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WHY CCS?

Stabilization of GHG emissions
Overview of Carbon Management
Portfolio Solutions

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The Need for an Integrated and Holistic Socio-Economic Approach to Carbon Planning -The Brazilian Case –

CSLF South Africa 2008

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AGENDA

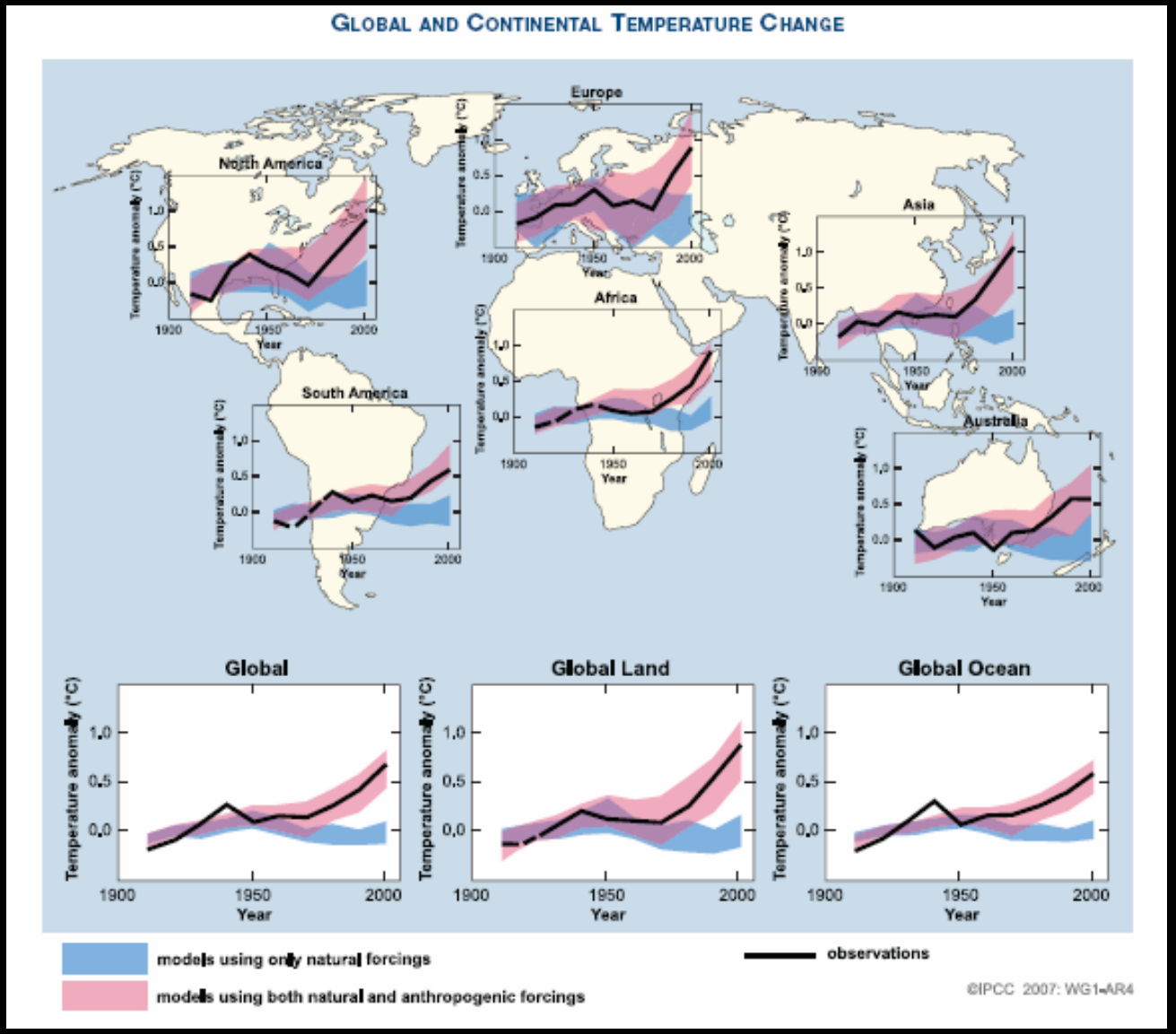
INTRODUCTION
Climate change, What is CCS?, CCS options, Analogs, Monitoring

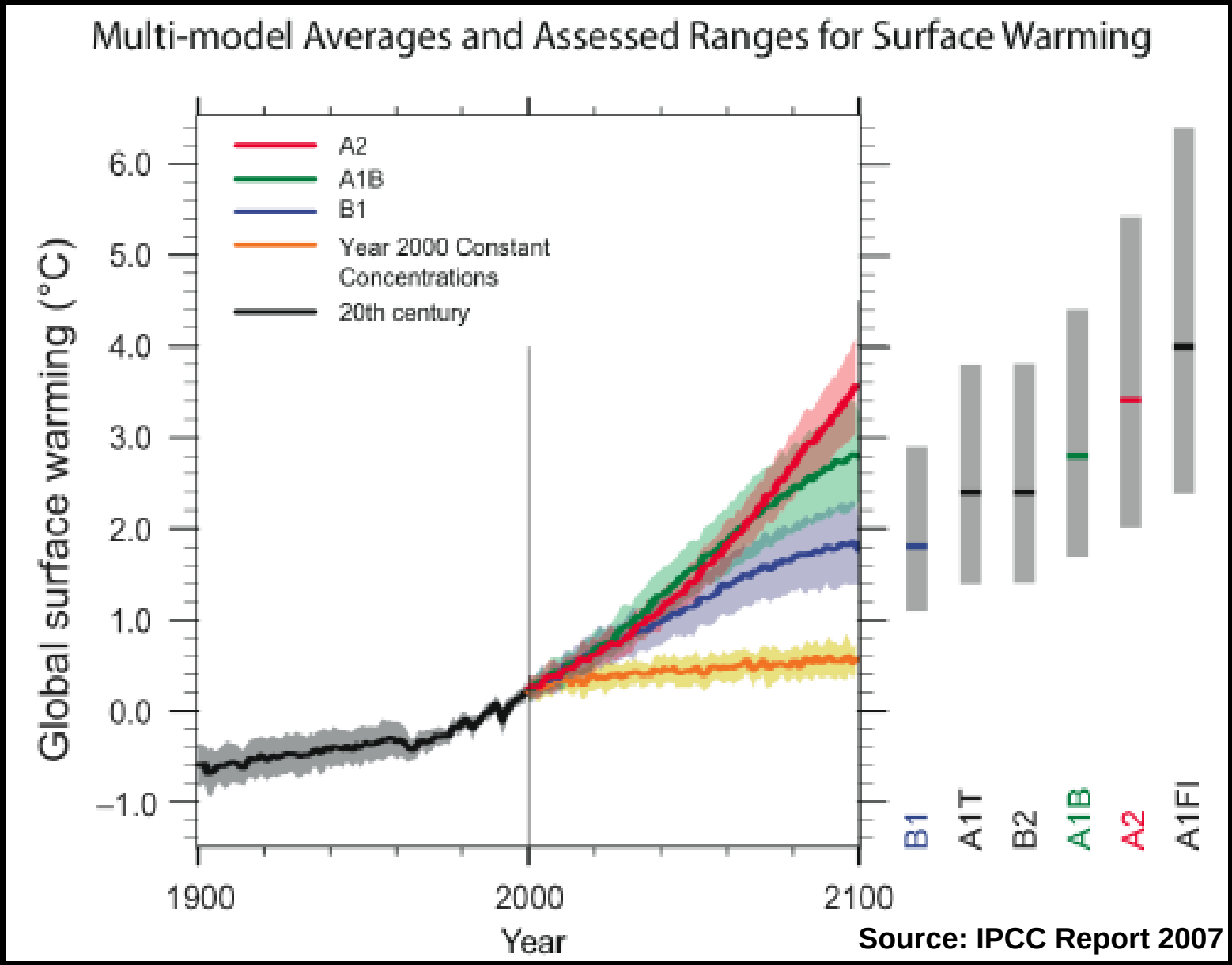
WHY CCS?
Scale of the problem, Scale of the solutions, The role of CCS

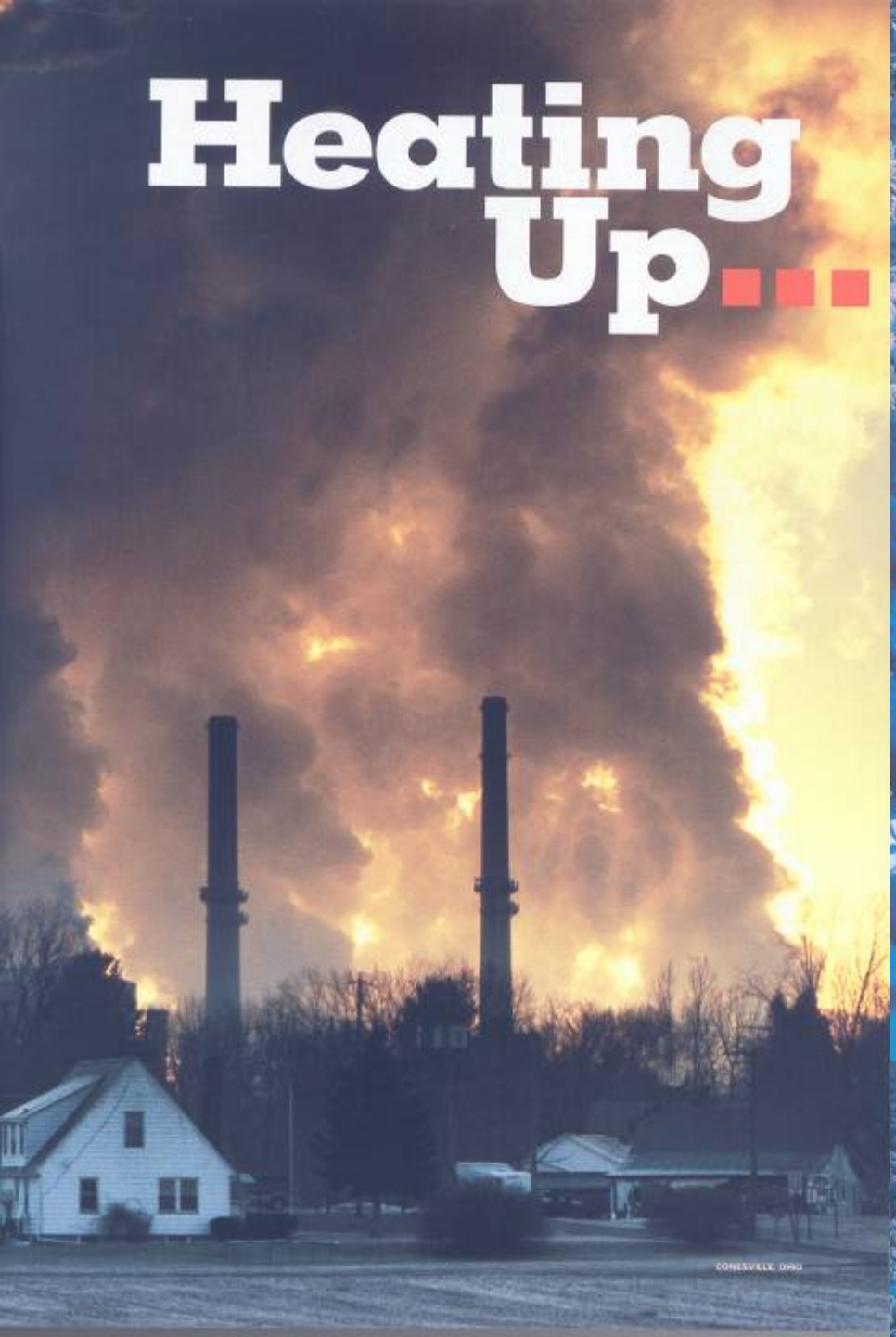
WHY NOT CCS?
Can we safely do CCS? How to deploy CCS?

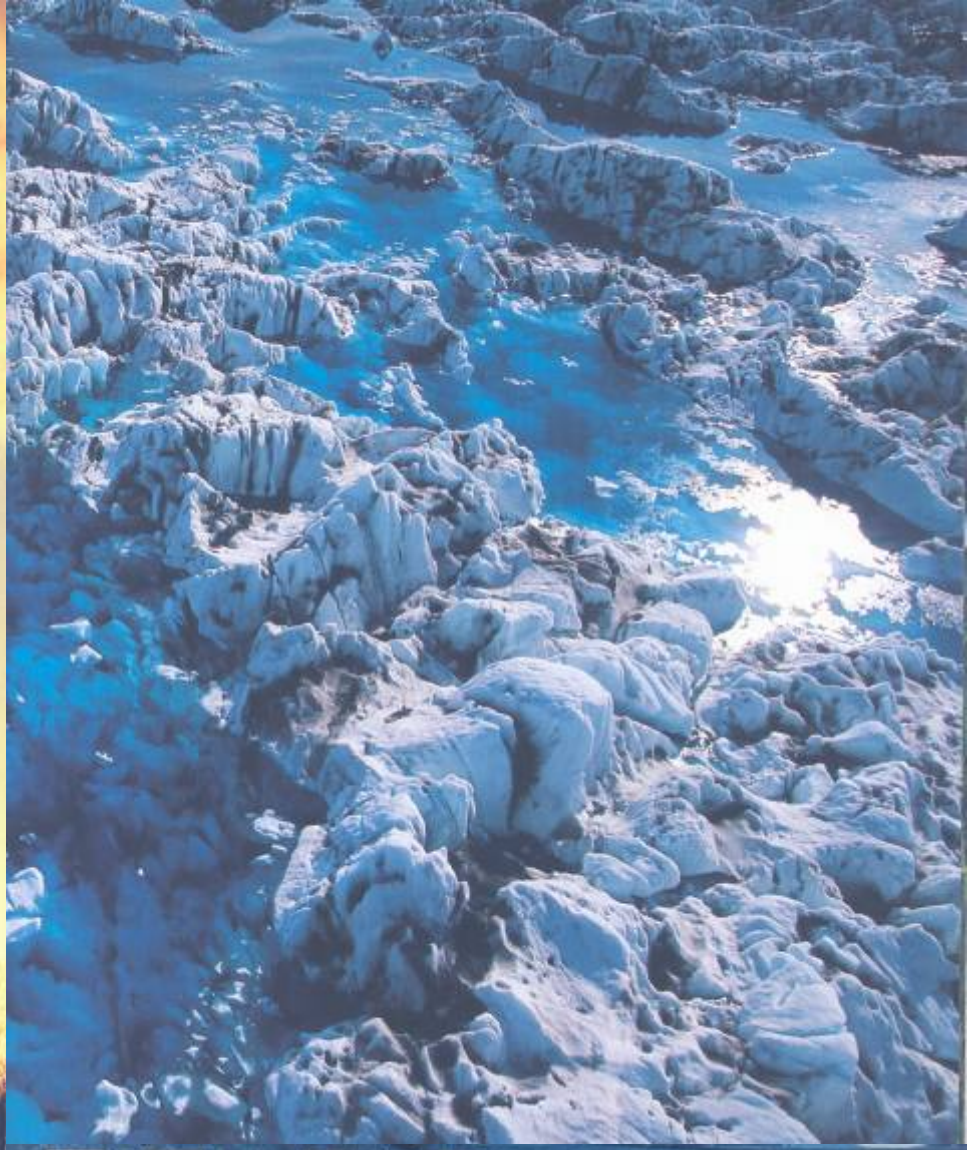
FINAL REMARKS

The question of “Why CCS” only makes sense if climate change is induced by human kind…




Multi-model Averages and Assessed Ranges for Surface Warming
Global surface warming (°C)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
−1.0
A2
A1B
B1
Year 2000 Constant Concentrations
20th century
1900
2000
2100
Year
B1
A1T
B2
A1B
A2
A1FI
Source: IPCC Report 2007

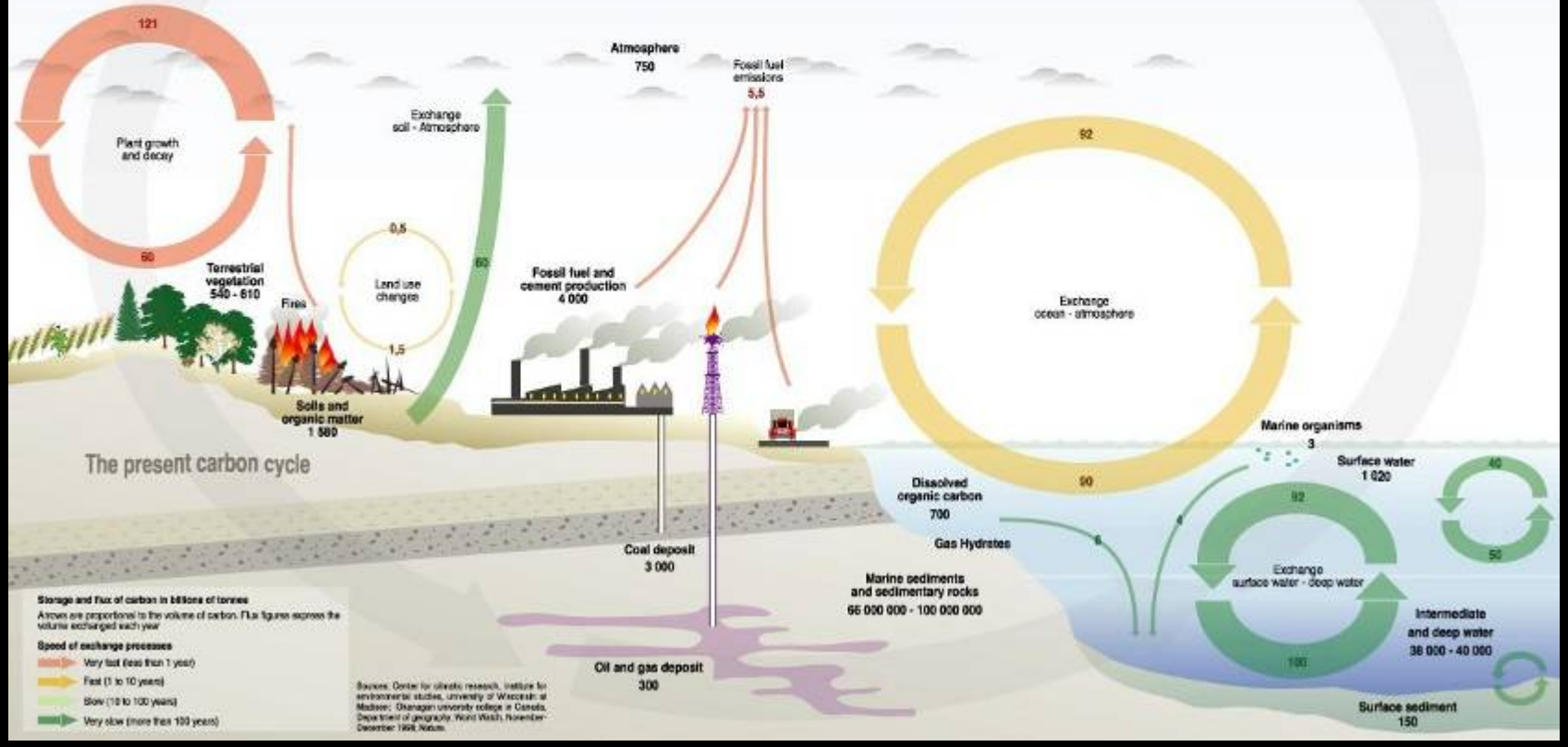

Heating Up...



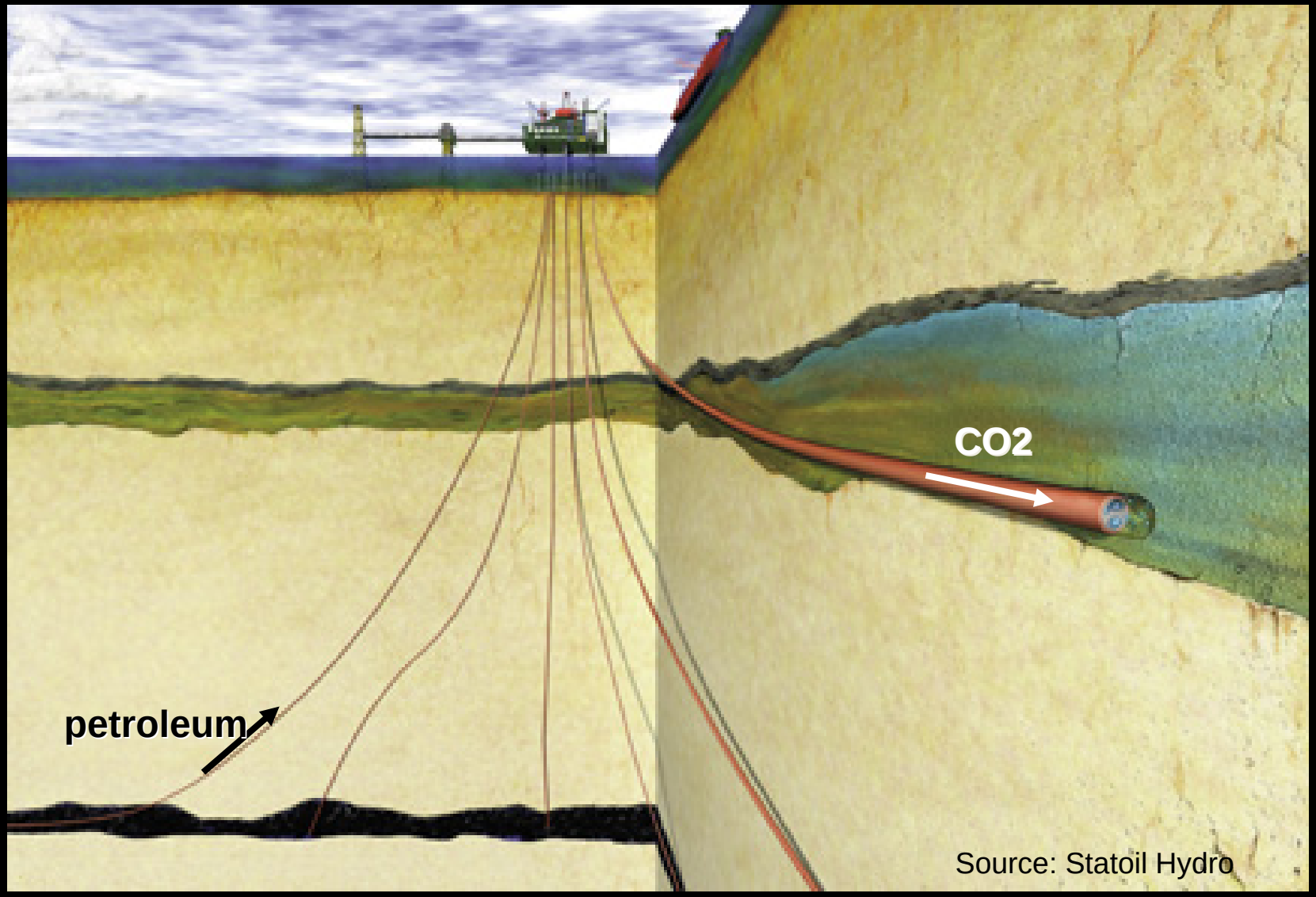

Melting Down...

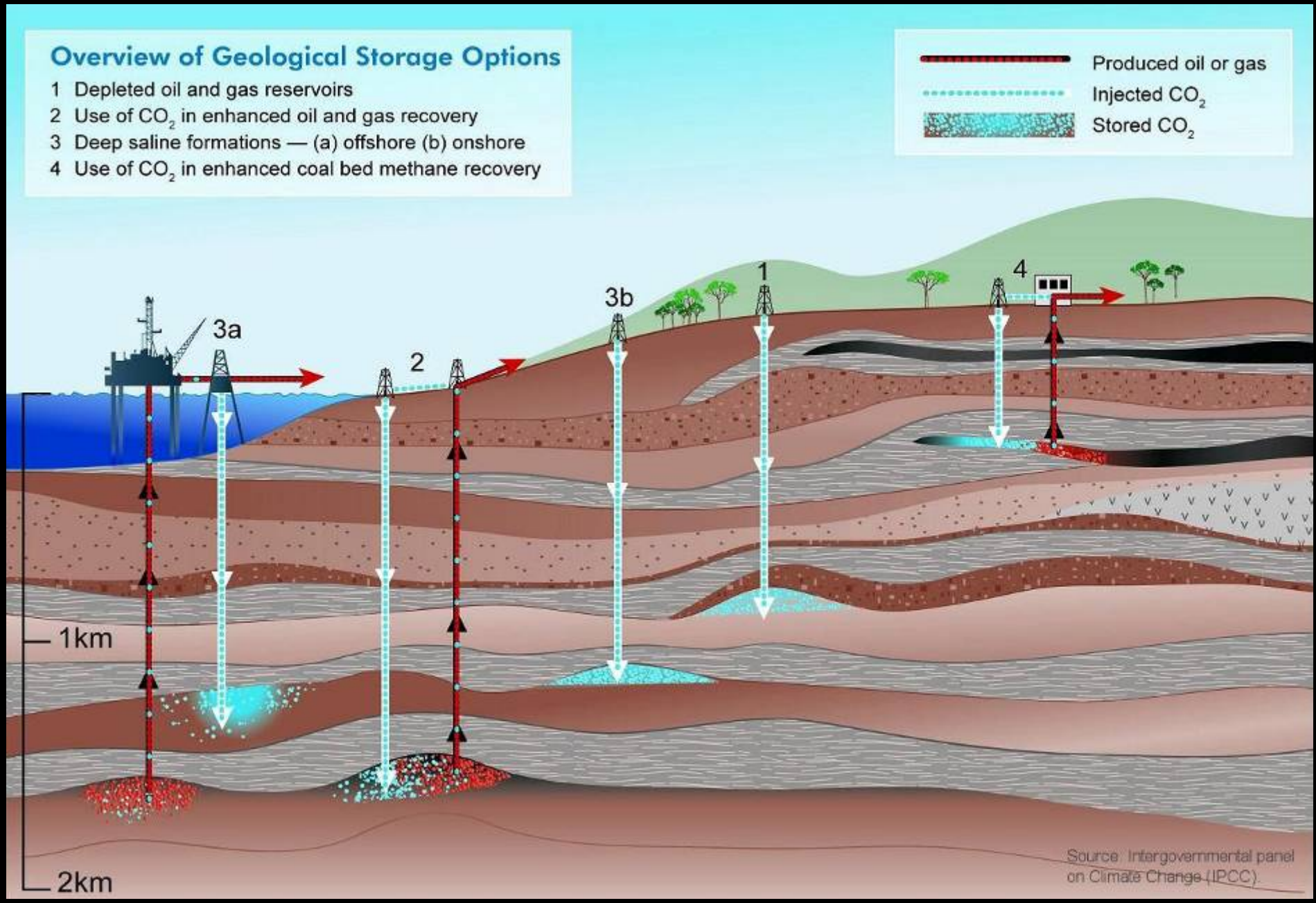
What is CCS?

CCS is an intervention in the Carbon Cycle to compensate accumulation of GHG in the atmosphere



CCS principle: “Putting carbon back to the ground”.




Overview of Geological Storage Options
1 Depleted oil and gas reservoirs
2 Use of CO_2 in enhanced oil and gas recovery
3 Deep saline formations — (a) offshore (b) onshore
4 Use of CO_2 in enhanced coal bed methane recovery
Produced oil or gas
Injected CO_2
Stored CO_2
1
2
3a
3b
4
1km
2km
Source: Intergovernmental panel on Climate Change (IPCC)

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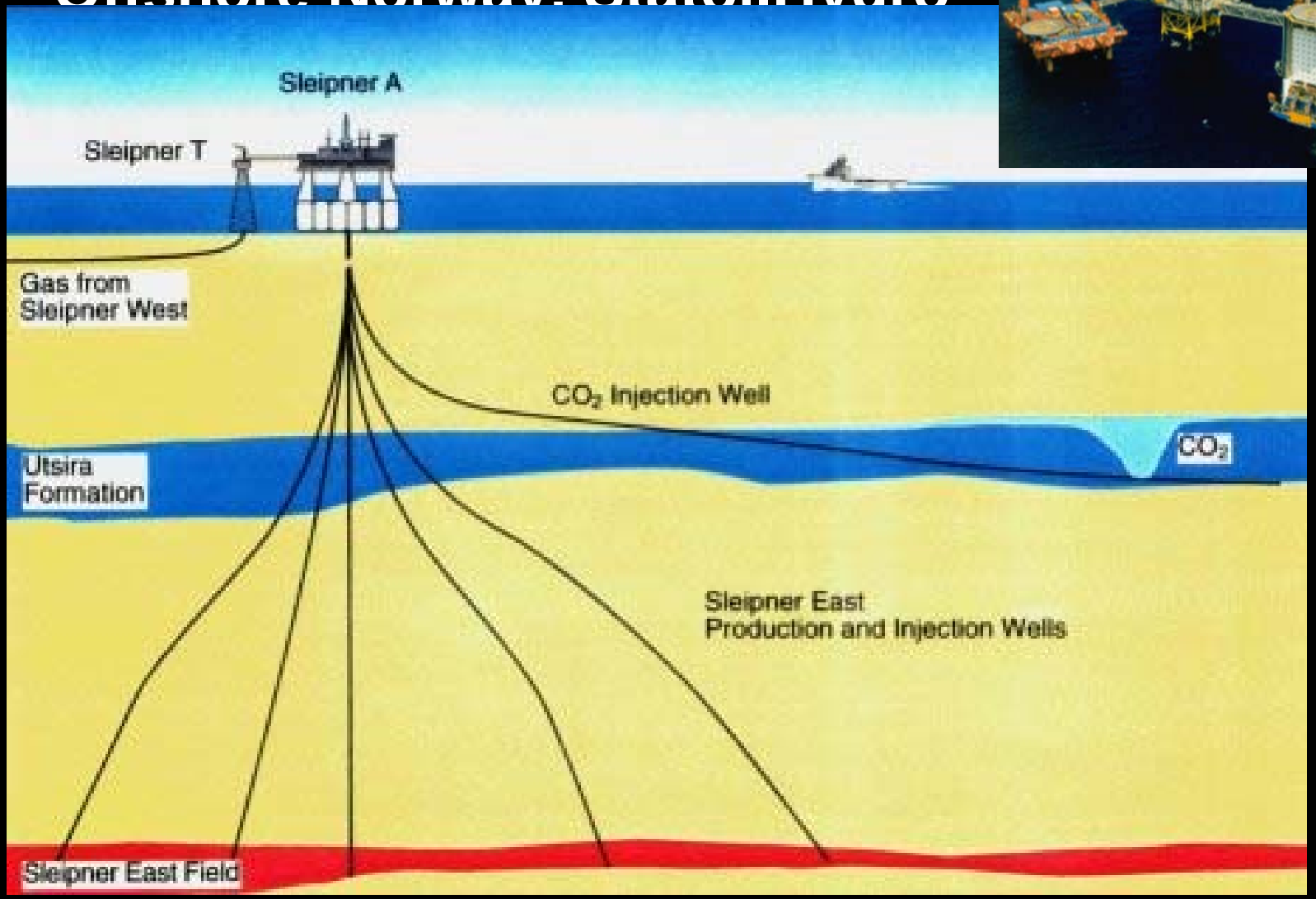
In Salah Project, Algeria (BP)

Source: BP

SACS (Saline Aquifer CO2 Storage)
Offshore Norway, StatoilHydro



How CO_2 remains stored in geological formations?

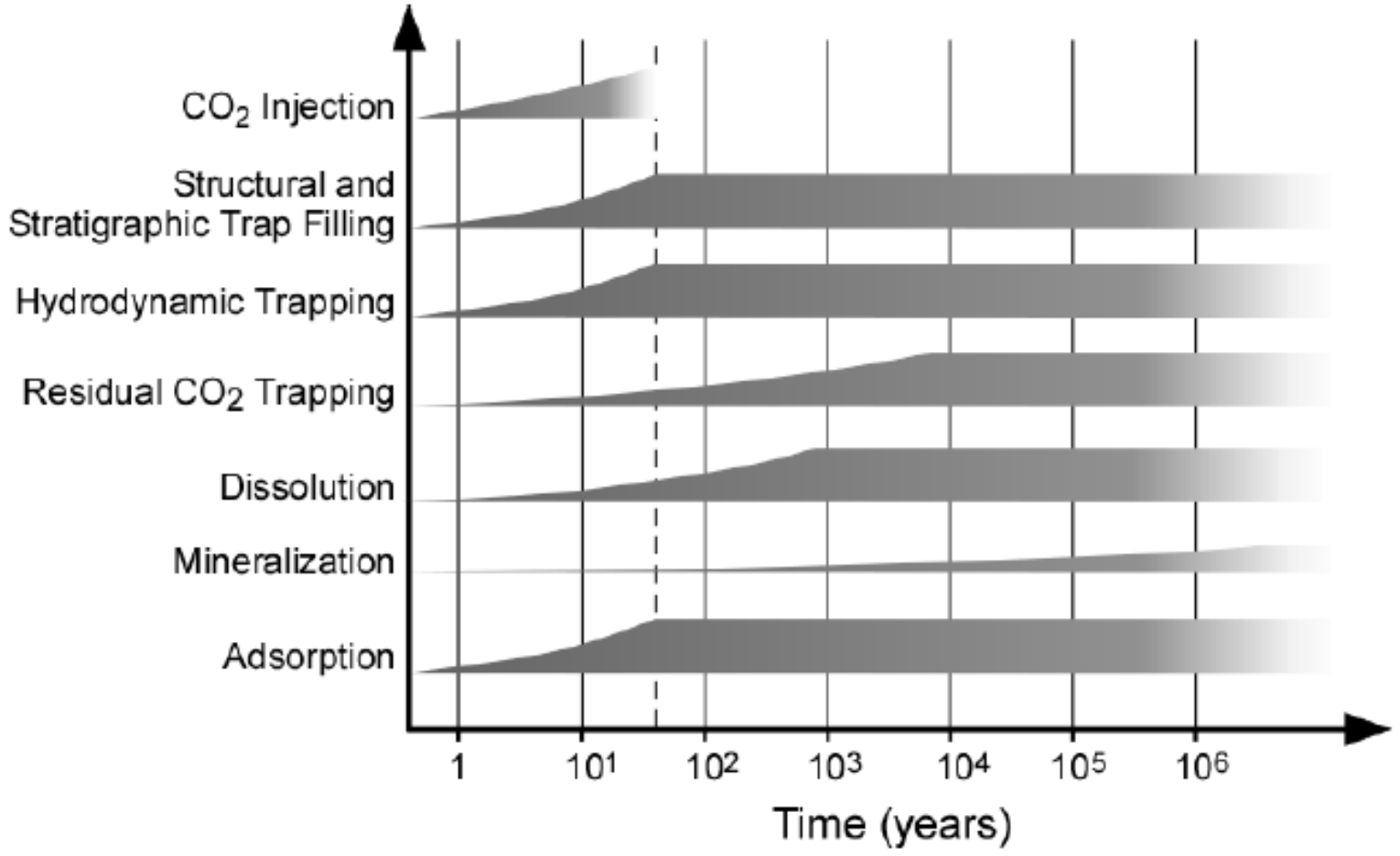
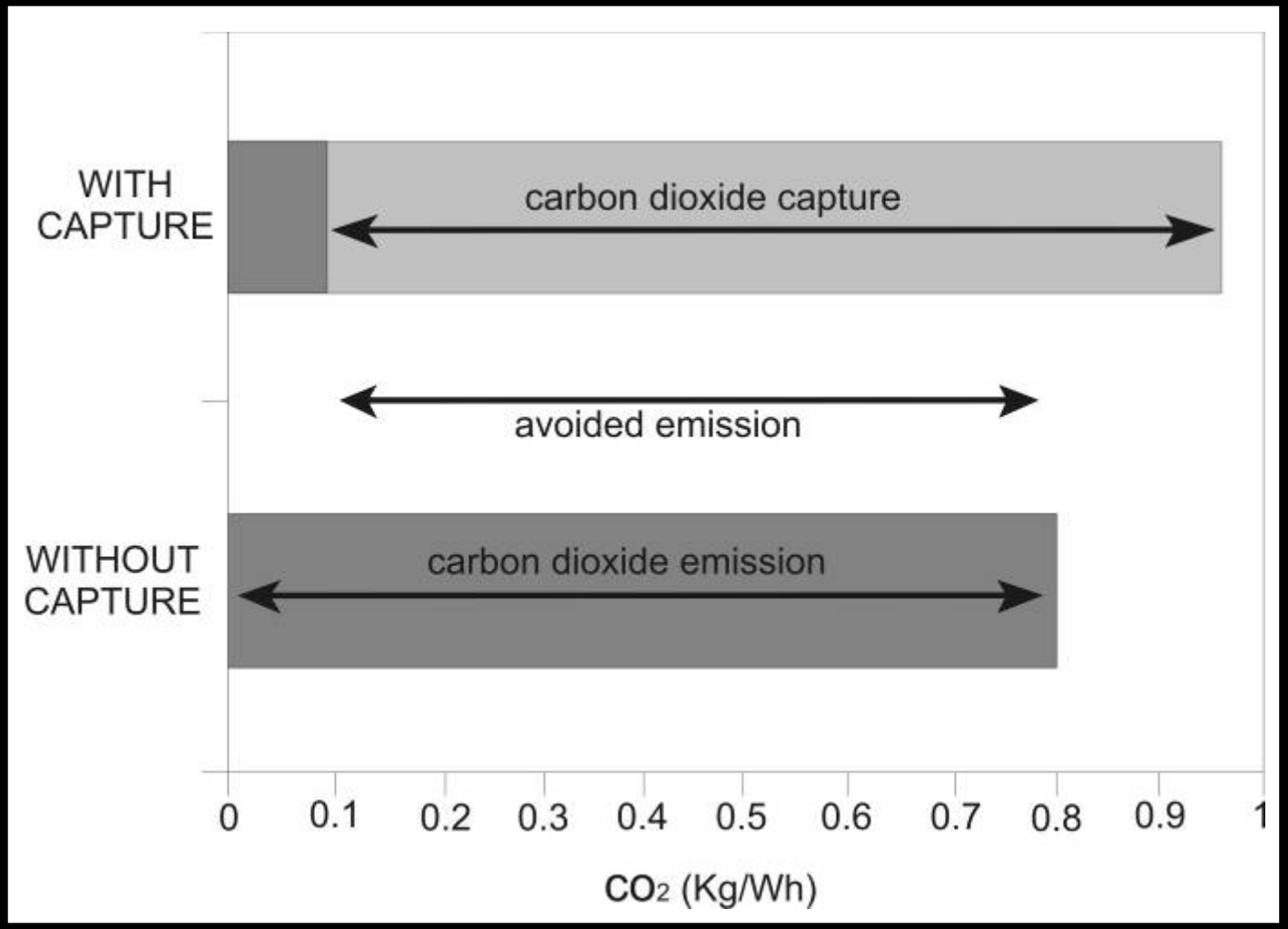


Figure 1. Operating time frame of various CO_2 geological-storage mechanisms (modified from IPCC, 2005).

CCS is expensive and less efficient (e.g., 25%)



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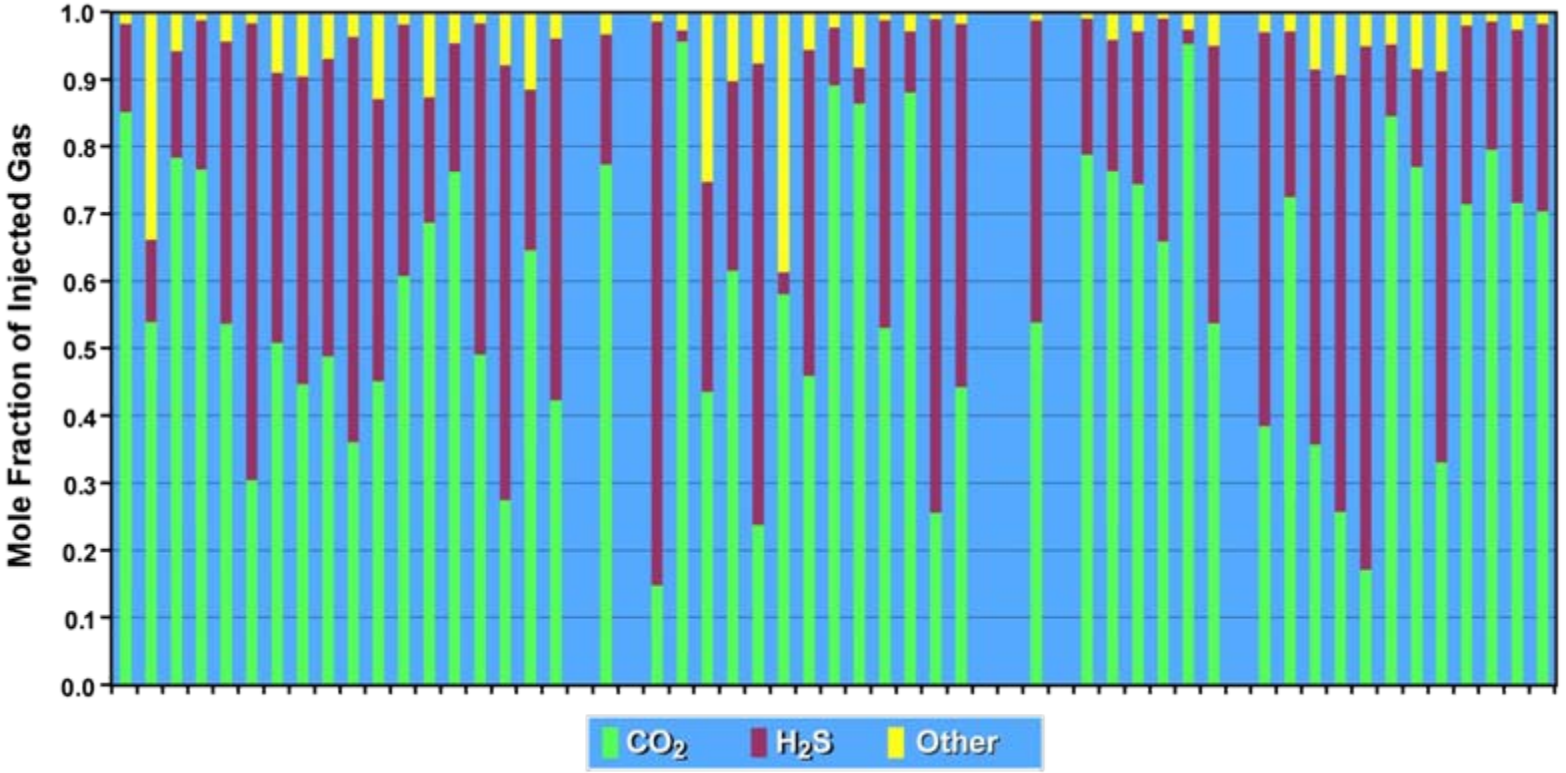
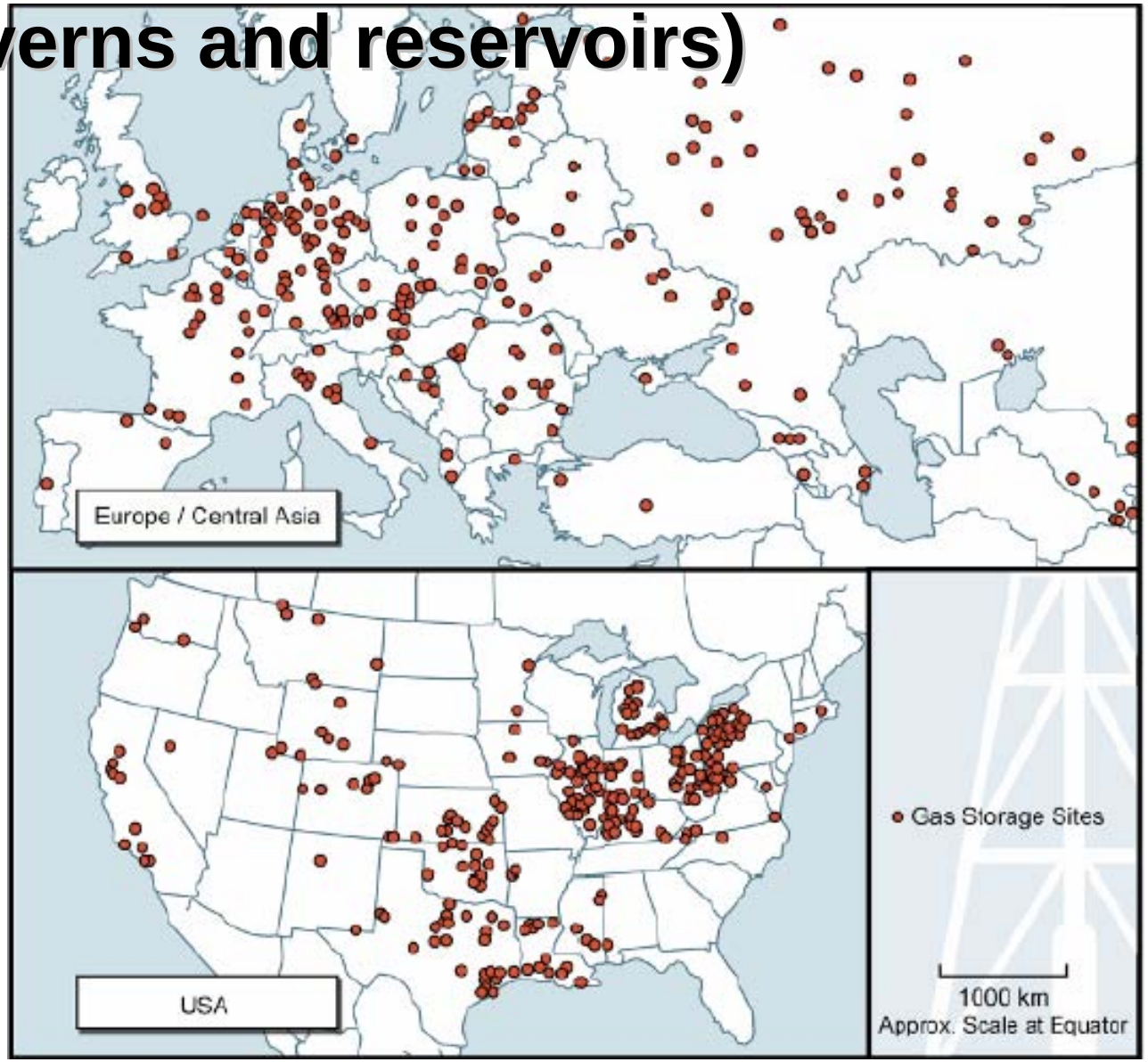
Analogs for CO_2 storage

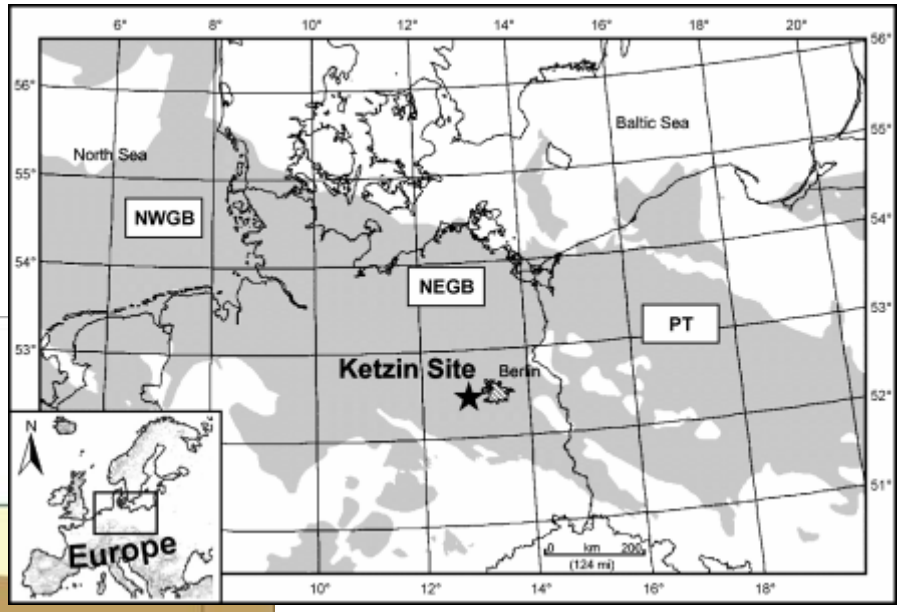
Acid gas storage in Canada

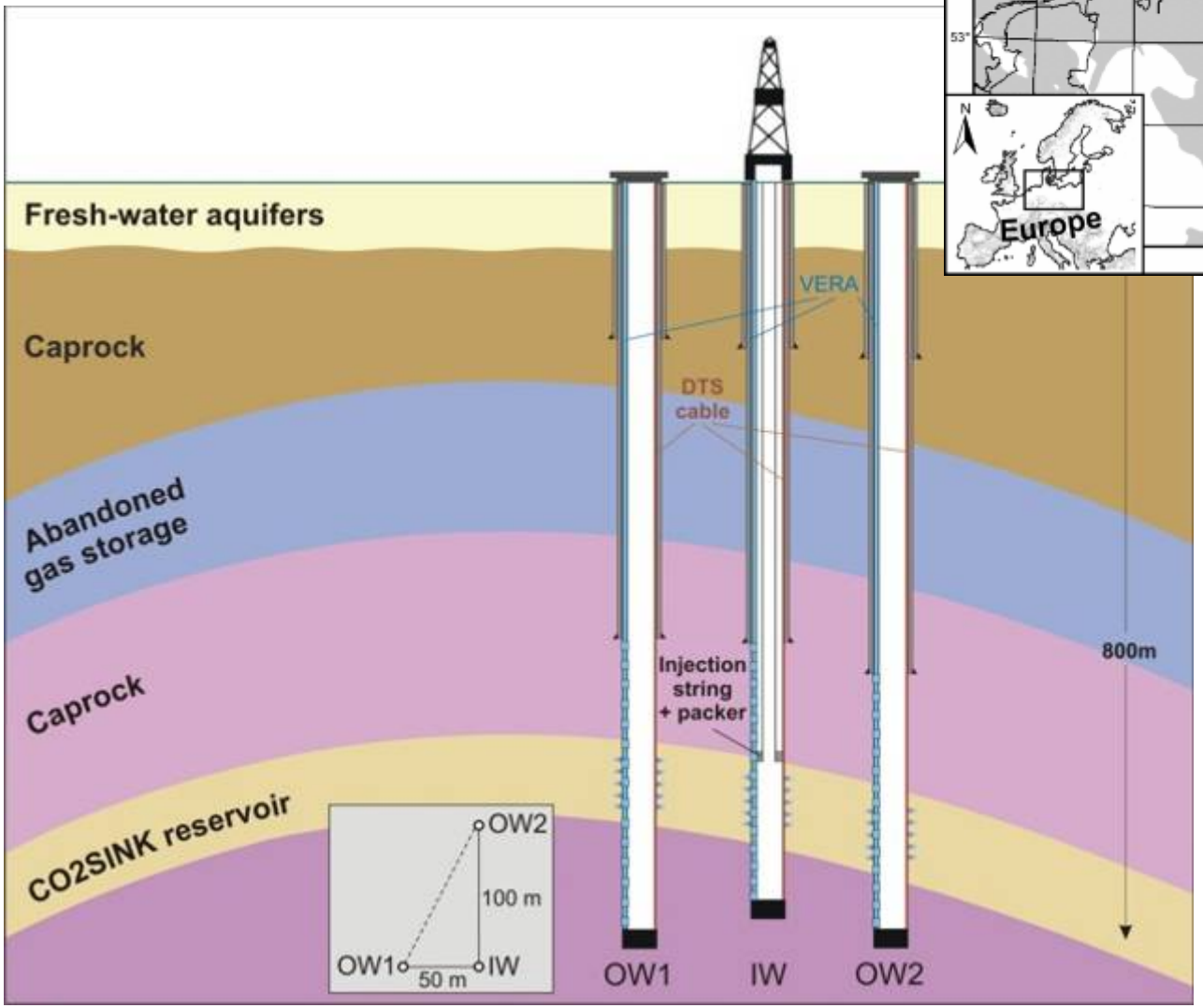


Natural gas storage sites in Europe and USA
(caverns and reservoirs)

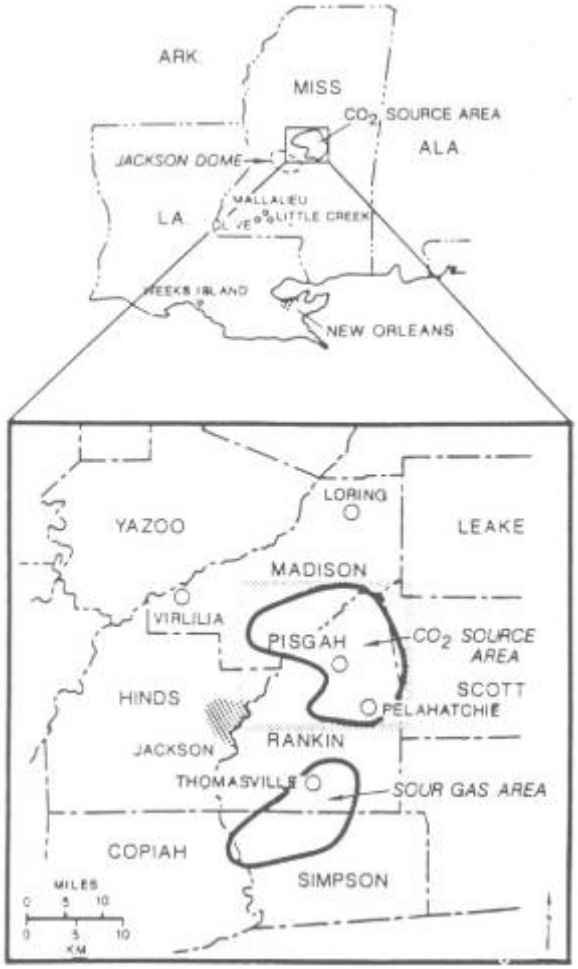


The Ketzin site, Germany

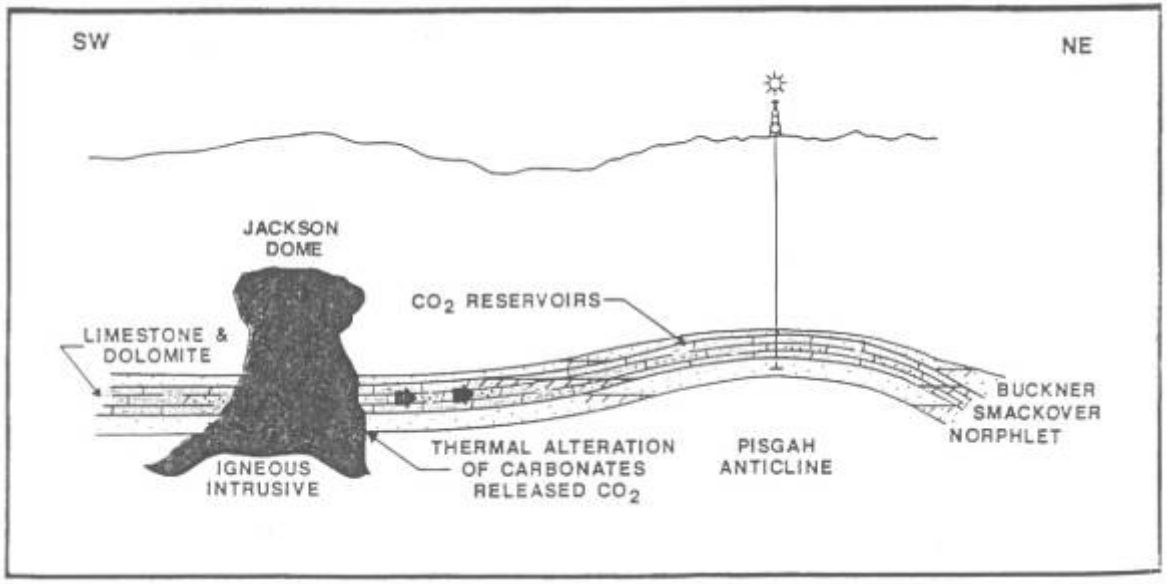


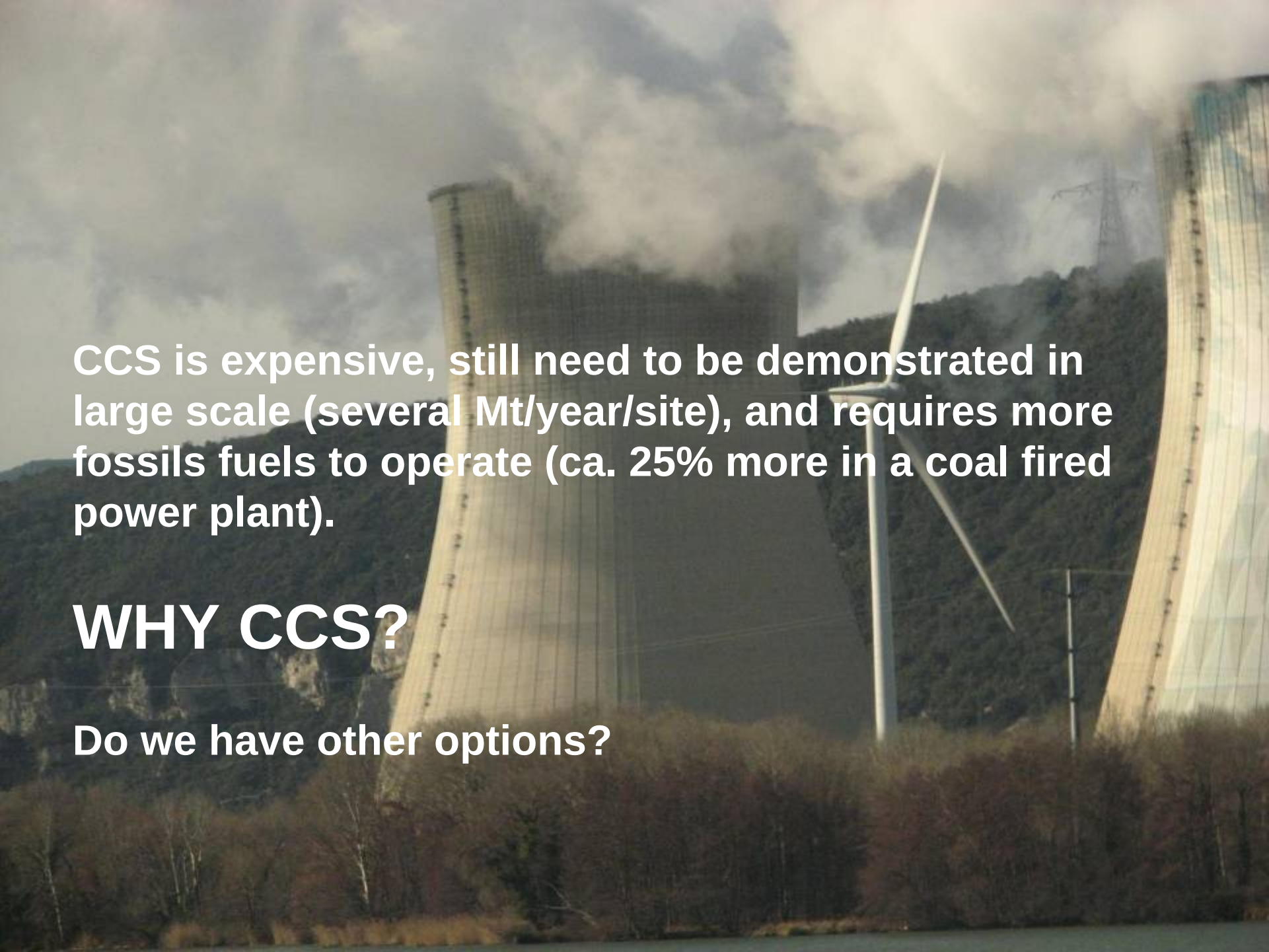


Natural CO_2 field, Norphlet Formation, Mississippi



- Jurassic aeolian sandstones
- Original CO_2 column: 154 m
- CO_2-water contact: 4.827 m
- Purity: > 98% CO_2 (3-120 ppm H_2S)
- Original volume in-place: 2,0 TCF (5,7 x 10^{10} m^3)
- Recovery 65%
- Operators: Shell, Chevron
- Discovered in 1967
- CO_2 piped to Mississippi and Louisiana oil fields for EOR





CCS is expensive, still need to be demonstrated in large scale (several Mt/year/site), and requires more fossils fuels to operate (ca. 25% more in a coal fired power plant).

WHY CCS?

Do we have other options?

Scale of the problem 1:

Any viable option must consider the present-day and future great dependency of fossil fuels

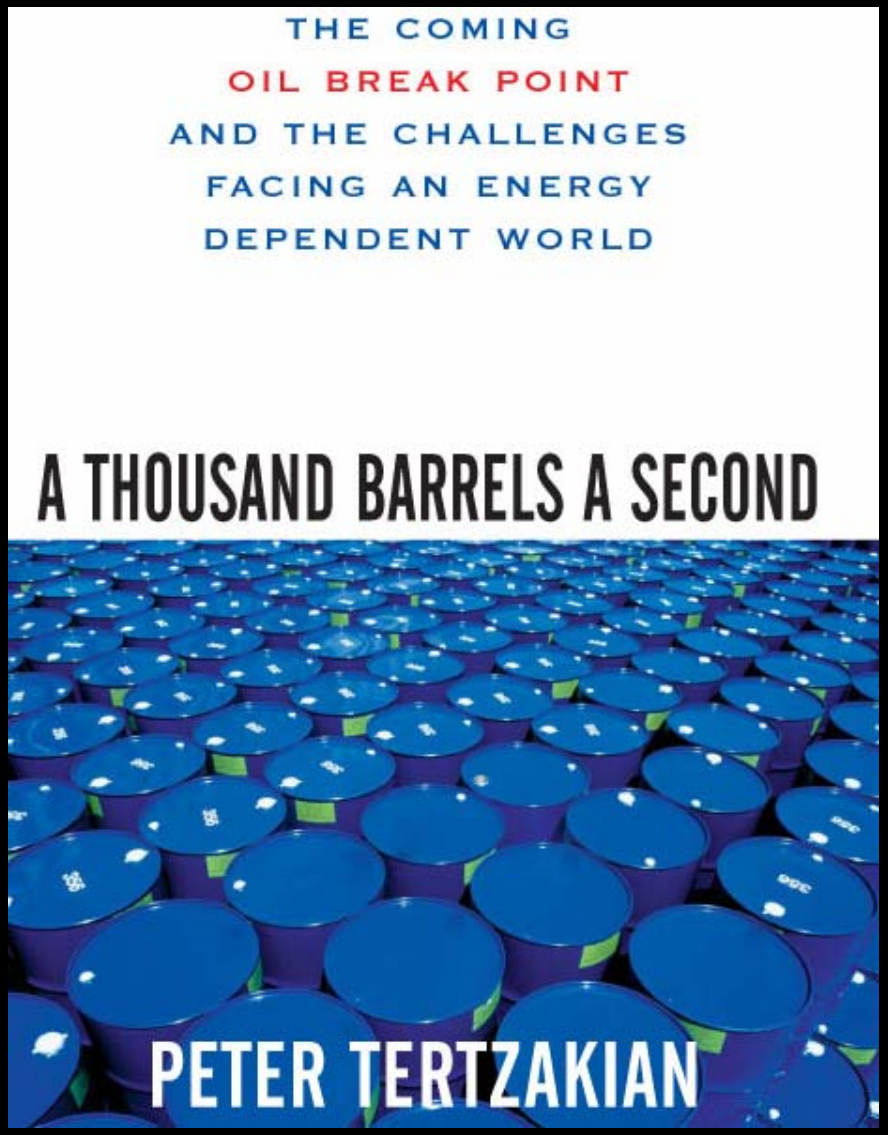
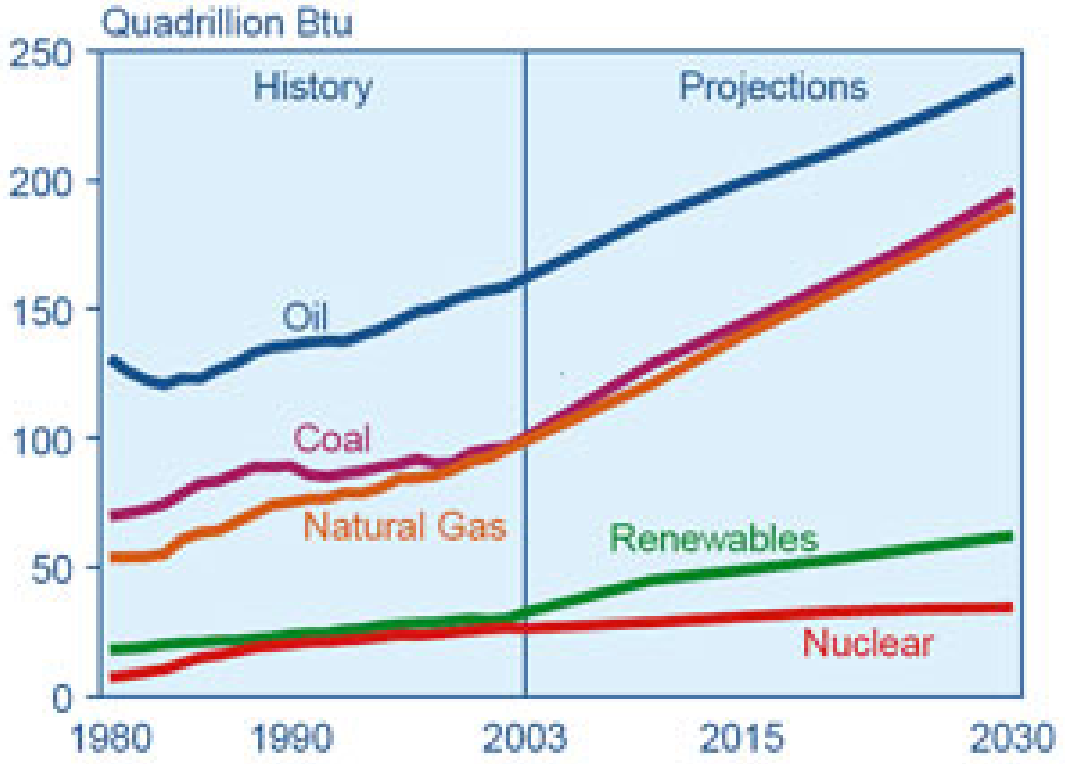
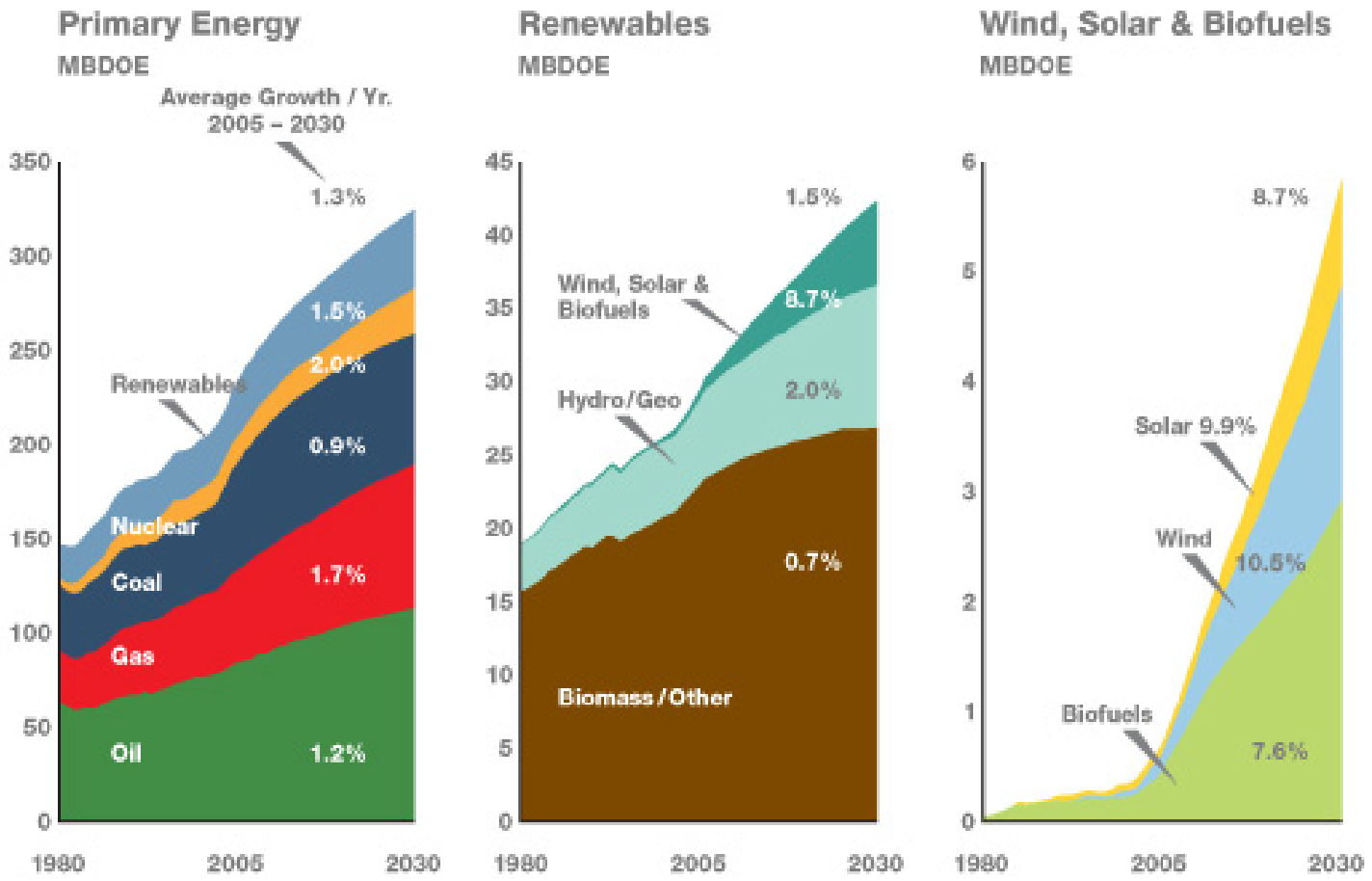


Figure 3. World Marketed Energy Use by Energy Type, 1980-2030



Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, System for the Analysis of Global Energy Markets (2006).

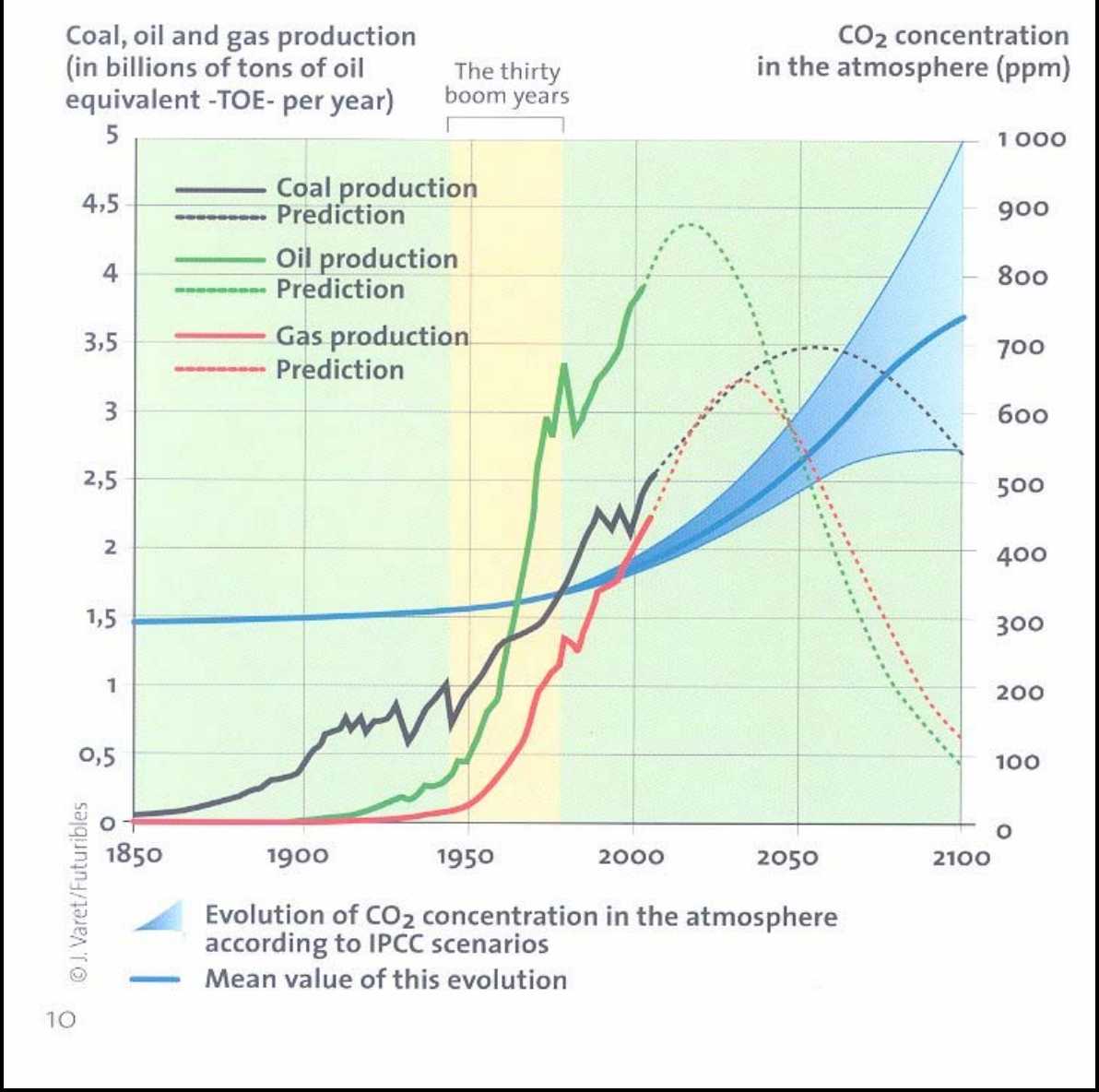
World Energy Demand – Primary Energy Supplies



www.exxonmobil.com

Scale of the problem 2:

Present-day emissions of 25 Gt/$CO_{2\ eq.}$ per year



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Scale of the solutions: “Tomato world”

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Scale of the solutions: “The Kyoto week”

Kyoto will delay climate change for one week in 2001 (Nordhaus & Boyer, 2000)

2nd Petrobras International Seminar on CO_2 Capture and Geological Storage

09-12 September 2008 - Salvador/BA – BRAZIL

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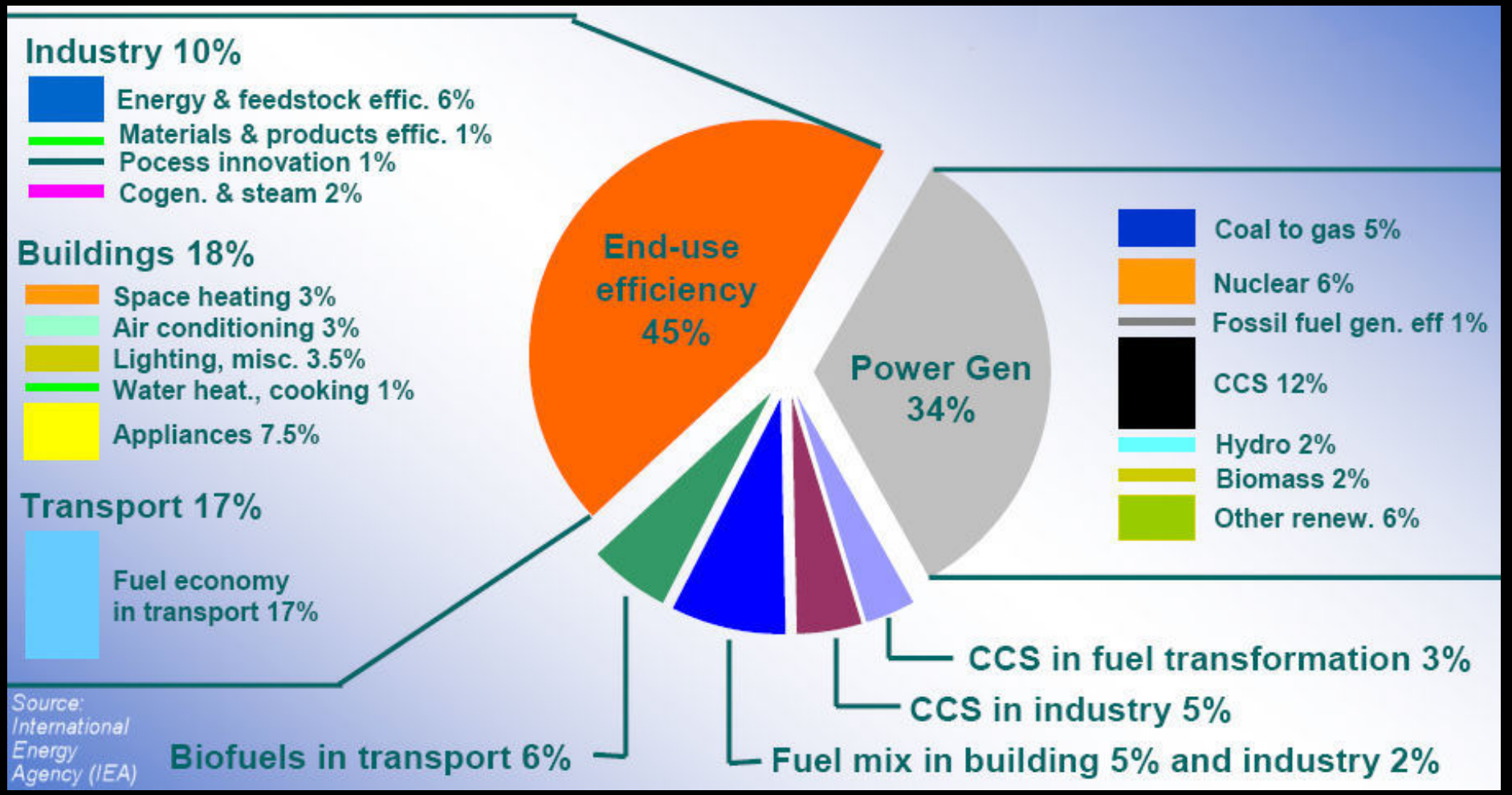
The contribution of CCS for GHG emission reduction (20% by 2030)



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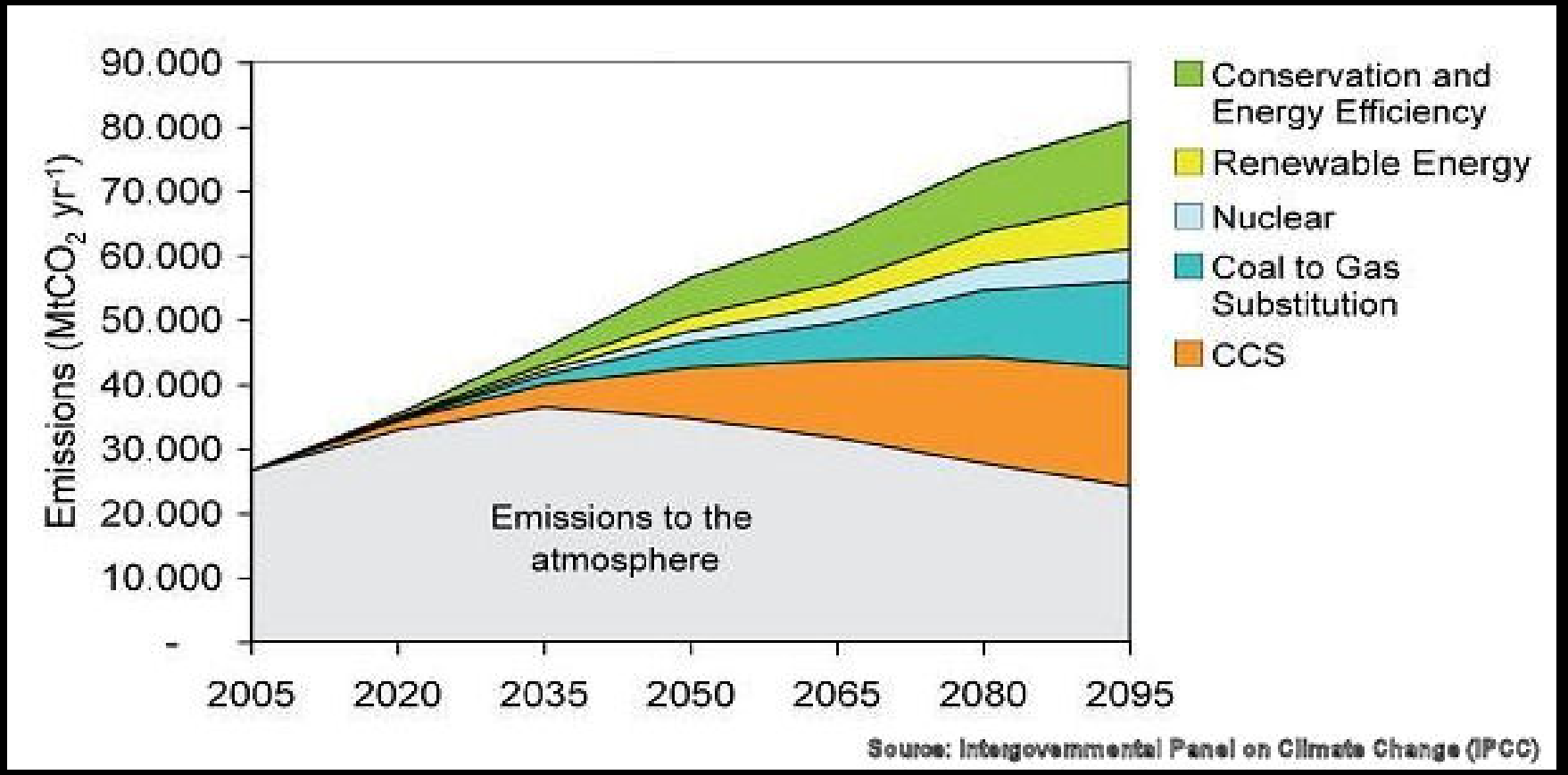
The contribution of CCS for GHG emission reduction (CCs will be the most import technology from 2030)



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Why not CCS?

Can we safely do CCS?

EOR and EGR
Nuclear waste disposal
Natural gas storage
Acid gas storage

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Safeness and monitoring

Storage security and trapping mechanisms in a time framew

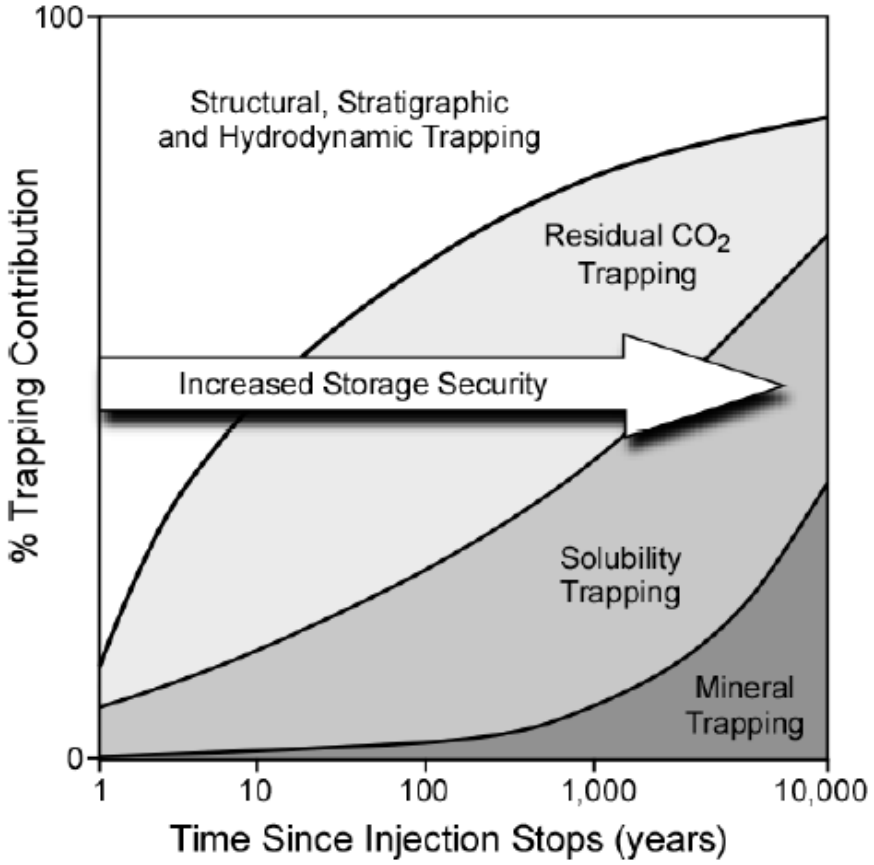

Figure 2. Contribution and storage security of various CO_2 geological-storage mechanisms (from IPCC, 2005).

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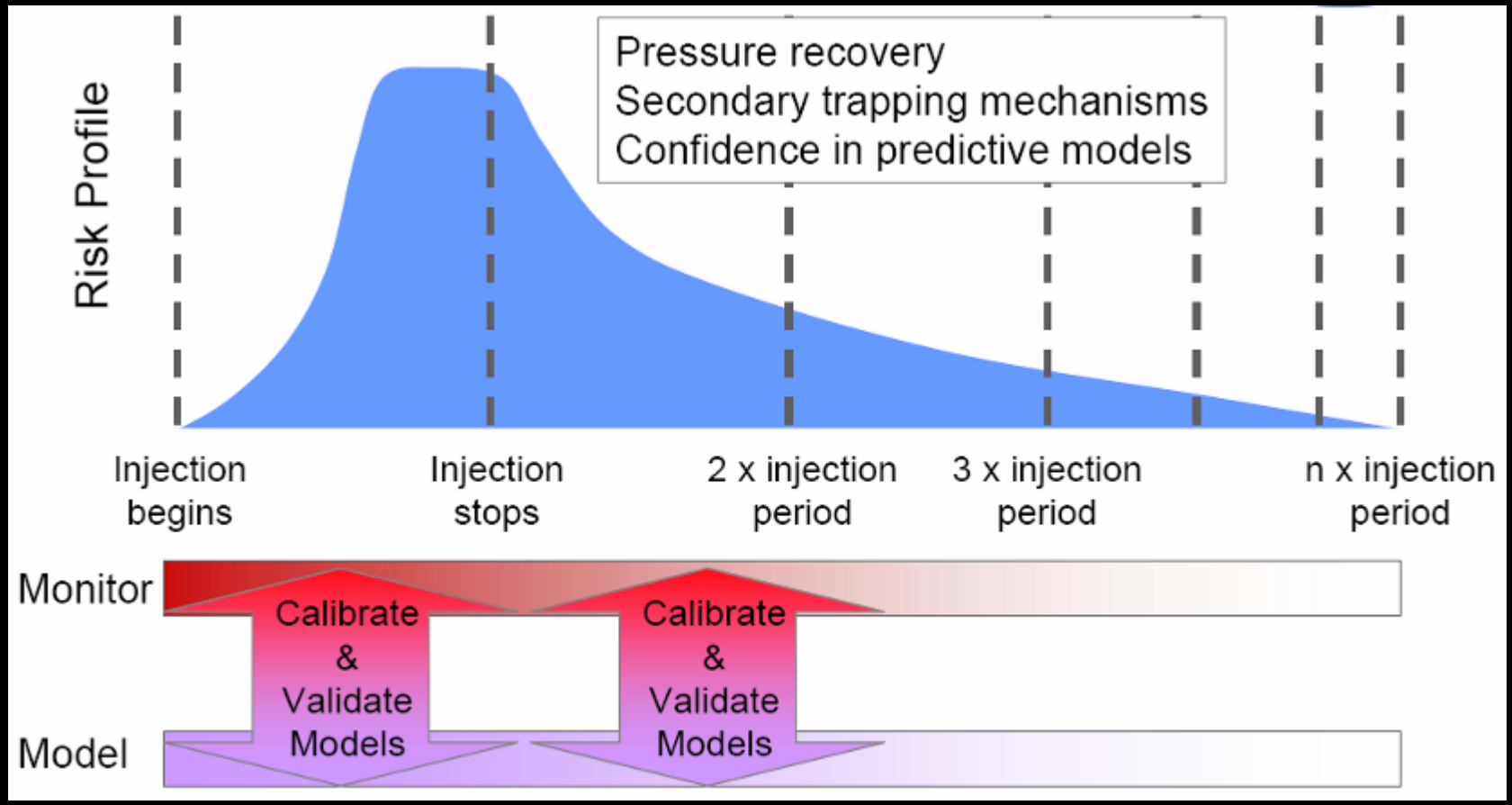
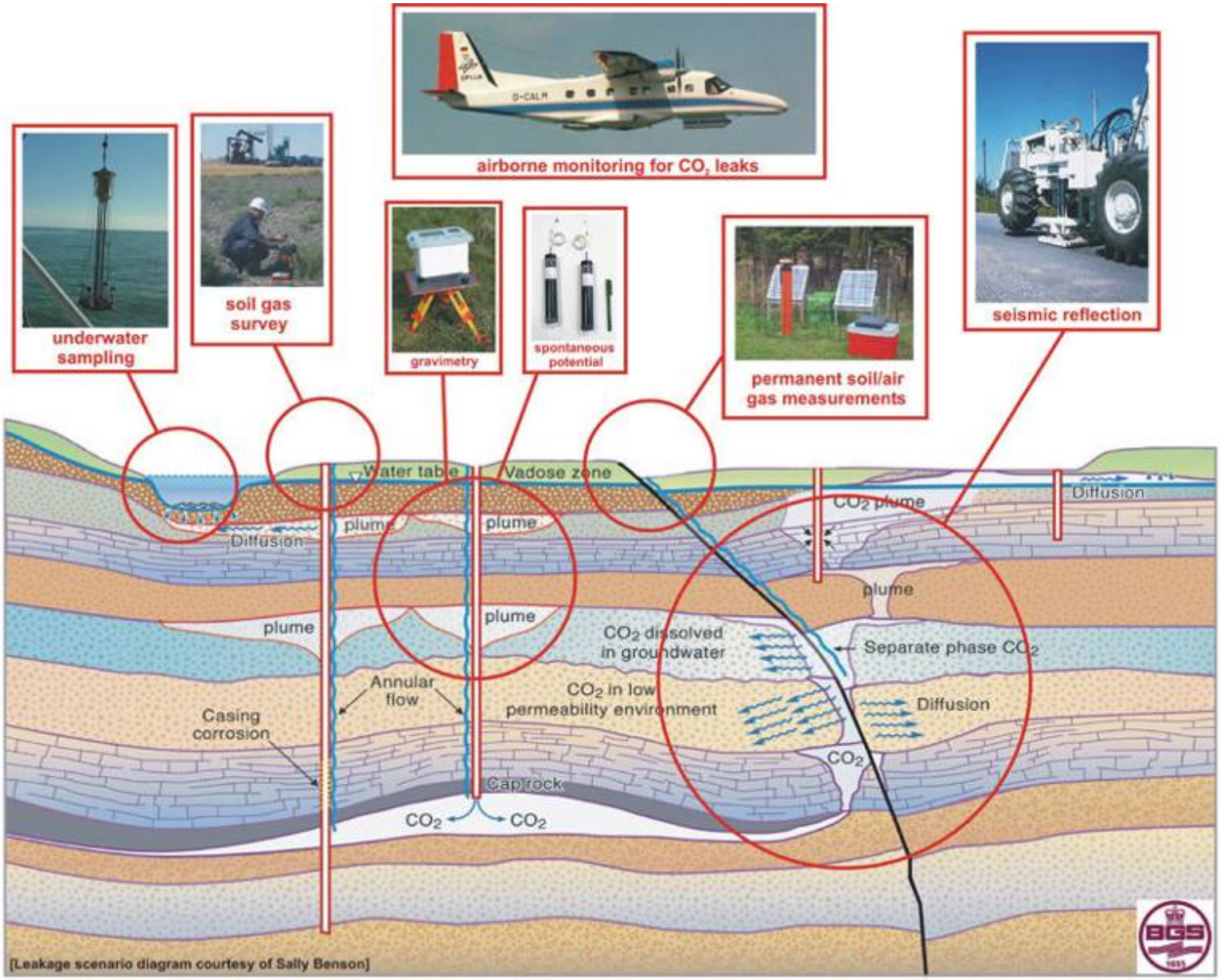
Risk (leakage) profile in time



(from Myer, CSFL workshop Brazil)

Measuring, monitoring, verification of stored CO_2



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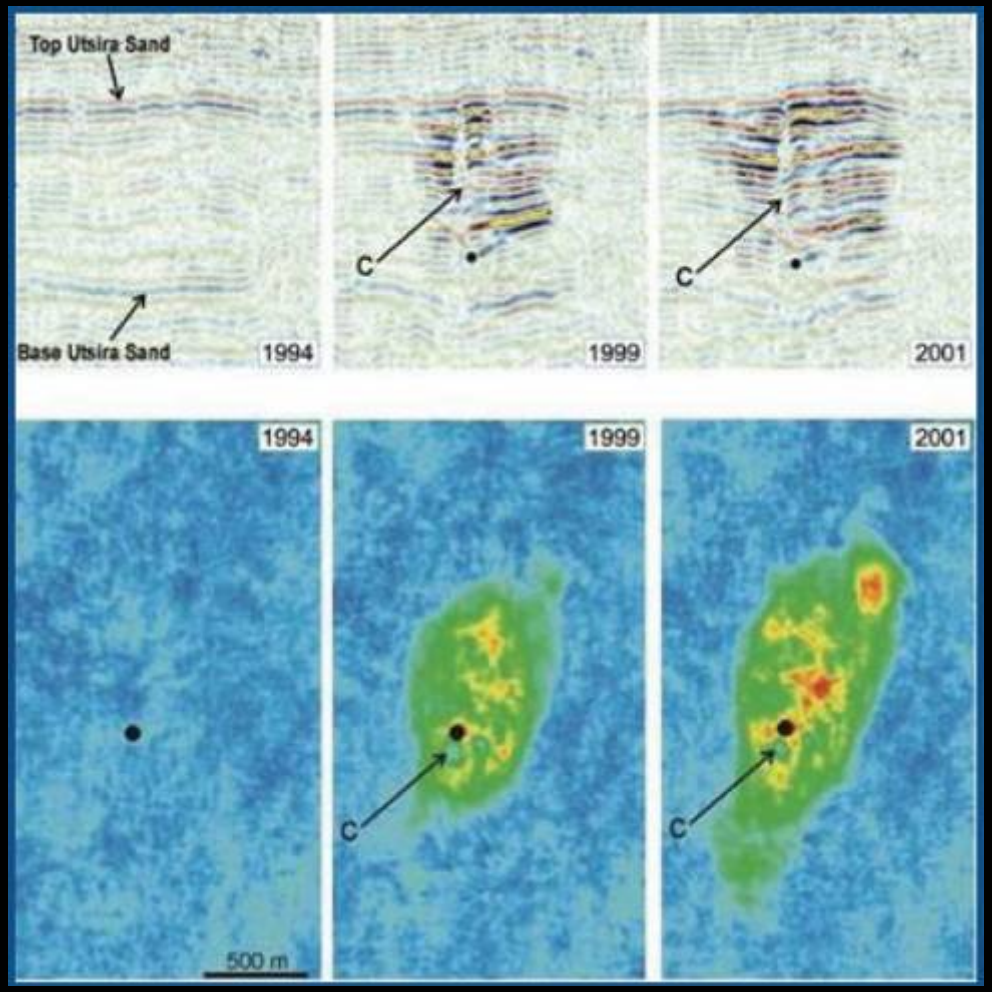
4D Seismic survey in the Utsira Formation (offshore Norway)



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How to deploy CCS?

The G8/IEA/CSLF plan of action

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THE G8/IEA/CSLF CARBON PLAN: The near-term first phase 200 Mt/yr (by 2025)

• Low-cost forms of CCS (processes that already capture CO2 or have “little” additional capture cost such as NG processing, ammonia and hydrogen plants).

• Forms of CCS with costs are offset by EOR or avoided emissions taxes.


Statoil


www.princeton.edu

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THE G8/IEA/CSLF CARBON PLAN: The longer-term second phase 6000 Mt/yr (by 2050)

• Widespread deployment of CCS for power generation, facilitated by reduction of capture costs.

• Forms of CCS with heavy industries, such as steel and cement.

• As opportunities for EOR decline, CCS will likely be in saline formations.

ZEROGEN - ARTISTS IMPRESSION - PROPOSED ZEROGEN POWER STATION SITE
VIEW SOUTH FROM FALLS CREEK HILL

gc3.cqu.edu.au

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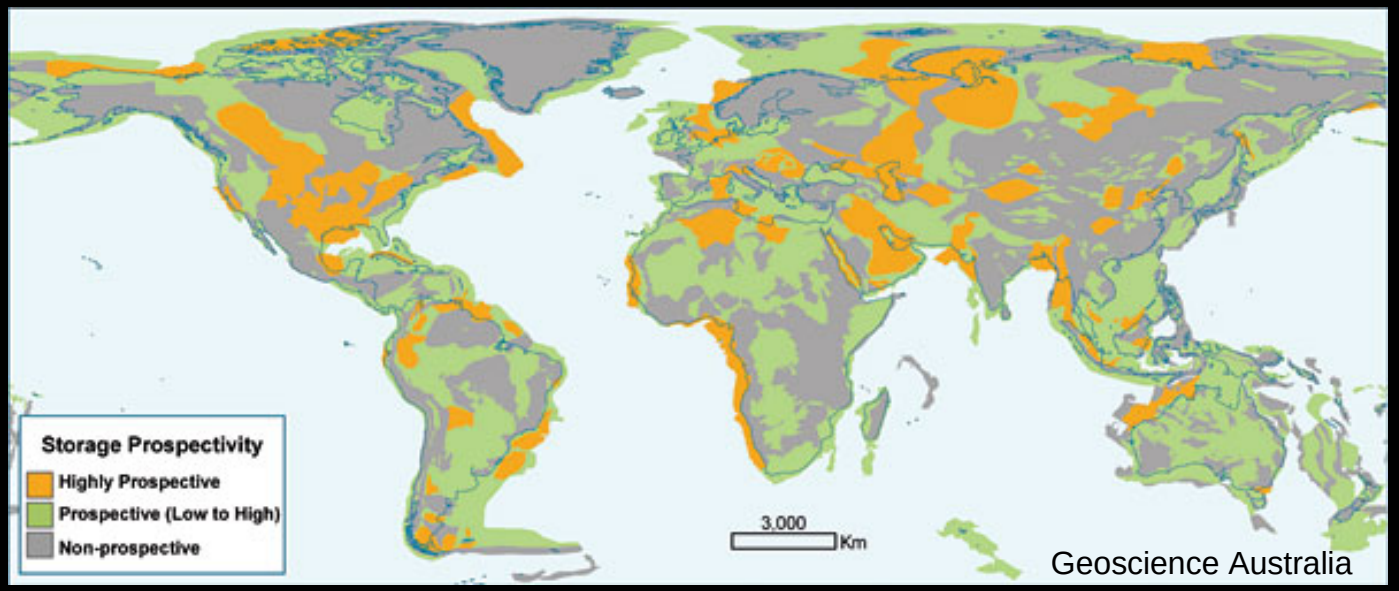
THE G8/IEA/CSLF CARBON PLAN: Key issues governing the deployment of CCS to be resolved already in the FIRST phase:

1. Identification and characterization of storage resources
2. The development and implementation of regulatory and incentive regimes
3. Deployment on a sufficient scale to gain community confidence and support
4. The development of low-cost capture technologies.



Geoscience Australia

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Final remarks:

- *Most of CCS technology is available.*

- *CCS is one of the most promising solutions to meet GHG emission reductions needs.*

- *CCS can assure the sustainable and safe use of affordable, secure fossil based energy.*

- *CCS doesn`t compete with renewable energy but contributes to a friendly transition from a fossil based to renewable based economy.*

- *Why not CCS?*

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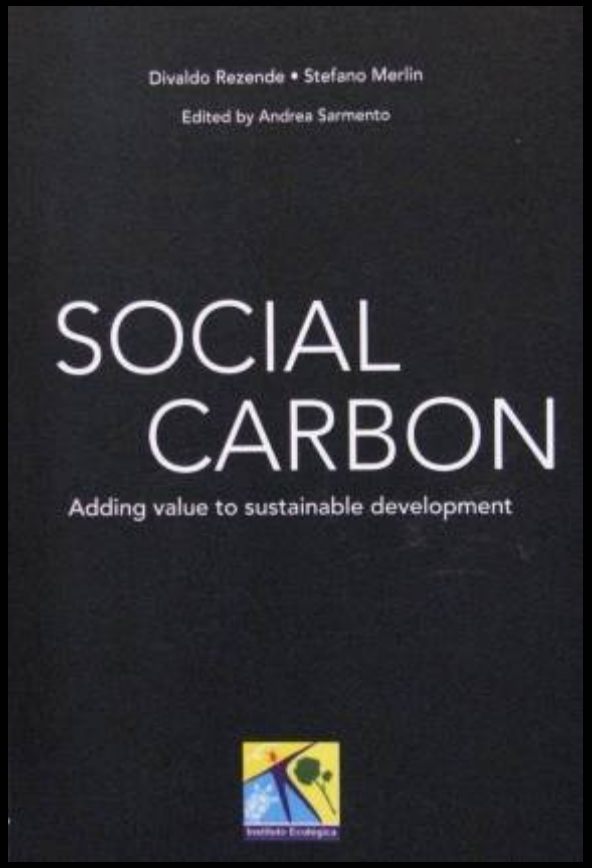
CCS may bring benefits to local communities

The CCS Sustainability map (economic-social-environmental aspects)

Tecnologias de Armazenamento de CO_2 e MMV							
Dimensão	**Fator de Sustentabilidade**	**TA0 - Injeção** Compreende a ação de introduzir o CO2 dentro de reservatórios geológicos, através de poços injetores, via pressurização do gás. Para tanto, compressores são utilizados.					
		grau de sustentabilidade			**meta**		**Linha de ação**
ambiental	uso de energia fóssil	+	3	justificativa:	2008	-	Otimização de processo. Avaliação de oportunidades para utilização do uso de fontes de energia renovável
				Uso de combustivel fossil é o mais comum nessa atividade.	2013	Modelagem matemática do processo e testes experimentais	
		-			2017	Definição de princípios e critérios para uso de energia renovável	
ambiental	uso de energia do grid	+	2	justificativa:	2008	-	Otimização de processo. Avaliação de oportunidades para utilização do uso de fontes de energia renovável
				Uso do grid leva ao aumento da demanda de energia eletrica.	2013	-	
		-			2017	melhorar a eficiencia em 20% do sistema de compressão.	

The CCS Social Carbon Project



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Thank you for your attention!

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