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A Matter of Permance: Geological Storage of CO_2 and Emission Trading Frameworks

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Paris, 26 September 2006

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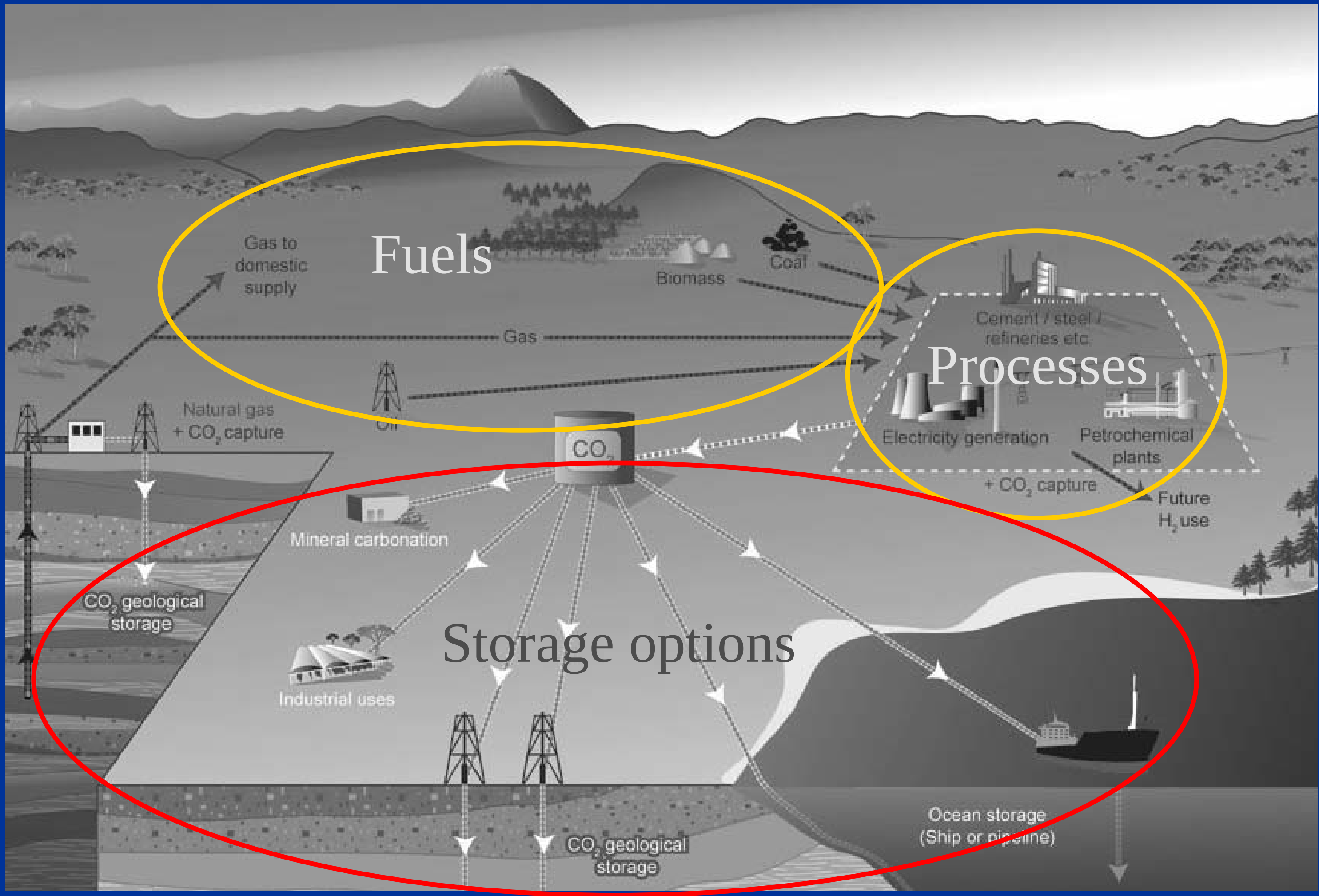
CO_2 capture and storage system



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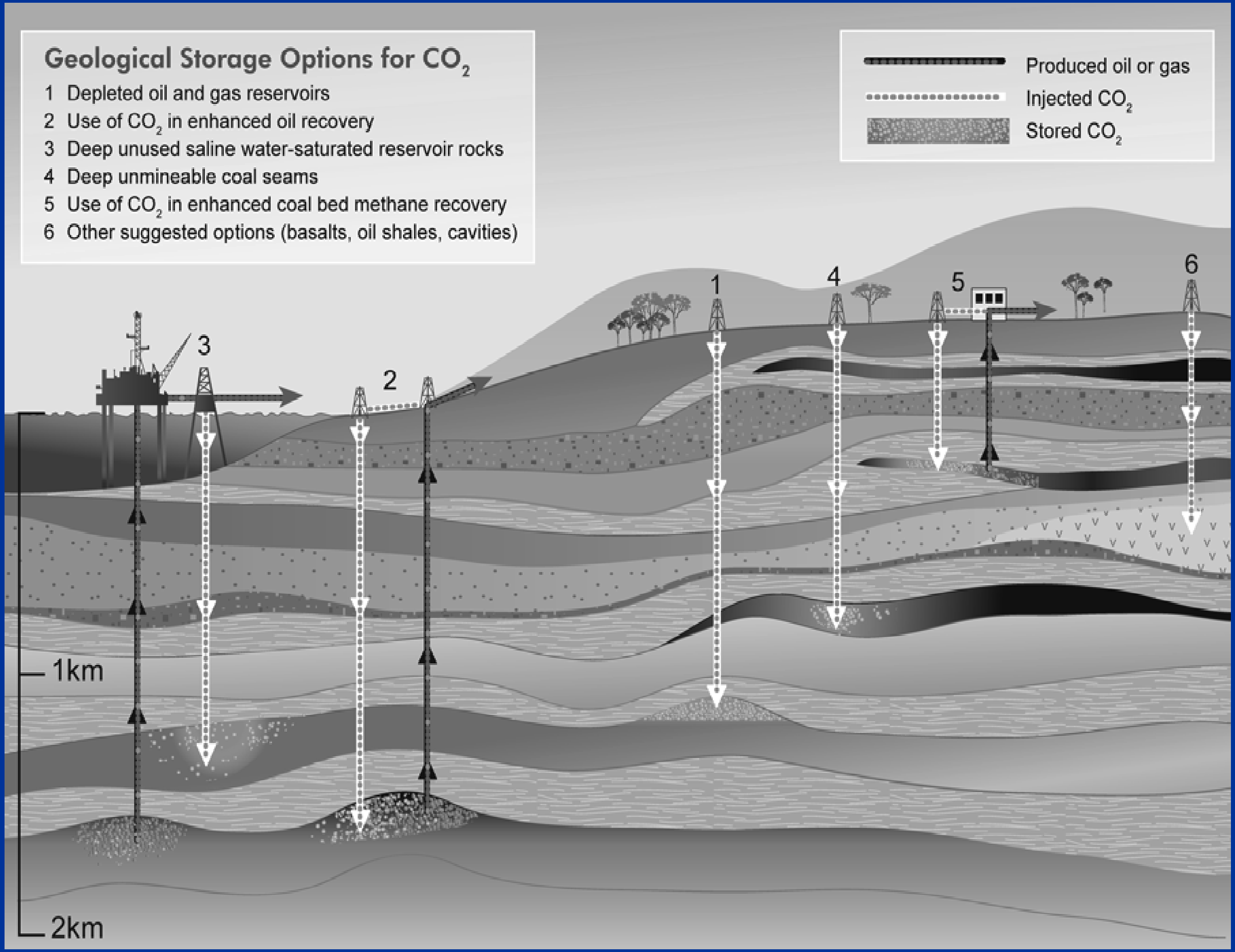
Options for Storing CO2



Nature of storage risks

Geological storage risks

Local

– Elevated gas-phase concentrations in the near-surface environment

– Effects of dissolved CO_2 on groundwater chemistry

– Effects that arise from the displacement of fluids by the injected CO_2

Global

– CO_2 back to the atmosphere

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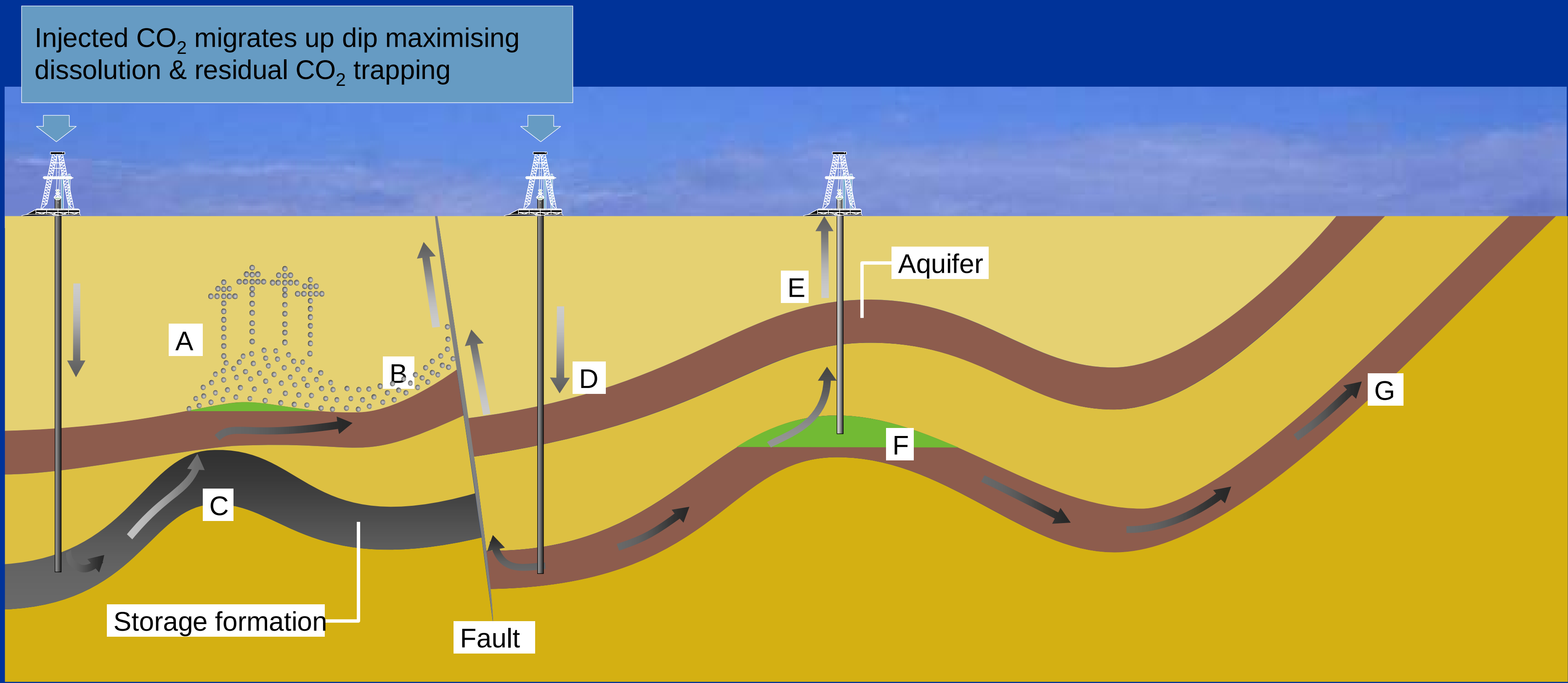
How could it leak?



Potential escape mechanisms

A. CO_2 gas pressure exceeds capillary pressure & passes through siltstone	B. Free CO_2 leaks from A into upper aquifer up fault	C. CO_2 escapes through 'gap' in cap rock into higher aquifer	D. Injected CO_2 migrates up dip , increases reservoir pressure & permeability of fault	E. CO_2 escapes via poorly plugged old abandoned well	F. Natural flow dissolves CO_2 at CO_2 /water interface & transports it out of closure	G. Dissolved CO_2 escapes to atmosphere or ocean

Risk Management

- **Site Selection**
- **Risk Assessement**
- **Monitoring and Verification**
- **Remediation Planning**

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What makes a good storage site?

Stratigraphy	**Caprock** - Low permeability - Large thickness - Lateral continuity - Absence of faults	**Storage formation** - High permeability - Large thickness - Areally extensive
Geomechanics	Tectonically stable Favorable stress conditions on faults and fractures	
Geochemistry	Mineralogies that - Buffer acidity increase - Promote trapping as an immobile solid phase	
Anthropogenic Factors	Location and conditions of abandoned wells	

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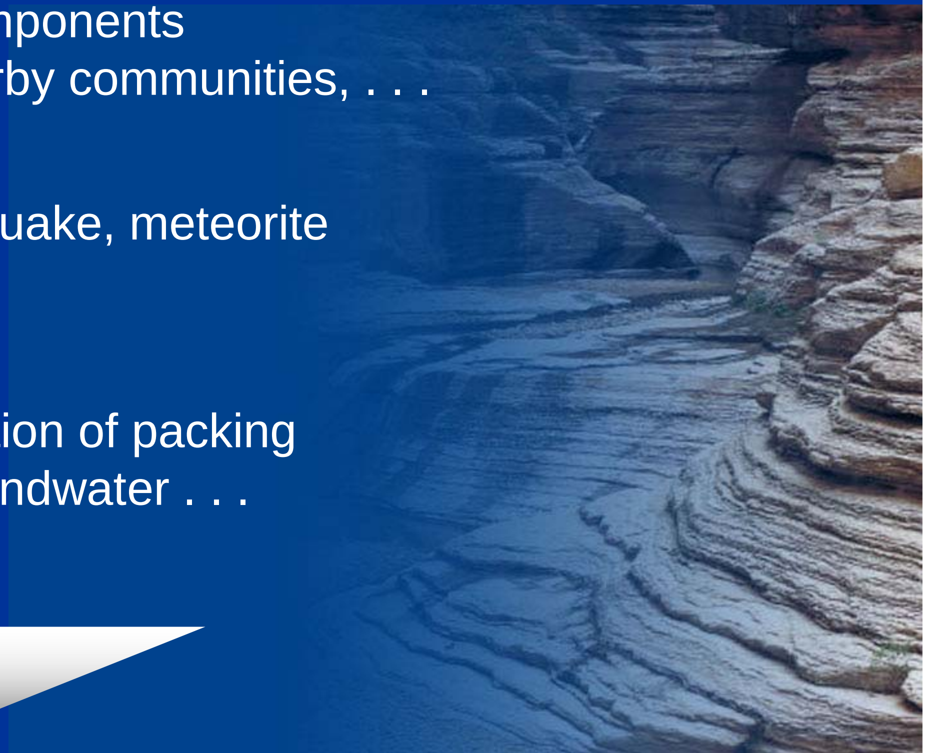
Long-term risk assessment: how to do it?



- **Feature:** characteristic of system components
  boreholes, lithography, nearby communities, . . .
- **Event:** a particular happening
  pipe fracture, nearby earthquake, meteorite impact . . .
- **Process:** natural phenomenon
  corrosion of casing, dissolution of packing material, convection of groundwater . . .

Scenario

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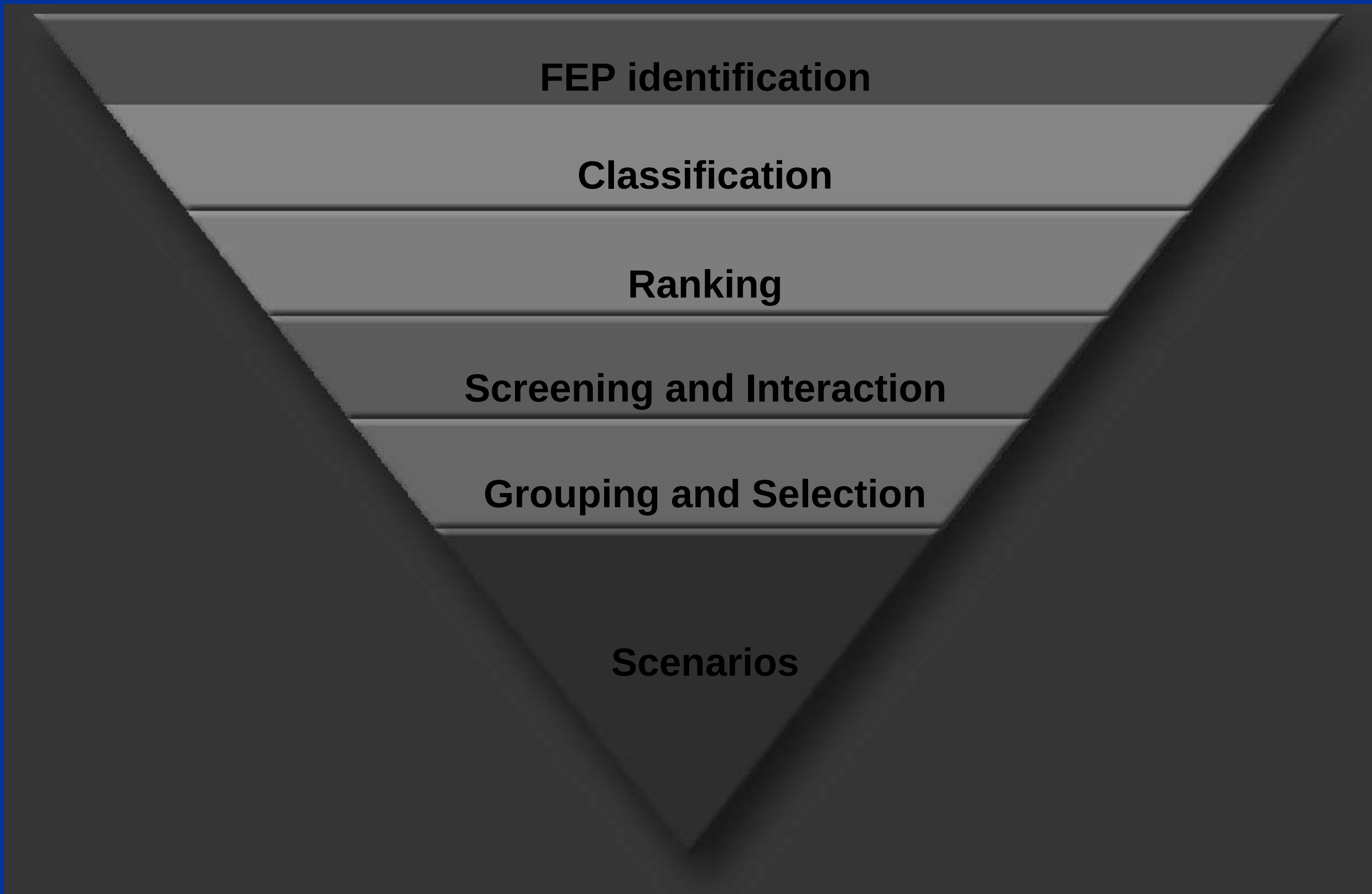
Scenario Development



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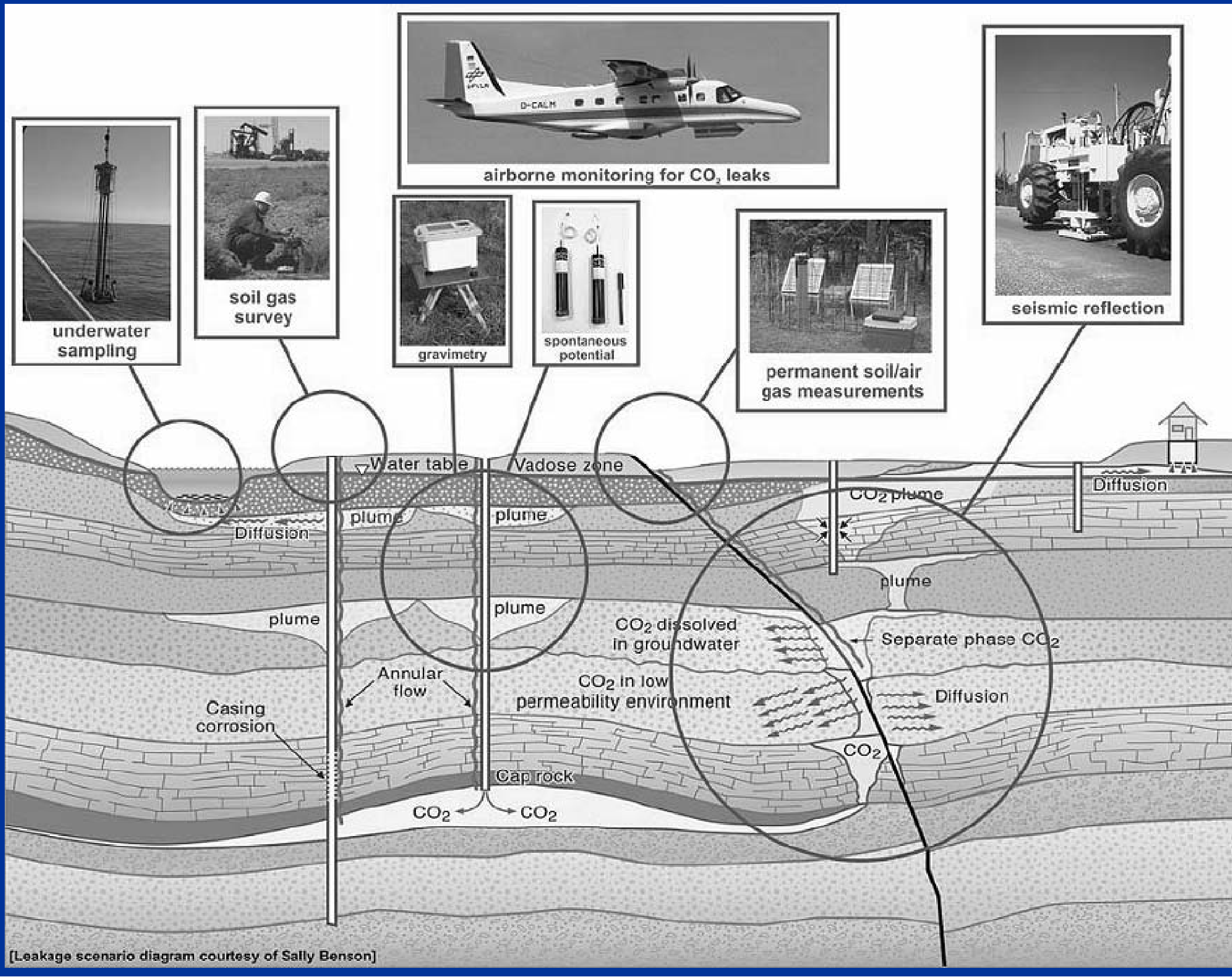
Monitoring: Tailored to the storage site



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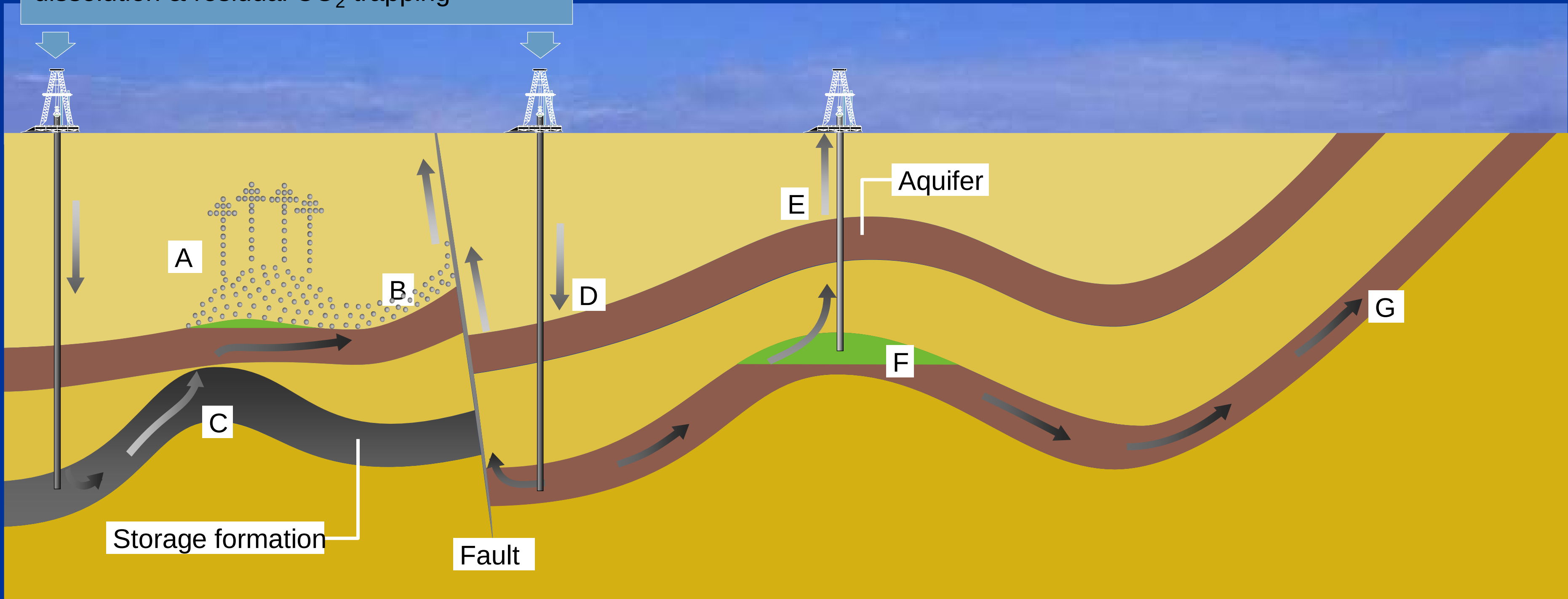
Remediation

Injected CO_2 migrates up dip maximising dissolution & residual CO_2 trapping



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Remedial measures

A. Extract & purify ground water	**B**. Extract & purify ground water	**C**. Remove CO2 & re-inject elsewhere	**D**. Lower injection rates or pressures	E. Re-plug well with cement	**F**. Intercept & re-inject CO2	**G**. Intercept re-inject CO2

What can be achieved?

According to IPCC SRCCS fraction retained in appropriately selected and managed geological reservoirs is

- very likely to exceed 99% over 100 years, and
- is likely to exceed 99% over 1,000 years.

"Likely" is a probability between 66 and 90%,"very likely" of 90 to 99%

Local risk of geological storage can be comparable to risks of current activities

- Natural gas storage, EOR

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What does this mean?

Seepage from storage site is a function of risk management

IPCC 2006 Guidelines for GHG Inventories support this view

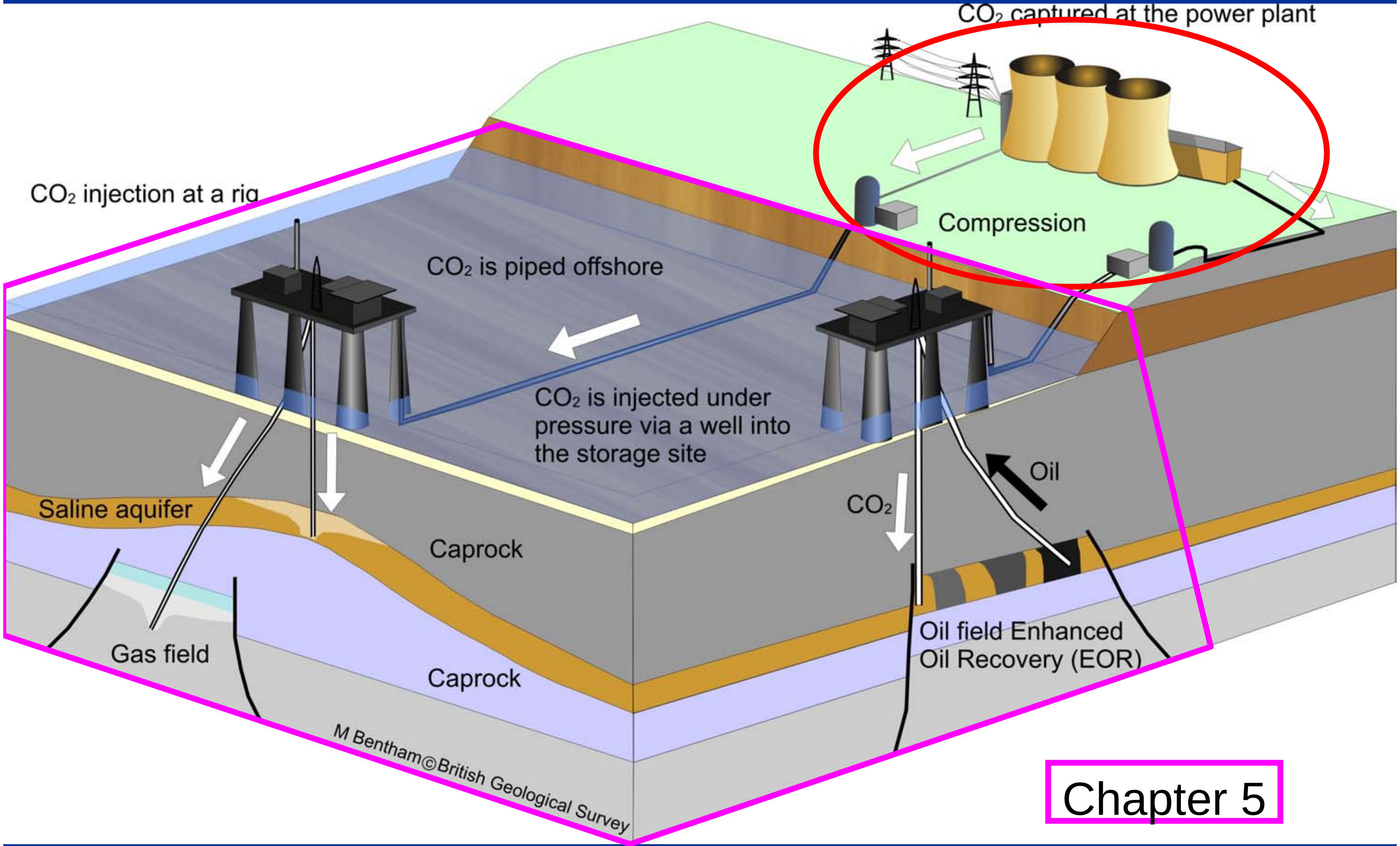
Use of temporary or long-term emission reduction credits for CCS not suitable

IPCC Guidelines on CCS Estimation Methodologies in National GHG Inventories

The 2006 Guidelines give a complete methodology for estimating leakage from CCS

CCS divided into three systems:

1. Capture and compression system
   - treated separately in the appropriate sector
     - Volumes two and three (e.g. stationary combustion)
2. Transport system
3. Storage system
   - Treated together in Volume two, Chapter five


CO2 captured at the power plant
CO2 injection at a rig
Compression
CO2 is piped offshore
CO2 is injected under pressure via a well into the storage site
Oil
CO2
Saline aquifer
Caprock
Gas field
Caprock
Oil field Enhanced Oil Recovery (EOR)
M Bentham©British Geological Survey
Chapter 5

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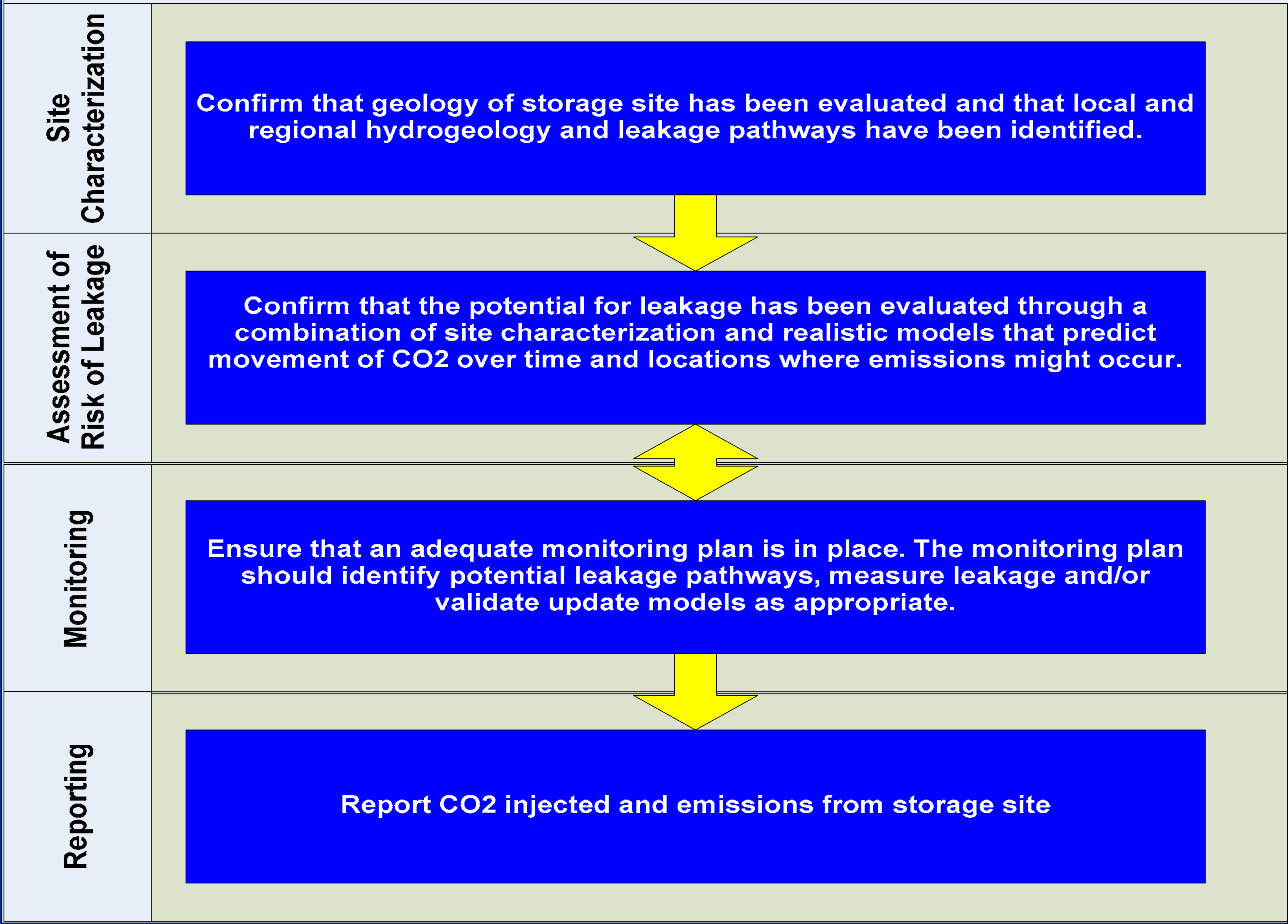
Estimating, Verifying & Reporting Emissions from CO_2 Storage Sites



Relevance

- 2006 IPCC Guidelines provide internationally approved basic elements for site selection, risk assessment, and monitoring
- Define good practice for national government CCS approval regimes
- Inherently support the evolution of emission trading frameworks for CCS

Immediate needs:

- Operationalise GL into a CDM methodology
- Liability regimes
- Offsets for remerging CO_2