JÜLICH
FORSCHUNGSZENTRUM

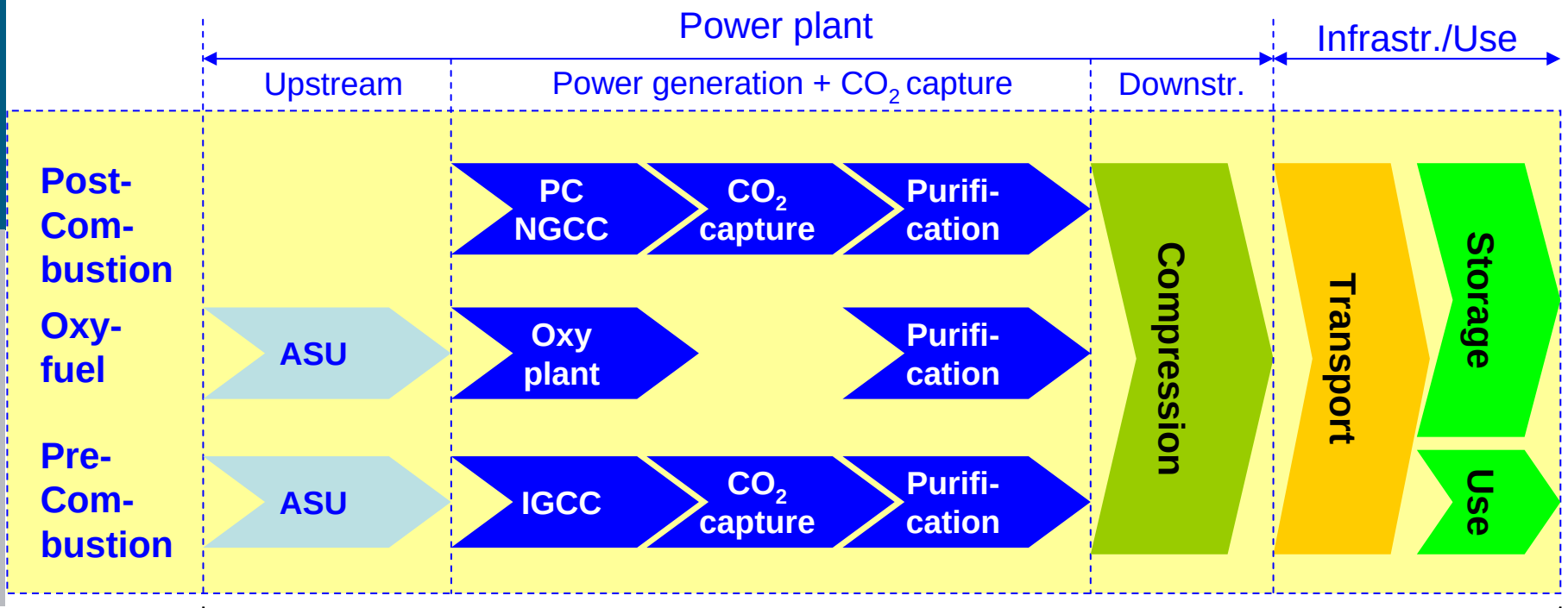
ALICE Workshop, Potsdam, 11.-12. March 2010

CCS from a scientific perspective

11. March 2010

W. Kuckshinrichs

CCS as an option to reduce CO_2



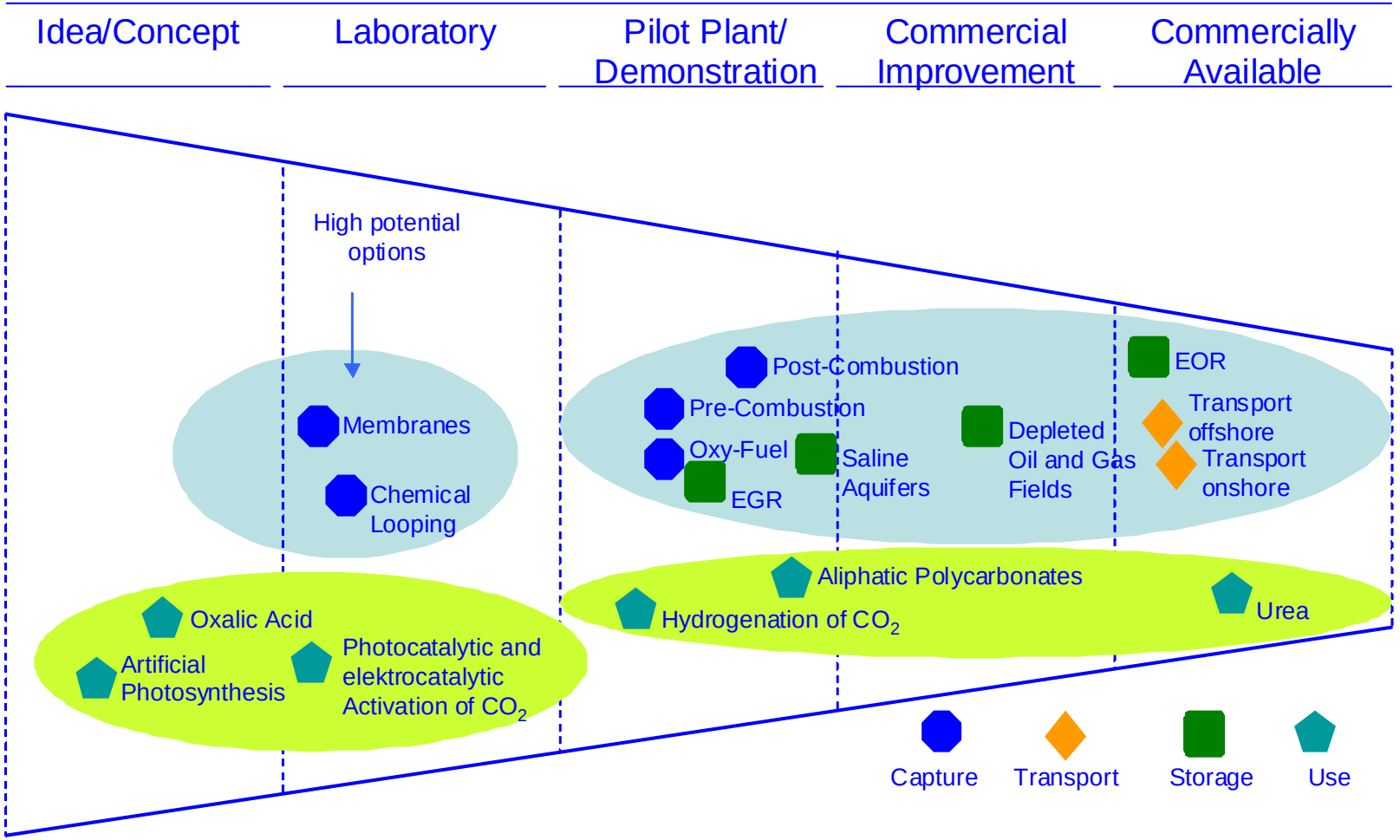
Key aspects:

- Energy penalty
- CO_2 purity
- Flexibility of power generation
- Resource use and environmental impact
- Costs (Capex and Opex)
- Ownership and long-term liability
- Infrastructure
- Acceptance

Window of opportunity ~ 2020

CCS as an option to reduce CO_2

Innovation phases

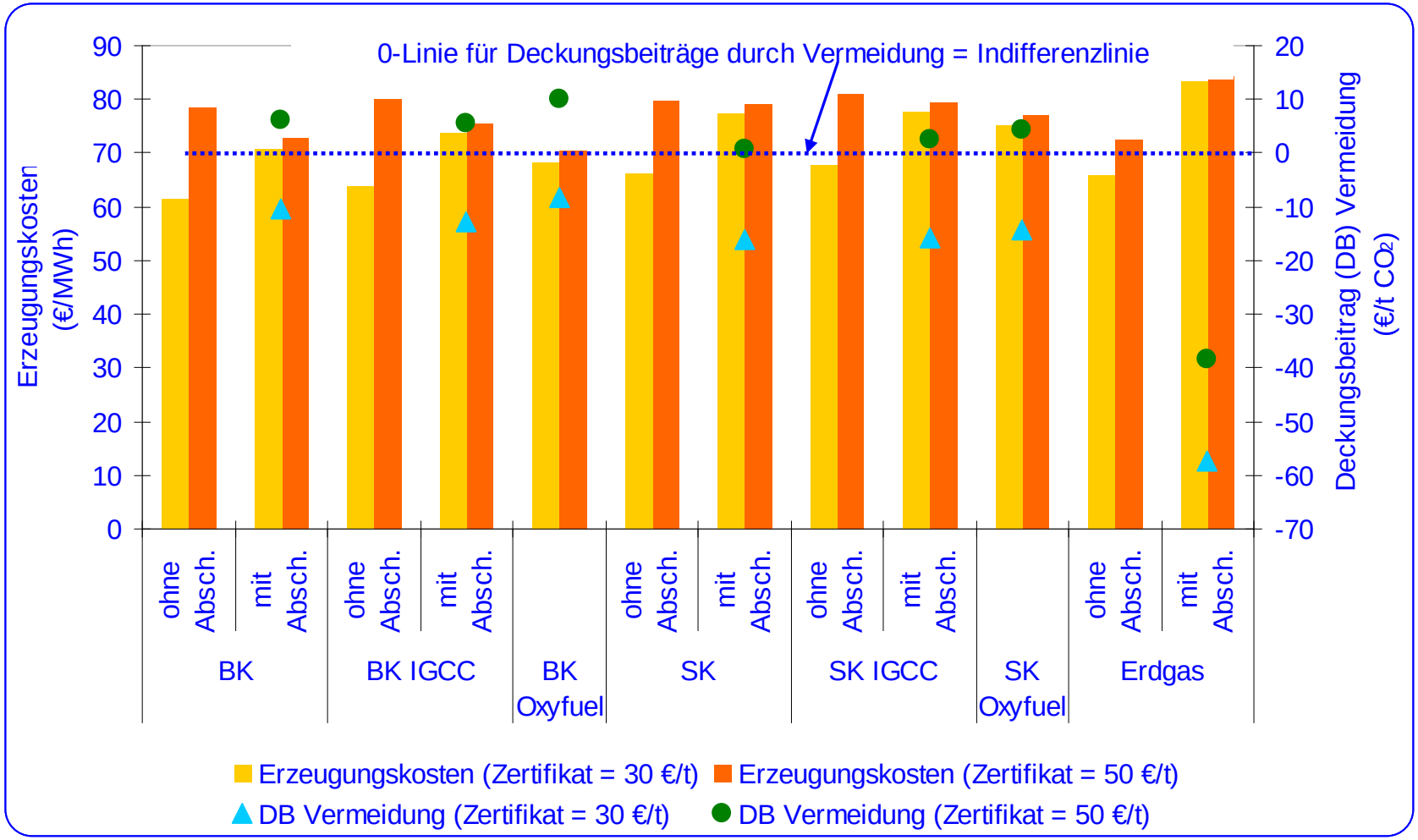


Revised version of: McKinsey (2008): Carbon Capture & Storage. www.mckinsey.com

Essential pre-conditions for success of CCS

- Commercial availability:
  Demonstration plants; ‚Window of opportunity' for Germany ~ 2020
- Construction of infrastructure:
  (Pipeline)-transport and storage; new sites for power plants
- Robust incentive system:
  Clear signal from CO_2 price
- Binding legal frame:
  KSpG
- Public acceptance:
  CCS and coal-based electricity generation

Electricity generation cost and marginal return of CO_2 avoidance



CCS - legal frame

- Sept. 2007
  OSPAR Commission: Permission for sub-seabed storage of CO_2
- Early 2008
  Draft EU directive for ‚Geological storage of carbon dioxide‘
- End of 2008
  EU CCS directive for ‚Geological storage of carbon dioxide‘
- April 2009
  Governmental proposal for German CCS law ‚Gesetz zur Regelung von Abscheidung, Transport und dauerhafter Speicherung von Kohlendioxid (KSpG)‘
- June 2009
  Process for parliamentary voting stopped

Public acceptance

- Two studies for Germany
  - BMWi study
    Consortium: Wuppertal-Institut, Forschungszentrum Jülich (IEF-STE), ISI Karlsruhe, BSR Karlsruhe
  - FENCO study (EU member countries)
    Consortium: Forschungszentrum Jülich (IEF-STE, Co-ordination), Wuppertal-Institut, several European research institutes
- Pre-commercial storage site in Schleswig-Holstein
  - RWE-DEA initiative for storage
  - part of proposed RWE IGCC/CCS power plant Hürth
  - local initiatives and majority of local politicians resist

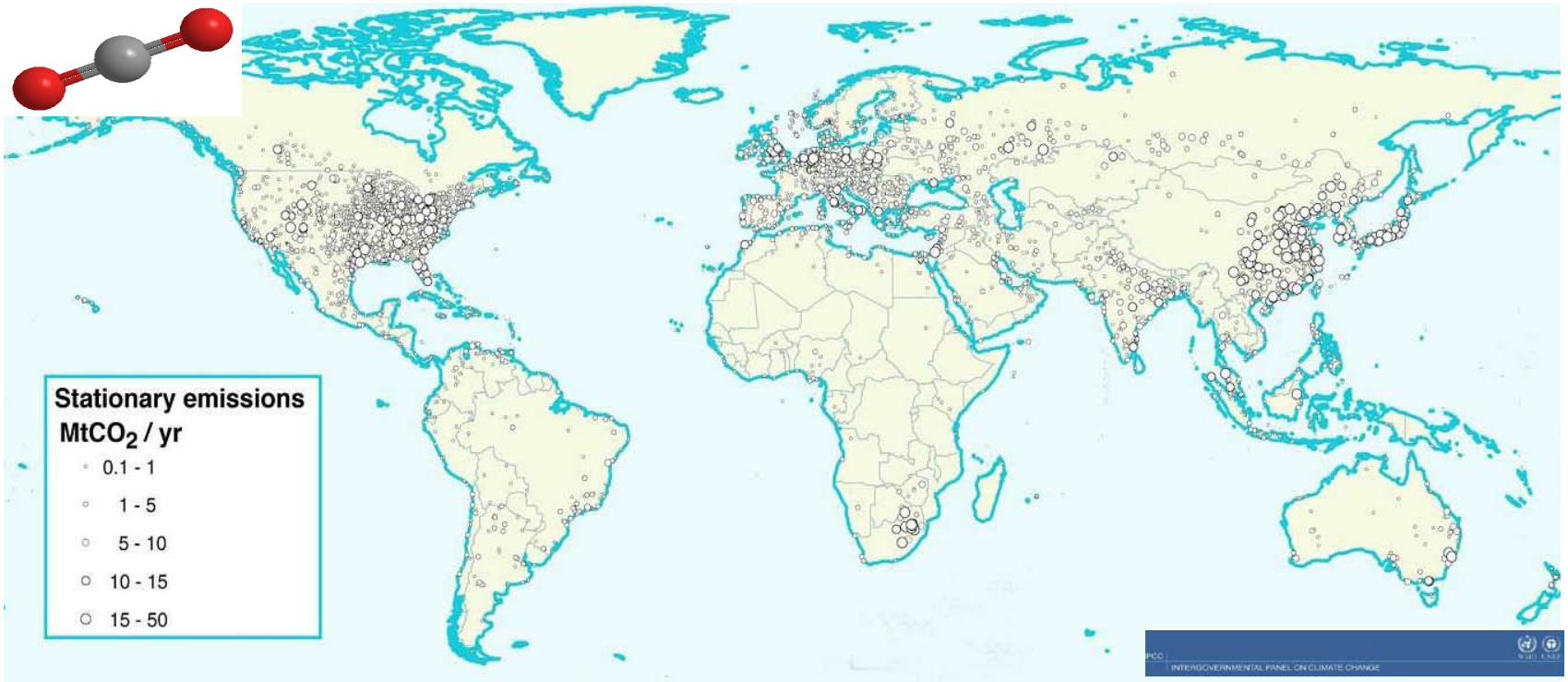
Conclusion

- Large potential for CCS as measure to reduce CO_2 emissions from point sources in energy supply (and energy-intensive industry!)
- Energy penalty and investment costs high! Reductions necessary
- No clear advantage for one of the three process routes
- First-generation technologies: Likely commercially available ~ 2020, if demonstration plants will be built
- Price for CO_2 certificates low by trend, but rising prices forecasted: Design of ETS
- EU directive on CCS enacted, necessary implementation into German law (KSpG) and process for parliamentary voting stopped – Obstacle for investing in CCS and demonstration plants
- Public acceptance for CCS uncertain, front-end aspect: Acceptance of coal-based electricity generation
- Second-generation technologies: Large potential for membranes to reduce energy penalty and costs

Thank You for Your Attention!

Back-up

Global CO_2 Emissions

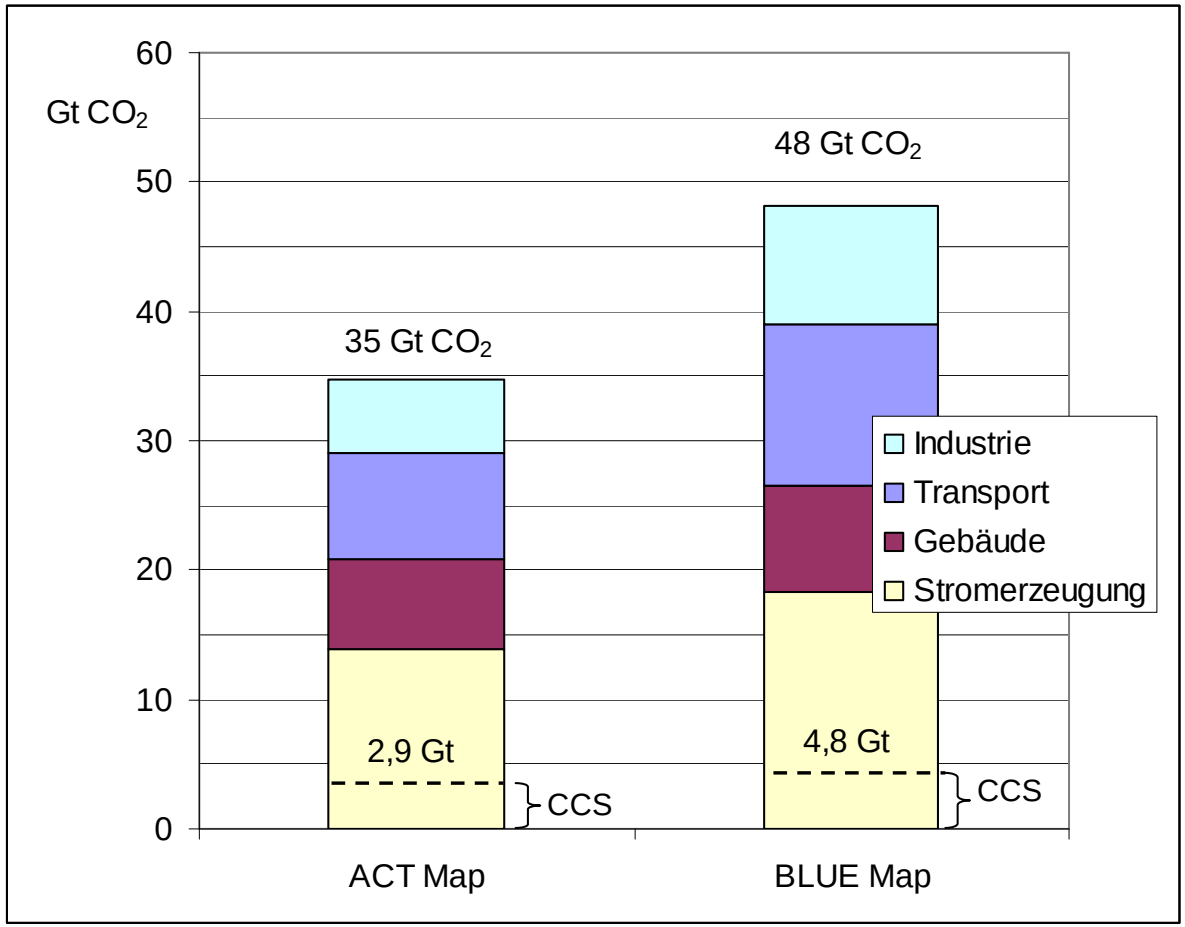


http://www.eia.doe.gov/iea/carbon.html

- Global CO_2 emissions 2008 appr. 29 bn t/a
- Increasing trend
- IEA-Scenario BaU 2050: 62 bn t/a

CO_2 reduction in the IEA scenarios - The contribution of CCS in 2050 -

- CO_2 reduction in IEA scenarios *ACT* and *BLUE*
- Highest share of CO_2 reduction from electricity generation
- CCS as measure with highest reduction potential:
  - ACT 21%
  - BLUE 26%



CO_2-avoidance costs

- Öko-Institut: 17 – 90 €/t CO_2
- Wuppertal Institut: 40 – 60 €/t CO_2
- McKinsey: 31 €/t CO_2
- IEF-STE: 30 – 50 €/t CO_2
- Current CO_2 price low

Uncertainty concerning:

- Capex (+ ~ 50%)
- Fuel cost
- CO_2 price
- Costs of transport infrastructure
- Storage costs