

Geological CO₂ storage

General overview

1. The rationale for CO₂ sequestration

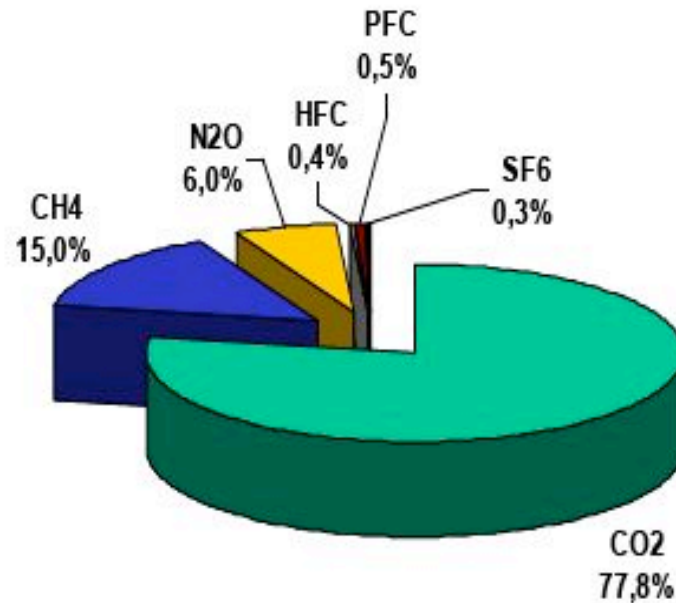
1990-2003 dans le monde: les chiffres-clés

- **PIB : +38 %**
- **Population : +19%**
- **CO₂-énergie : +21%**
- **CO₂/habitant : +1,7%**
- **CO₂/PIB : -12%**

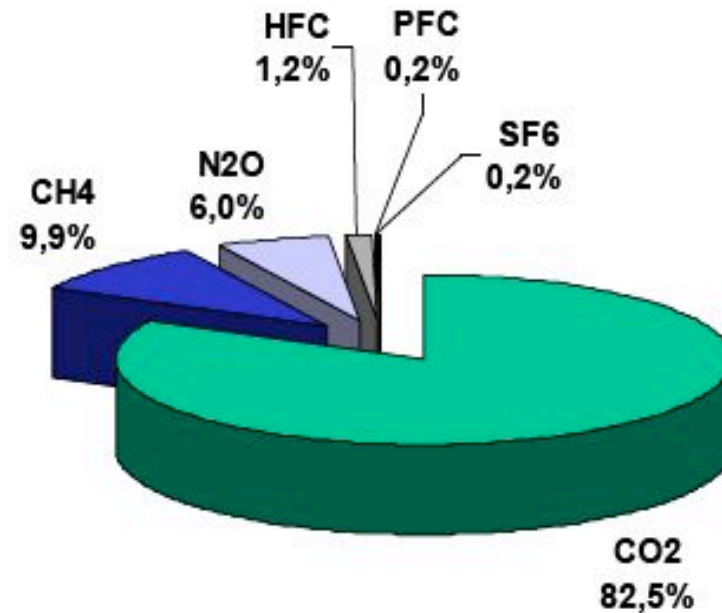
CO₂ is the main anthropogenic greenhouse gas

Le CO₂ pèse pour plus de 80% dans les émissions de gaz à effet de serre et sa part progresse depuis 1990

Répartition des Emissions
Totales de GES par Gaz
- 1990 -



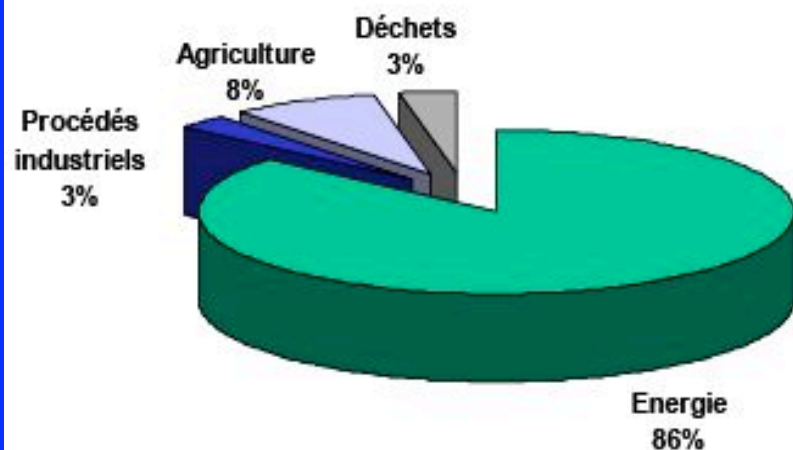
Répartition des Emissions
Totales de GES par Gaz
- 2002 -



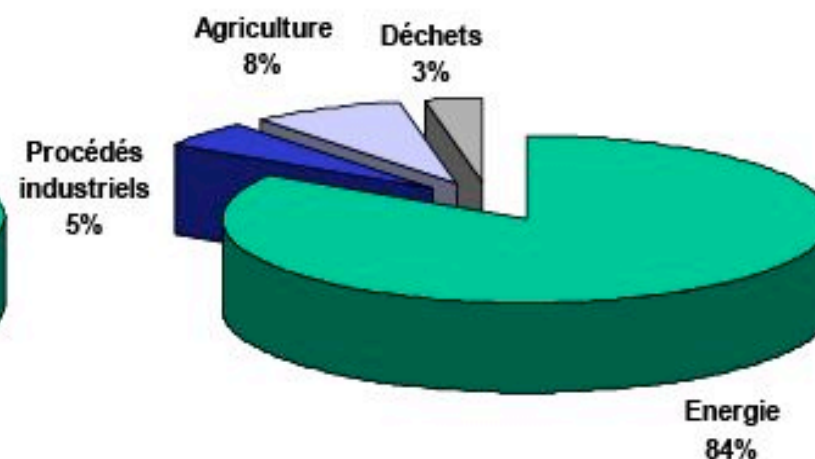
CO₂ : Energy and Transport

L'énergie pèse pour 85% dans les émissions de GES

Répartition des Emissions
Totales de GES par Secteur
- 1990 -



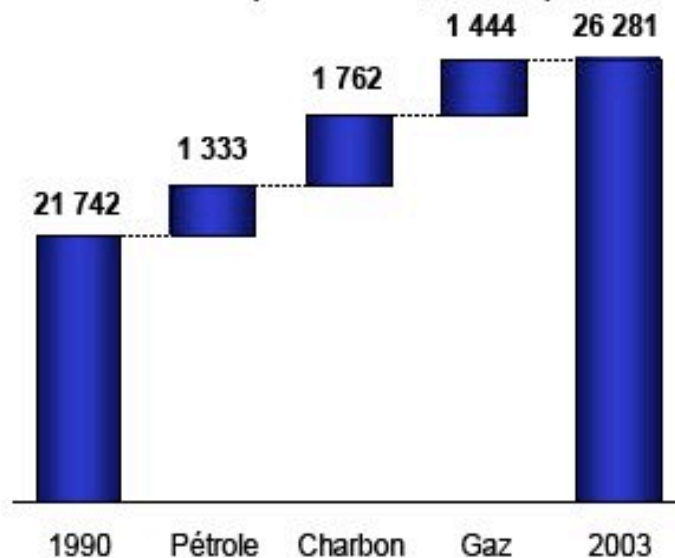
Répartition des Emissions
Totales de GES par Secteur
- 2002 -



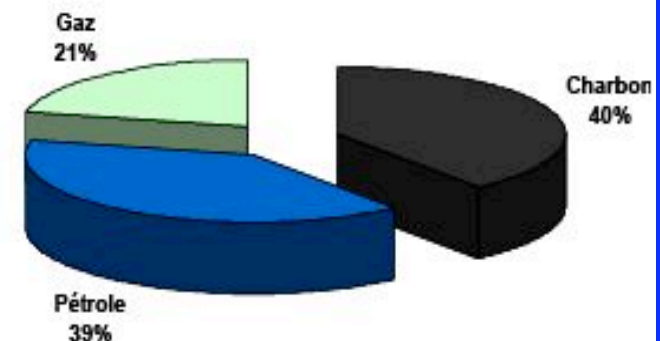
Fossil fuels

Le CO₂-énergie dans le monde par source d'émissions en 2003

Evolution des Emissions de CO₂-énergie par source (1990-2003; MtCO₂)

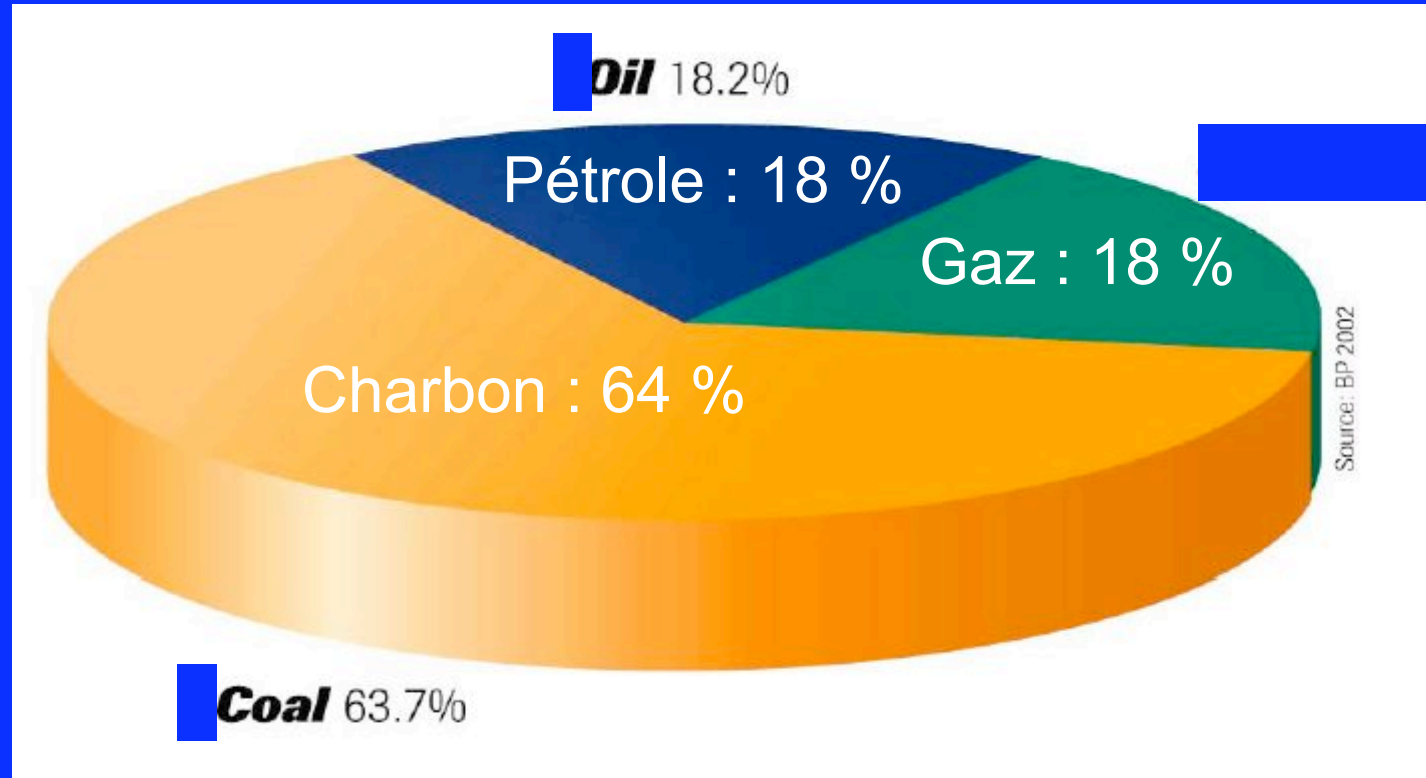


Répartition des Emissions de CO₂-énergie par Source (2003, en %)



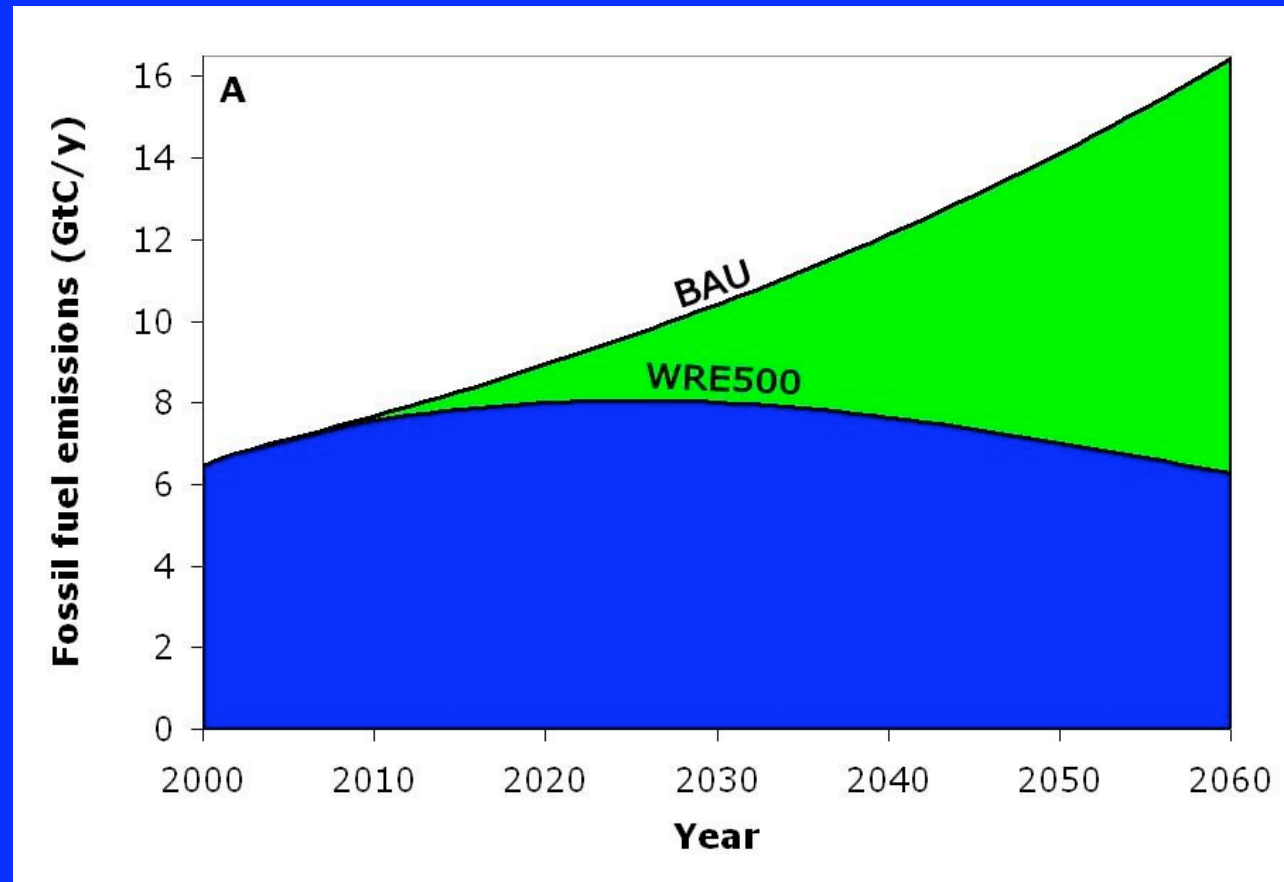
- > Le charbon est la principale source d'émission dans le monde en 2003
- > depuis 1990, l'accroissement des émissions est principalement dû au charbon
 - charbon : 39%
 - gaz : 32%
 - pétrole 29%

Fossil fuels : future



- Oil : 40 yrs
- Gas : 100 yrs
- Coal : 1000 yrs

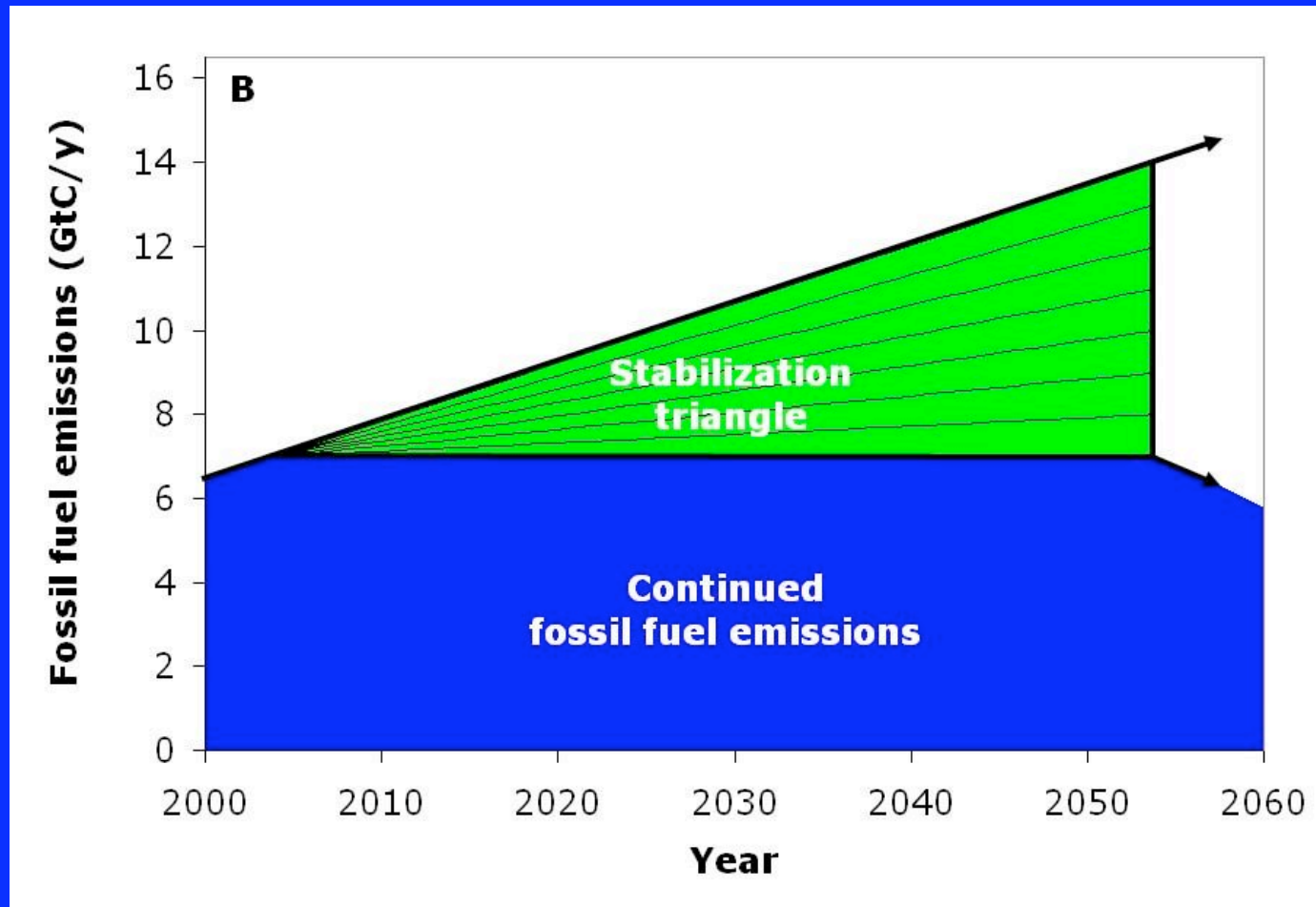
CO₂ emissions : future



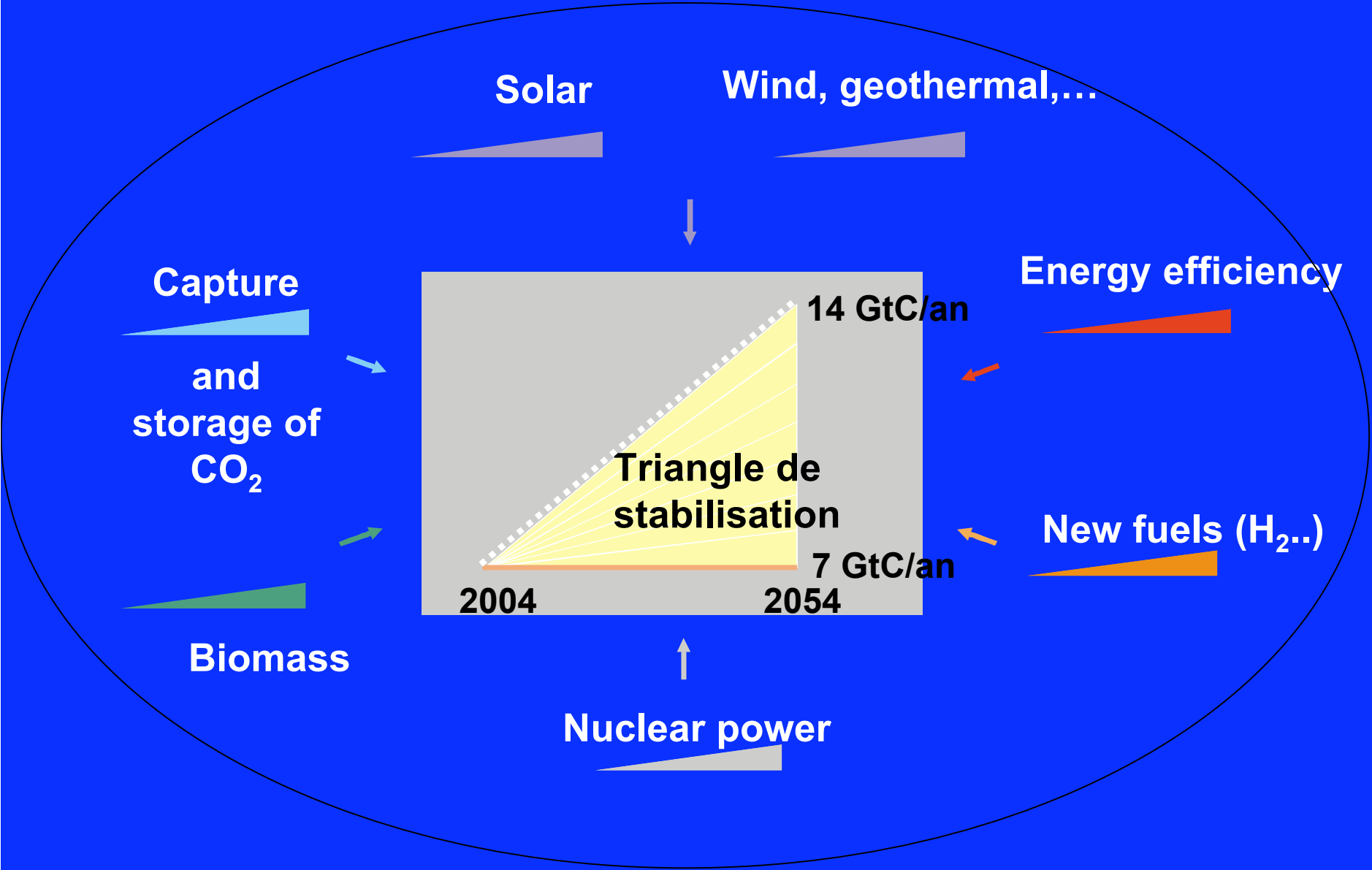
Two models:

- BAU (Business as usual) :
- WRE500: Wigley, Richels, Edmonds (stabilisation at 500 ppm).

The “stabilization triangle” (after Sokolow, 2004)



Components of the stabilization triangle



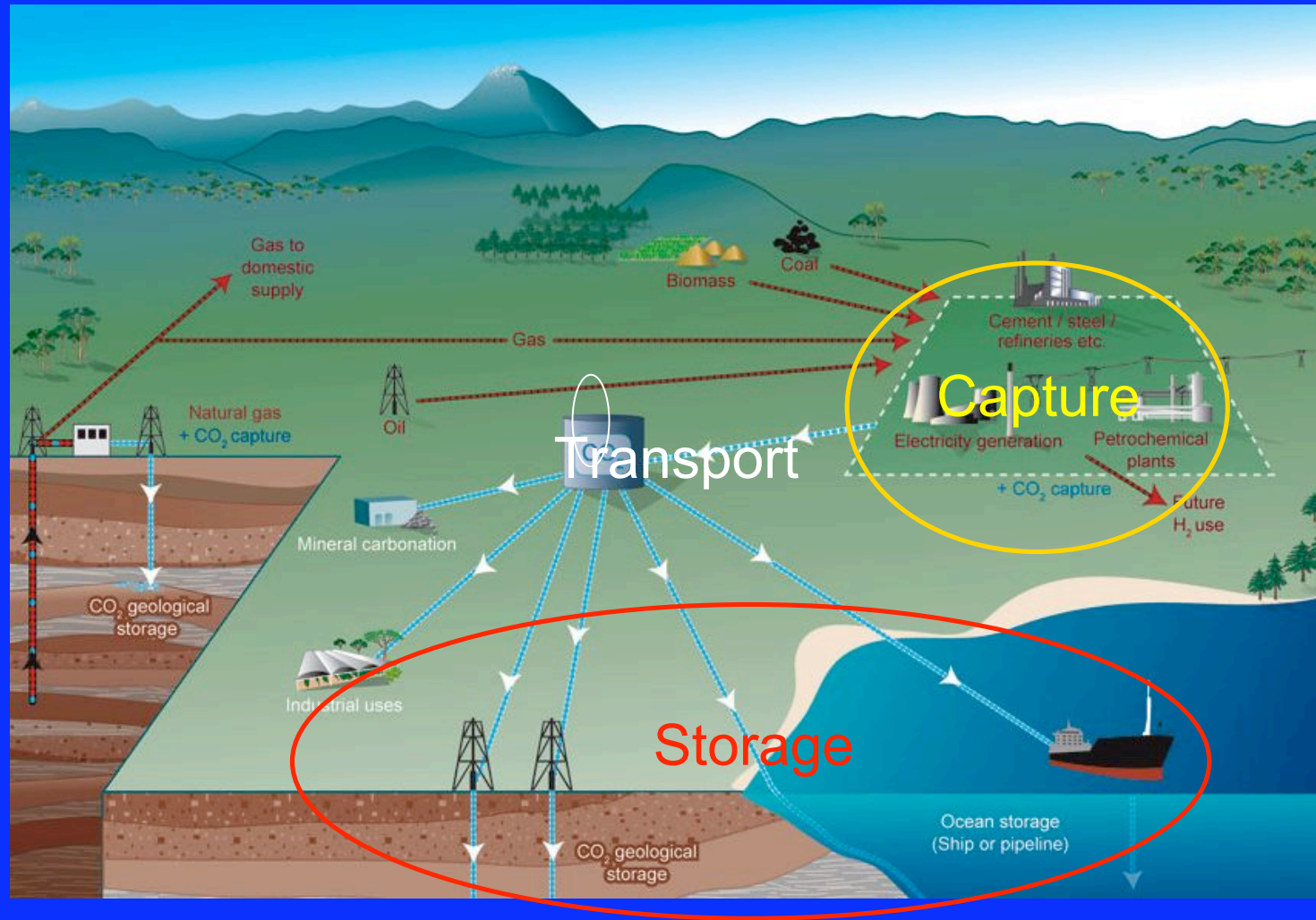
2. How to implement CO₂ sequestration on a large scale?

Capture of CO₂

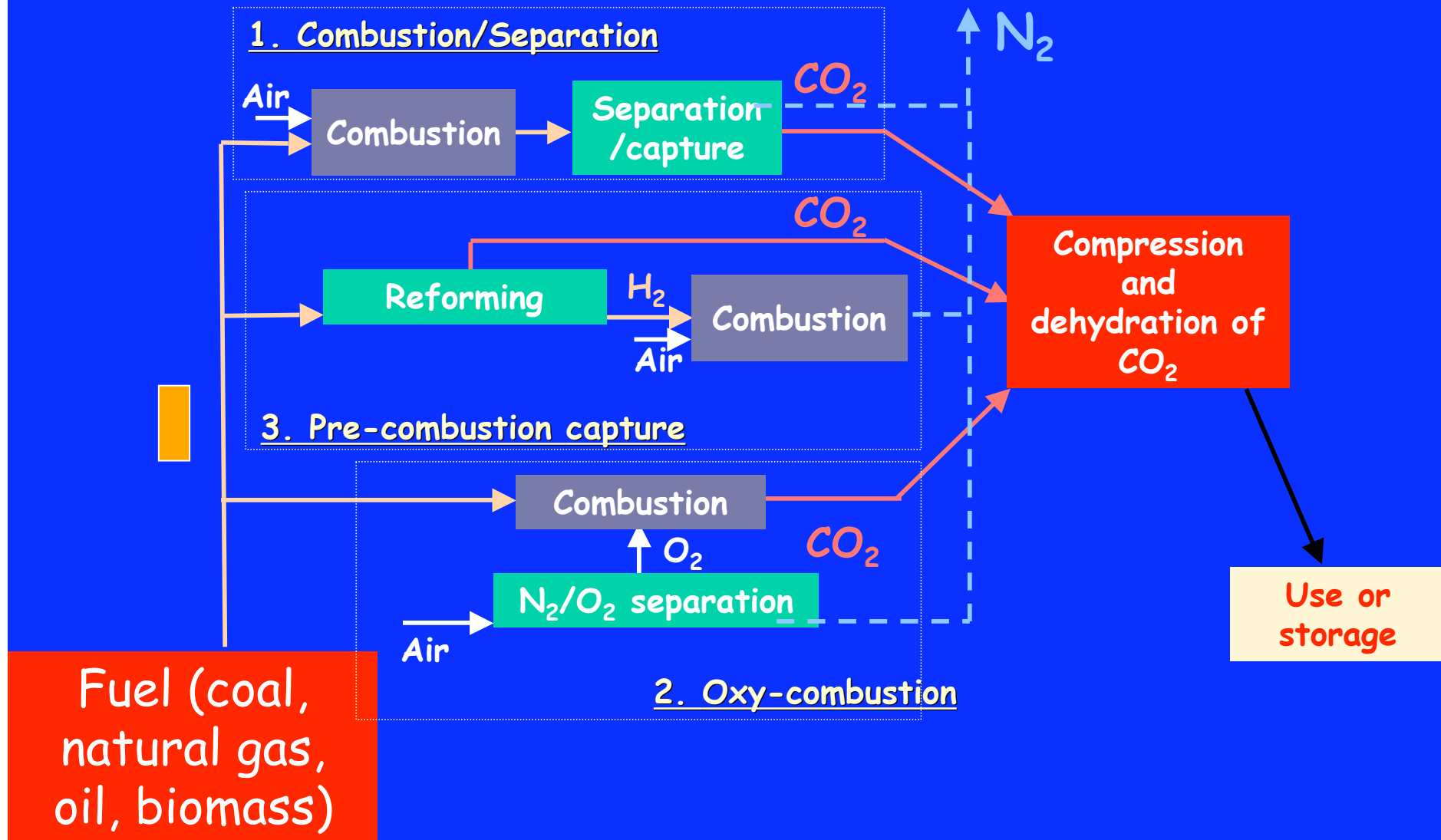
(source > 0.1 MtCO₂/an)

Process	No. of sources	Emissions (MtCO ₂ /yr)
Fossil Fuels		
Power (coal, gas, oil and others)	4,942	10,539
Cement production	1,175	932
Refineries	638	798
Iron and steel industry	269	646
Petrochemical industry	470	379
Oil and gas processing	N/A	50
Other sources	90	33
Biomass		
Bioethanol and bioenergy	303	91
Total	7,887	13,466

The general scheme



Capture of CO₂

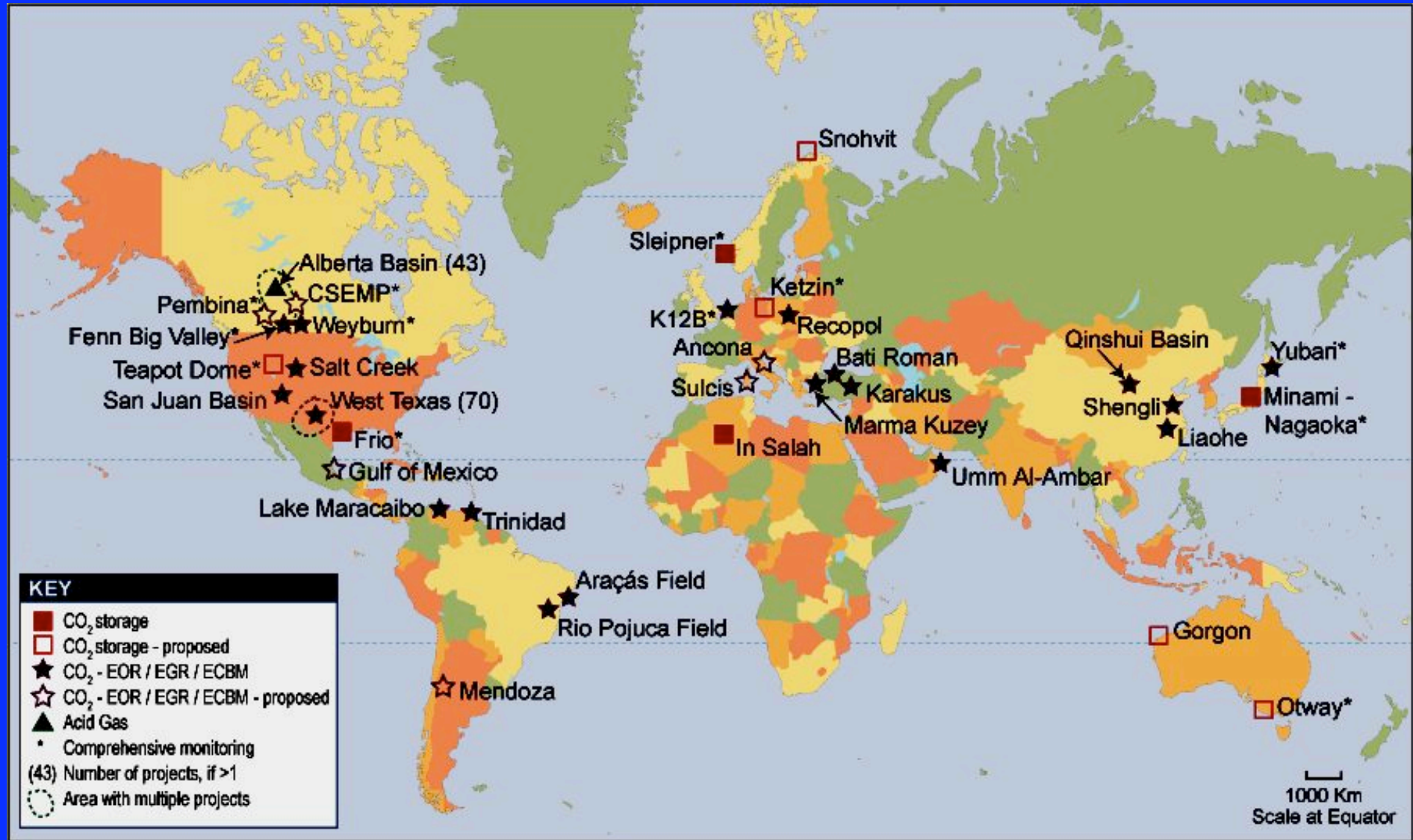


CO₂ capture and storage component costs

CCS component	Cost
Capture from a power plant	15 - 75 US\$/tCO ₂ net captured
Capture from gas processing or ammonia production	5 - 55 US\$/tCO ₂ net captured
Capture from other industrial sources	25 - 115 US\$/tCO ₂ net captured
Transportation	1 - 8 US\$/tCO ₂ transported per 250km
Geological storage	0.5 - 8 US\$/tCO ₂ injected
Ocean storage	5 - 30 US\$/tCO ₂ injected
Mineral carbonation	50 - 100 US\$/tCO ₂ net mineralized

The issue of geological storage of CO₂ is not (generally) a matter of cost-reducing technologies (unlike capture). It is rather a matter of reliability, safety, and of general understanding and acceptance.

Pilot sites (2005)



2007 Main examples

Site	Country	Begin	injection (tCO ₂ /day)	Total goal (tCO ₂)	Type
Weyburn	Canada	2000	5000	20 000 000	EOR
In Salah	Algeria	2004	3 000 – 4 000	17 000 000	Gas field
Sleipner	Norway	1996	3 000	20 000 000	Aquifer
K12B	NL	2004	100	8 000 000	EGR
Frio	USA	2004	177	1 600	Aquifer