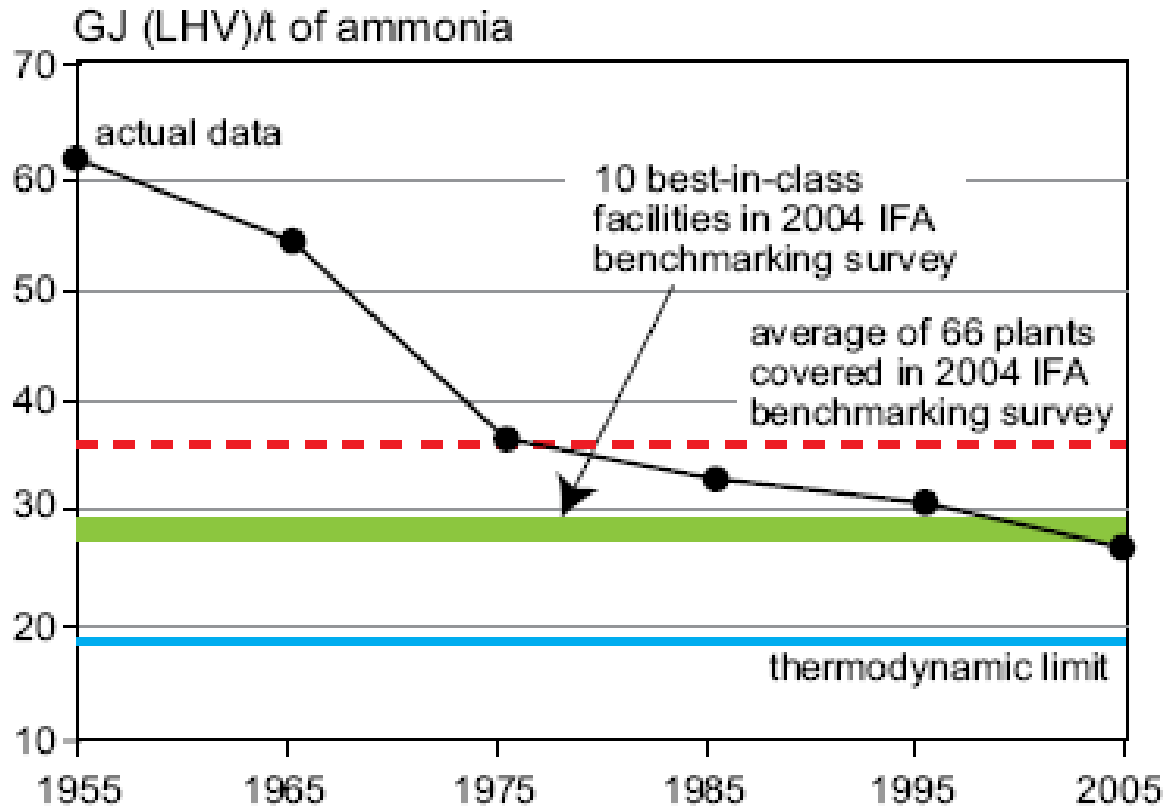


Mitigation options in the industry and waste management sector

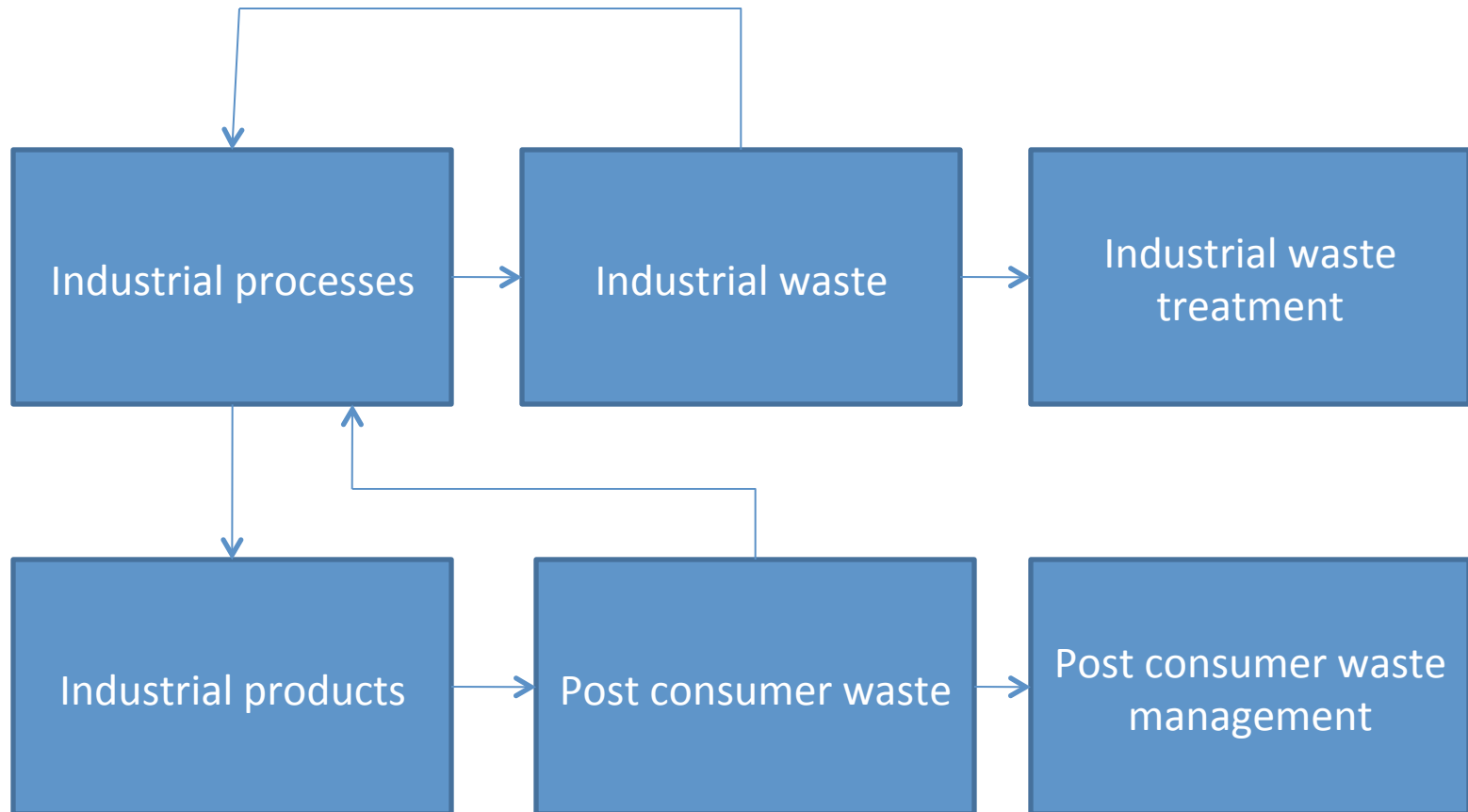
Production of energy intensive industrial products

| Country | Steel production | Share of global | Cement production | Share of global |
|-------------|------------------|-----------------|-------------------|-----------------|
| | Mt/yr | % | Mt/yr | % |
| China | 419 | 34 | 1064 | 47 |
| EU | 210 | 17 | 230 | 10 |
| Japan | 116 | 9 | 74 | 3 |
| USA | 98 | 8 | 99 | 4 |
| Russia | 71 | 6 | 45 | 2 |
| South Korea | 48 | 4 | 50 | 2 |
| India | 44 | 4 | 130 | 6 |
| Ukraine | 41 | 3 | n/a | n/a |
| Brazil | 31 | 2 | 39 | 2 |
| Turkey | 23 | 2 | 38 | 2 |
| | | | | |
| World | 1242 | | 2284 | |

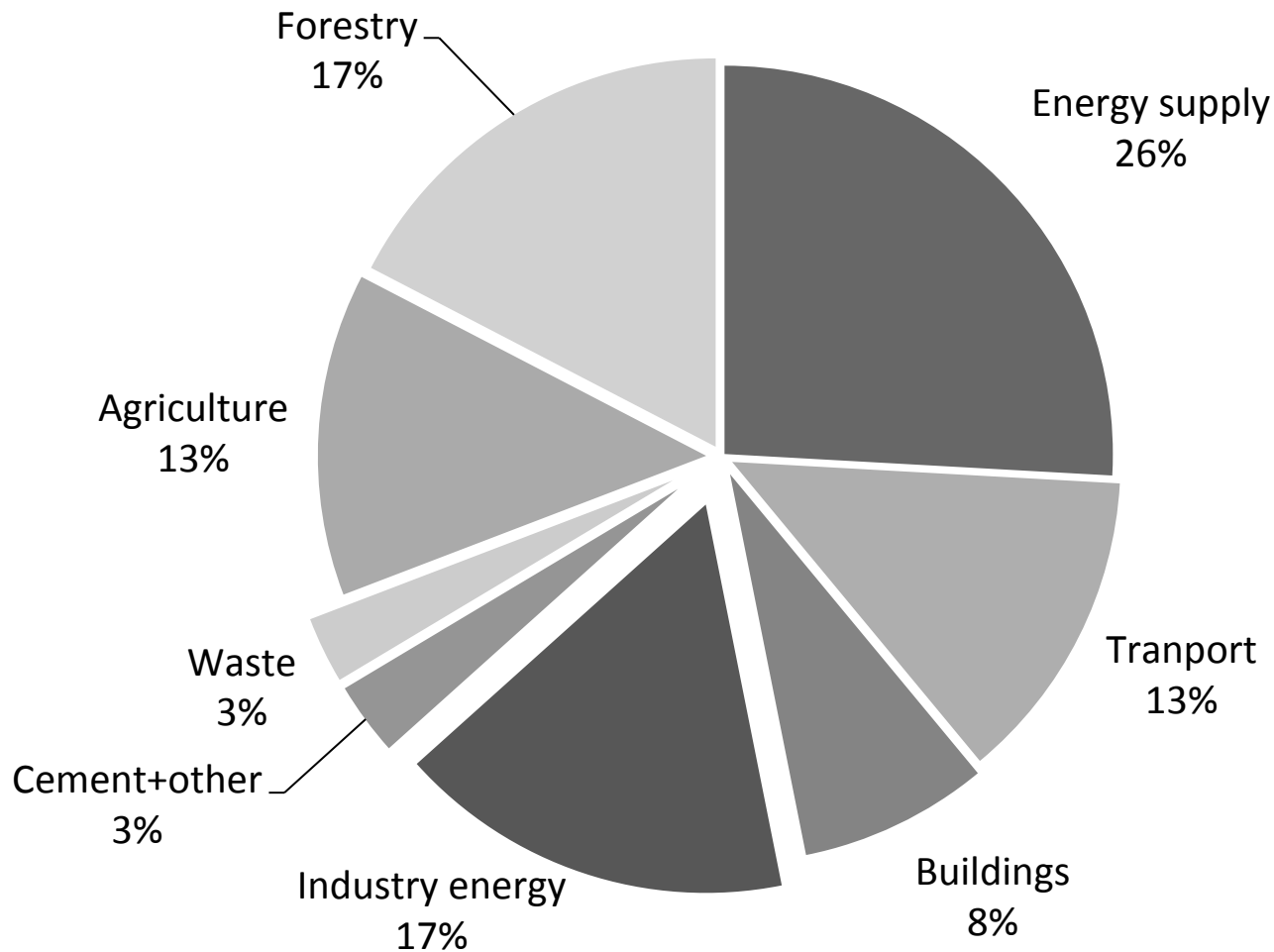
Autonomous energy efficiency improvement, ammonia production



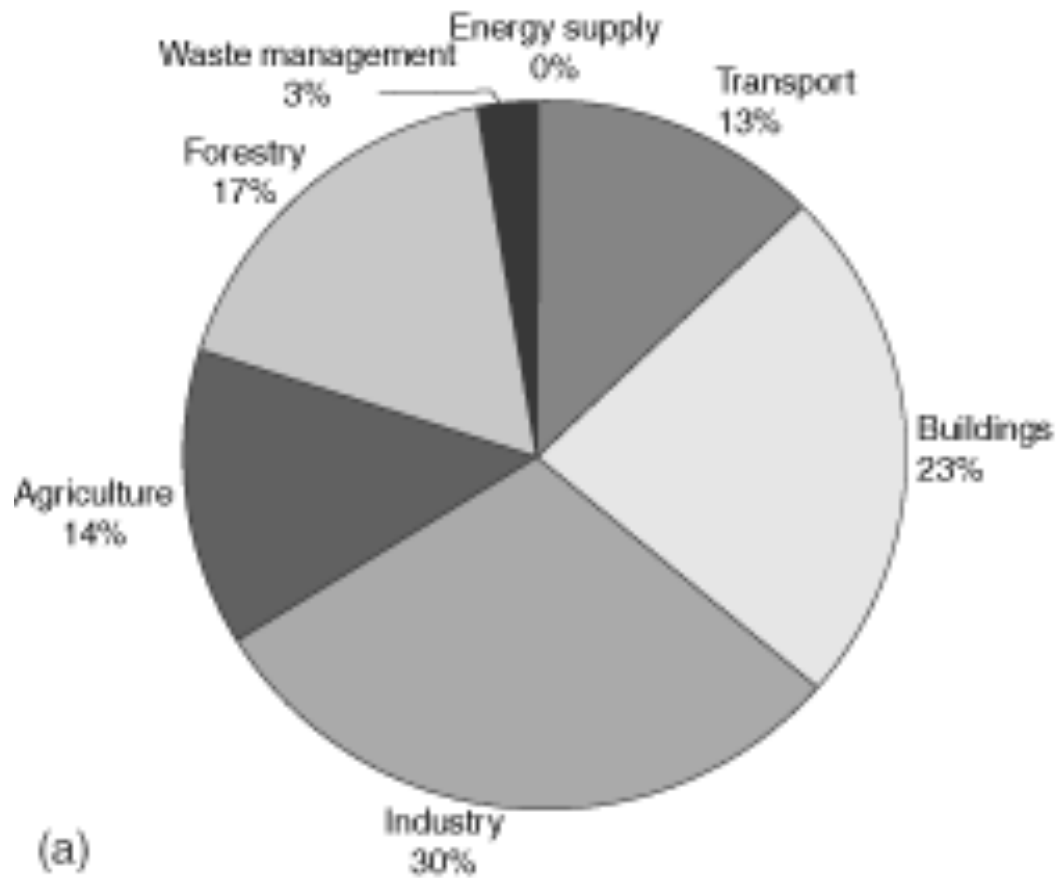
Waste management



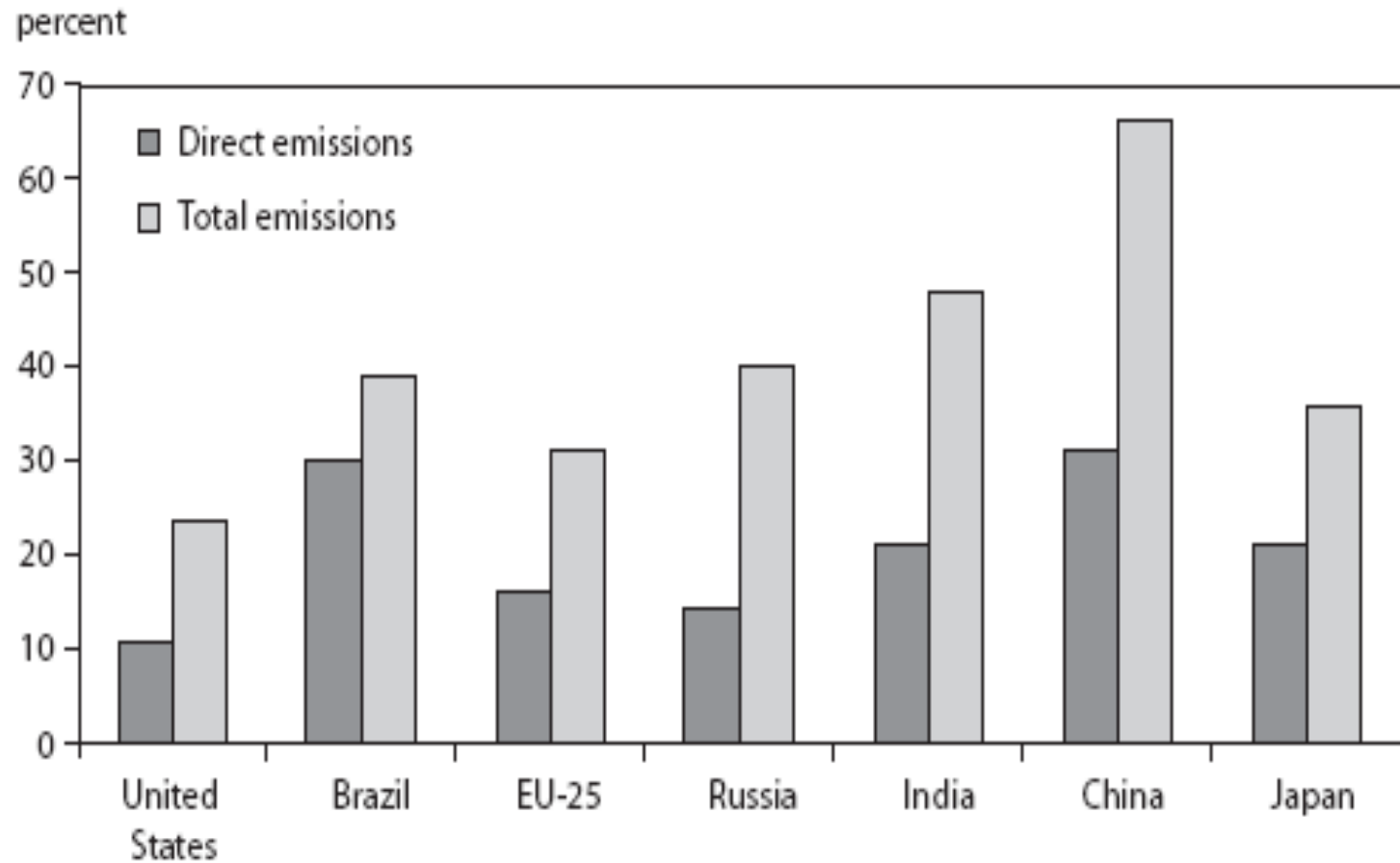
Direct GHG emissions from industry and waste management



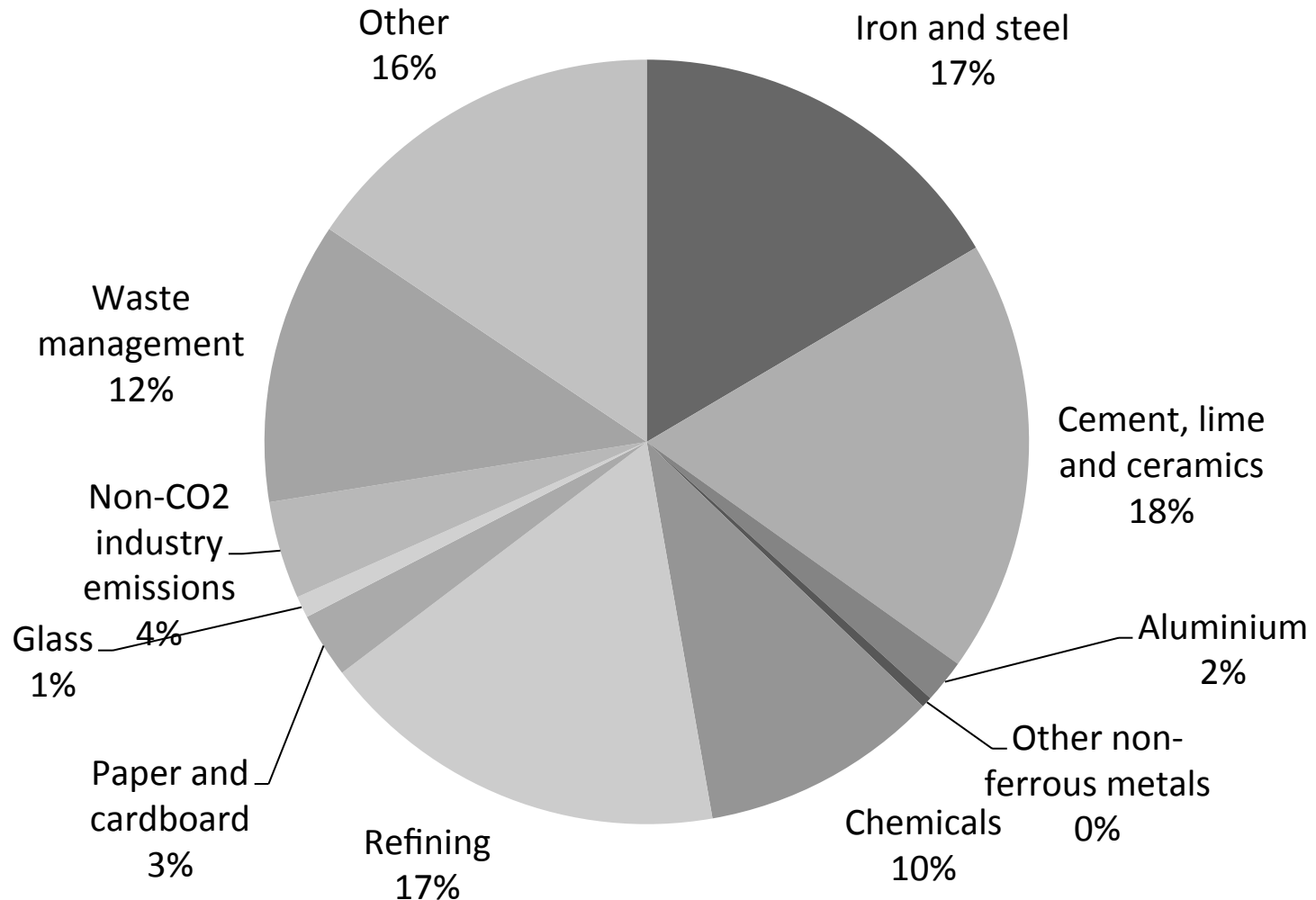
Indirect GHG emissions from industry and waste management



Industry emissions as share of total



Contributions of industrial processes to GHG emissions



Ways to reduce emissions in industry

- Replace energy intensive/ high emitting products with low emissions alternatives
- Reduce consumption
- Reduce emissions per unit product (efficiency, low carbon sources, CCS)

Energy



Energy efficiency

Energy use per unit of product

Carbon content of energy



Energy



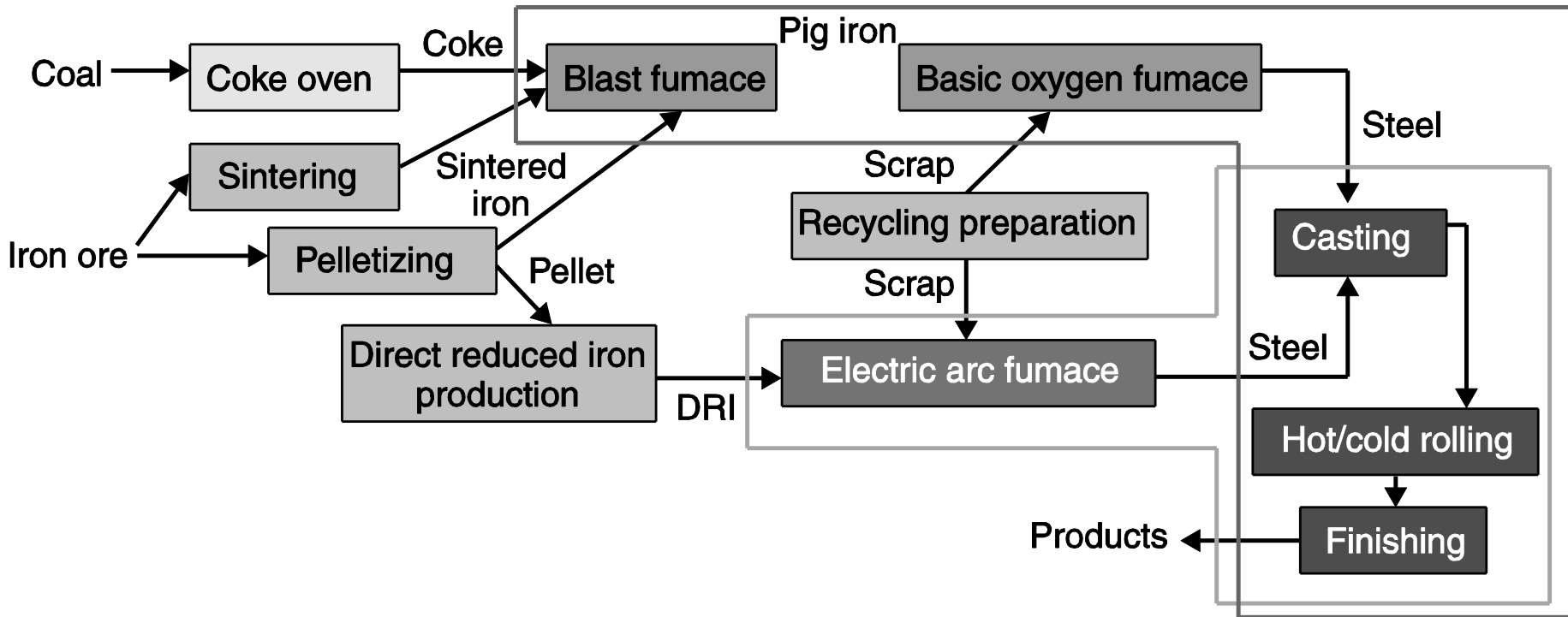
Carbon efficiency

GHG emission per unit of product

Iron and steel production

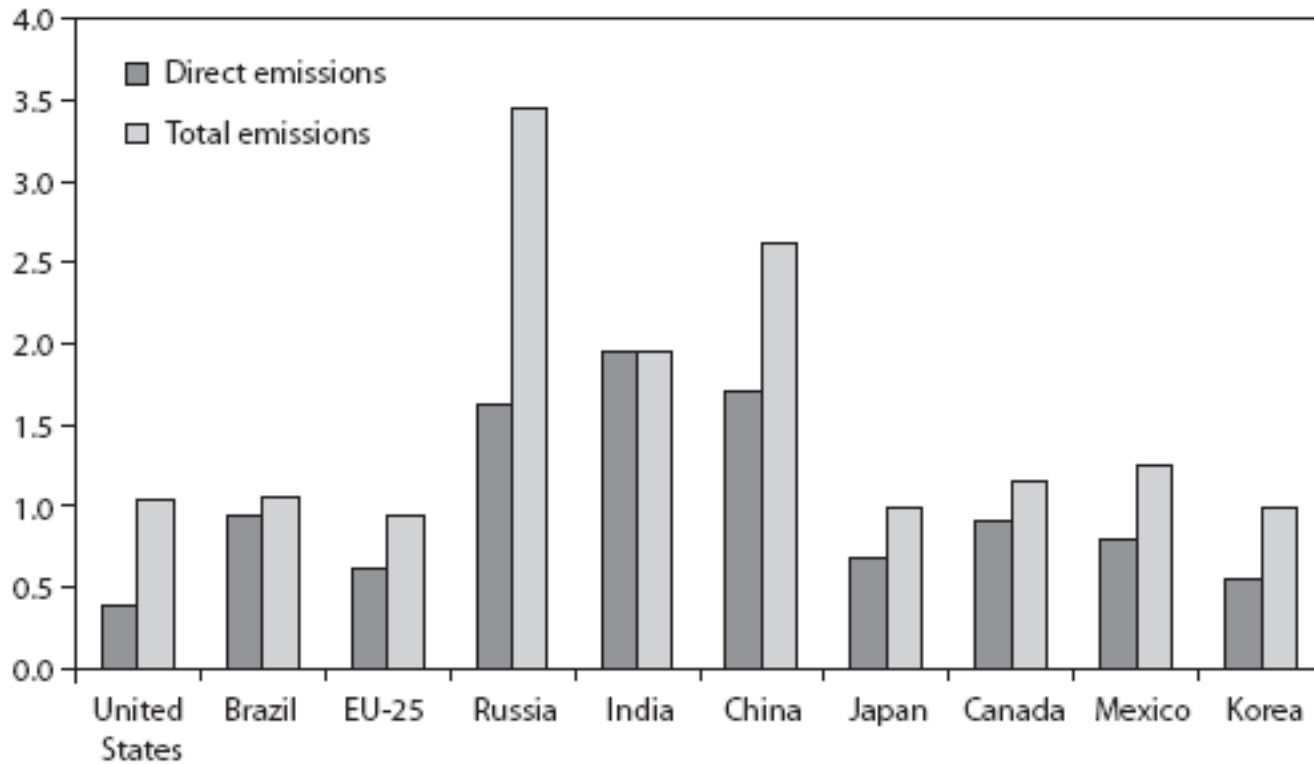


Main steel making processes



Carbon intensity of steel production

tCO₂/ t steel



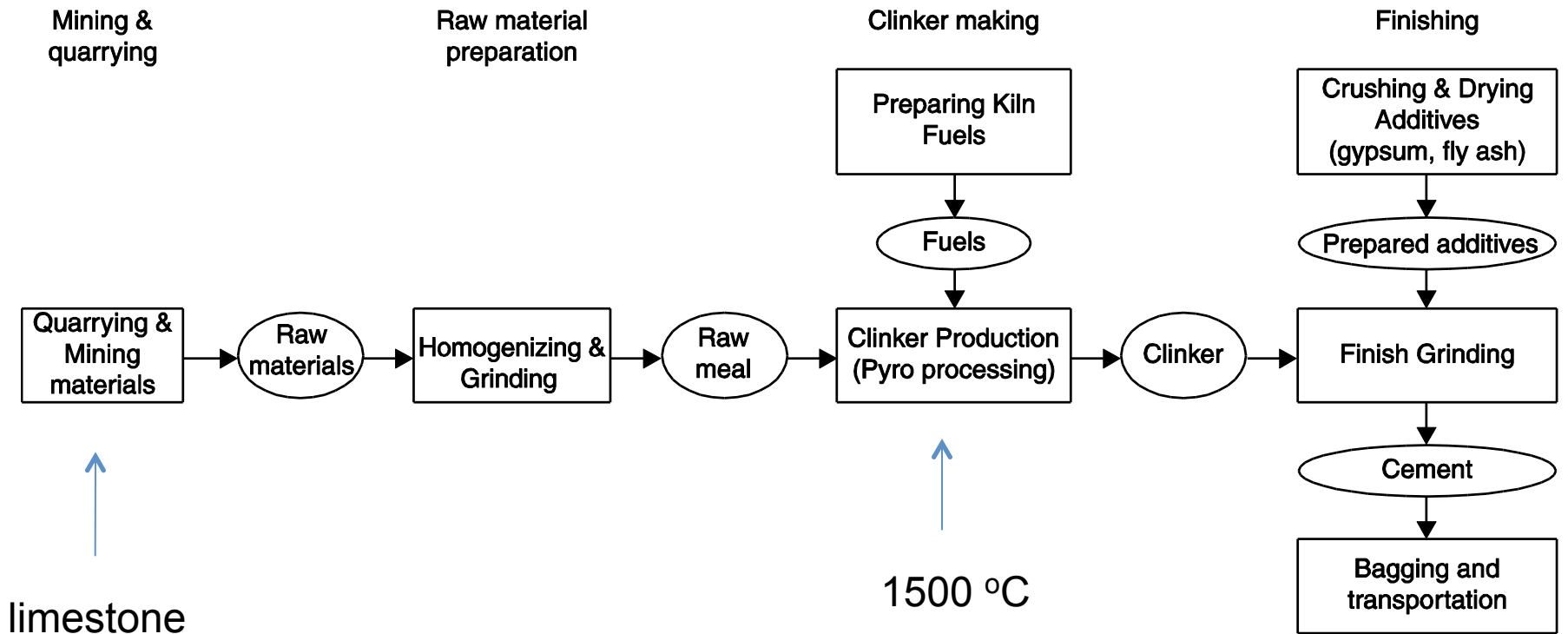
Measures to reduce emissions from steel making

- Replace steel in construction
- Minimise steel in products
- Shift to other production process (includes recycling)
- Shift to low carbon electricity
- Improve efficiency of existing process
- Shift from coal/coke to other reducing agents (biomass, oil, gas, waste)
- Apply CCS

Cement production



Cement production



GHG emissions of cement

| Country | Average emissions (tCO ₂ / t cement) |
|-------------|---|
| Europe | 0.70 |
| Japan | 0.73 |
| South Korea | 0.73 |
| China | 0.90 |
| India | 0.93 |
| USA | 0.93 |

Measures to reduce emissions from cement production

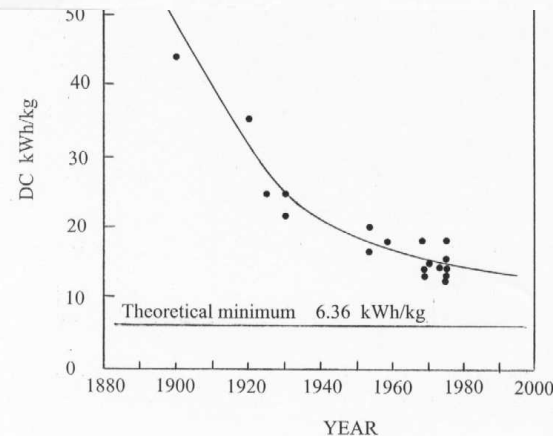
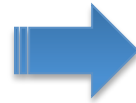
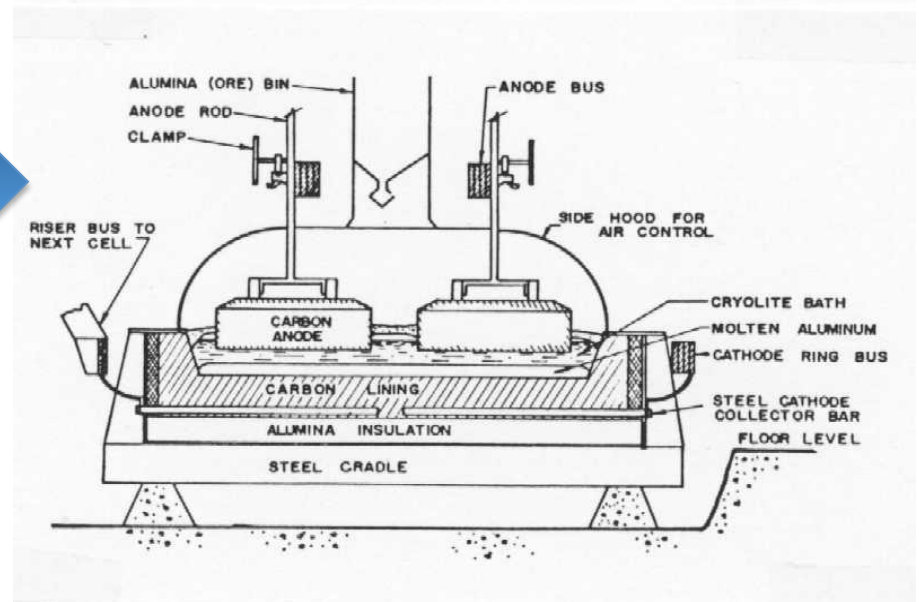
- Reduce cement use in construction
- Use blended cements
- Use dry kiln process
- Use low carbon fuel for kiln
- Improve energy efficiency of process equipment
- Use low carbon electricity
- Apply CCS

Measures to reduce emissions in refineries and chemicals manufacture

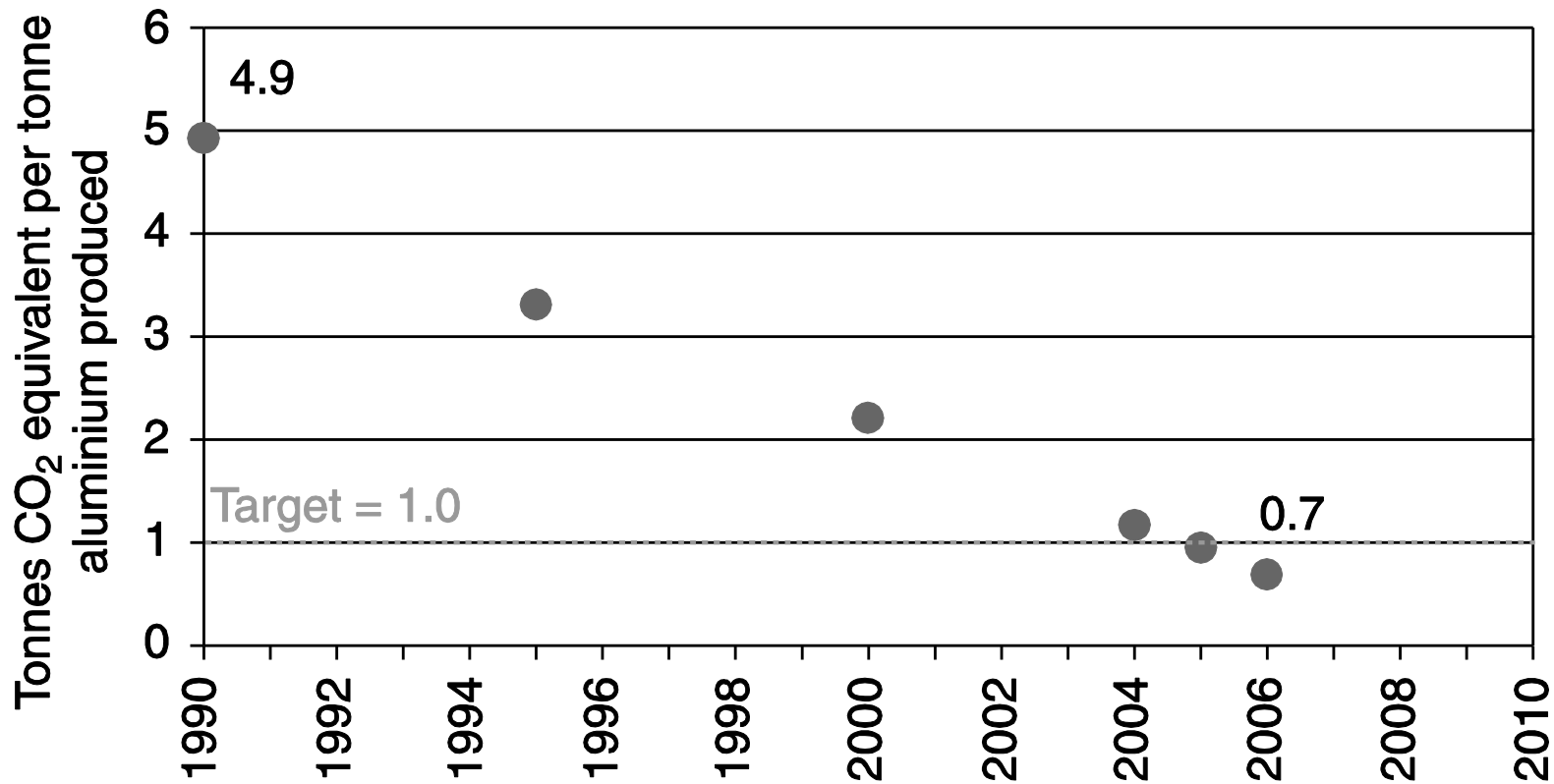
- Refineries:
 - 15-20% of energy used in process
 - Energy efficiency improvement 10-20% by 2030
 - CCS
- Chemicals
 - Ethylene, methanol, ammonia good for 70% of energy used
 - 50% of fuel for heating; 50% feedstock >> energy efficiency, low carbon energy and alternative feedstocks
 - CCS
 - N₂O and HFC byproducts >> incineration

Measures to reduce emissions in aluminium production

- Lower CO₂ emissions from reduction of aluminium oxide with carbon anode in electrochemical process
- Energy efficiency improvement
- Reduce PFC emissions from reaction with molten electrolyte >> process improvements



GHG emission reduction in aluminium production as a result of voluntary measures by industry



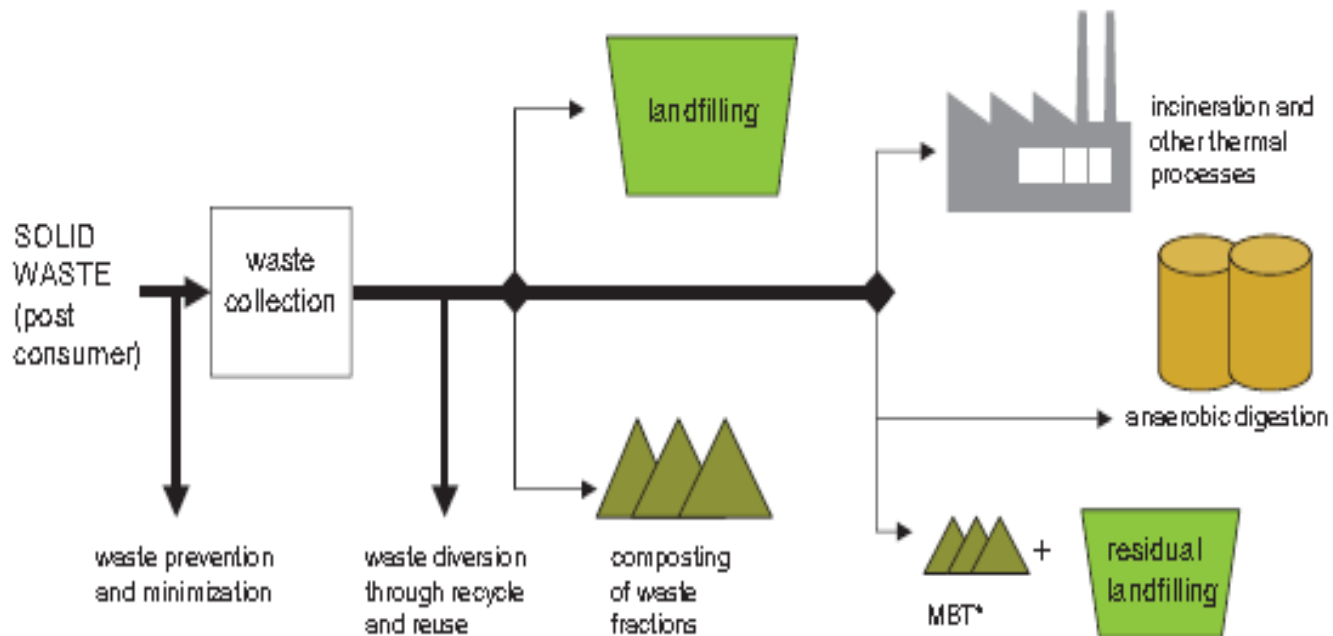
Mitigation measures in some other industrial processes

| <i>Industry</i> | <i>Main mitigation opportunity</i> |
|-----------------|--|
| Pulp and paper | Use of waste biomass fuel |
| | Combined heat and power |
| | Gasification of wood pulping waste (black liquor) waste for fuel use |
| | Increased recycling |
| Food processing | Energy efficiency improvement |
| | Combined heat and power |
| | Methane recovery from waste water |
| Glass | Energy efficiency improvement |
| | Switching from oil to gas heating |
| | CCS in combination with oxygen |
| | Increased recycling |

Generic options

- More efficient electric motors (65% of elec use) >> 30-40% improvement
- More efficient compressed air systems (20% leaking)
- More efficient steam boilers
- Insulation, heat recovery, maintainance (10-20% easy; 40-50% possible)
- Recycling
- Combined heat and power
- Use renewable energy

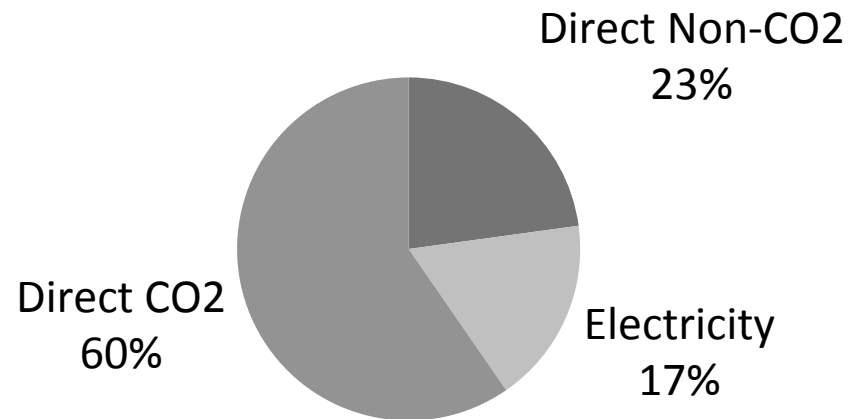
Solid waste management



Contributions to mitigation potential industry and waste management (direct and indirect)

| Mitigation option | Economic potential 2030 (GtCO ₂ eq/yr) | Cost range (US\$/t CO ₂ eq avoided) |
|--------------------------------------|--|--|
| Iron and steel | 0.4-1.5 | 20-50 |
| Cement | 0.5-2.1 | <50 |
| Chemicals and refining | 1.0 | 75% of potential <20 |
| Other industries | 0.5-0.6 | <100 |
| Generic options | 0.1-0.3 | <100 |
| Household/office waste management | 0.4-1.0 | <100 |
| | | |
| Total | 2.9-6.5 | <100 |

Reduction potential industry and waste management sector



Sensitivity for unfair competition

