The Role and Impact of CO_2 Capture and Sequestration (CCS) in Long Term Energy Scenarios

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EMF-IEW

22-24 June 2004

IEA Paris

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CCS

- CCS means storage of CO_2 in geological formations
- Major sources are found in the power sector, industry , fuel conversion
- Competes in the power sector with other CO_2 reducing measures: fuel switch; efficiency improvement; conservation; renewables; advanced technologies (fuel cells, nuclear)
- Additional to known technologies (e.g. IGCC)

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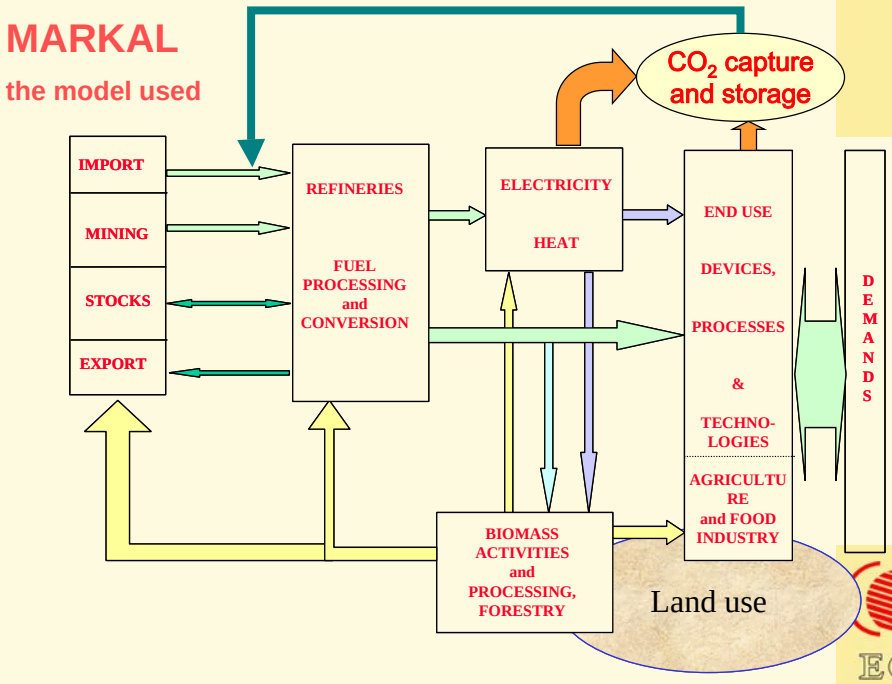
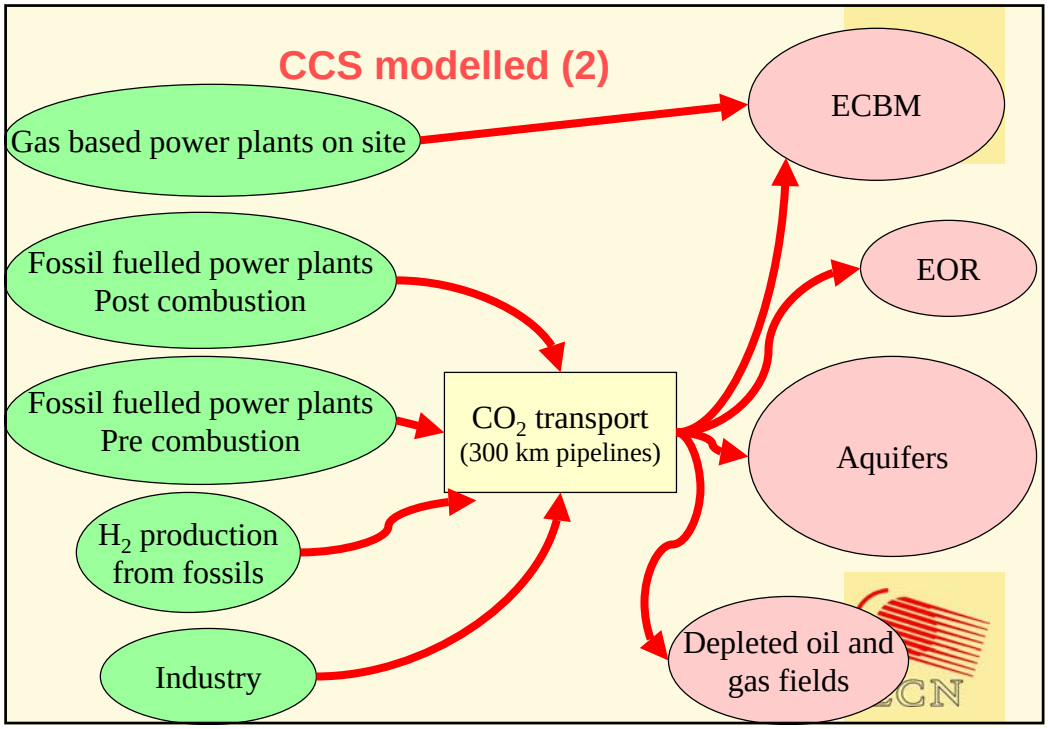
the model used



CCS modelled

- Model covers Western Europe, no trade in CO_2 assumed, only “domestic” storage options
- CO_2 capture and storage involves:
  - Emission sources
    - Large point sources in power sector and industry
  - CO_2 capture
    - Pre and post combustion CO_2 capture
  - CO_2 transport
    - Pipelines
  - CO_2 storage
    - Aquifers, EOR, ECBM, depleted oil and gas fields
  - Leakage

CCS modelled (2)



Technology improvement for CCS

- Out of 19 learning components/technologies in the model, 4 are related to CCS:
  - Post combustion capture from gaseous fuels
  - Post combustion for solid fuels
  - Pre combustion from fossil fuels (solid incl biomass & liquid)
  - CO_2 injection into geological formations
- These components appear in 28 technologies, 22 for capture and 6 for storage
  - example for capture: IGCC with CO_2 capture: coal, oil, biomass and co-fired based
- Learning parameters estimated from literature because no actual (=realised) data available : PR (default = 0.9) and costs from expert estimates

Cases

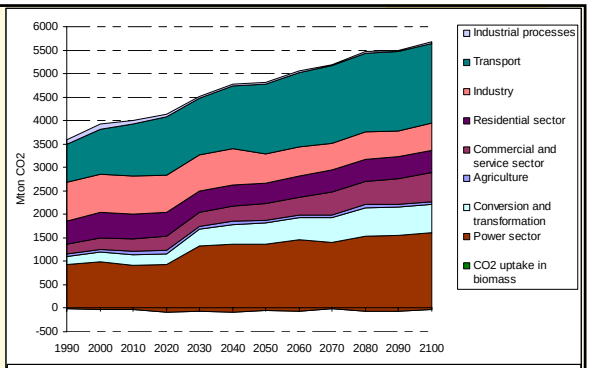
- A reference case, i.e. no additional policy for climate change mitigation, optimistic technology development, no severe constraints on nuclear, moderate but continuous fuel price development and economic growth
- A CO_2 stabilisation case at 550ppmv
- 4 cases with different CO_2 price tags : 10 – 20 - 50 and 100 €/ton CO_2 from 2020 onwards
- All cases use the same potential (≈ CO_2 reservoirs) per mode of storage

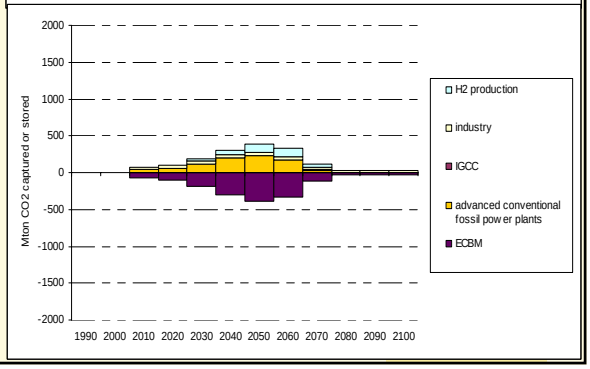
Results

- Reference case:
  - Total CO_2 emissions
  - CO_2 captured and stored + rationale
- 550ppmv case
  - Total CO_2 emissions
  - CO_2 captured and stored
  - Reduction cost curve for CO_2
- Alternative case with no CCS allowed
  - Difference in CO_2 reduction cost curve

Reference case

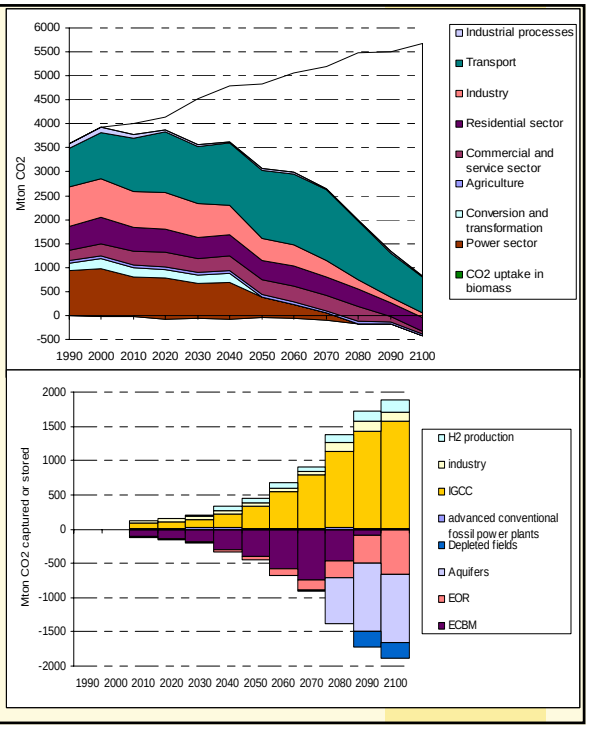
- CO_2 grows to 5,7 Gton by 2100 (+ 58% vis-a-vis 1990 level)
- Major sources are power sector (28%) and transport (29%)
- Modest contribution from CCS, ECBM ("low hanging fruit") seems attractive due to the energy recovery benefits, but once potential is exhausted, only small & dedicated CCS by industry (purity CO_2 flow)





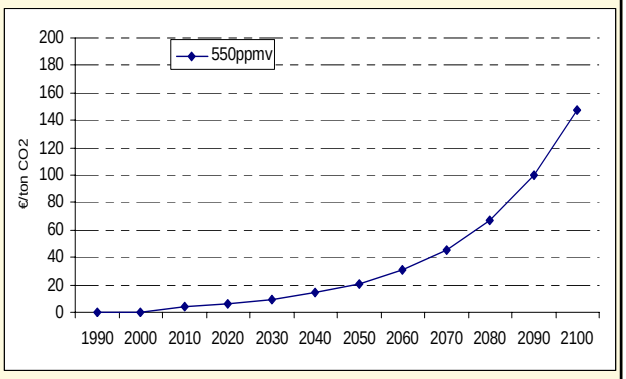
550ppmv case

- CO_2 reduced to 0.8 Gton/year by 2100 (- 77% vis-a-vis 1990 level)
- Major sources remain transport and residential sector
- Considerable contribution from CCS, CO_2 originating from power sector and storage in order in ECBM, EOR (mostly off shore), aquifers and depleted fields



CO_2 reduction cost

- CO2 reduction cost increases to 150 €/ton CO_2 (550 €/ton C)



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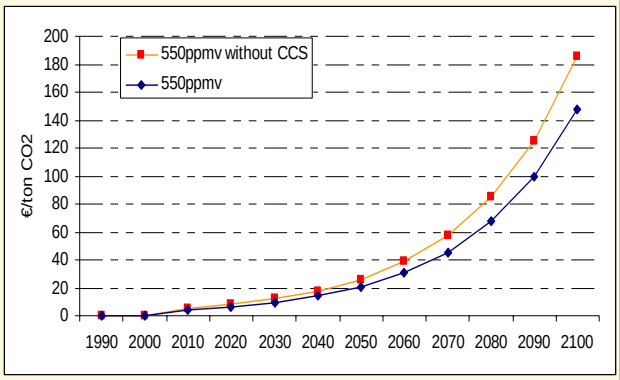
CO_2 reduction cost

- CO2 reduction cost increases to 150 €/ton CO_2 (550 €/ton C)
- If no CCS is allowed, CO_2 reduction cost increases with 25, or with CCS is % 20% lower



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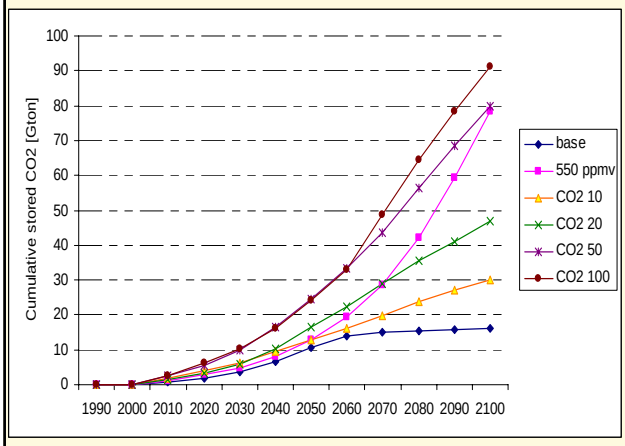
Influence of different CO_2 taxes



- Small CO_2 tax doubles stored amount
- Potential (301 Gton) not reached
- Higher taxes do not increase storage much => other alternatives come in (renewables, nulcear, demand effects)

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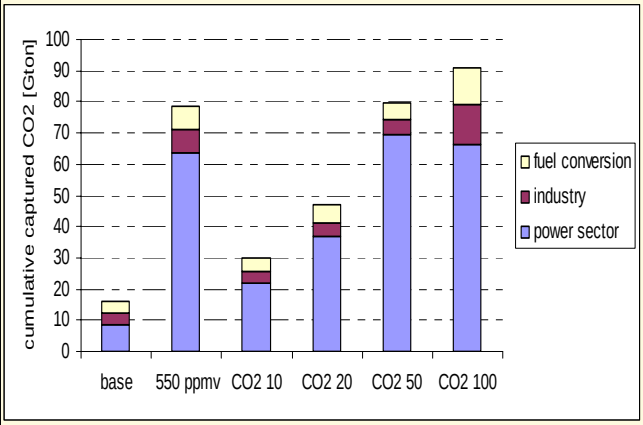
Origin of CCS

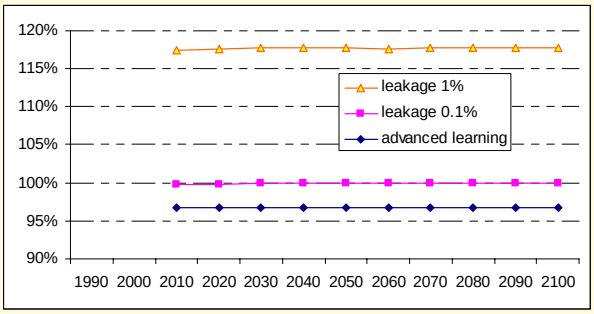


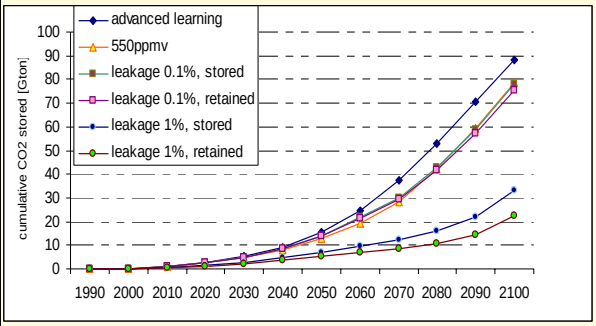
- Major source of CCS remains power sector (54%- 87%)
- Other sources need to be investigated and included in the model

Sensitivity of CCS

- 3 cases relative to the 550 ppmv case:
  - Advanced learning of CCS related (capture and injection) technologies (PR= 0.80)
  - Retention rate or leakage of stored CO_2: no proven estimations available, very sensitive for policy makers and public acceptance, in this case assumed to be 0.1% and 1% of cumulative stored amount of CO_2
  - No other changes included

Sensitivity of CCS (2)





- Small leakage hardly affects the marginal abatement cost of CO_2; 1% leakage increases it with 18%; advanced learning of CCS tech's reduces cost with 5%
- Advanced learning increases cumulative storage with 10 Gton
- Leakage affects cumulative level stored amount
- Small leakage reduces stored amount with 3%; considerable leakage reduces it with 33%

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Conclusions

- CCS is an as important part of emission reduction as other mitigation options (renewables, nuclear, efficiency improvement)
- CO_2 reduction costs without CCS allowed increase with 25% in a climate stabilisation case
- Advanced learning in CCS could be advantageous in achieving climate objectives
- Small leakage hardly affects CCS deployment, 1% leakage has severe impact on level and abatement cost

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