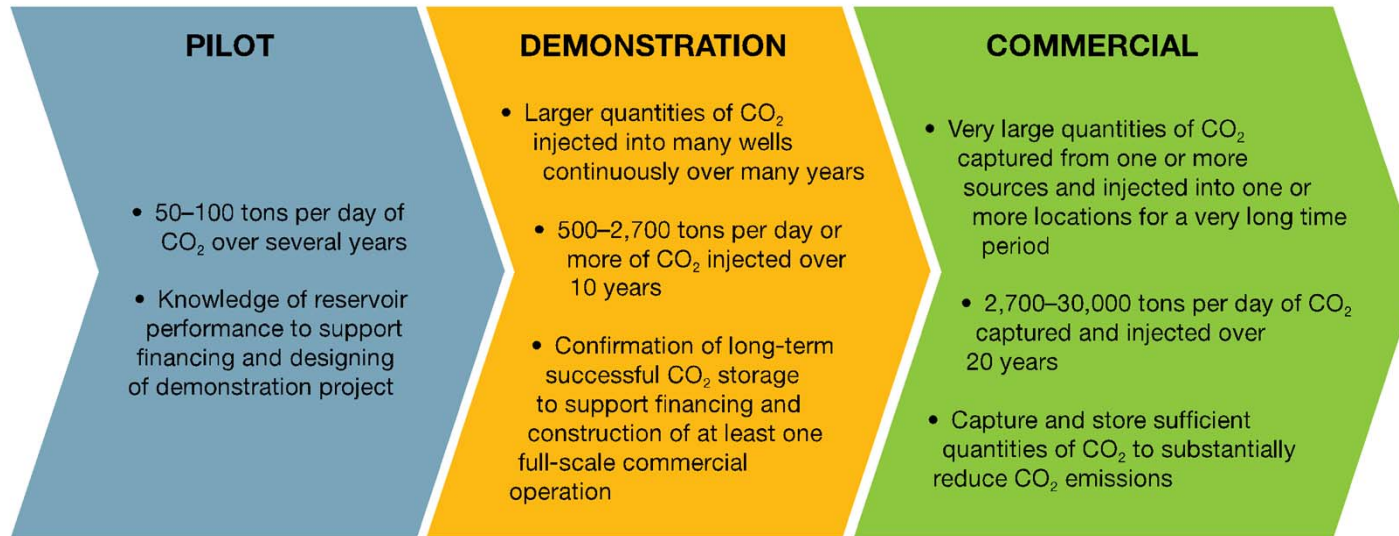
Source: GCCSI



Stages of Carbon Capture and Storage Development

LEARNING by DOING !

Source: ADB, 2013



Most CCS/CCUS projects operating in North America and Europa and main operators are major oil and gas companies.

Some projects in East Asian countries (China, Japan, South Korea), Australia and Middle East, but less in Southeast Asian countries.



"...realise a **cost-effective** solution for full-scale CCS in Norway, provided that this incite **technology development in an international perspective**".

Much Progress on Carbon Storage, But Uncertainties Remain

Source: US DOE

| | Then CCS Program Initiated (1997) | Now Progress to Date | Future CCS Broad Commercial Deployment |
|-----------------------------------|--|--|---|
| Storage R&D | <ul style="list-style-type: none"> • Little known | <ul style="list-style-type: none"> • Knowledge gained and tools being developed and tested | <ul style="list-style-type: none"> • “Commercial toolbox” developed |
| Infrastructure/Field Tests | <ul style="list-style-type: none"> • Little known; Sleipner project initiated | <ul style="list-style-type: none"> • Increased visibility; Knowledge gained and lessons learned | <ul style="list-style-type: none"> • Potential realized; Frameworks in place for market deployment |

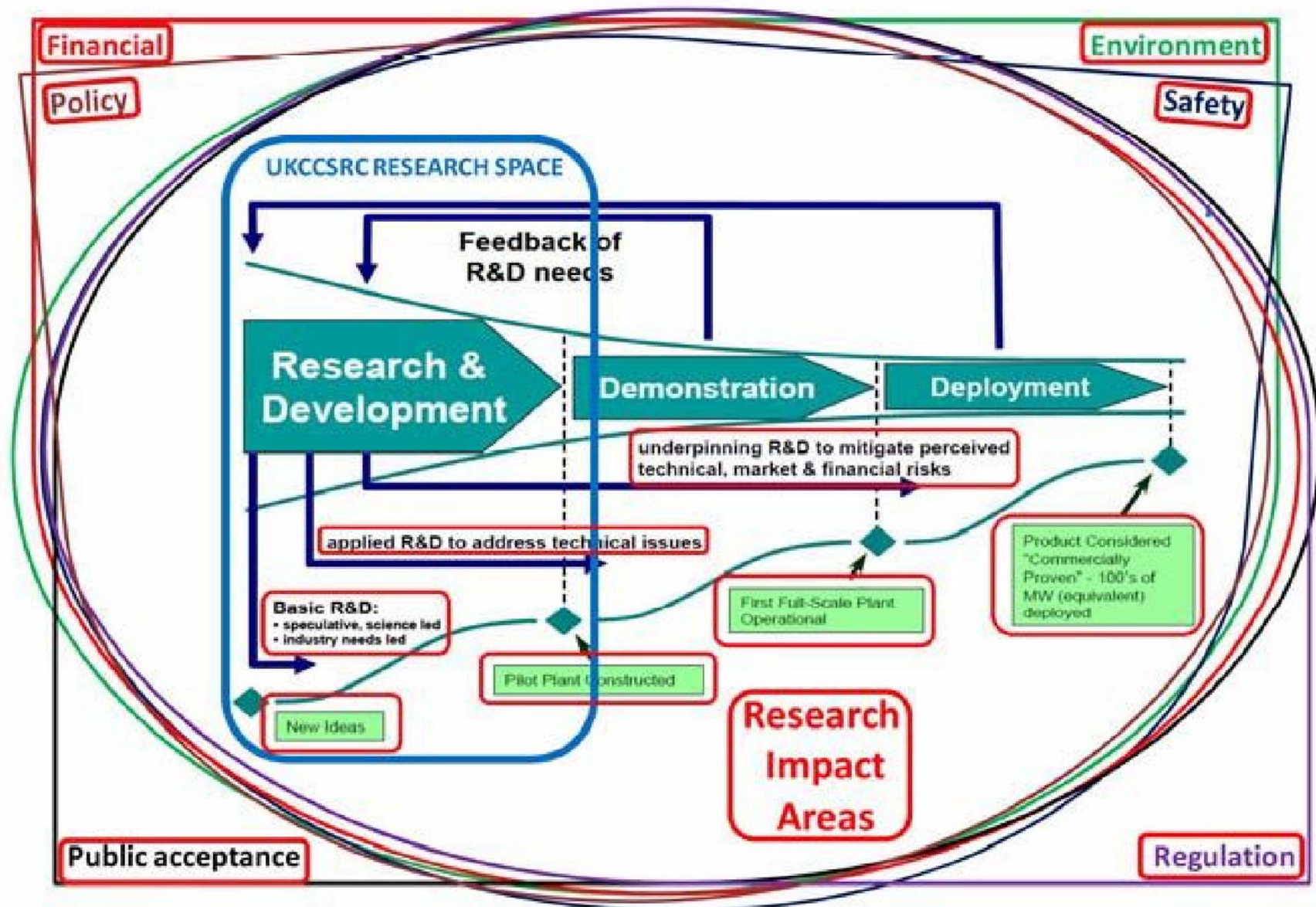
➤ If cost issues lie with capture, risk issues lie with storage

- **Questions about scale up, liability, performance**

• R&D focused on: **Cost** (Capture) and **Confidence** (Storage),

• Demonstrations: **Integration** and **Learning**

Can We Achieve Commercial CO₂ Storage?



Source: Cathcart et al., 2013