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Options to supply the UK steel demand and meet the CO$_2$ targets

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Steel global production and impacts

Global industrial CO$_2$ emissions, 2005

- Steel, 25%
- Cement, 19%
- Aluminium, 3%
- Plastic, 4%
- Paper, 4%
- Other, 44%

Industrial carbon emissions: 10 GtCO$_2$

(Allwood et al., 2012)

Global crude steel production

Mt


(World Steel Association, 2014)

+70%

+70%
Reducing steel industrial emissions and supply future demand

How can steel industry emissions be reduced?

1. Switching to more efficient production routes;
2. Increasing the efficiency of current production routes;

In the UK:

• The Government has committed to a reduction of UK GHG emissions to 80% of the 1990 levels by 2050.

• How to supply future demand for steel in the UK and meet this climate target?
Steel flow to supply the UK demand, 2007
Steel flow to supply the UK demand, 2007

Iron and Steel Sector
- DR: Direct reduction
- BF: Blast furnace
- OBF: Open hearth furnace
- BOF: Basic oxygen furnace
- EAF: Electric-arc furnace
- FIC: Foundry of iron casting
- IC: Ingot casting
- CC: Continuous casting
- SPC: Steel product casting

Rolling/Forming

Other Industry Sectors

UK Stock Added
- 20 Mt

Legend:
- Iron Ore used in the Rest of the World [Mt]
- UK Production [Mt]
- Crude Iron produced in the Rest of the World [Mt]
- Scrap in the Rest of the World [Mt]
- Steel produced in the Rest of the World [Mt]
- Losses [Mt]
In-use stock saturation

- Metal goods
- Vehicles
- Industrial Equipment
- Buildings and infrastructure

Stock added (per capita)

Stock removed (per capita)
## Estimating future UK crude steel demand

<table>
<thead>
<tr>
<th>Product categories</th>
<th>Saturation stock [tonnes per capita] (Pauliuk et al., 2013)</th>
<th>Average lifetime [years] (Pauliuk et al., 2013)</th>
<th>Demand for new steel additions to stock [Mt]</th>
<th>Demand for crude steel [Mt]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicles</td>
<td>1.3</td>
<td>20</td>
<td>5.4</td>
<td>7.4</td>
</tr>
<tr>
<td>Industrial equipment</td>
<td>0.9</td>
<td>30</td>
<td>2.6</td>
<td>3.4</td>
</tr>
<tr>
<td>Buildings and infrastructure</td>
<td>10.0</td>
<td>75</td>
<td>13.3</td>
<td>16.4</td>
</tr>
<tr>
<td>Metal goods</td>
<td>0.6</td>
<td>15</td>
<td>3.3</td>
<td>4.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>12.8</strong></td>
<td></td>
<td><strong>24.5</strong></td>
<td><strong>31.7</strong></td>
</tr>
</tbody>
</table>
Options for future UK steel production
## Options for future UK steel production

<table>
<thead>
<tr>
<th>Iron sources</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot metal from BF</td>
<td>67%</td>
<td>84%</td>
<td>5%</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>DRI</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td>Scrap</td>
<td>33%</td>
<td>16%</td>
<td>95%</td>
<td>75%</td>
<td>50%</td>
</tr>
</tbody>
</table>
UK Carbon Plan Pathways

4 pathways for a low carbon future:

- Core MARKAL (cost optimisation)
  - Higher renewables; more energy efficiency
  - Higher nuclear; less energy efficiency
  - Higher CCS; more bioenergy
Emissions for the UK steel industry in 2050

- Without CCS in steel industry
- With CCS in steel industry
**UK Steel scenarios / Energy pathways**

<table>
<thead>
<tr>
<th>CoreMARKAL</th>
<th>High CCS, more bioenergy</th>
<th>High renewables, more energy efficiency</th>
<th>High nuclear, less energy efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>A: Current Scrap / BF – BOF</td>
<td>Total CO₂ emissions (in UK or other countries) required to supply UK steel demand in 2050, in terms of:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **UK production / steel imports required;**
- **Use of CCS in UK steel industry;**
- **Levels of UK electricity decarbonisation;**
- **Share of end-of-life scrap recycled;**
- **Products’ lifetime.**

B: BF – BOF

C: 95% Scrap – EAF

D: 75% Scrap / 25% DRI – EAF

E: 50% Scrap / 50% DRI – EAF
UK steel production / steel imports required


Mt crude steel

A B C D E

UK production Imports
Use of CCS in the UK steel industry


Mt CO₂

with CCS without CCS UK emissions

A B C D E
Change in products’ lifetime in the UK

![Chart showing changes in 
products’ lifetime in the UK.](chart.png)
Conclusions

Best solutions to **minimise global CO₂ emissions** caused by steel purchased in the UK and to **reduce dependence on imports**:

- Maximise domestic end-of-life scrap in UK steel production;

- Deployment of direct reduced iron – electric arc furnace route in the UK;

- Extending products’ lifetime in the UK.
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