CO_2 Capture Project

Overview of the CO_2 Capture Project (CCP)

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www.Co2captureproject.org

NorCap Seminar

14th – 15th October, 2003

Introduction

- Background on the CO_2 Capture Project
  - Opportunities and challenges
  - Project objectives and who is involved
- Project progress and time line
- Overview of findings of the CCP
  - Capture & geologic storage findings to date
  - Progress of other program areas
  - Common economic model, policy and incentives, communication, costs
- Conclusions

Background on the CO_2 Capture Project

Why focus on capture and geologic storage?

- Fossil fuels will be required to meet the worlds energy needs for the foreseeable future
- Possible to achieve material reductions in CO_2 emissions & provide a bridge to a lower carbon future
- Applicable to broad range of industry sectors
- Cost of decarbonising fossil fuels is currently to high
- Carbon sequestration is needed to make H_2 possible in near/medium term with no/low GHG emissions
- Can provide a win ~ win for both energy security and environment

CO_2 Capture Project

US Department of Energy

European Union

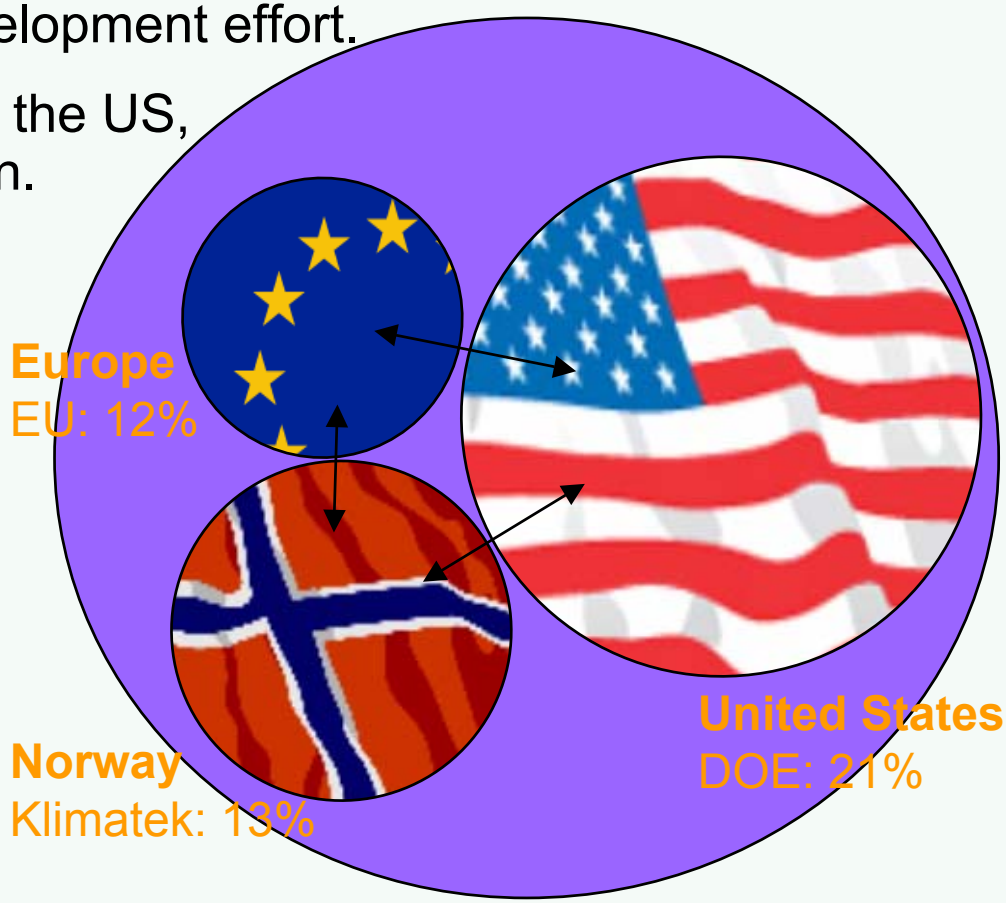
Klimatek NorCap

CO_2 Capture Project objectives

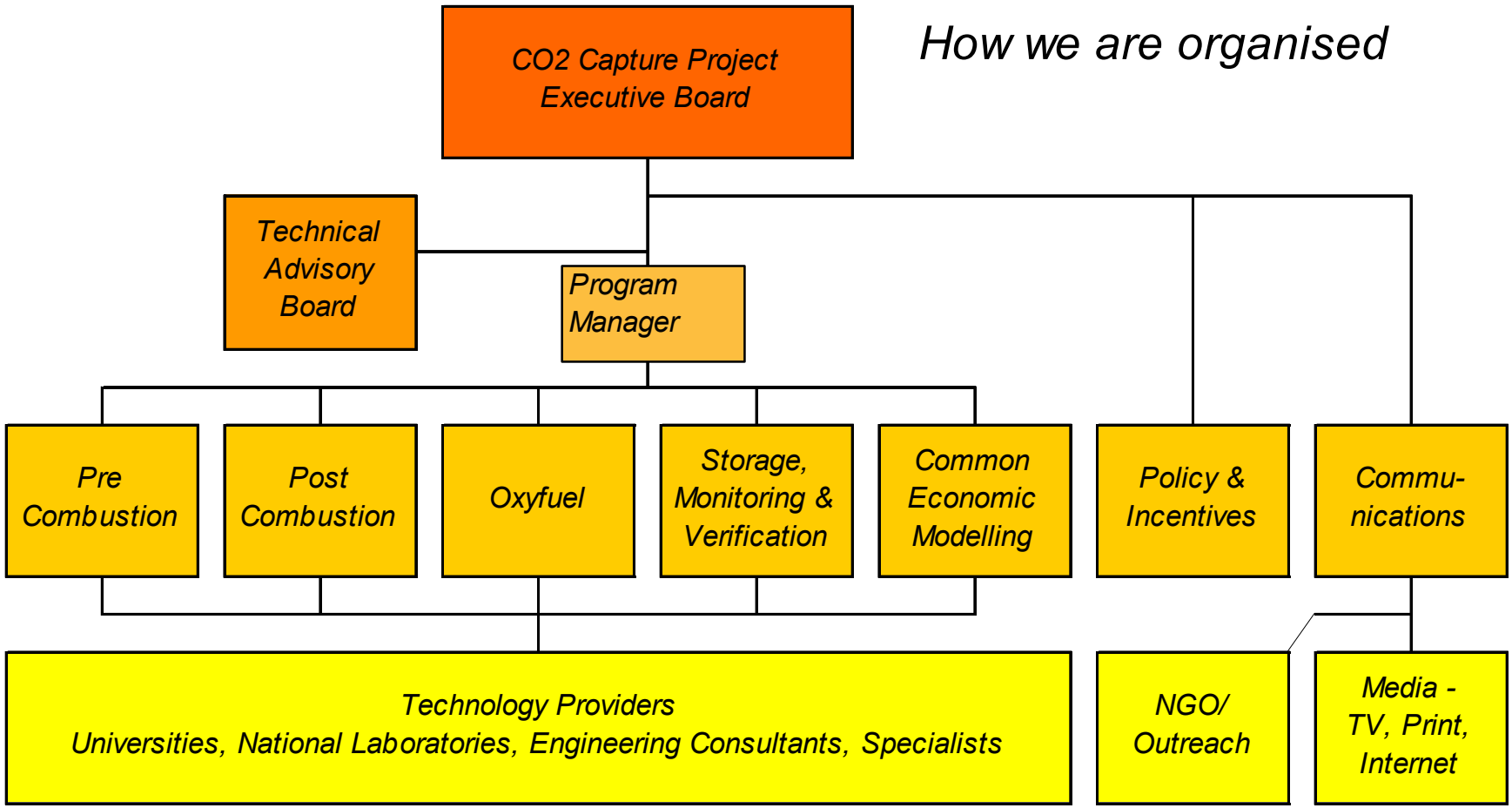
- Achieve major reductions in the cost of CO_2 capture and storage:
  - 50% reduction when applied to a retrofit application.
  - 75% reduction when applied to a new build application.
- Demonstrate to external stakeholders that CO_2 storage is safe, measurable, and verifiable.
- Progress technologies to:
  - 'Proof of concept' stage by 2003/4.

Program structure

- International technology development effort.
- Distinct *regional* programs in the US, Norway, and European Union.
- Sharing among programs to leverage results and reduce duplication.
- Project funding $25mm
- Project cost $50mm

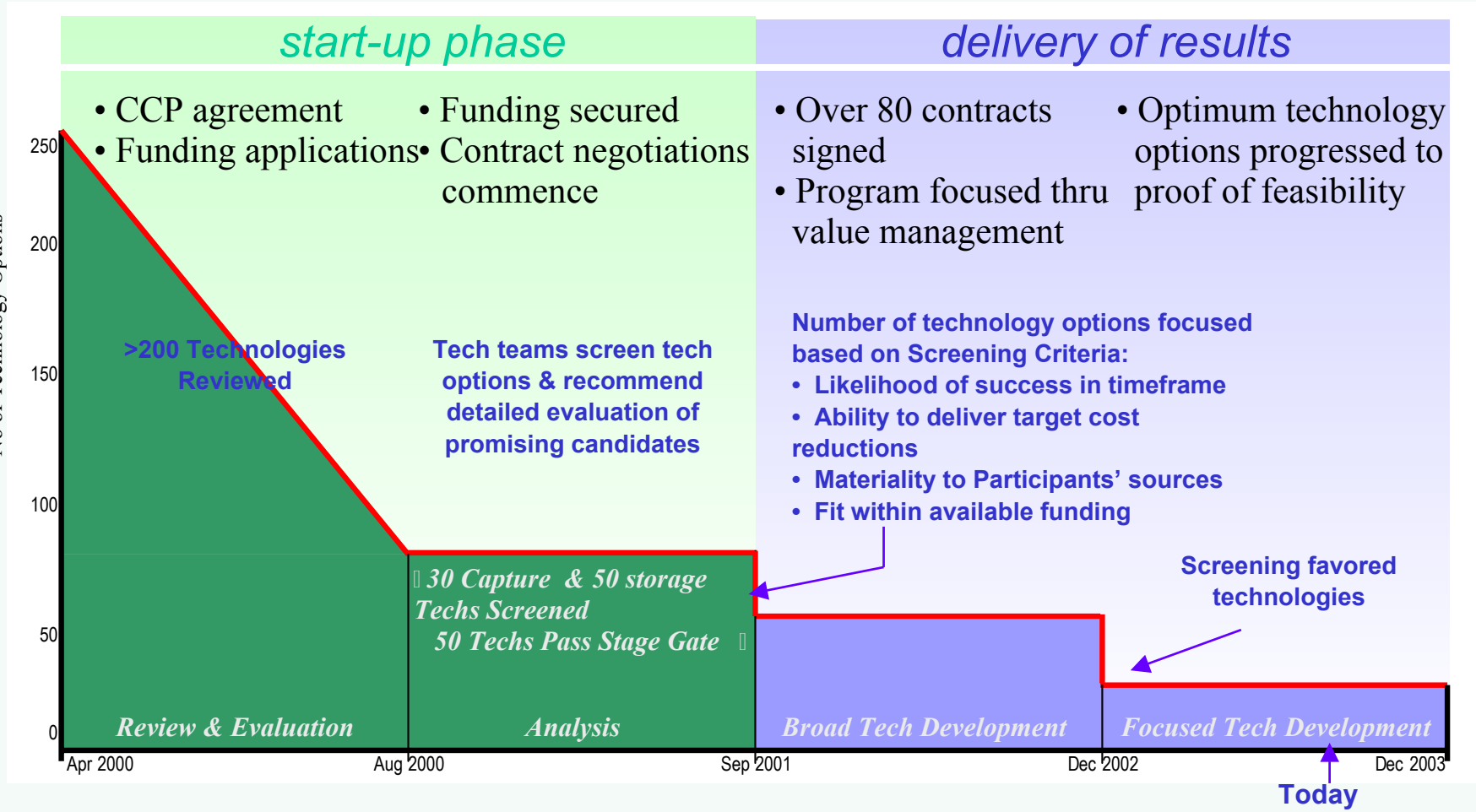


How we are organised

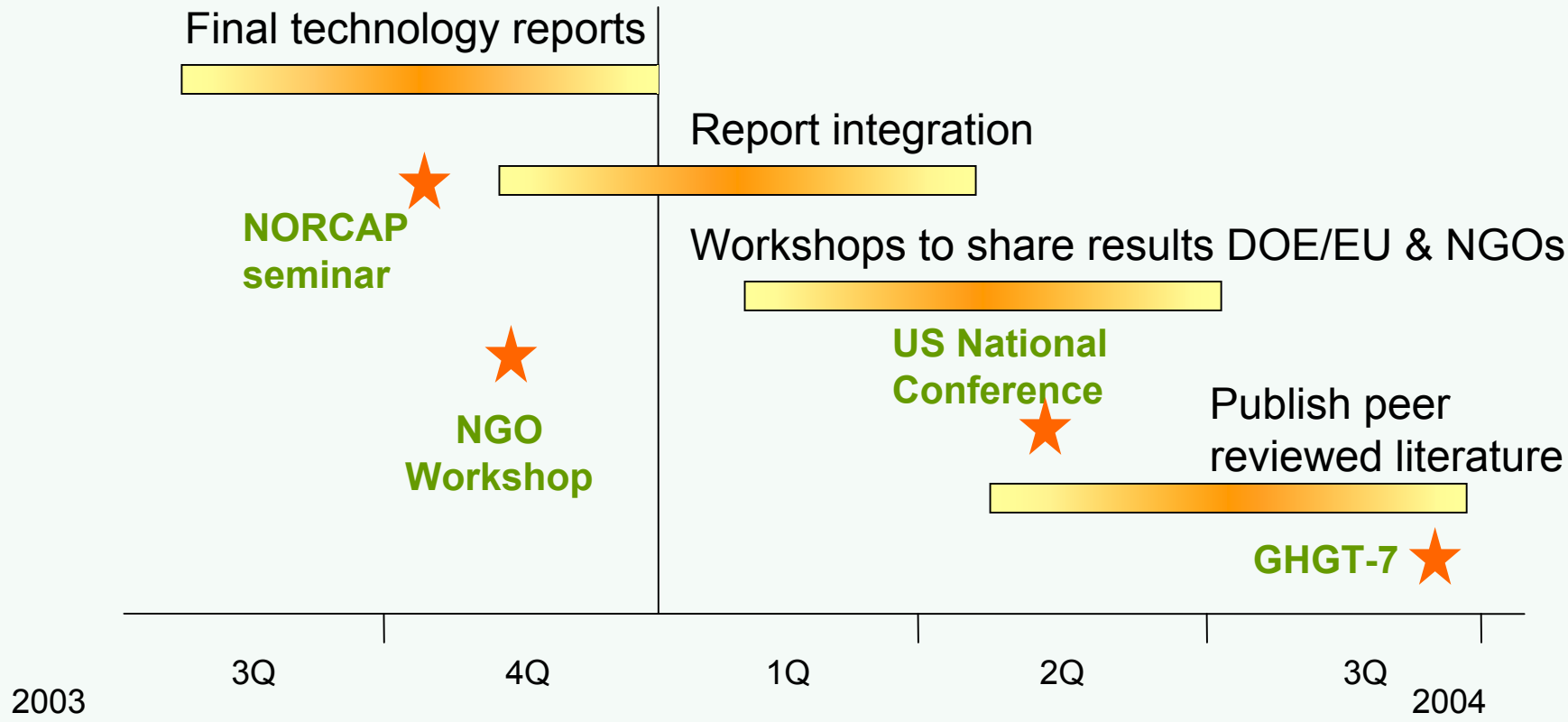


CCP project progress and time line

Project overview- we've come a long way!



Communication of Results Plan



Project accomplishments

- Website in place, experiencing > 6000 hits/d
- State of the art review & critical gaps analysis, identify most promising technologies for development
- Stakeholder workshops held, active input sought
- Review of policy barriers and opportunities to shape technology development and application
- Produced comprehensive and detailed cost analysis of C&S for 4 real life case studies
- Developed an economic model for cross technology cost comparison on a common basis
- First project to establish an international public private partnership in this area

Overview of findings of the CCP

Overview of Findings: Capture

- CCP has developed technologies that will form the new "state of the art"
- Most significant opportunities for cost reduction are in pre-combustion and oxyfuel technologies
- Integration is an important theme in terms of combining technologies, process simplification and the number of process stages
- Membrane technology development underpins process simplification
- High performance chemistry offers opportunity to reduce equipment size for large scale capture application

Overview of Findings: Storage

- CCP has developed a new set of tools that can be applied to manage CO_2 geologic storage, monitoring and verification, long term
- CCP has pioneered the "risk based approach for CO_2 storage" and developed new thinking and principles for how this should be applied, recognizing that all reservoirs are different
- An integrated approach for risk management is required, which builds on and goes beyond what is typically being done in the oil and gas industry today

Overview of Findings: Generally

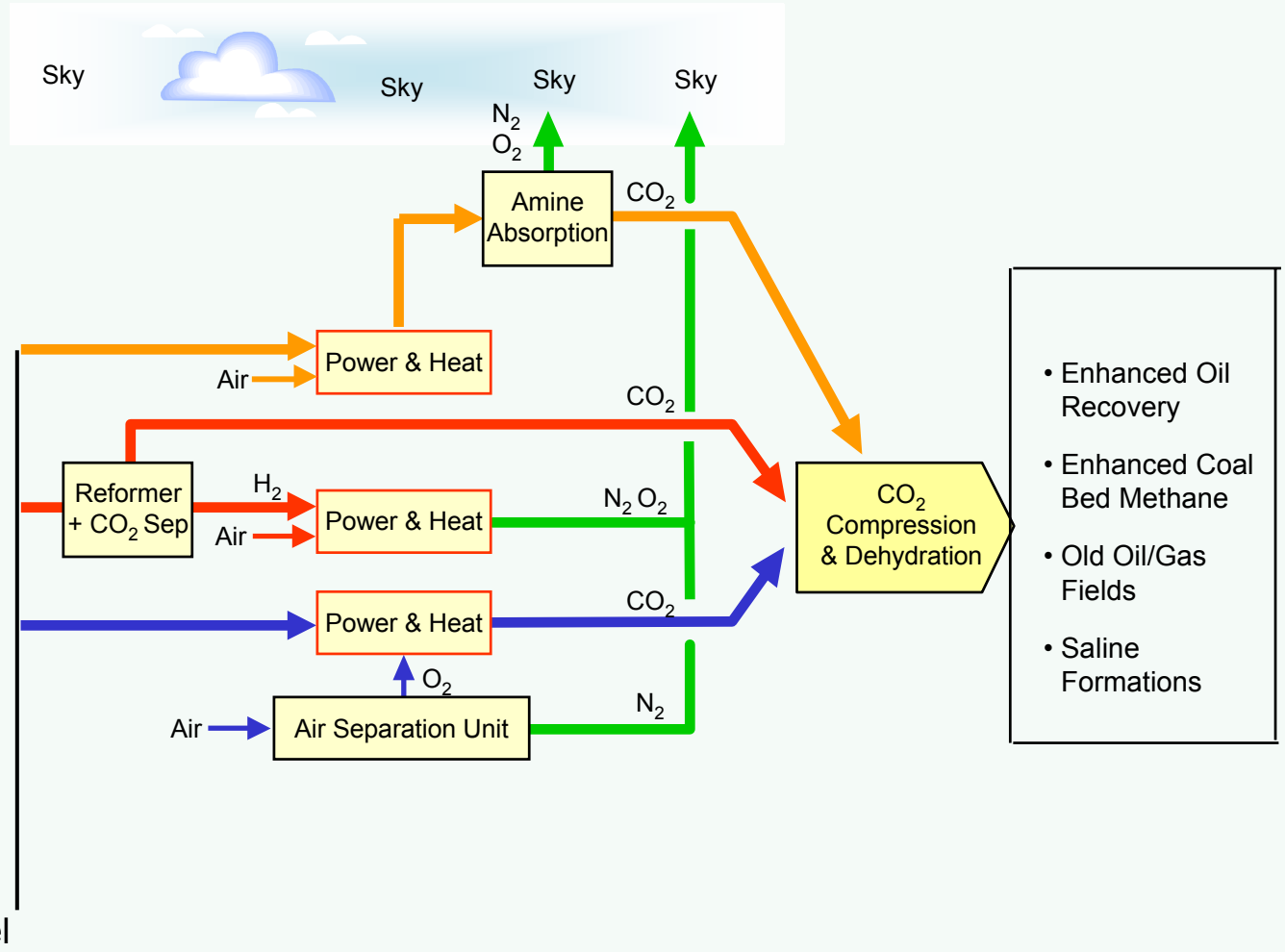
- Capture technology is energy intensive and hence CO_2 avoided cost is a key PI
- Early application of capture technology most likely to be applied to highly concentrated emission streams with the CO_2 used for EOR
- Acceptability of geologic storage is more likely to be a show stopper, than capture technology for C&S

Capture technologies

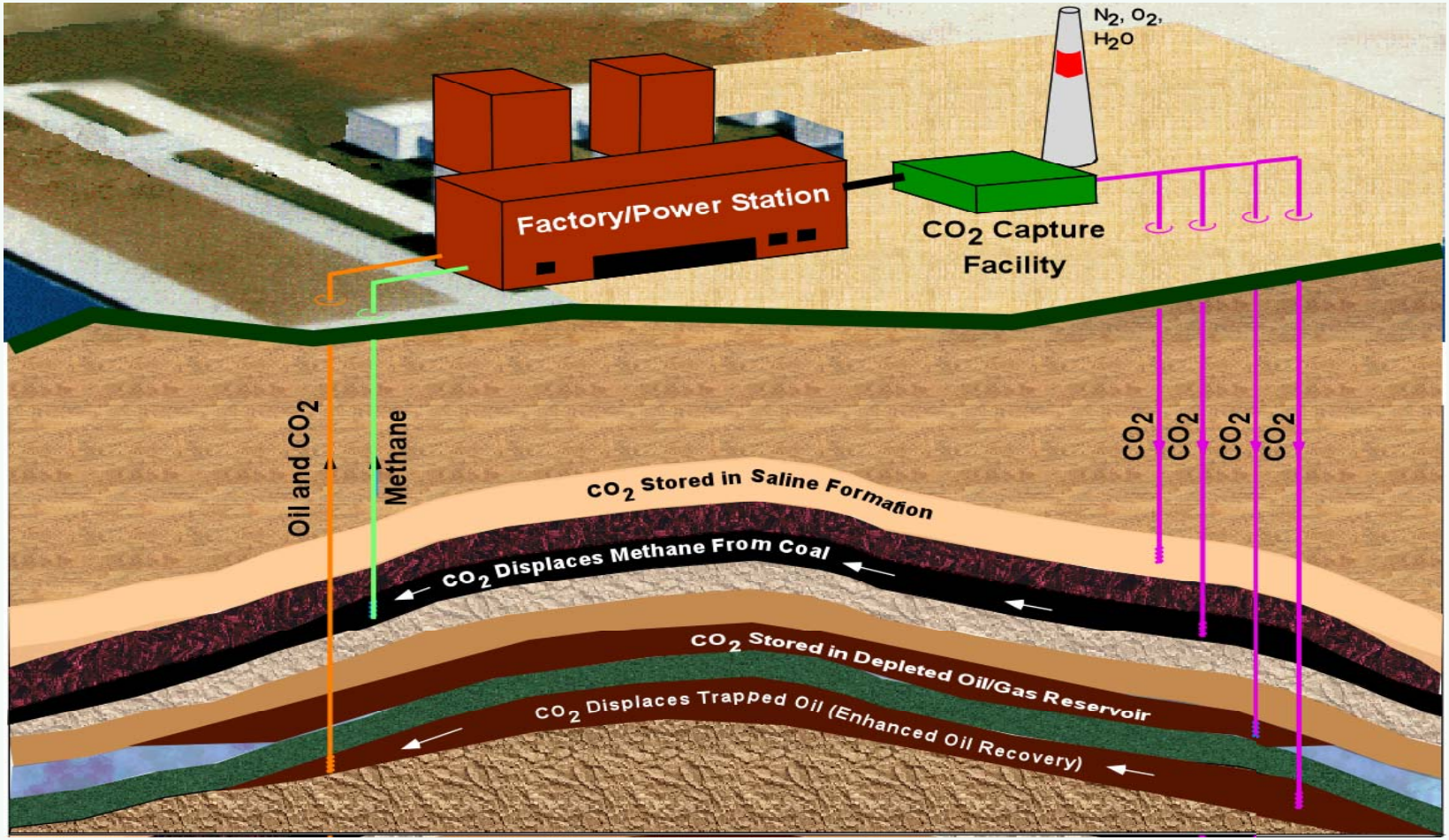
Post Combustion Decarbonisation

Precombustion Decarbonisation

Oxyfuel



Storage technology



Progress in other program areas

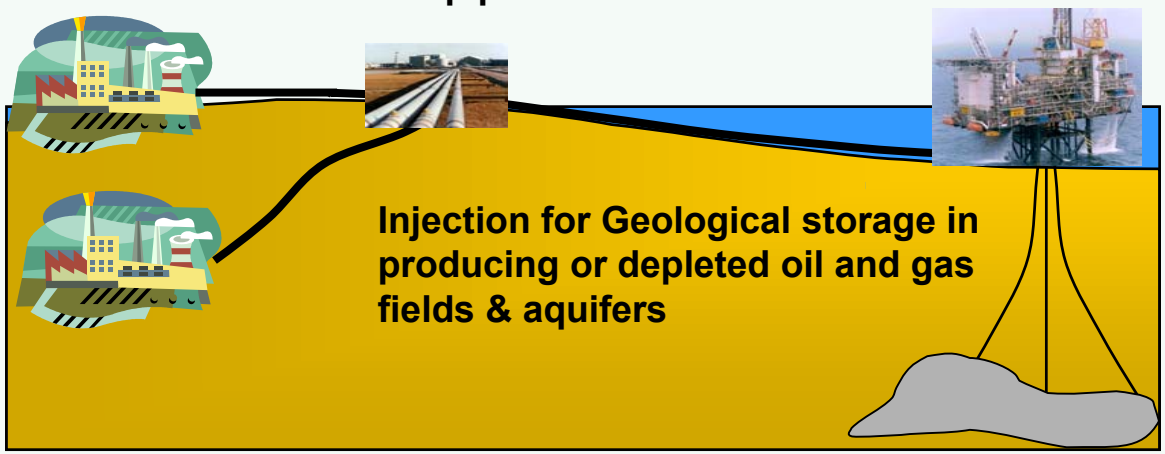
- **Common Economic Model** - methodology developed and used for cost comparison and technology selection
- **Policy and Incentives** - conducted review of current policy matters and identified opportunities and barriers for technology development and application
- **Technology Advisory Board** – meets regularly to review technology and progress
- **Communications** – Undertaken outreach activities and ramping up communications effort

CO_2 cost chain

Power & Industrial processes with CO_2 capture and conditioning

CO_2 export terminal and pipeline infrastructure

*long term monitoring costs to be determined



Conclusions

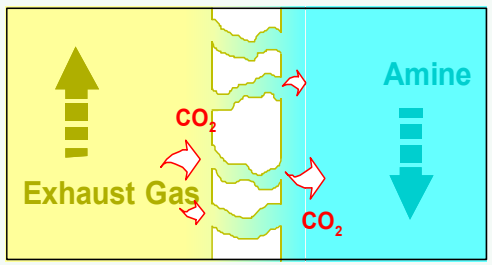
Conclusions

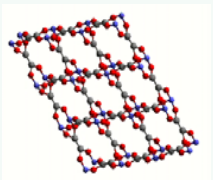
- Industry and governments have come together, on an international scale to provide strong leadership on technology development
- A portfolio of technologies with broad application are being developed and will represent state-of-the-art
- Technology R&D is producing step reductions in cost
- CO_2 sequestration must be proactively managed to reduce risks and ensure broad acceptance
- Communication and publication of results is planned
- Visit www.co2captureproject.org for more information

Capture: Summary of Progress

Post Combustion studies in progress

Process integration and standards review started
Membrane separation & advanced solvents pilot study completed
Specific, stable solid adsorbents designed and under test





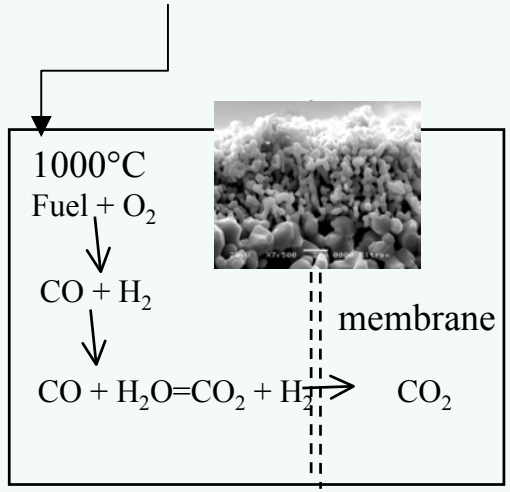
Example of solid adsorbent

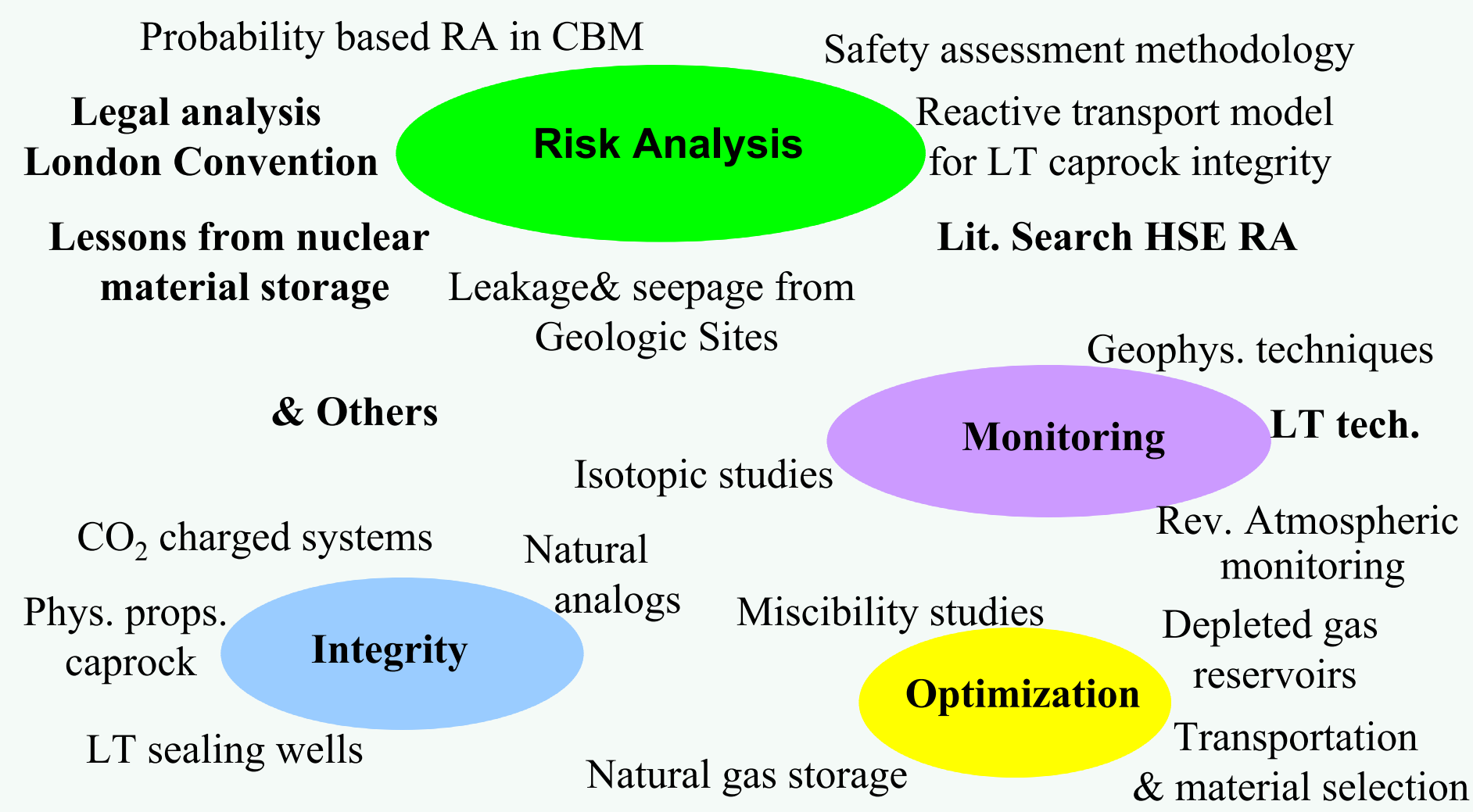
Pre-Combustion studies in progress

VLS autothermal reforming study complete
Gas turbine retrofit study to begin
Compact reformer with PSA study to begin
4 major step reduction & integration studies in final phase. I.e. membrane water gas shift, SEWGS, H_2 membrane tech. for gas turbines, H_2 membrane reformer, heaters/boilers

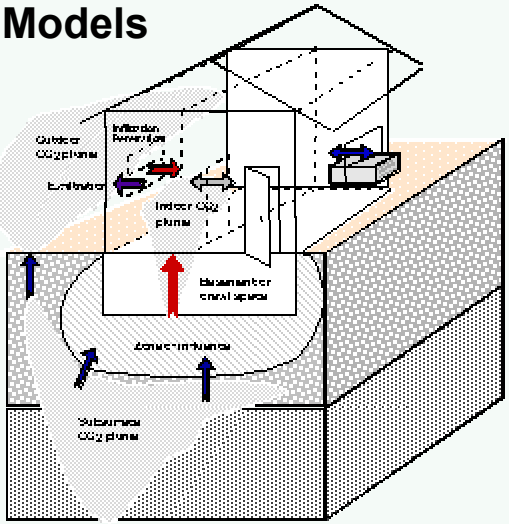
Oxyfuel studies in progress

Chemical looping , particles developed for O_2 generation in-situ . Pilot rig tests begun
Heaters and boilers conversion study almost complete

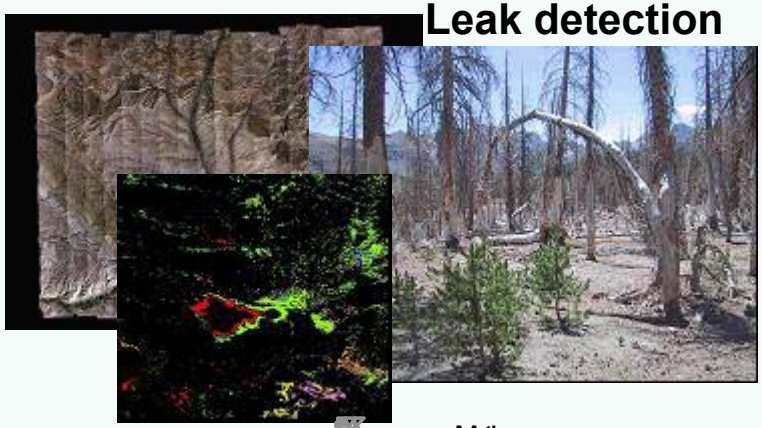



Probability based RA in CBM
Safety assessment methodology
Legal analysis
London Convention
Risk Analysis
Reactive transport model
for LT caprock integrity
Lessons from nuclear
material storage
Lit. Search HSE RA
Leakage& seepage from
Geologic Sites
Geophys. techniques
& Others
Monitoring
LT tech.
Isotopic studies
Rev. Atmospheric
monitoring
CO_2 charged systems
Natural
analogs
Phys. props.
caprock
Integrity
Miscibility studies
Depleted gas
reservoirs
Optimization
LT sealing wells
Natural gas storage
Transportation
& material selection

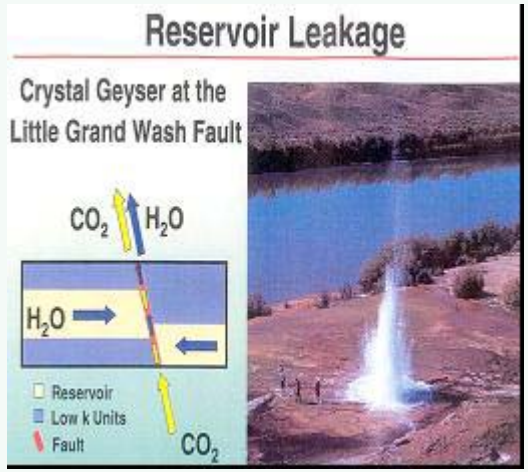
Models



Leak detection

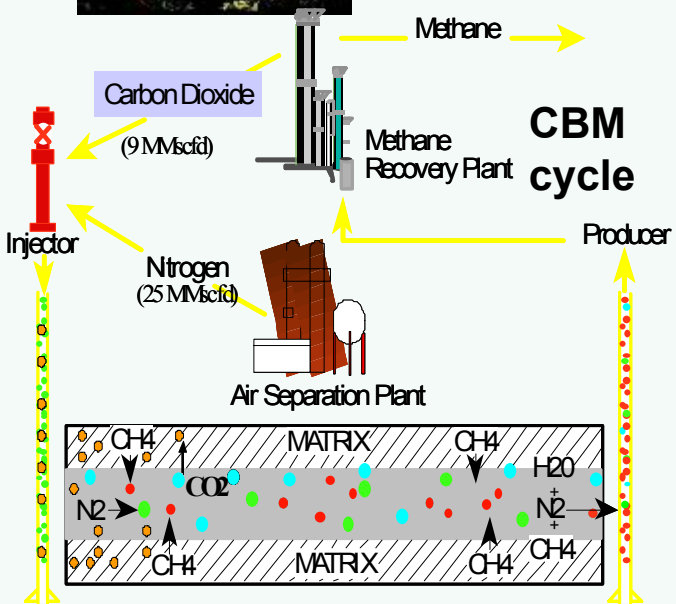


Natural analogs



Caprock mechanics

CBM cycle



Reservoir movement