Abating CO_2 in Energy Intensive Industries

Katharina Grave

Institute of Energy Economics

Cologne, Germany

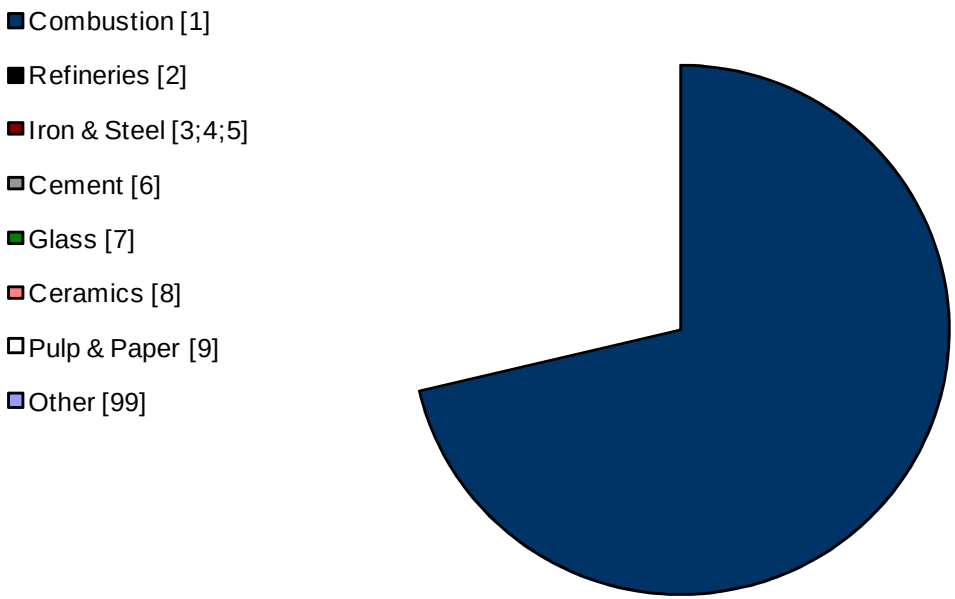
Agenda

1. Aim
2. Theoretical Approach
3. Quantifying Abatement Potentials
4. Implementation
5. First Results

Aim

Analyse the structure of the “other half“ of the emissions covered by the European Emission Trading System and quantify CO_2-abatement potentials outside the energy sector

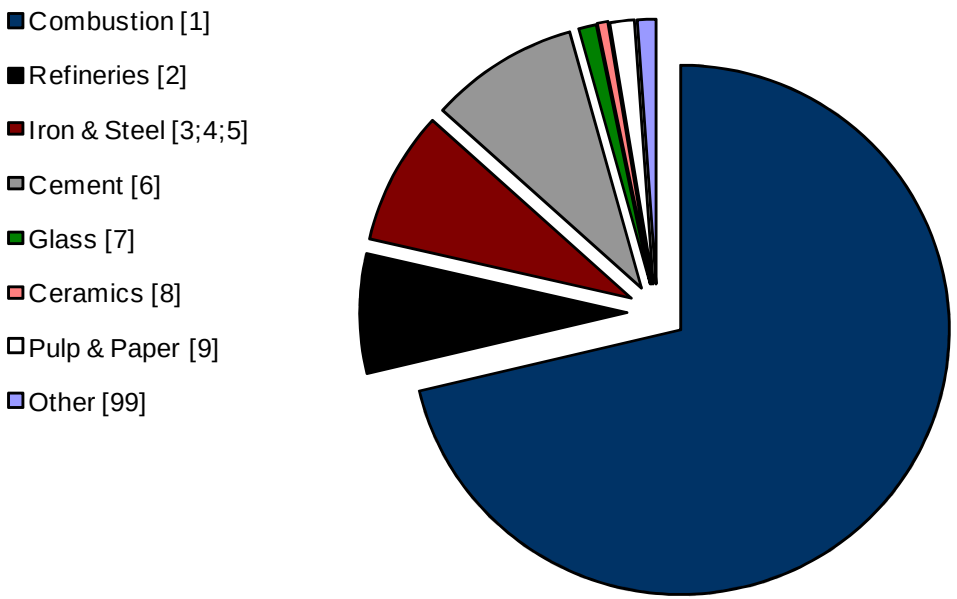
Theoretical Approach: Analysing CITL



The main category: Combustion

Verified Emissions 2009

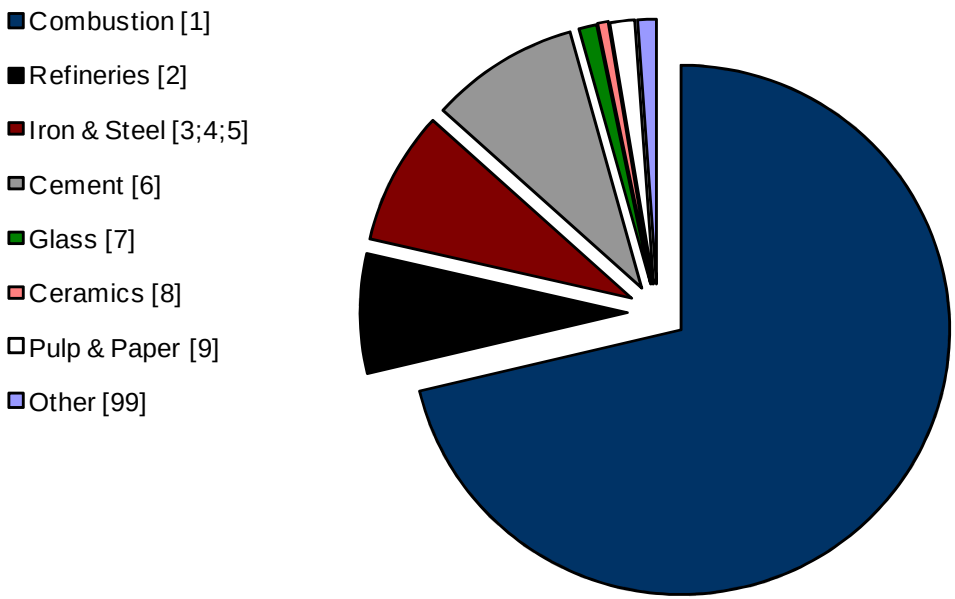
Theoretical Approach: Analysing CITL



Verified Emissions 2009

main industrial emitters:
iron and steel,
cement,
and refining

Theoretical Approach: Analysing CITL

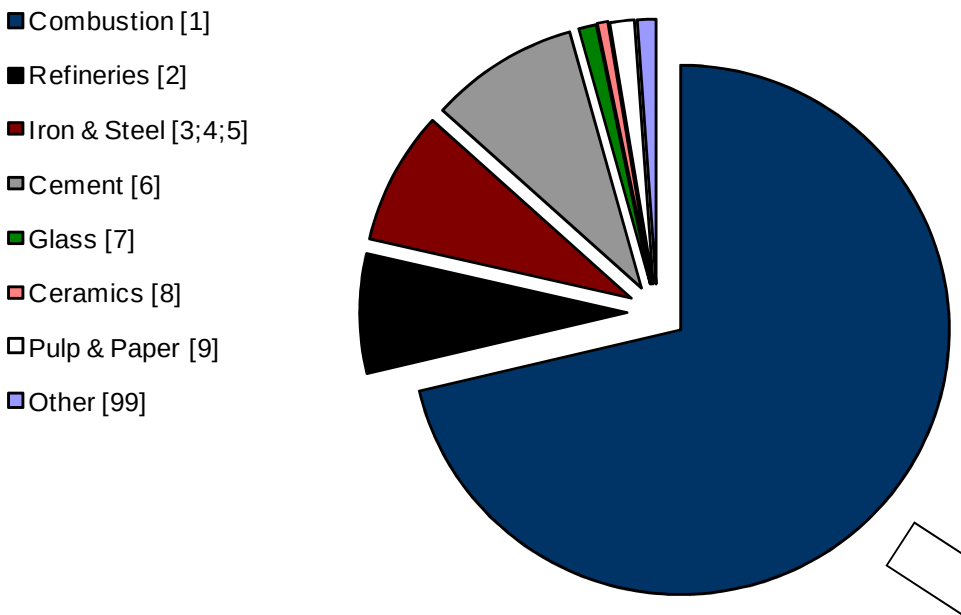


Verified Emissions 2009

main industrial emitters:
iron and steel,
cement,
and refining

Problem:
Combustion is also a main process in the industrial sector

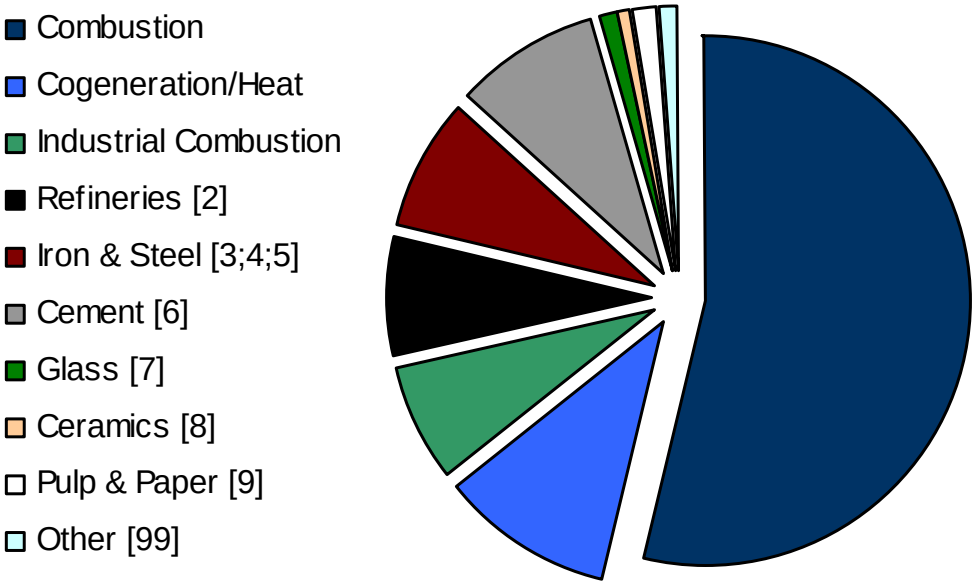
Theoretical Approach: Analysing CITL



Verified Emissions 2009

What part of it belongs to the industrial sector?

Theoretical Approach: Analysing CITL



Trotignon/Delsbosc:

15% is emitted in cogeneration plants

10% are industrial emissions

Quantifying Abatement Potentials: Collecting Data

- **Industrial studies (specific and general)**
- **Institutes**
- **Stakeholder-Interviews**

Quantifying Abatement Potentials: Classification

1) Specific abatement
   - Electric arc furnaces instead of integrated steel mills
   - Clinker substitution
2) Fuel-switching
3) Carbon capture and storage (CCS)
4) Carbon leakage

Quantifying Abatement Potentials: Variables

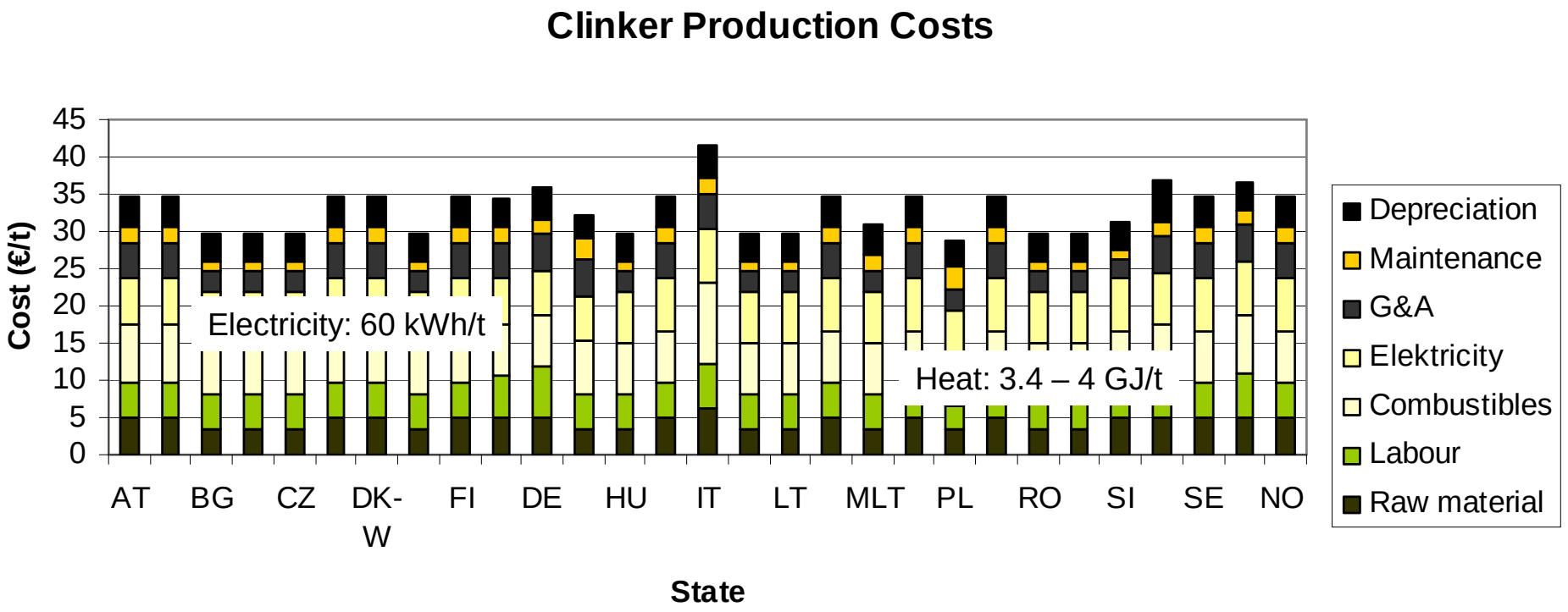
- Production (covered by ETS)
- Average emissions per tonne
  - Process emissions
  - emissions from combustion
- Electricity demand
- Costs of abatement per tonne
- Exogenous limits of applicability

Quantifying Abatement Potentials: Variables

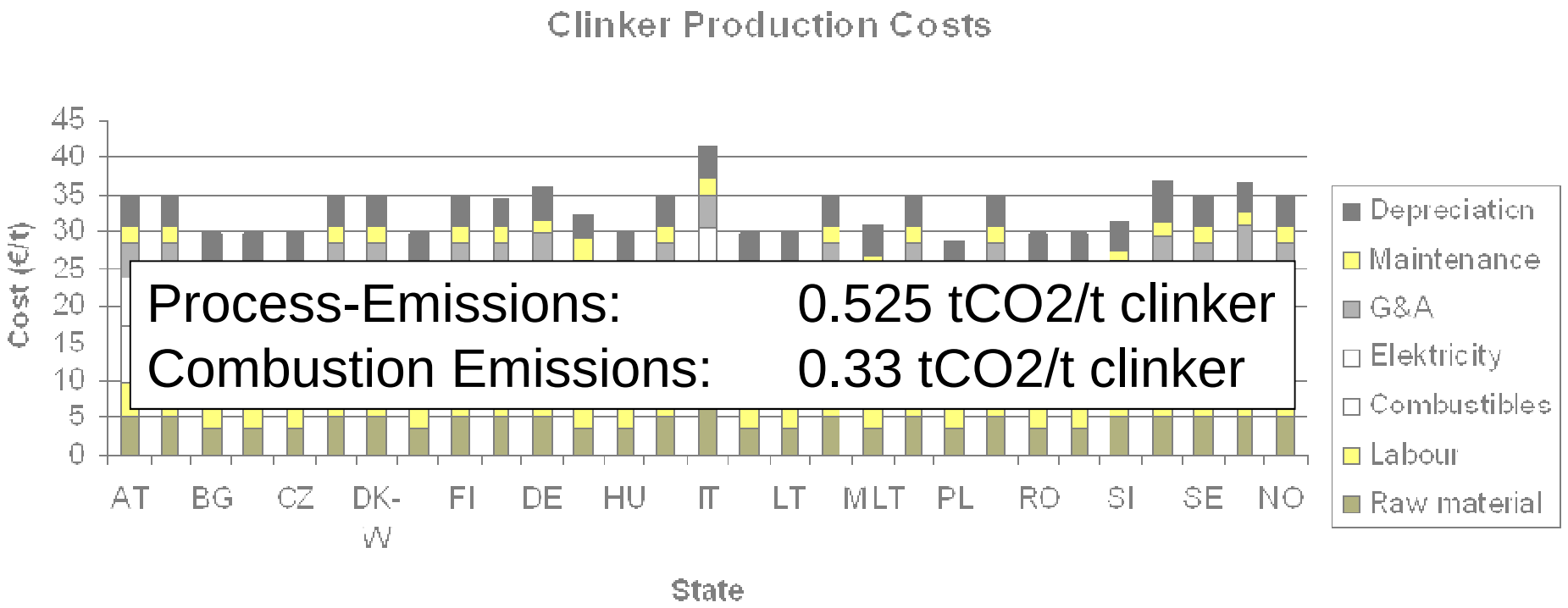
- Production (covered by ETS)
- Average emissions per tonne
  - Process emissions
  - Emissions from combustion
- Electricity demand
- Costs of abatement per tonne
- Exogenous limits of applicability

For each state
+
For each industry

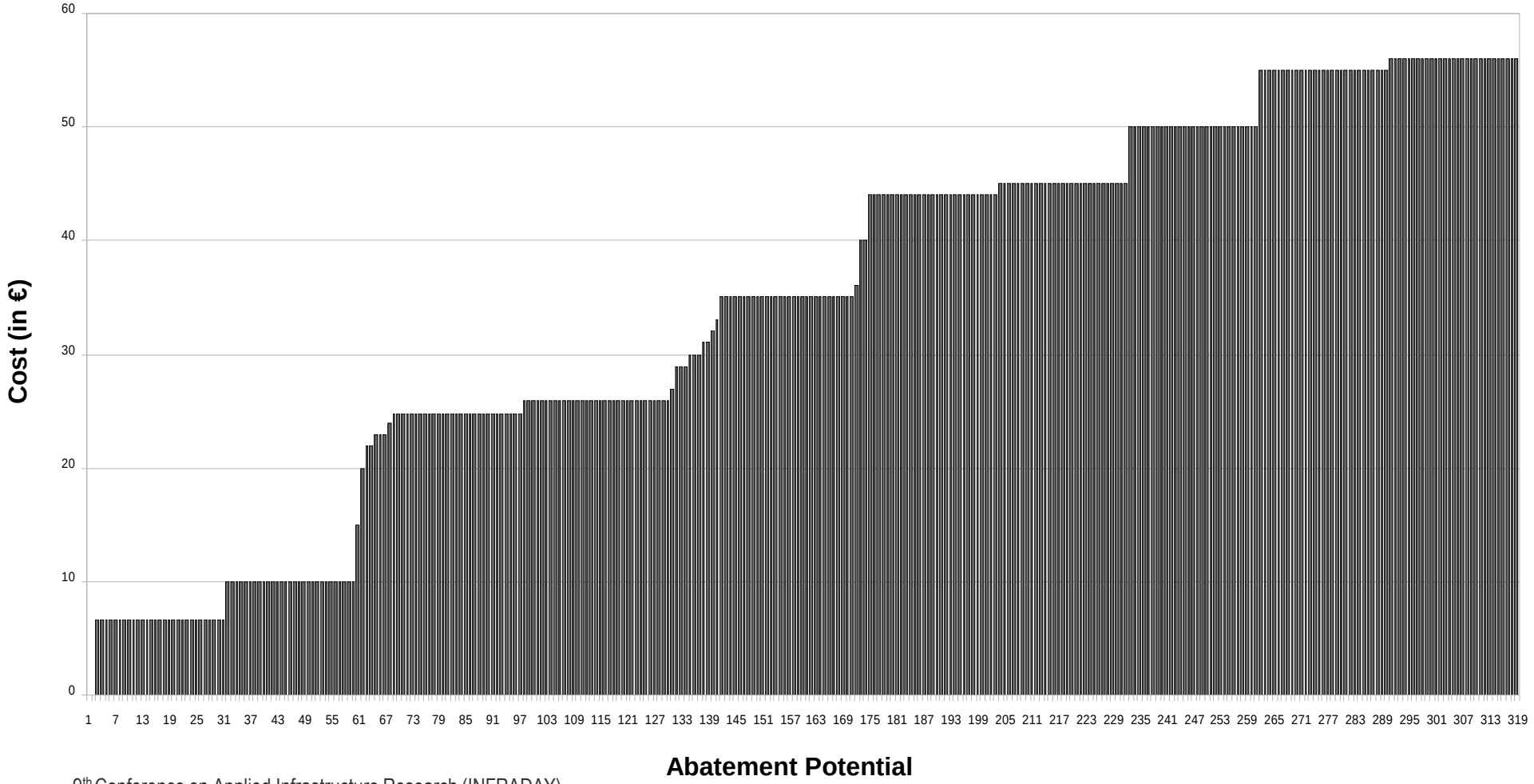
Example: Cement



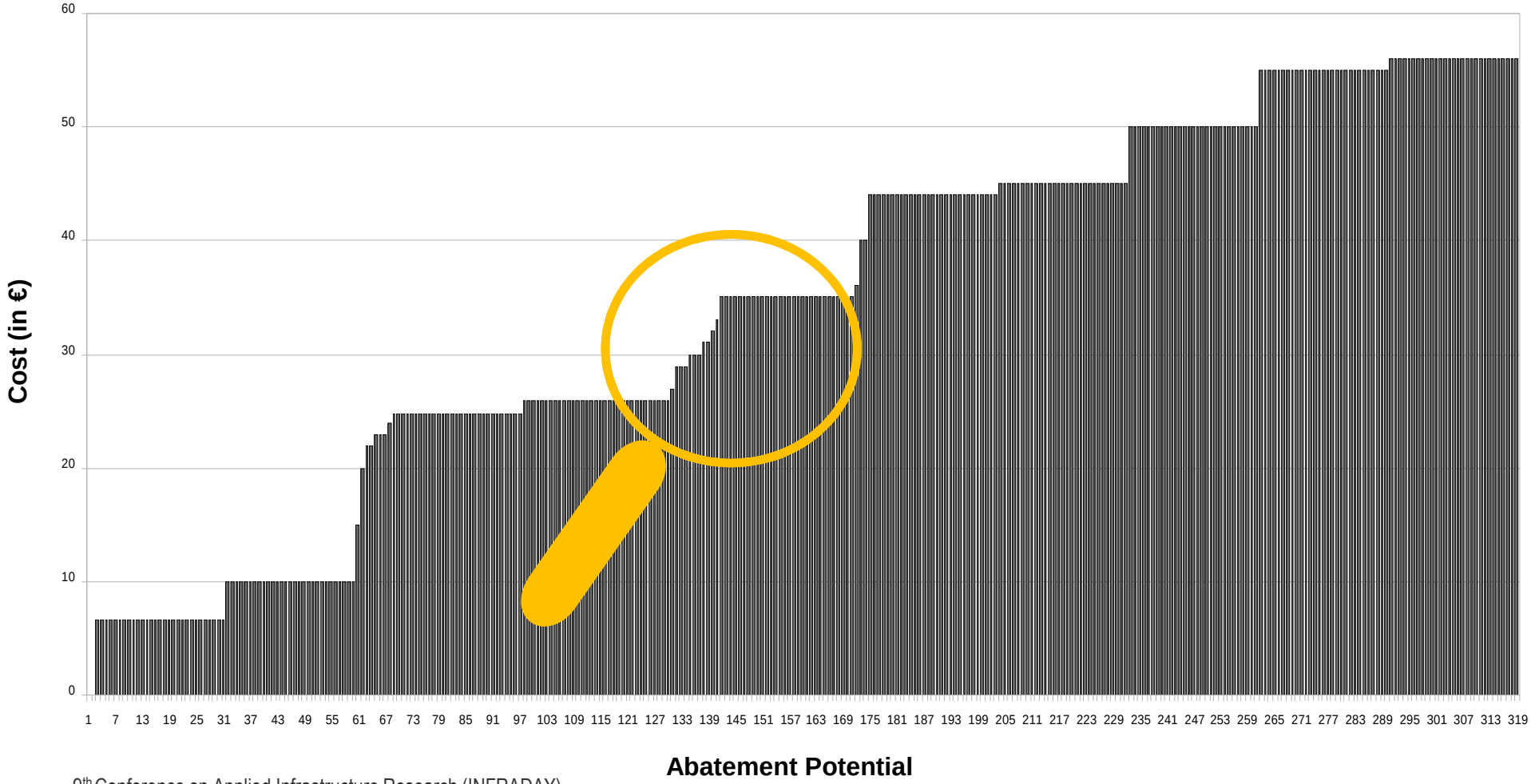
Example: Cement



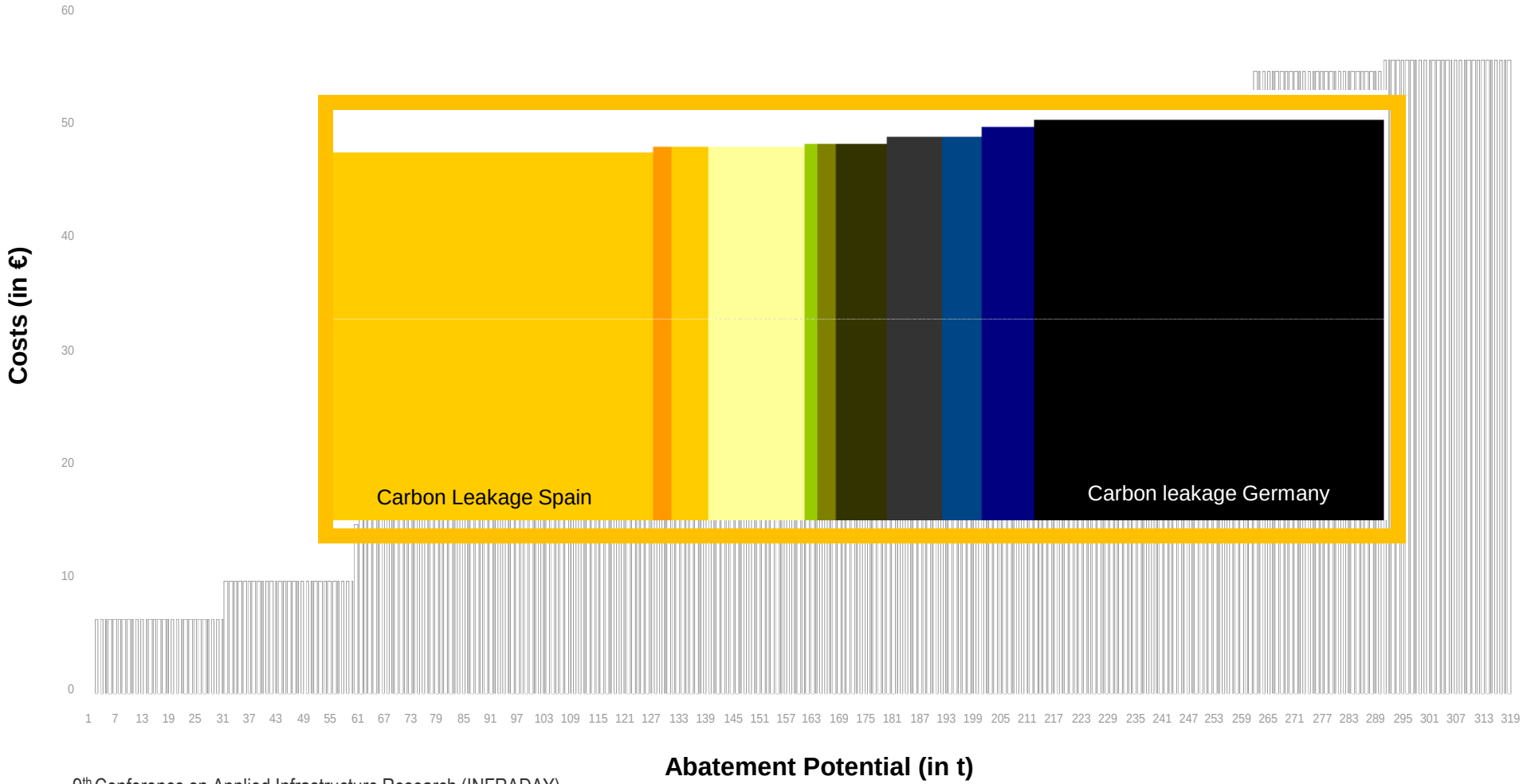
Merit Order of Abatement



Merit Order of Abatement



Merit Order of Abatement



Implementation

DIME

- Linear optimisation model
- Calculation to 2050
- Aim: Minimisation of the total costs of electricity generation
- constraint:

  Limited emission of CO_2

Implementation

Objective function:

C[…] ⇒ min

New constraint:

$$\Sigma E_e(y) = B(y) + A_g(y)$$

Implementation

Abatement:

$$A_g(y) = \Sigma A_i (r,m,y)$$

Limited potential:

$$A_i \max * (1+g_i (r,m)^j) > A_i$$

Implementation

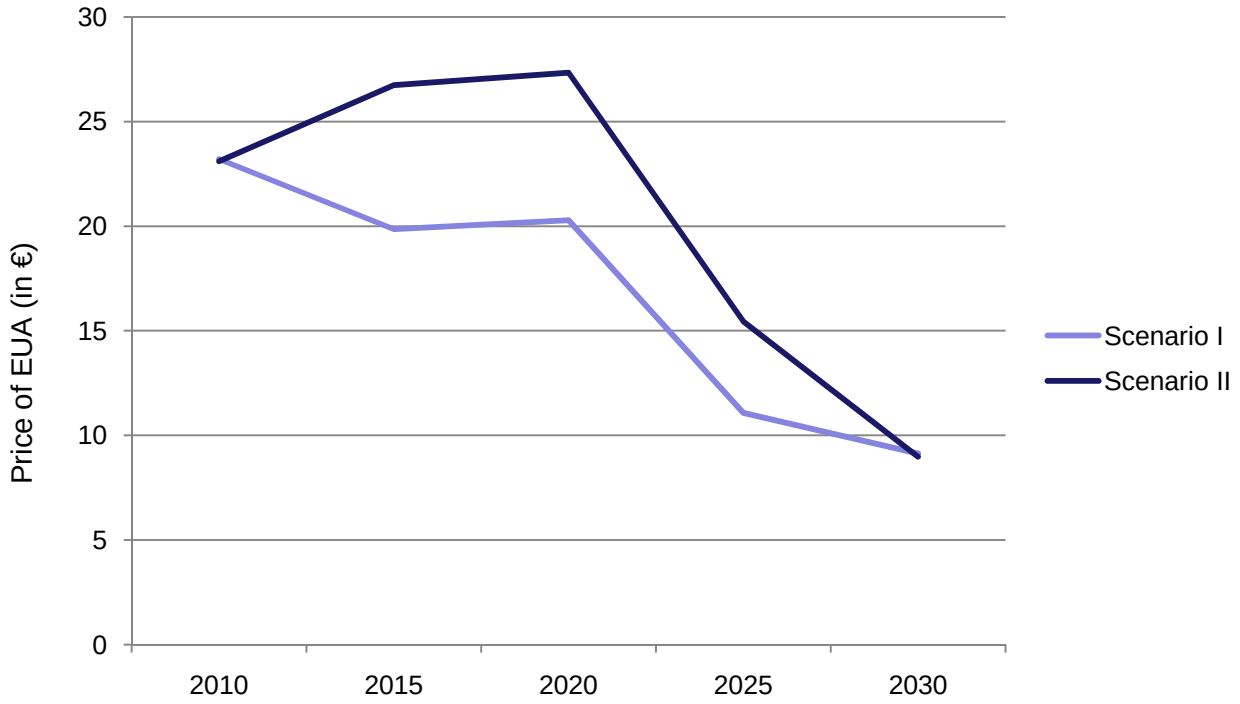
Industrial abatement costs:

$$AC_g = \Sigma (A_i * C_i (r,m,y))$$

Additional demand for electricity:

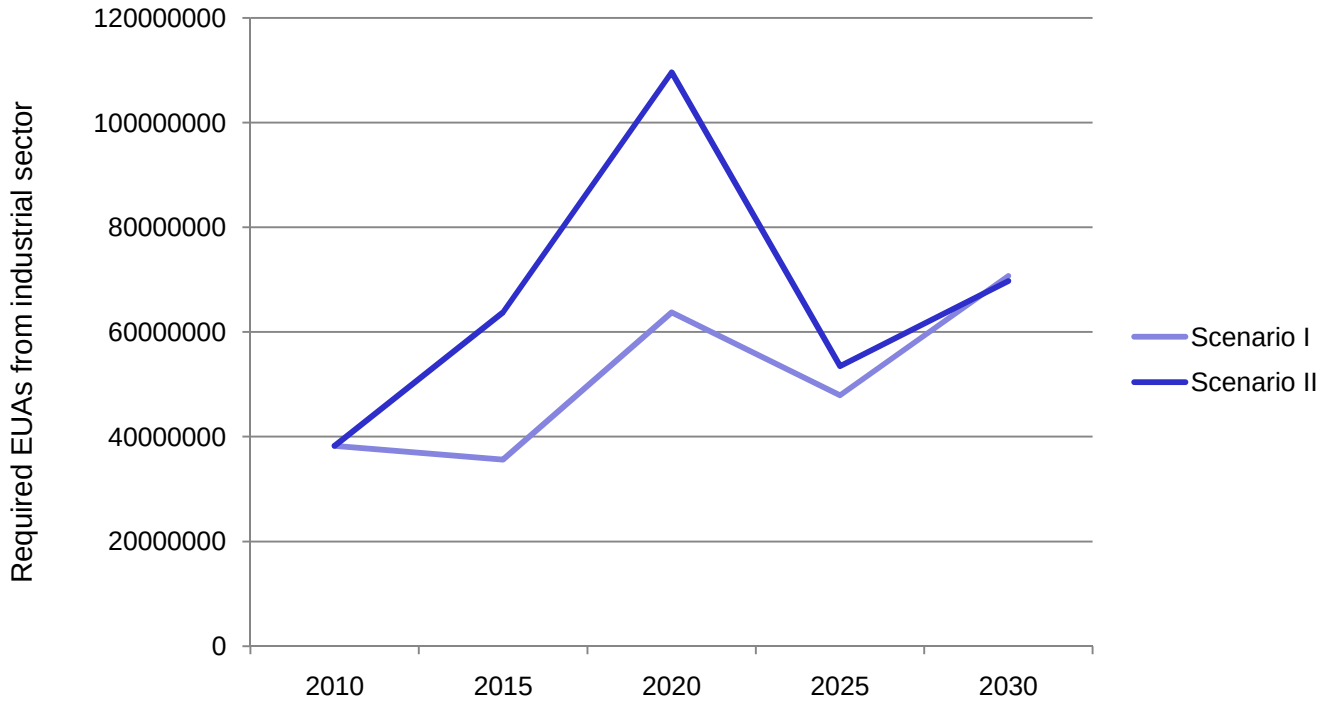
$$L_g (r,y,s,d,h) = l (r,y,s,d,h) + A_i * f (r,m)$$

First Results



5

First Results



Further Research

- Similar costs of production
- Missing data
  - Production covered by ETS in glass and ceramics sector
  - Production costs outside carbon constraint
- Limited application of abatement potentials
- Estimations for carbon leakage
- Assumptions about technical progress

Thank you for your attention!

Katharina Grave

Energiewirtschaftliches Institut
an der Universität zu Köln
Vogelsanger Str. 321
50827 Köln
Tel.: 0221-27729-306
katharina.grave@uni-koeln.de

Backup: Main Studies

- McKinsey für BDI (2007): Kosten und Potentiale der Vermeidung von Treibhausgasemissionen in Deutschland
- IEA (2005): Industrial Competitiveness under the European Union Emissions Trading Scheme
- BREF Reports
- Sektorenspezifische Studien

Backup: Experts

CEPI:	**Marco Mensink (Energy&Environment Director)**
FEVE:	**Adeline Farrelly**
Cembureau:	**Nina Sparacio (Assistent of Claude Lorea, Technical Director)**
VdZ:	**Dr. Volker Hoenig; Dr. Stefan Schäfer, Stefan Woywadt (Energy and Production Engineering)**
HVG DGG:	**Karlheinz Gitzhofer (Environmental Protection)**
FEHS:	**Dr. Dirk Mudersbach, Anja Garbach (Building Materials)**
IMA/EuLA:	**Bert d'Hooge (Scientific Advisor)**
BMU:	**Franzjosef Schafhausen (Director Environment and Energy)**
McKinsey:	**Dr. Phillip Beckmann (research for BDI)**
IEHK Aachen:	**Dr. Stephan Geimer (CO2-topics)**
Wirtschaftsvereinigung Stahl:	**Roderick Hömann (Energy Economics and Techical Design); Achim Beerheide (supply and logistics)**
VDEh:	**Dr. Bodo Lüngen (production)**
BdF:	**Jörg Schulze (environment and security)**