Composition and drivers of energy prices and costs in energy intensive industries

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CEPS, Brussels 26 February 2014
Agenda

- About the study
- Key research areas
- Methodology
- Caveats
- Some key findings
- Cross-sectoral analysis
- Ammonia (chemicals)
- Chlorine (chemicals)
- Flat glass
- Bricks and roof tiles (ceramics)
- Wall and floor tiles (ceramics)
- Steel
- Aluminium
About the study

• **Objective**
  Analysis of the composition and drivers of energy prices and costs in energy intensive industries

• **Sectors covered**
  - Bricks and roof tiles (ceramics)
  - Wall and floor tiles (ceramics)
  - Ammonia (chemicals)
  - Chlorine (chemicals)
  - Flat glass

↔ 5 studies, 15 CEPS researchers involved, 24 Jul – 31 Oct 2013

• Separate studies for aluminium (cumulative cost assessments) and steel
Analysis

1. Overview of energy prices development (2010-2012)
   - Absolute price level
   - Structure of the bill (energy component, grid fees, RES levies and other non-recoverable taxes)

2. Energy intensity/efficiency

3. Impact of energy costs on production costs and other key performance indicators (where data available)

4. Comparison with non-EU production sites (where data available)

5. Indirect ETS costs
Methodology

- Data collection based on questionnaires filled in by producers
  - 78 received, 65 were used either in the Sector Reports or in the cross-sectoral analysis
  - 24 further questionnaires from the aluminium and steel sectors were used in the cross-sectoral analysis
- Data validation
  - Plausibility checks
  - Electricity and natural gas bills (when available)
  - Data sources from third parties
- Strict compliance with confidentiality
  - Anonymised, aggregated and/or indexed data presentation
    - no data can be attributed to any specific plant
- Criteria for establishing the samples: geographical, plant capacity, technology & size (SMEs and large companies)
Caveats

1. Industry self-reporting & sample choice & representativeness

2. Not all revenue streams may be reported (e.g. waste energy, demand responses payments etc.)

3. Validation

4. Margins

5. Period chosen: 2010-2012

6. Timeline
Some key findings

• Bigger than expected differences across member states
• Differences according to consumption level
• Separate drivers for gas and electricity
• Power prices are driven by RES costs (fees & levies) but often/sometimes compensated for by exemptions and …. mitigated by overcapacity and renewables merit order effect
• Impact on margins not clear across sectors
• Some trends but devil is (often) in detail
Some key findings (cont’d)

Aluminum and steel

- Cumulative cost of **EU** regulation not excessive but energy policy matters

  → Aluminium: depending on power supply contracts. (Power price is key!)

  → Steel: when margins are low any cost increase hurts (Margins are key!)
Composition and drivers of energy prices and costs in energy intensive industries: Cross-sectoral analysis

Dr. Fabio Genoese

CEPS, Brussels 26 February 2014
Cross-sectoral analysis

• Sector reports reflect general regional trends but what about the situation in member states?  
  cross-sectoral analysis

• Data from all plants in all sectors used

• For four member states (DE, IT, ES, PL) sufficiently large number of questionnaires to allow country-specific analysis

• Focus on electricity
Electricity consumption and price variations grouped by sector (89 facilities)
Sector comparison

Observations:
• Increasing consumption levels are accompanied by decreasing power prices
• Ø consumption: ~360 times higher in Aluminium than in Ceramics
• Ø price: ~43 €/MWh (Aluminium) vs. ~64 €/MWh Ceramics

Possible reasons:
• More favourable supply contracts (e.g. long-term contracts that had been negotiated when the level of prices was lower)
• Discounts for large-scale consumers
• Different level of levies and taxes (incl. exemptions for large-scale consumers)

تبادل National analysis of cost structure required (sufficient number of questionnaires for 4 member states)
Structure of electricity costs in Italy, Spain, Germany and Poland in absolute terms (€/MWh)

Included: exemptions from levies/taxes

<table>
<thead>
<tr>
<th>Year</th>
<th>IT (5 plants)</th>
<th>ES (10 plants)</th>
<th>DE (8 plants)</th>
<th>PL (5 plants)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>75</td>
<td>75</td>
<td>49</td>
<td>48</td>
</tr>
<tr>
<td>2011</td>
<td>75</td>
<td>61</td>
<td>53</td>
<td>49</td>
</tr>
<tr>
<td>2012</td>
<td>78</td>
<td>60</td>
<td>48</td>
<td>48</td>
</tr>
</tbody>
</table>

Ø consumption in GWh/a

IT (5 plants): 23
ES (10 plants): 14
DE (8 plants): 313
PL (5 plants): 242

- RES levy
- Other (excl. VAT)
- Grid fees
- Energy comp.
Key messages of the cross-sectoral analysis

#1: Internal Energy Market is not complete

- Significant differences – even in the energy component.
- Energy component: linked to wholesale market prices

**Wholesale electricity market prices: Germany vs. Italy**

<table>
<thead>
<tr>
<th>Year</th>
<th>DE</th>
<th>IT</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>60</td>
<td>80</td>
<td>+24%</td>
</tr>
<tr>
<td>2009</td>
<td>40</td>
<td>70</td>
<td>+39%</td>
</tr>
<tr>
<td>2010</td>
<td>50</td>
<td>70</td>
<td>+31%</td>
</tr>
<tr>
<td>2011</td>
<td>60</td>
<td>50</td>
<td>+29%</td>
</tr>
<tr>
<td>2012</td>
<td>70</td>
<td>80</td>
<td>+44%</td>
</tr>
</tbody>
</table>
Key messages of the cross-sectoral analysis

#2: Internal Wholesale Energy Market ≠ Internal Energy Market

- Market coupling only affects wholesale market prices
- Increasing importance to look at all cost components

Present...

Wholesale market price

RES support, grid charges, taxes

Competition / EU policy (Internal Energy Market)

National policy

... Future?

Wholesale market price

RES support, grid charges, taxes
Composition and drivers of energy prices and costs in energy intensive industries: The case of the chemical industry

Vasileios Rizos

CEPS, Brussels 26 February 2014
Ammonia

- EU-27 ammonia production is spread over 17 different member states and 42 production plants
- Sample includes 10 plants from 10 different member states
  - Sample represents about 27% of the total EU-27 capacity
- Data aggregated together per three major EU geographical regions (Southern Europe, Western Northern Europe & Eastern Europe)
Ammonia

Data aggregated and allotted to three major regions:

**Southern Europe:**
12% of EU capacity

**Western Northern Europe:**
65% of EU capacity

**Eastern Europe:**
23% of EU capacity
Ammonia

Energy sources

• Natural gas ➔ 90-94% of total energy costs

• Electricity ➔ 4-8% of total energy costs

• Focus on natural gas
Ammonia

Total production costs of sampled EU ammonia producers (indexed)
Ammonia

Natural gas prices paid by sampled EU ammonia producers (€/MWh)

- EU Average
- Eastern Europe
- Southern Europe
- Western Northern Europe
### Descriptive statistics for natural gas prices paid by sampled EU ammonia producers, (€/MWh)

<table>
<thead>
<tr>
<th>Region</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU (average)</td>
<td>22.2</td>
<td>28.5</td>
<td>31.2</td>
</tr>
<tr>
<td>Eastern Europe (average)</td>
<td>21</td>
<td>27.6</td>
<td>31.2</td>
</tr>
<tr>
<td>Southern Europe (average)</td>
<td>23.6</td>
<td>30.7</td>
<td>34.8</td>
</tr>
<tr>
<td>Western Northern Europe (average)</td>
<td>22.4</td>
<td>28.4</td>
<td>29.8</td>
</tr>
</tbody>
</table>
Ammonia

Components of the natural gas bill paid by sampled EU ammonia producers (in %)

<table>
<thead>
<tr>
<th>Year</th>
<th>EU average</th>
<th>Western Northern Europe</th>
<th>Eastern Europe</th>
<th>Southern Europe</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>96%</td>
<td>96%</td>
<td>97%</td>
<td>96%</td>
</tr>
<tr>
<td>2011</td>
<td>96%</td>
<td>97%</td>
<td>96%</td>
<td>95%</td>
</tr>
<tr>
<td>2012</td>
<td>97%</td>
<td>97%</td>
<td>97%</td>
<td>94%</td>
</tr>
</tbody>
</table>

- **Energy component**
- **Grid fees**
- **RES levy**
- **Other non-recoverable taxes**
Chlorine

• EU production is spread across 19 different member states and 72 production plants

• Sample includes 9 plants and represents about 12% of the total EU-27 capacity

• Three major regions used for data aggregation: Southern Western Europe, Central Northern Europe and Southern Eastern Europe
Chlorine

Data aggregated and allotted to three major regions:

**Southern Western Europe:**
19% of EU capacity (3 plants)

**Central Northern Europe:**
70% of EU capacity (6 plants)

**Southern Eastern Europe:**
11% of EU capacity
Chlorine

Energy sources

• Electricity ➔ 91% of total energy costs

• Focus on electricity
Chlorine

Total production costs of sampled EU chlorine producers (€/tonne)

- Other costs
- Electricity costs
Chlorine

Electricity prices paid by sampled EU chlorine producers (€/MWh)

- Central Northern Europe
- Southern Western Europe
- EU average
## Descriptive statistics for electricity prices paid by sampled EU chlorine producers, (€/MWh)

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU (average)</td>
<td>59.4</td>
<td>59.8</td>
<td>56.4</td>
</tr>
<tr>
<td>Southern Western Europe (average)</td>
<td>51.9</td>
<td>61.5</td>
<td>72.7</td>
</tr>
<tr>
<td>Central Northern Europe (average)</td>
<td>60.3</td>
<td>59.5</td>
<td>54.1</td>
</tr>
</tbody>
</table>
Chlorine

Components of the electricity bill paid by sampled EU chlorine producers (in %)

<table>
<thead>
<tr>
<th>Year</th>
<th>EU average</th>
<th>Central Northern Europe</th>
<th>Southern Western Europe</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>84%</td>
<td>87%</td>
<td>82%</td>
</tr>
<tr>
<td>2011</td>
<td>84%</td>
<td>84%</td>
<td>77%</td>
</tr>
<tr>
<td>2012</td>
<td>87%</td>
<td>89%</td>
<td>75%</td>
</tr>
</tbody>
</table>

- **Energy component**
- **Grid fees**
- **RES levy**
- **Other non-recoverable taxes**
Composition and drivers of energy prices and costs in energy intensive industries: the case of the flat glass industry

Susanna Roth

CEPS, Brussels 26 February 2014
Flat glass

- **Float** glass dominates flat glass production (95% of EU total production). The sample only includes float glass producers.

- EU-27 float glass production is spread over 12 member states. 46 plants are operating in the EU.

- Sample includes 10 plants from 8 member states

- The sample represents about 19% of European capacity

- Data aggregated together per three major EU geographical regions (Southern Europe, Western Europe & Eastern Europe)
Flat glass

Data aggregated and allotted to three major regions:

**Western Europe:**
54% of EU float glass plants (6 plants in sample)

**Eastern Europe:**
24% of EU float glass plants (2 plants in sample)

**Southern Europe:**
22% of EU float glass plants (2 plants in sample)
Flat glass

Energy sources:

- Energy costs have on average a share of 37% of total production cost.
- **Natural gas** accounts for the majority of energy costs (71%).
- Fuel oil accounts for about 14%.
- Electricity accounts for about 15%. 
Flat glass

Natural gas prices paid by sampled EU float glass producers (€/MWh)
## Flat glass

Descriptive statistics for natural gas prices paid by sampled EU float glass producers, (€/MWh)

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EU (average)</strong></td>
<td>23.7</td>
<td>27.3</td>
<td>30.3</td>
</tr>
<tr>
<td><strong>Eastern Europe</strong></td>
<td>23.8</td>
<td>27.2</td>
<td>32.7</td>
</tr>
<tr>
<td>(average)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Southern Europe</strong></td>
<td>23.7</td>
<td>27.7</td>
<td>33.2</td>
</tr>
<tr>
<td>(average)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Western Northern</strong></td>
<td>23.6</td>
<td>27.3</td>
<td>28.7</td>
</tr>
<tr>
<td>Europe (average)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Flat glass

Components of the natural gas bill paid by sampled EU float glass producers (in %)

<table>
<thead>
<tr>
<th>Year</th>
<th>EU</th>
<th>Western Europe</th>
<th>Eastern Europe</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>96%</td>
<td>97%</td>
<td>94%</td>
</tr>
<tr>
<td>2011</td>
<td>96%</td>
<td>97%</td>
<td>94%</td>
</tr>
<tr>
<td>2012</td>
<td>95%</td>
<td>96%</td>
<td>95%</td>
</tr>
</tbody>
</table>

- Energy component
- Grid fees
- Other (excl. VAT)
Composition and drivers of energy prices and costs in energy intensive industries: The case of the ceramic industry

Julian Wieczorkiewicz

CEPS, Brussels 26 February 2014
The ceramic industry

Two sub-sectors:

1. Bricks and roof tiles = “bricks”
2. Wall and floor tiles = “ceramic tiles”

• Bricks $\rightarrow$ energy = 30-35% of total production costs
  - Natural gas has a share of 73-75% of total energy costs
  - Electricity has a share of 25-27% of total energy costs

• Ceramic tiles $\rightarrow$ energy = 17-29% of total production costs
  - Natural gas has a share of 66-70% of total energy costs
  - Electricity has a share of 30-34% of total energy costs

The two sub-sectors are heavily populated by SMEs!
Bricks and roof tiles

Data aggregated and allotted to three major regions:

→ 13 plants

Northern Europe: 38% of EU production (5 plants)

Central Europe: 35% of EU production (3 plants)

Southern Europe: 27% of EU production (5 plants)
Bricks and roof tiles - Gas

Prices of natural gas paid by sampled producers (€/MWh)

- EU (boxplot)
- Northern Europe (weighted average)
- Central Europe (weighted average)
- Southern Europe (weighted average)
Bricks and roof tiles - Gas

Descriptive statistics for natural gas prices paid by sampled producers (€/MWh)

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EU (average)</strong></td>
<td>30.4</td>
<td>33.2</td>
<td>39.5</td>
</tr>
<tr>
<td><strong>Northern Europe (average)</strong></td>
<td>28.9</td>
<td>32.7</td>
<td>39.7</td>
</tr>
<tr>
<td><strong>Central Europe (average)</strong></td>
<td>30.0</td>
<td>29.7</td>
<td>31.9</td>
</tr>
<tr>
<td><strong>Southern Europe (average)</strong></td>
<td>31.2</td>
<td>36.2</td>
<td>43.2</td>
</tr>
</tbody>
</table>
Bricks and roof tiles - Gas

Components of the natural gas bill paid by sampled producers (in %)

**Natural gas cost components (%)**

<table>
<thead>
<tr>
<th>Year</th>
<th>EU</th>
<th>Northern Europe</th>
<th>Central Europe</th>
<th>Southern Europe</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>10%</td>
<td>87%</td>
<td>79%</td>
<td>92%</td>
</tr>
<tr>
<td>2011</td>
<td>6%</td>
<td>93%</td>
<td>80%</td>
<td>90%</td>
</tr>
<tr>
<td>2012</td>
<td>4%</td>
<td>95%</td>
<td>85%</td>
<td>89%</td>
</tr>
</tbody>
</table>

- Energy component
- Grid fees
- Other (excl. VAT)
Wall and floor tiles

Data aggregated and allotted to three major regions:

→ 12 plants

Central & Northern Europe:
42% of EU production
(5 plants)

South-western Europe:
20% of EU production
(3 plants)

South-eastern Europe:
38% of EU production
(4 plants)
Wall and floor tiles - Gas

Prices of natural gas paid by sampled producers (€/MWh)

- Central and Northern Europe (w. average)
- South-Western Europe (w. average)
- South-Eastern Europe (w. average)

Natural gas costs (€/MWh)

- Central and Northern Europe (w. average)
- South-Western Europe (w. average)
- South-Eastern Europe (w. average)
Wall and floor tiles - Gas

Descriptive statistics for natural gas prices paid by sampled producers (€/MWh)

<table>
<thead>
<tr>
<th>Region</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU (average)</td>
<td>25.0</td>
<td>26.2</td>
<td>31.7</td>
</tr>
<tr>
<td>Central and Northern Europe (average)</td>
<td>25.7</td>
<td>23.8</td>
<td>28.7</td>
</tr>
<tr>
<td>South-Western Europe (average)</td>
<td>25.6</td>
<td>29.7</td>
<td>34.7</td>
</tr>
<tr>
<td>South-Eastern Europe (average)</td>
<td>23.0</td>
<td>25.0</td>
<td>31.4</td>
</tr>
</tbody>
</table>
Wall and floor tiles - Gas

Components of the natural gas bill paid by sampled producers (in %)

<table>
<thead>
<tr>
<th>Year</th>
<th>EU</th>
<th>Central and Northern Europe</th>
<th>South-Western Europe</th>
<th>South-Eastern Europe</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td></td>
<td>89%</td>
<td>88%</td>
<td>90%</td>
</tr>
<tr>
<td>2011</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Other (excl. VAT)**
- **Grid fees**
- **Energy component**
The Steel Industry in the European Union: Composition and drivers of energy prices

Dr. Giacomo Luchetta

CEPS, Brussels 26 February 2014
Steel

• Steel Production per EU area: NW 59%; CEE 15%; S 26%.
• Sample includes 17 plants from 9 different MSs ~15% of EU crude steel capacity
• Production technologies: **Blast Oxygen Furnace** (58%) and **Electric Arc Furnace** (42%)
• 4 BOF plants; 11 EAF plants; 2 rolling mills
• Plants owned by global players, regional champions, and niche specialists

**Electricity costs**
EAF 9% of total costs; BOF 4% of total costs

**Natural gas costs**
EAF 4% of total costs; BOF 1.5% of total costs
Steel

Data aggregated and allotted to three major regions:

**Central Eastern Europe:**
15% of EU crude steel production in 2012 (3 plants in sample)

**North-Western Europe:**
59% of EU crude steel production in 2012 (9 plants in sample)

**Southern Europe:**
26% of EU crude steel production in 2012 (5 plants in sample)
Steel

Electricity prices paid by sampled EU steel producers, (€/MWh)
## Descriptive statistics for electricity prices paid by sampled EU steel producers, (€/MWh)

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU (average)</td>
<td>66.8</td>
<td>71.2</td>
<td>71.4</td>
</tr>
<tr>
<td>Central and Eastern EU</td>
<td>77.7</td>
<td>84.7</td>
<td>92.5</td>
</tr>
<tr>
<td>(average)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Southern EU (average)</td>
<td>67.7</td>
<td>68.8</td>
<td>74.2</td>
</tr>
<tr>
<td>North-Western EU (average)</td>
<td>60.7</td>
<td>64.3</td>
<td>59.4</td>
</tr>
</tbody>
</table>
Steel

Components of the electricity bill paid by sampled EU steel producers
Energy Costs vs. Margin and Production Costs: EAF Wire Rods (€, 2012)
Steel

Energy Costs vs. Margin and Production Costs: BOF Hot Rolled Coils (€, 2012)
Assessment of cumulative cost impact for the aluminium industry

Dr. Lorna Schrefler

CEPS, Brussels 26 February 2014
Aluminium

• The Cumulated Cost Assessment (on 8 policy areas) covers primary & secondary aluminium production and a selection of downstream players in rolling and extrusion
• For energy: focus on primary aluminium only, with a sample of 11 plants out of 16 currently operational in 10 EU MS, representing 60% of EU production in 2012
• Sample can be divided in two sub-samples:
  ✓ Plants procuring energy via old long-term contracts or through self-generation
  ✓ Plants who purchase electricity on the market
• Three scenarios including different pass-on rates for ETS indirect costs

Results as regards energy and in particular the indirect cost of ETS in electricity prices differ markedly between the two subsamples
Cumulative regulatory costs for primary production range from 114 €/tonne to 149 €/tonne (entire sample)

- 45% for ETS indirect costs
- 41% for energy policy
- 13% for environmental regulation

The difference between subsamples is substantial

- **20-27€/tonne** in subsample 1:
  - 23% for energy policy

- **179-228€/tonne** in subsample 2:
  - 47% for energy policy
  - 45% for ETS indirect costs

Aluminium
Aluminium

Cumulative Regulatory Costs - Comparison among scenarios (2012, €/tonne)

Lower bound | Intermediate | Upper bound
---|---|---
20 | 24 | 27
114 | 132 | 149
179 | 203 | 228

Subsample 1
Sample
Subsample 2
Aluminium

Prices of electricity for the sample aluminium smelters - 2012 ($/MWh, delivered at plant)

Source: Interviews and CRU
### Aluminium

#### Breakdown of electricity prices paid by sampled producers (€/MWh)

<table>
<thead>
<tr>
<th></th>
<th>Sample</th>
<th></th>
<th></th>
<th>Subsample 1</th>
<th></th>
<th></th>
<th>Subsample 2</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy component</td>
<td>34.90</td>
<td>38.40</td>
<td>40.58</td>
<td>21.56</td>
<td>21.83</td>
<td>23.93</td>
<td>47.97</td>
<td>52.41</td>
<td>50.16</td>
</tr>
<tr>
<td>RES Costs</td>
<td>0.39</td>
<td>1.51</td>
<td>2.19</td>
<td>0.16</td>
<td>0.18</td>
<td>0.37</td>
<td>0.61</td>
<td>2.74</td>
<td>2.89</td>
</tr>
<tr>
<td>Transmission Costs</td>
<td>2.10</td>
<td>1.81</td>
<td>1.40</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>3.13</td>
<td>2.63</td>
<td>2.17</td>
</tr>
<tr>
<td>Taxes</td>
<td>0.62</td>
<td>0.56</td>
<td>0.53</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.90</td>
<td>0.81</td>
<td>0.78</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>38.01</strong></td>
<td><strong>42.28</strong></td>
<td><strong>44.70</strong></td>
<td><strong>21.72</strong></td>
<td><strong>22.01</strong></td>
<td><strong>24.30</strong></td>
<td><strong>52.61</strong></td>
<td><strong>58.59</strong></td>
<td><strong>56.00</strong></td>
</tr>
</tbody>
</table>
Aluminium

Prices of electricity for the aluminium smelters in different world areas - 2012 ($/MWh, delivered at plant)

Source: Interviews and CRU
Aluminium

Share of electricity costs over total costs for aluminium smelters in different world areas - 2012

Source: Interviews and CRU
Availability of CEPS studies

• Studies on ceramics, flat glass and chemicals are available at:


• Study on aluminium is available at:
Time for questions