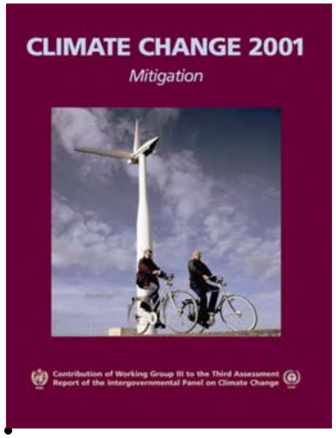
The IPCC Special Report on Carbon dioxide Capture and Storage

IPCC WG III on Mitigation

IPCC WGIII 8th Session

Montreal, September 22nd – 24th, 2005

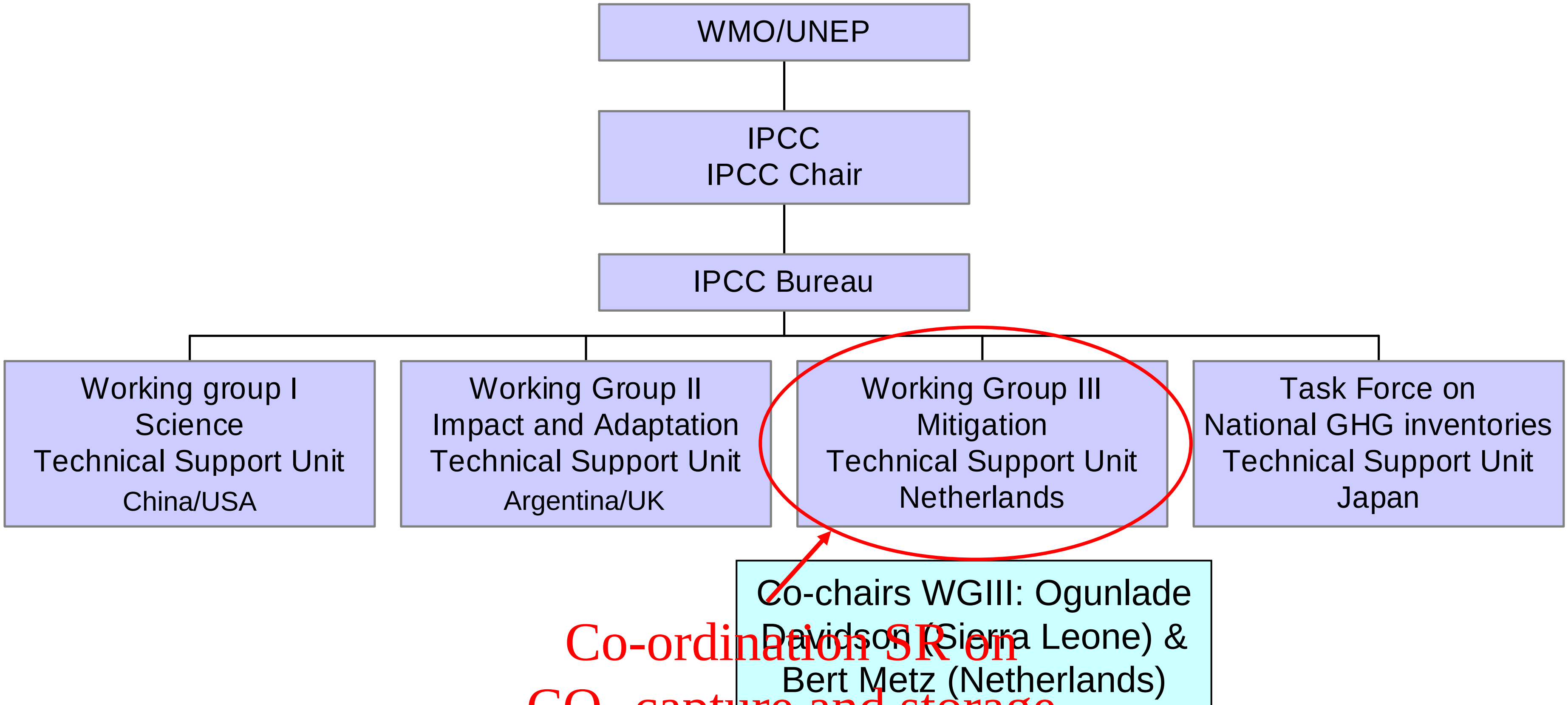
About IPCC



Established by WMO and UNEP 1988:

- Assess scientific, technical and socio-economic information on climate change, impacts and options for adaptation and mitigation
- Publication of reports
- No research, no monitoring, no recommendations
- Based on peer-reviewed literature
- Extensive review processes of its reports
- Support to UNFCCC

About IPCC: organisation



Co-ordination SR on CO_2 capture and storage

IPCC process and the SRCCS

- Scientifically and technically sound information
- Authors are best experts available worldwide
- Covering academic, industrial and NGO experience
- Reviewed by Experts *and* Governments
- Policy relevant, but NOT policy prescriptive

The news

The Summary for Policymakers of the IPCC Special Report on Carbon dioxide Capture and Storage has been approved

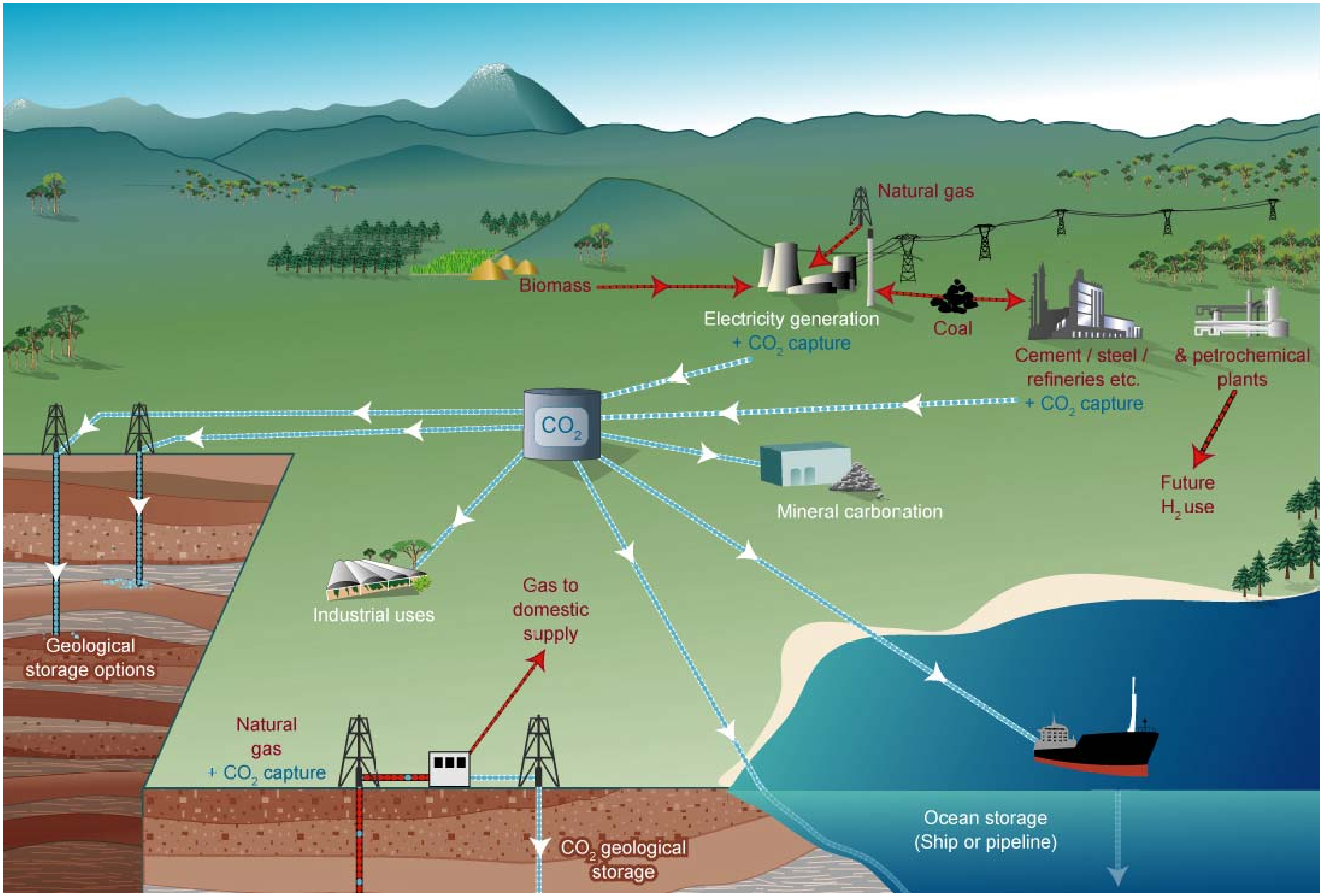
Approval of the SPM

- Final Draft of the full report, including the Technical Summary accepted
- Summary for Policymakers: draft provided by the authors
- Plenary meeting (Montreal) with representatives from 180 governments modify and approve on a line-by-line basis
- Finalised yesterday at 1:00h in the morning
- Press conference in Montreal today at 13:30h local time
- This presentation: literal text from the SPM

Key questions addressed in SPM

- Storage options: geological storage, ocean storage, mineral carbonation
- What is CO_2 capture and storage and how could CCS play a role in mitigating climate change?
- What is the current status of CCS technology?
- What are the location of suitable sources of CO_2, and are they within reach of the storage reservoirs?
- What are the cost and what is the technical and economic potential for storage?
- What are the local health safety and environment risks?
- Will leakage of stored CO_2 compromise CCS as a mitigation option?

CO_2 capture and storage system



How could CCS play a role in mitigating climate change?

- *“No single technology option will provide all of the emission reductions needed to achieve stabilization, but a portfolio of mitigation measures will be needed.”*
- *"CCS has the potential to reduce overall mitigation costs and increase flexibility in achieving greenhouse gas emission reductions."*
- *"Widespread application of CCS would depend on (…) diffusion and transfer of the technology to developing countries and their capacity to apply the technology"*

Status of development of CCS technology (1)

- 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.

Status of development of CCS technology (2)

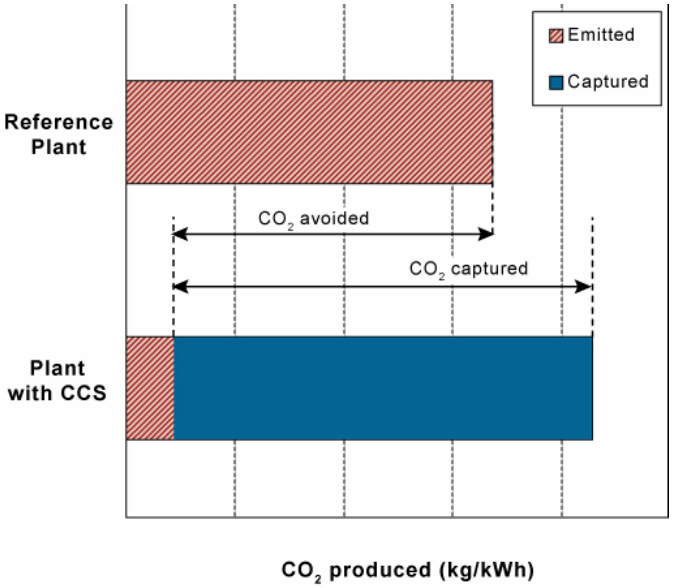
CCS Component		R	D	E	M
Capture	Post combustion			X	
	Pre combustion			X	
	Oxyfuel combustion		X		
	Industrial separation (natural gas processing, ammonia production)				X
Transport	Pipeline				X
	Ship			X	

Status of development of CCS technology (3)

CCS Component		R	D	E	M
Geological storage	Enhanced Oil Recovery				X
	Oil and gas fields			X	
	Saline formations			X	
	Enhanced Coal Bed Methane		X		
Ocean storage	Direct injection	X			
Mineral carbonation	Natural silicate minerals	X			
	Waste materials		X		
Industrial uses					X

Emission reduction from a power plant with CCS

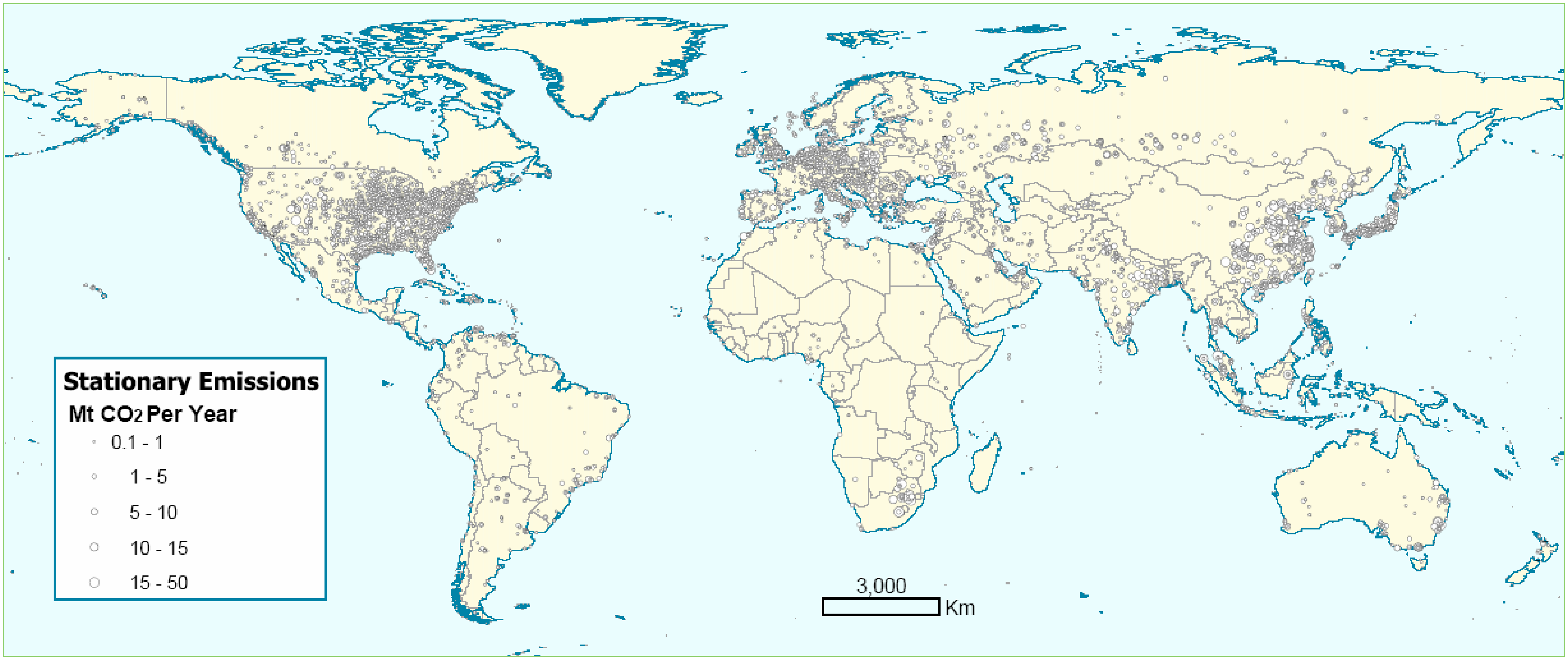
- *"roughly 10 - 40% more energy than a plant of equivalent output without CCS, most of it for capture and compression." (geological/ ocean storage)*
- *"For secure storage, the net result is that a power plant with CCS could reduce CO_2 emissions to the atmosphere by approximately 80 - 90% compared to a plant without CCS"*



Geographical relationship between sources and storage opportunities

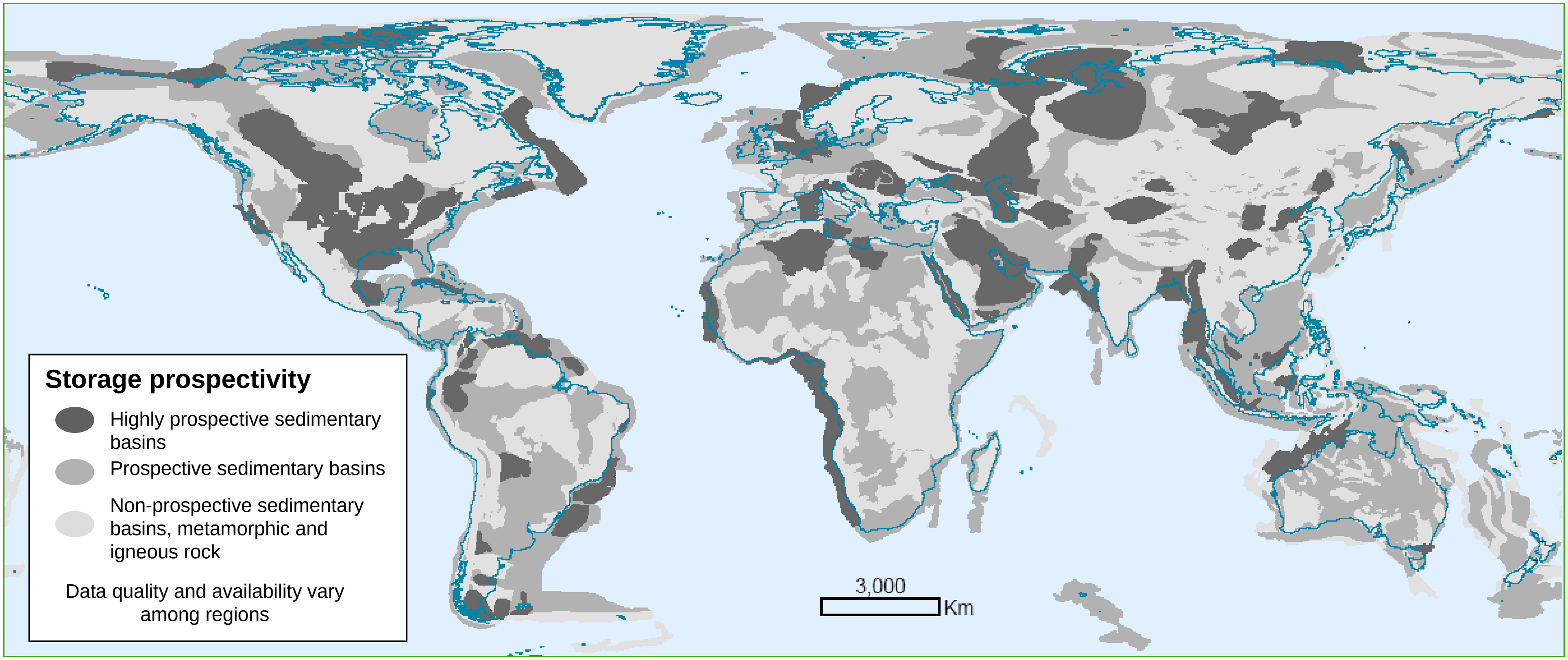
- *"Large point sources of CO_2 are concentrated in proximity to major industrial and urban areas."*
- *"Many such sources are within 300 km of areas that potentially hold formations suitable for geological storage."*
- *"Preliminary research suggests that, globally, a small proportion of large point sources is close to potential ocean storage locations"*

Matching sources…



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

… and reservoirs



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).

Costs

Power plant system	Natural Gas Combined Cycle (US$/kWh)	Pulverized Coal (US$/kWh)	Integrated Gasification Combined Cycle (US$/kWh)
Without capture (reference plant)	0.03 - 0.05	0.04 - 0.05	0.04 - 0.06
With capture and geological storage	0.04 - 0.08	0.06 - 0.10	0.05 - 0.09
With capture and EOR	0.04 - 0.07	0.05 - 0.08	0.04 - 0.07

Costs of CCS: production costs of electricity for different types of generation, without capture and for the CCS system as a whole. The cost of a full CCS system for electricity generation from a newly built, large-scale fossil fuel-based power plant depends on a number of factors, including the characteristics of the power plant and the capture system, the specifics of the storage site, the amount of CO2, and the required transport distance. The numbers assume experience with a large-scale plant. Gas prices are assumed to be 2.8 - 4.4 US$ per gigajoule (GJ), coal prices 1 - 1.5 US$/GJ

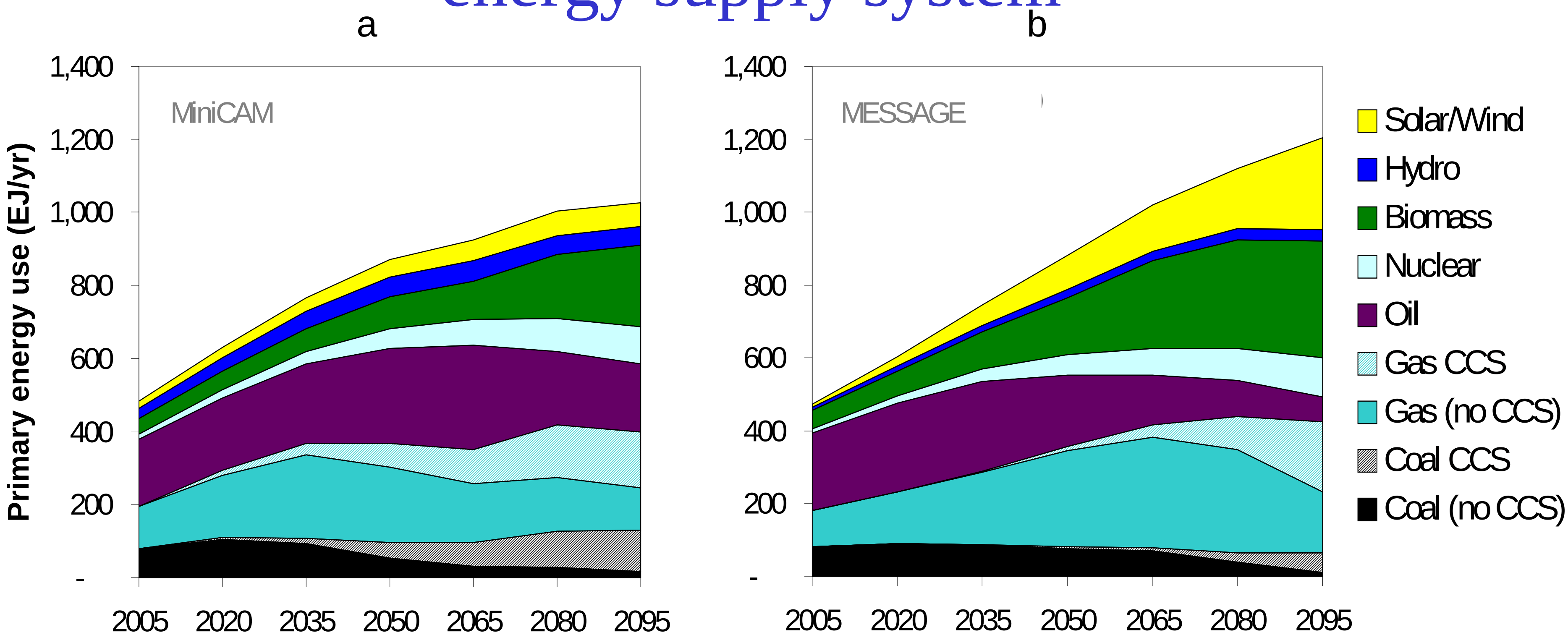
Type of power plant with CCS	Natural Gas Combined Cycle reference plant	Pulverized Coal reference plant
	US$/t$CO_2$ avoided	US$/t$CO_2$ avoided
Power plant with capture and geological storage		
Natural Gas Combined Cycle	40 – 90	20 – 60
Pulverized Coal	70 – 270	30 – 70
Integrated Gasification Combined Cycle	40 – 220	20 – 70
Power plant with capture and EOR		
Natural Gas Combined Cycle	20 – 70	0 – 30
Pulverized Coal	50 – 240	10 – 40
Integrated Gasification Combined Cycle	20 – 190	0 – 40

CO2 avoidance costs for the complete CCS system for electricity generation, for different combinations of reference power plants without CCS and power plants with CCS (geological and EOR). The amount of CO2 avoided is the difference between emissions of the reference plant and the emissions of the power plant with CCS. Gas prices are assumed to be 2.8 - 4.4 US$/GJ, coal prices 1 - 1.5 US$/GJ

CCS component costs

CCS component	Cost range
Capture from a power plant	15 - 75 US$/t$CO_2$ net captured
Capture from gas processing or ammonia production	5 - 25 US$/t$CO_2$ net captured
Capture from other industrial sources	25 - 115 US$/t$CO_2$ net captured
Transportation	1 - 8 US$/t$CO_2$ transported
Geological storage	0.5 - 8 US$/t$CO_2$ injected
Geological monitoring	0.1 - 0.3 US$/t$CO_2$ injected
Ocean storage	5 - 30 US$/t$CO_2$ injected
Mineral carbonation	50 - 100 US$/t$CO_2$ net mineralized

Posible future penetration of CCS into the global energy supply system



These figures are an illustrative example of the global potential contribution of CCS as part of a mitigation portfolio. They are based on two alternative integrated assessment models (MESSAGE and MiniCAM) adopting the same assumptions for the main emissions drivers. The results would vary considerably on regional scales. This example is based on a single scenario and, therefore does not convey the full range of uncertainties. Panels a) and b) show global primary energy use, including the deployment of CCS.

Economic potential

"In most scenarios for stabilization of atmospheric greenhouse gas concentrations between 450 and 750 ppmv CO_2 and in a least-cost portfolio of mitigation options":

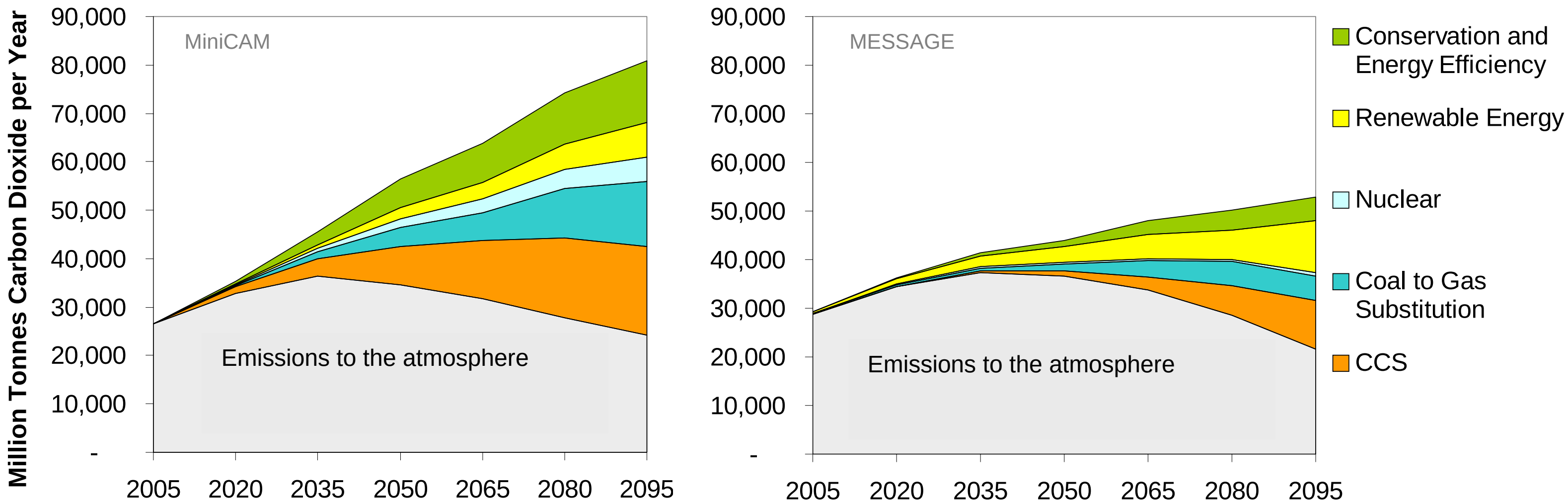
- *"Economic potential of CCS would amount to 220 - 2,200 $GtCO_2$ (60 - 600 GtC) cumulatively"*
- *"would mean that CCS contributes 15 to 55% to the cumulative mitigation effort worldwide until 2100, averaged over a range of baseline scenarios."*

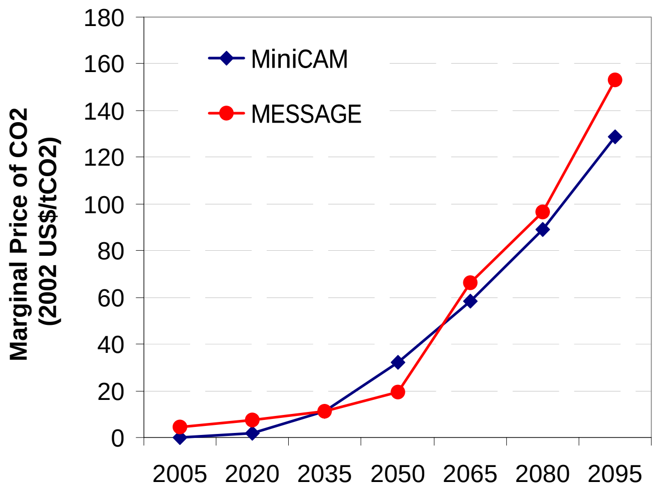
Future role of CCS in mitigation portfolios

"In most scenario studies,

- *the role of CCS in mitigation portfolios increases over the course of the century and*
- *including CCS in a mitigation portfolio is found to reduce the costs of stabilizing CO_2 concentrations by 30% or more."*

CCS and other mitigation options





Storage potential

Technical potential:

- Geological storage: *"Available evidence suggests that worldwide, it is likely that there is a technical potential of at least about 2,000 $GtCO_2$ (545 GtC) of storage capacity in geological formations"*

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

- Industrial uses: *"Not expected to contribute much to reduction of CO_2 emissions"*

Modelling results:

- Ocean storage: *"Could be on the order of thousands of $GtCO_2$, depending on the assumed stabilization level in the atmosphere, and on environmental constraints such as ocean pH change."*

Estimation

- Mineral carbonation: *"can currently not be determined"*

Technical and economic potential

- *"It is likely that the technical potential for geological storage is sufficient to cover the high end of the economic potential range, but for specific regions, this may not be true."*

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

Local risks

- CO_2 pipelines: *"The local risks associated with CO_2 pipeline transport could be similar to or lower than those posed by hydrocarbon pipelines in operation."*
- Geological storage: with:
  - *"appropriate site selection informed by available subsurface information"*
  - *"a monitoring program to detect problems"*
  - *"a regulatory system"*
  - *"the appropriate use of remediation methods to stop or control CO_2 releases if they arise"*

"The local health, safety and environment risks of geological storage would be comparable to risks of current activities such as natural gas storage, EOR, and deep underground disposal of acid gas."

Local risks

- Ocean storage:
  - *"Adding CO_2 to the ocean or forming pools of liquid CO_2 on the ocean floor at industrial scales will alter the local chemical environment."*
  - *"Experiments have shown that sustained high concentrations of CO_2 would cause mortality of ocean organisms."*
  - *"CO_2 effects on marine organisms will have ecosystem consequences."*
  - *"The chronic effects of direct CO_2 injection into the ocean on ecosystems over large ocean areas and long time scales have not yet been studied."*
- Mineral carbonation:
  - *Environmental impacts of large-scale mineral carbonation would be a consequence of the required mining and disposal of resulting products that have no practical use.*

Will physical leakage of stored CO_2 compromise CCS as a climate mitigation option?

- *"Observations from engineered and natural analogues as well as models suggest that the 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" is a probability between 90 and 99%

- *"Release of CO_2 from ocean storage would be gradual over hundreds of years."*

Will physical leakage of stored CO_2 compromise CCS as a climate mitigation option?

- *"If continuous leakage of CO_2 occurs, it could, at least in part, offset the benefits of CCS for mitigating climate change."*
- *"Assessments of the implications of leakage for climate change mitigation depend on the framework chosen for decision-making and on the information on the fractions retained for geological or ocean storage"*

What are the legal and regulatory issues for implementing CO2 storage?

- *"Some regulations for operations in the subsurface exist that may be relevant or in some cases directly applicable to geological storage, but few countries have specifically developed legal or regulatory frameworks for long-term CO_2 storage."*
- *"No formal interpretations so far have been agreed regarding whether or under what conditions CO_2 injection into the geological sub-seabed or the ocean is compatible with certain provisions of international law."*

Further on the report

- Press release by UNEP/WMO at 13:30h (Montreal time)
- Full report on the web by beginning of December
- Separate booklet with SPM, Technical Summary
- Presentation at a side-event at COP11
- Agenda item at the Subsidiary Body of the UNFCCC
- Outreach

Thank you

ENB report of the Montreal (WGIII 8, IPCC 24) meeting:
via http://www.iisd.ca/climate/ipcc24/

Summary for Policymakers availabe on www.ipcc.ch
including a view of this presentation

Reflecting uncertainties

- New mitigation option, not always complete information to answer all relevant questions
- Range of findings/ numbers reflected
- Assessment also relies on expert judgement of authors, based on available literature
- Uncertainties reflected quantitatively where possible (as used in earlier IPCC reports "*very likely = 90-99%, likely is 66-90% probability*"); qualitatively in other cases