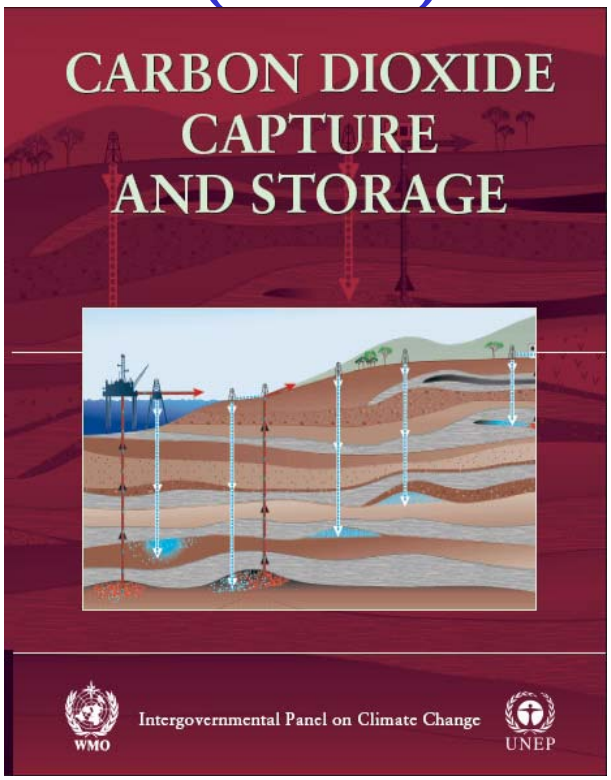
The IPCC Special Report on Carbon dioxide Capture and Storage (CCS)



EU-OPEC Roundtable on Carbon Dioxide Capture and Storage

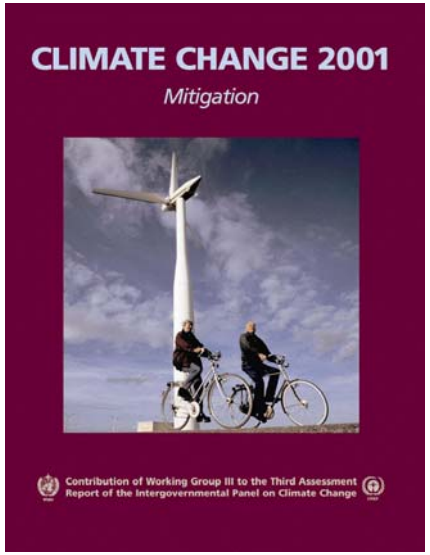
Riyadh, Saudi Arabia, 21 September 2006

Dr. Leo Meyer, IPCC Working Group III

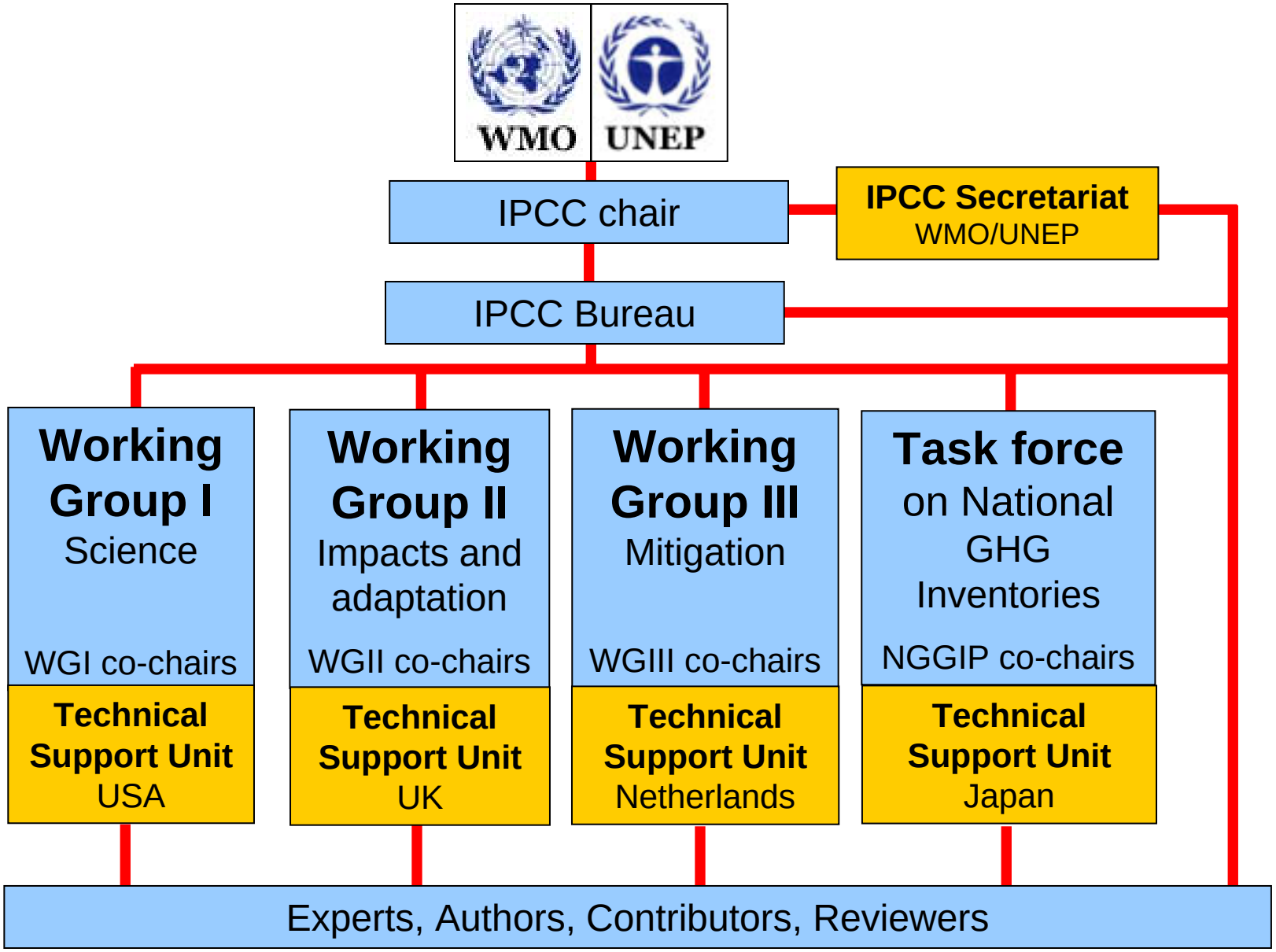
Key issues addressed in this presentation

1. About IPCC and the Special Report on CCS
2. What is CO_2 capture and storage?
3. Sources, Capture, transport
4. Geological storage, Ocean storage, mineral carbonation
5. Maturity of the technologies
6. Cost and potential
7. Health, safety and environment risks
8. Legal and regulatory issues
9. New IPCC Inventory guidelines on CCS

About IPCC



- Founded 1988 by UNEP and WMO
- No research, no monitoring, no recommendations
- Preferably peer-reviewed literature
- Authors academic, industrial and NGO
- Reviews by Experts *and* Governments
- Policy relevant, but NOT policy prescriptive
- Summary for policymakers: government approval
- Fourth Assessment cycle 2003-2008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Science
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Impacts and adaptation
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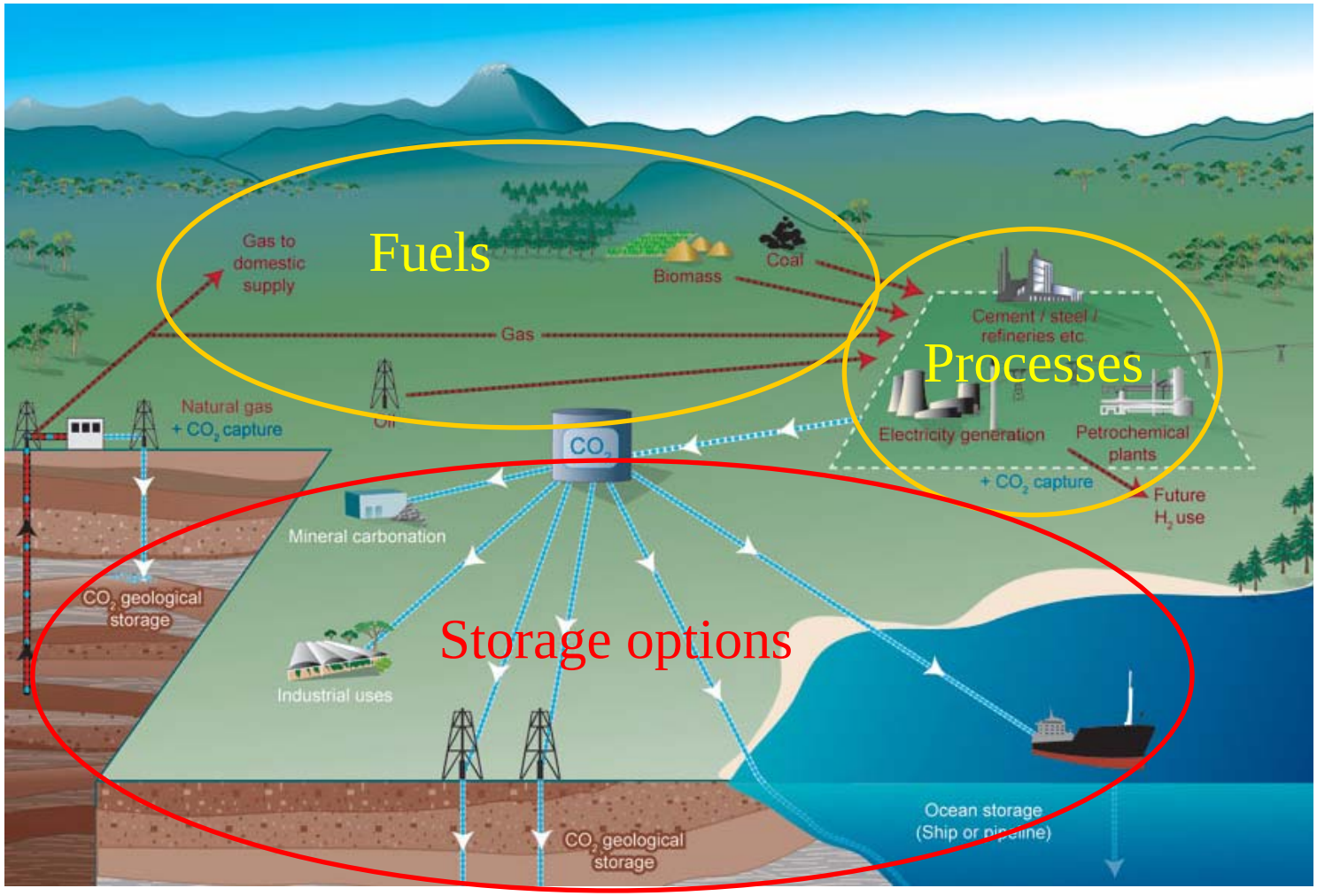
WGIII co-chairs
Technical Support Unit
Netherlands
Task force
on National GHG Inventories
NGGIP co-chairs
Technical Support Unit
Japan
Experts, Authors, Contributors, Reviewers

About this report

- UN Climate Convention, 2001 invites IPCC (initiative Saudi Arabia) to prepare a report on carbon storage technologies
- IPCC (2003) decided to prepare a Special Report on CCS
- Written by over 100 authors from 30 countries , all continents, extensively reviewed by over 200 experts, 750 pages
- Approved by IPCC (180 governments) in September 2005, published December 2005
- Presented at UN Climate Convention Dec 2005

CO_2 capture and storage system



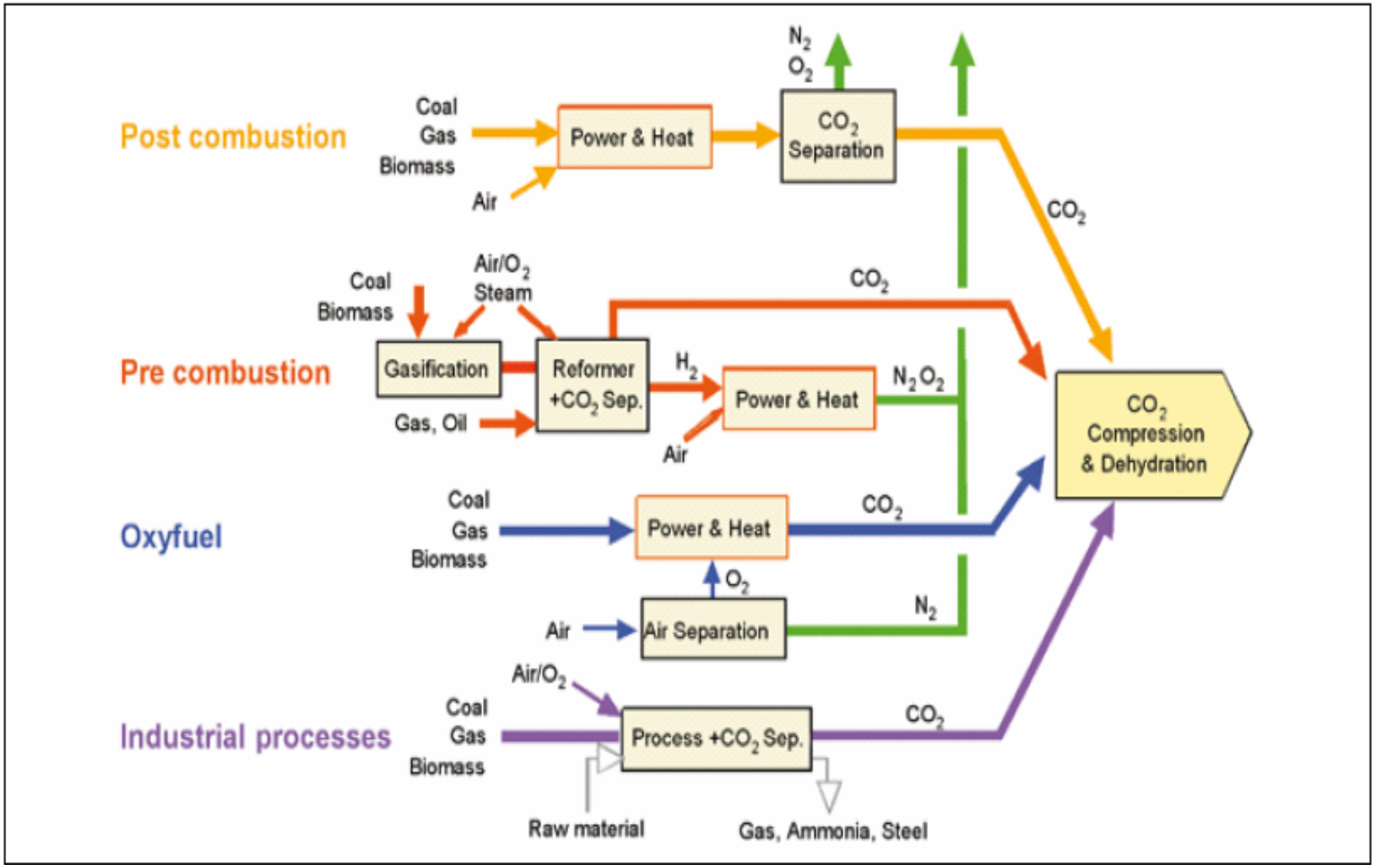
Qualifying CO_2 sources

- Large stationary point sources
- High CO_2 concentration in the waste, flue gas or by-product stream (purity)
- Pressure of CO_2 stream
- Distance from suitable storage sites

Global large stationary CO_2 sources with emissions of more than 0.1 $MtCO_2$/year

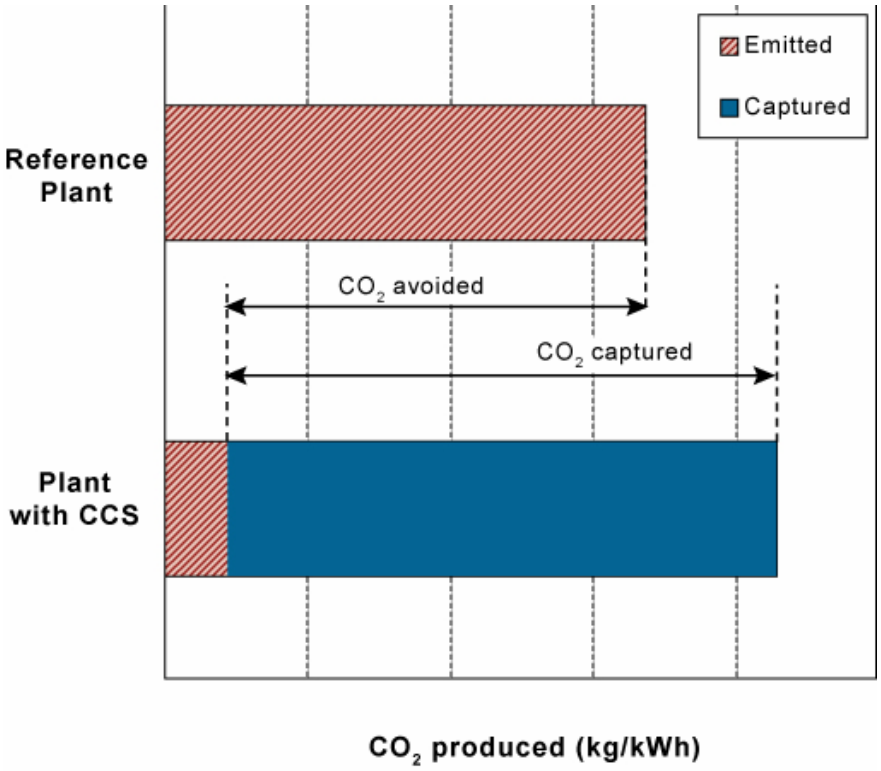
Process	No. of sources	Emissions ($MtCO_2$/yr)
Fossil Fuels		
Power (coal, gas, oil and others)	4,942	10,539
Cement production	1,175	932
Refineries	638	798
Iron and steel industry	269	646
Petrochemical industry	470	379
Oil and gas processing	N/A	50
Other sources	90	33
Biomass		
Bioethanol and bioenergy	303	91
Total	**7,887**	**13,466**

Overview of CO_2 capture systems



Capture and transport energy requirements

- Additional energy use of 10 - 40% (for same output)
- Capture efficiency: 85 - 95%
- Net CO_2 reduction: 80 - 90%
- Assuming safe storage



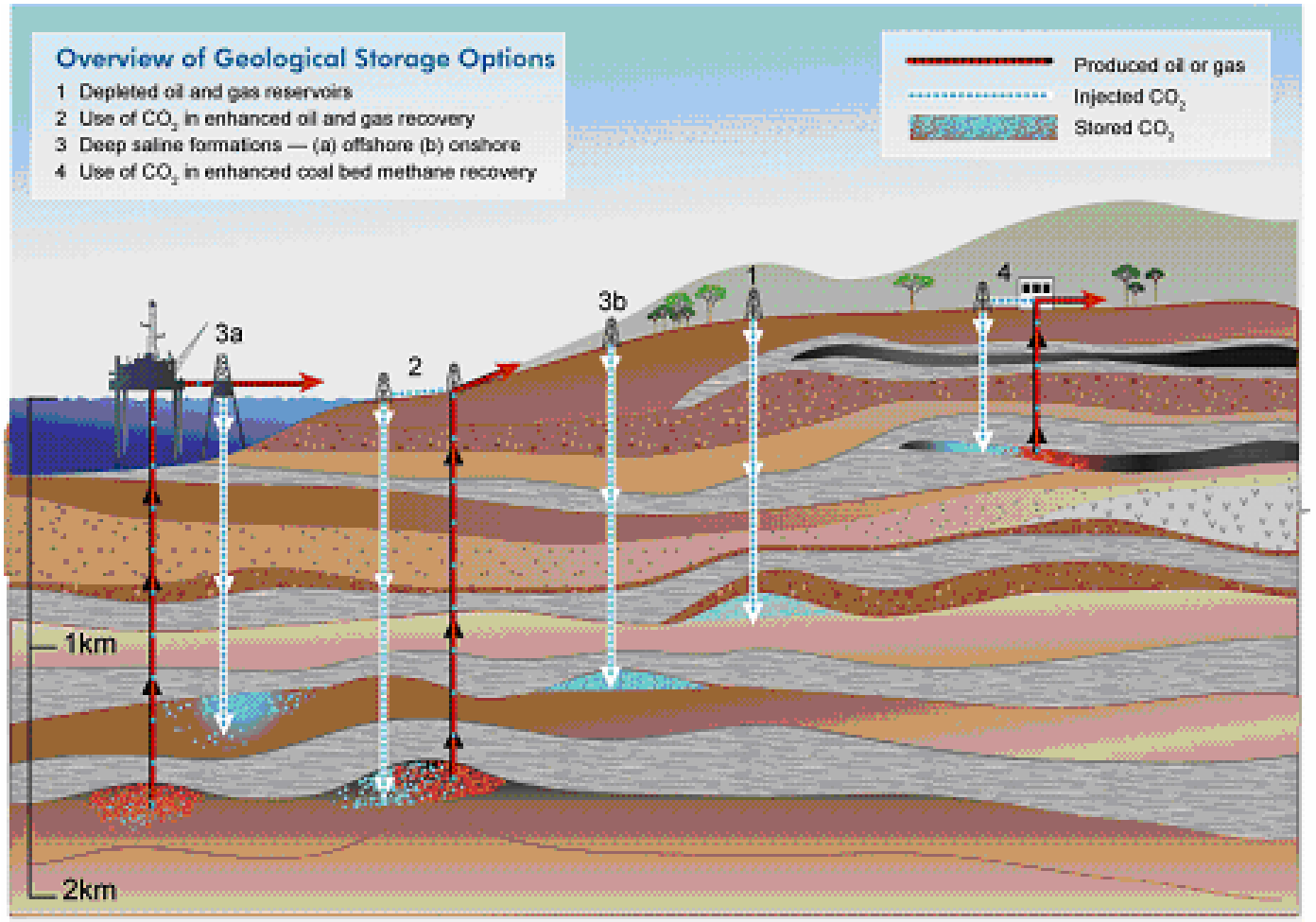
Capture energy requirements

- 50 % solvent/absorbent regeneration (heat)
- 33 % Compression
- 17 % Pumps, blowers, other

Capture energy requirements

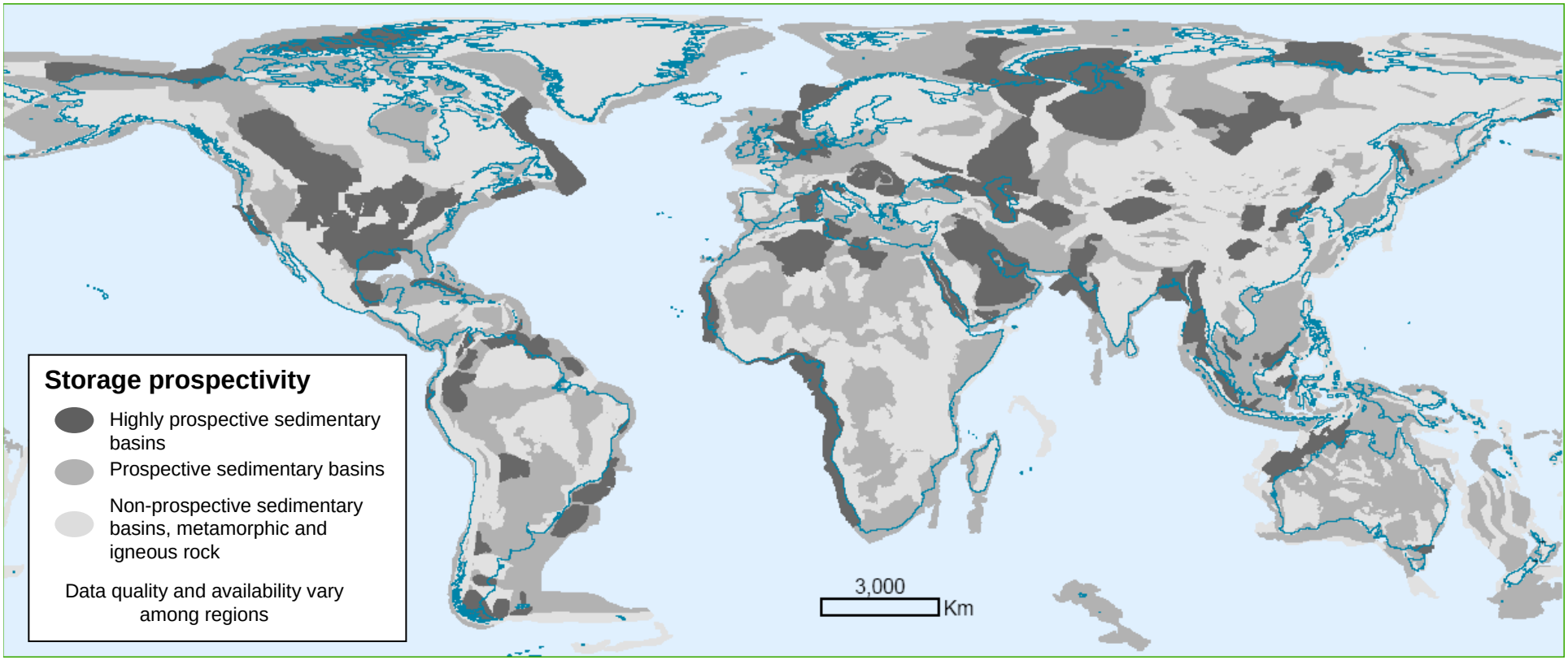
Power plant (new)	**Thermal eff. without capture (LHV), %**	**Thermal eff. with capture (LHV), %**	**Increased primary energy use / output electricity %**
Pulverized Coal	41- 45	30 - 35	24 - 40
NGCC	55 - 58	47 - 50	11 - 22
IGCC	38 - 47	31 - 40	14 - 25

Geological storage



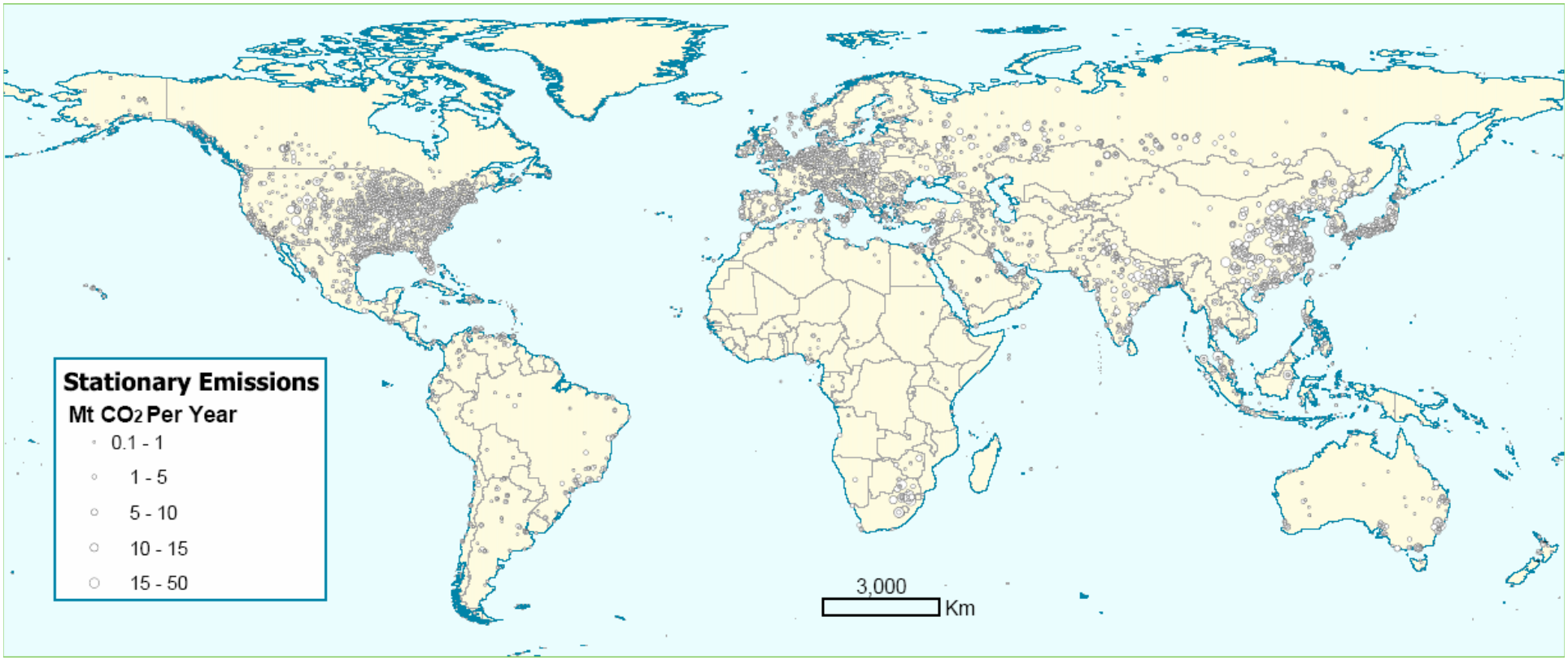
Planned and current locations of geological storage

Geographical relationship between sources and storage opportunities



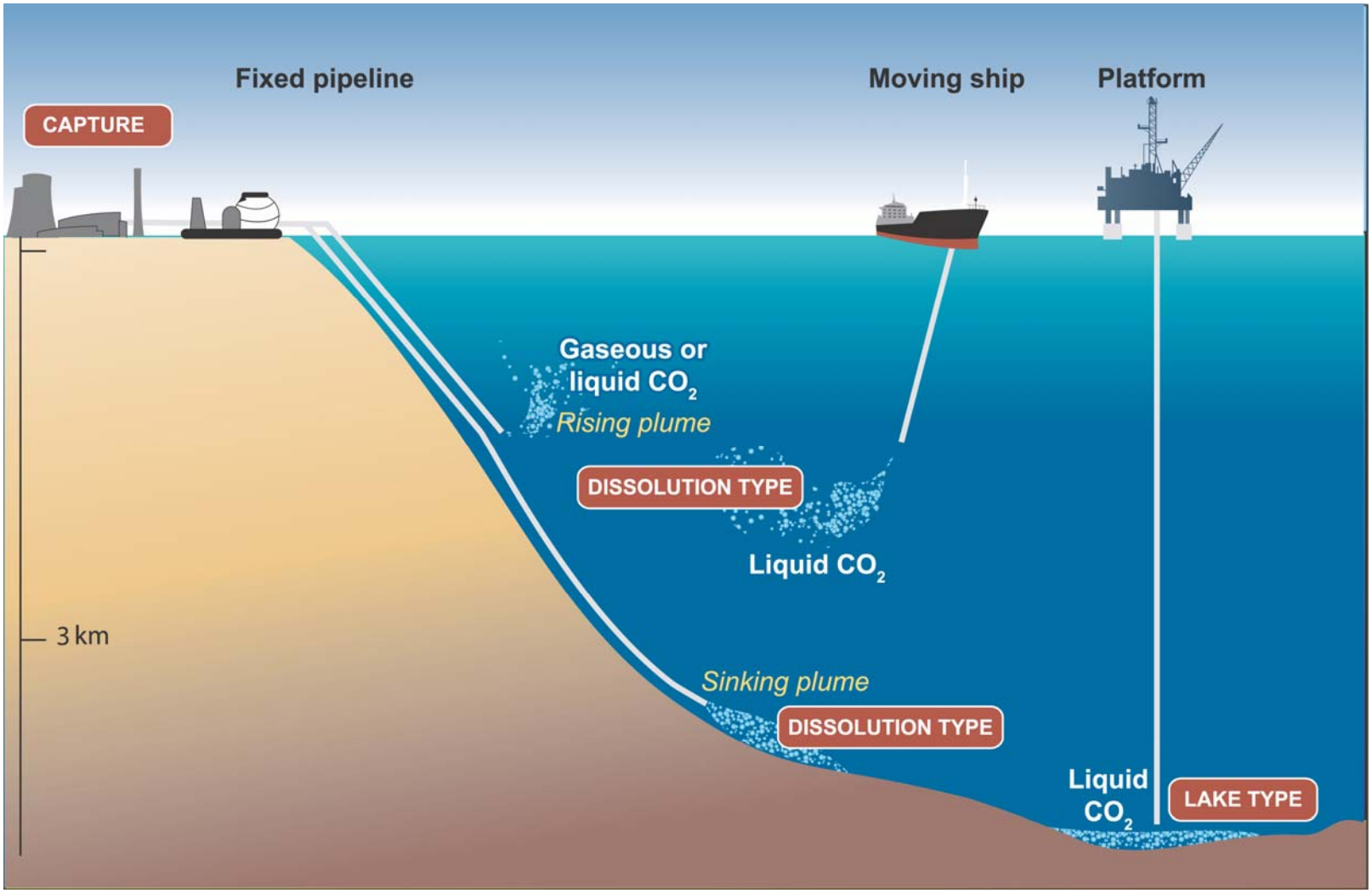
Prospective areas in sedimentary basins where suitable saline formations, oil or gas fields, or coal beds may be found. Locations for storage in coal beds are only partly included. Prospectivity is a qualitative assessment of the likelihood that a suitable storage location is present in a given area based on the available information. This figure should be taken as a guide only, because it is based on partial data, the quality of which may vary from region to region, and which may change over time and with new information (Courtesy of Geoscience Australia).

Geographical relationship between sources and storage opportunities

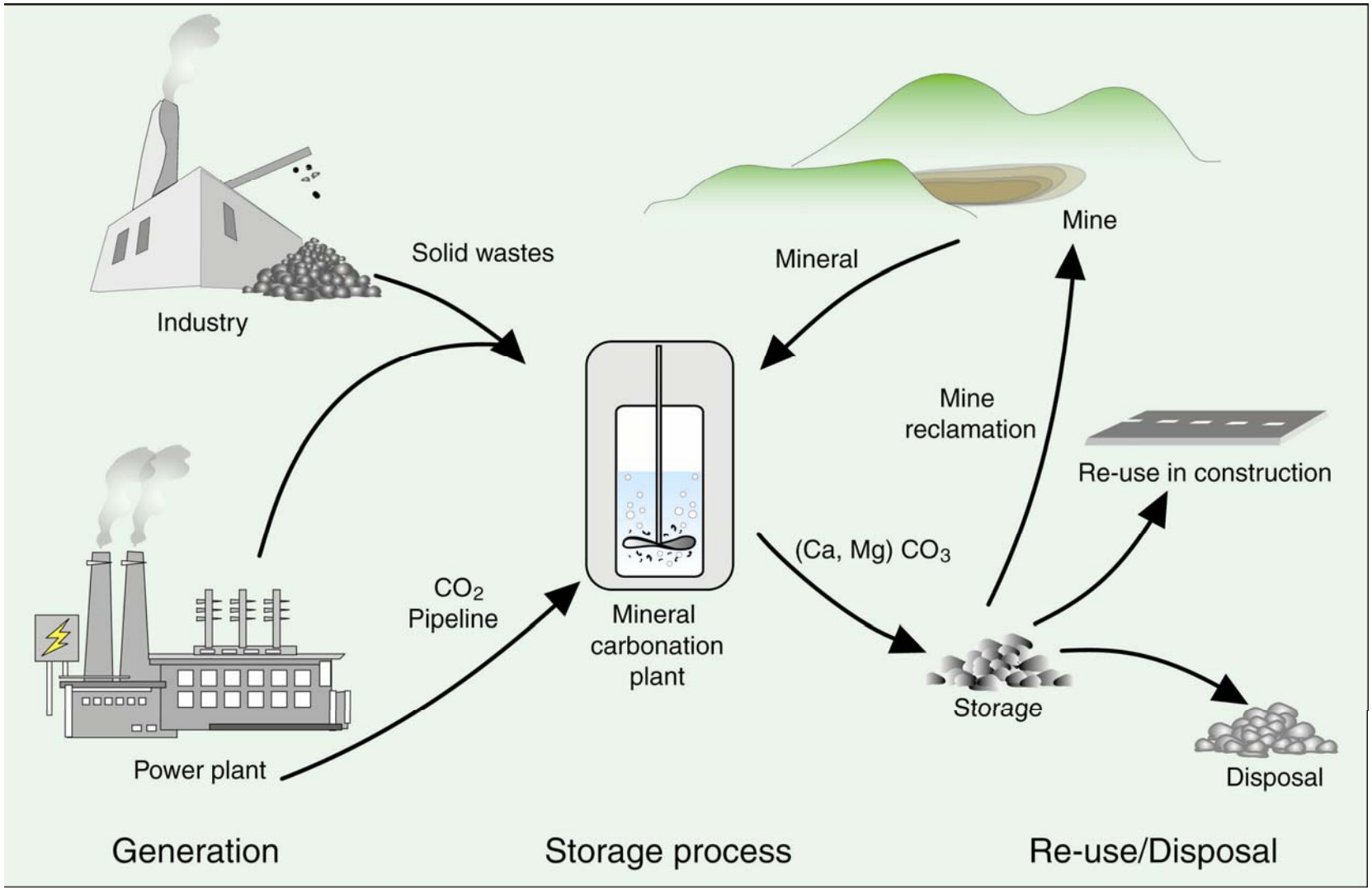


Global distribution of large stationary sources of CO_2 (Based on a compilation of publicly available information on global emission sources, IEA GHG 2002)

Ocean storage



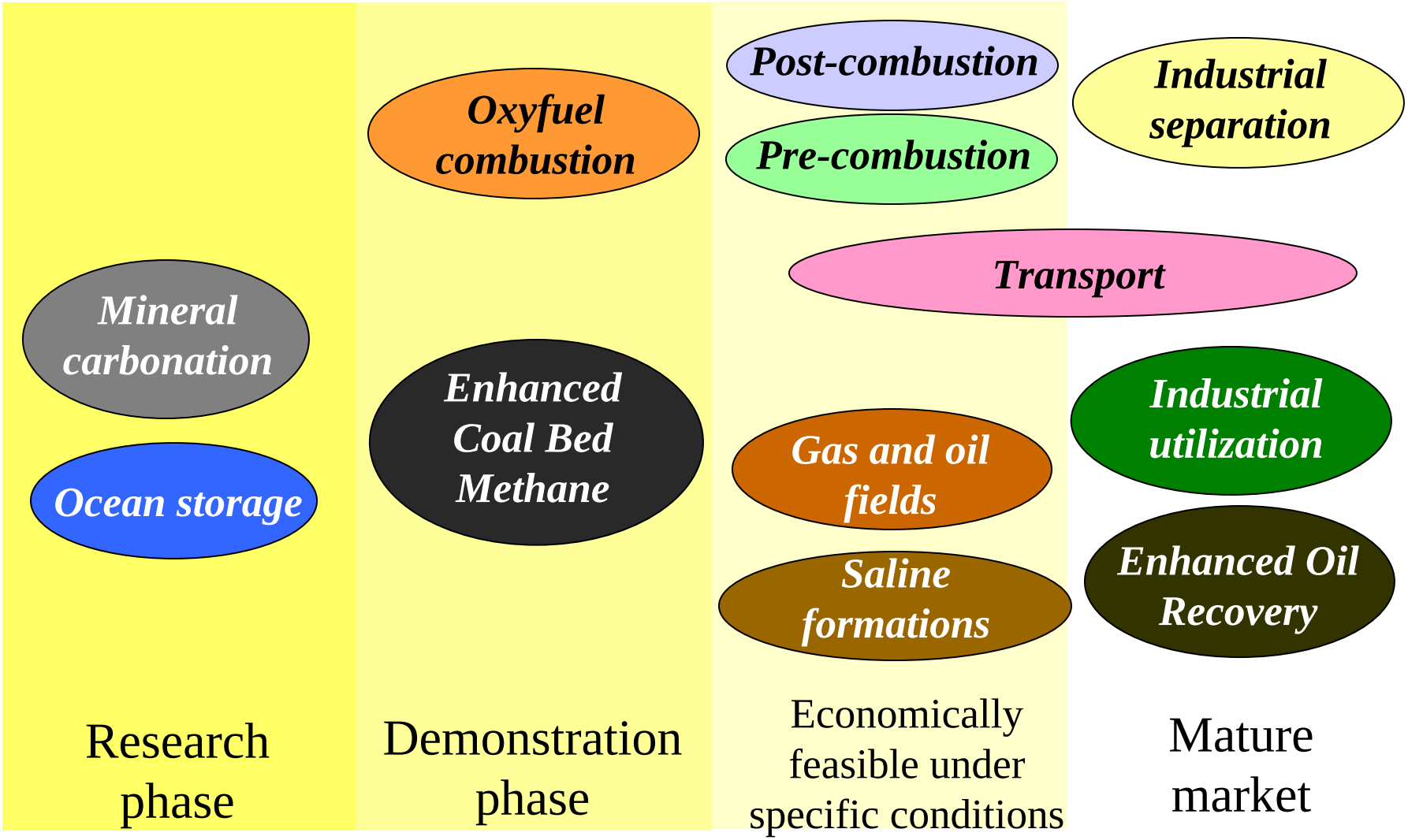
Mineral carbonation



Maturity of CCS technology

- **Research phase** means that the basic science is understood, but the technology is currently in the stage of conceptual design or testing at the laboratory or bench scale, and has not been demonstrated in a pilot plant.
- **Demonstration phase** means that the technology has been built and operated at the scale of a pilot plant, but further development is required before the technology is ready for the design and construction of a full-scale system.
- **Economically feasible under specific conditions** means that the technology is well understood and used in selected commercial applications, such as in case of a favourable tax regime or a niche market, processing at least 0.1 $MtCO_2$/yr , with few (less than 5) replications of the technology.
- **Mature market** means that the technology is now in operation with multiple replications of the commercial-scale technology worldwide.

Maturity of CCS technology



Costs

Two ways of expressing costs:

- Additional electricity costs
  - Energy policymaking community
- CO_2 avoidance costs
  - Climate policymaking community

Different outcomes:

0.01 - 0.05 US$/kWh

20* - 270 US$/t$CO_2$ avoided

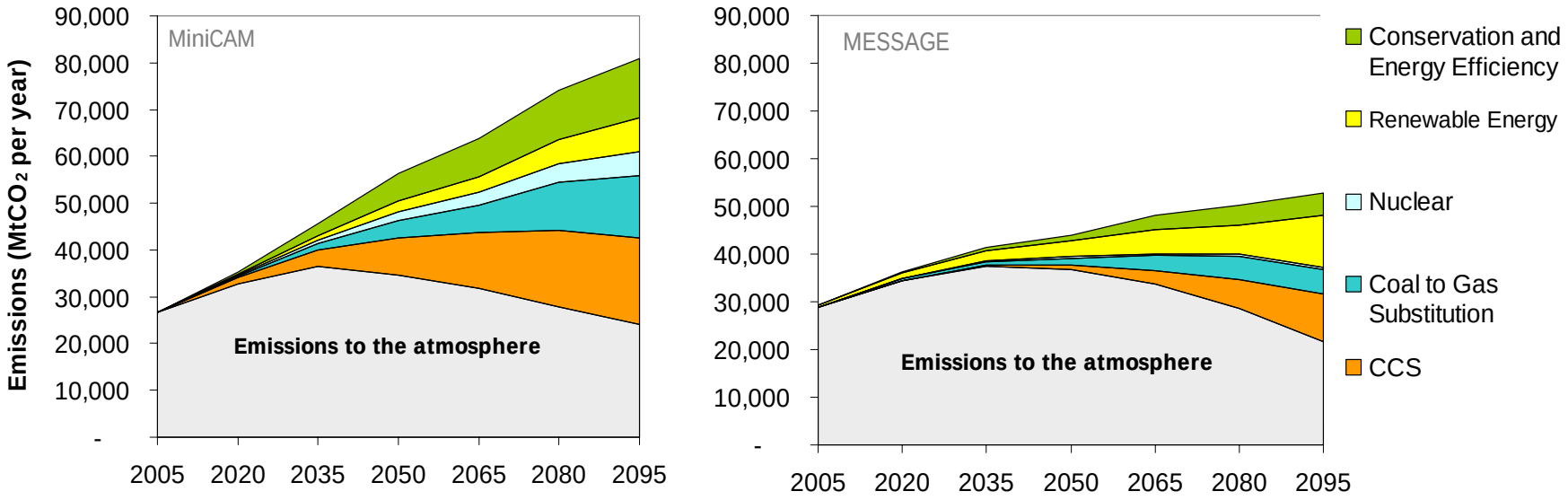
(with EOR: 0*– 240 US$/t$CO_2$ avoided)

* low-end: capture-ready, low transport cost, revenues from storage: 360 MtCO_2/yr

CCS component costs

CCS component	Cost range
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

Economic potential



Economic potential

- Cost reduction of climate change stabilisation: 30% or more
- Most scenario studies: role of CCS increases over the course of the century
- Substantial application above CO_2 price of 25-30 US$/t$CO_2$
- 15 to 55% of the cumulative mitigation effort worldwide until 2100
- 220 - 2,200 GtCO_2 cumulatively up to 2100, depending on the baseline scenario, stabilisation level (450 - 750 ppmv), cost assumptions

Storage potential

- Geological storage: likely at least about 2,000 $GtCO_2$ in geological formations

  "Likely" is a probability between 66 and 90%.

- Ocean storage: on the order of thousands of $GtCO_2$, depending on environmental constraints
- Mineral carbonation: can currently not be determined
- Industrial uses: Not much net reduction of CO_2 emissions

Health, safety, environment risks

- **In general**: lack of real data, so comparison with current operations
- **CO_2 pipelines**: similar to or lower than those posed by hydrocarbon pipelines
- **Geological storage**:
  - appropriate site selection, a monitoring program to detect problems, a regulatory system, remediation methods to stop or control CO_2 releases if they arise:
  - comparable to risks of current activities (natural gas storage, EOR, disposal of acid gas)

Health, safety, environment risks

- **Ocean storage**:
  - pH change
  - Mortality of ocean organisms
  - Ecosystem consequences
  - Chronic effects unknown
- **Mineral carbonation**:
  - Mining and disposal of resulting products
  - Some of it may be re-used

Leakage

- 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%
- Release of CO_2 from ocean storage would be gradual over hundreds of years

Legal and regulatory issues CO_2 storage

- Onshore: national regulation
  - Few legal or regulatory frameworks for long-term CO_2 storage liabilities
- Offshore: international treaties
  - OSPAR (regional), London Convention
  - Ocean storage and sub-seabed geological storage
  - Unclear whether or under what conditions CO_2 injection is compatible with international law

‘Take home messages’

1. Potential 15 -55 % of mitigation effort to 2100, but no silver bullet - portfolio needed to address climate change
2. Reduce overall mitigation costs (30%) by increasing flexibility in achieving greenhouse gas emission reductions
3. Energy requirements still considerable (10-40 %)
4. No substantive deployment unless CO_2 price over 25-30 USD/tonne CO_2
5. Risks comparable to current industrial activities, but more experience needed

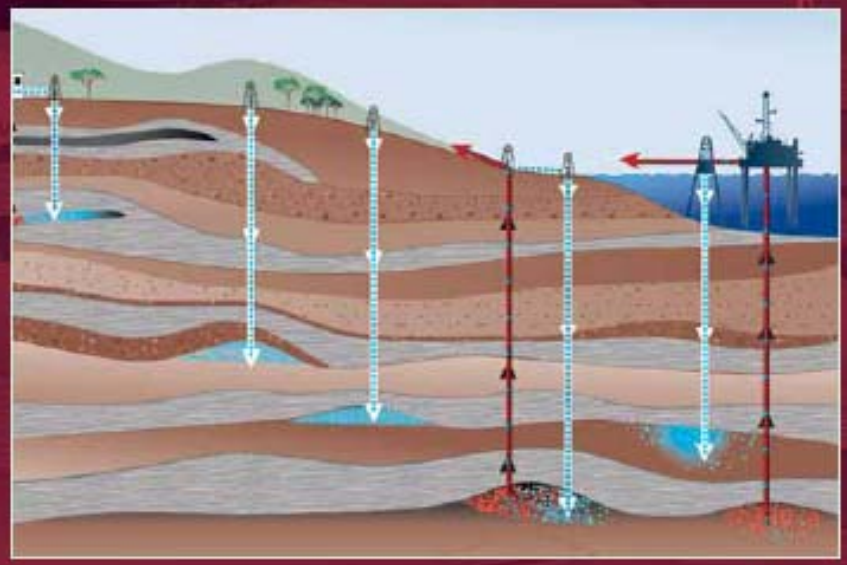
Report published by
Cambridge University Press
Order at www.cambridge.org

Documents available on
www.ipcc.ch

Summary translated in 6 UN languages

احتجاز ثاني أكسيد الكربون وتخزينه

ملخص لواضعي السياسات وملخص فني



WMO

الهيئة الحكومية الدولية المعنية بتغير المناخ (IPCC)

UNEP

WMO

UNEP

Just published : the 2006 IPCC Guidelines for National Greenhouse Gas Inventories

- Includes guidance on CCS emission estimation methodologies in National Inventories of GHGs
- Consistent with the IPCC Special Report on CCS, compatible with 1996 Guidelines
- Covers straight forward methods for capture, transport, injection and geological storage
- Storage requires detailed site characterisation including modelling and monitoring - likely to be required for regulatory, health and safety requirements

THANK YOU FOR YOUR ATTENTION!

More information:

- Special Report CCS: www.ipcc.ch
- 2006GL: www.ipcc-nggip.iges.or.jp/ public/2006gl/ ppd.htm

or email to: ipcc3tsu@mnp.nl