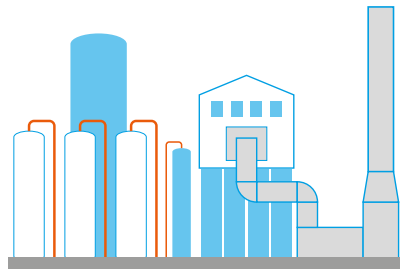
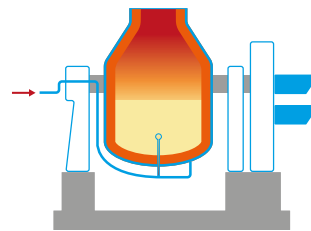


**Notes:**

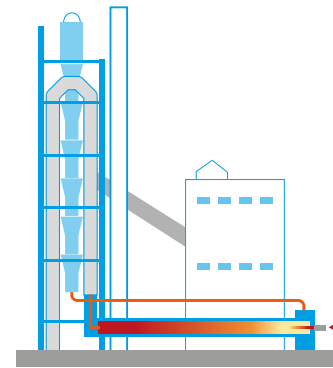
- CO<sub>2</sub> emissions are also associated with the energy and power requirements for this industry sector – the focus in this table is CO<sub>2</sub> emissions from within the process
- CCS to capture CO<sub>2</sub> from the process and / or the associated energy production is possible



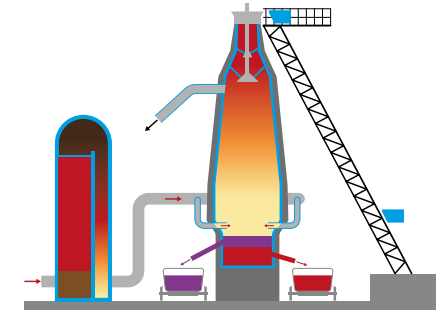
Steam Methane Reformer



Aluminium smelting



Calciner tower & clinker kiln



Blast furnace

|   | Oil refining  | Aluminium smelting   | Cement making  | Iron making   |
|---|---|--|--|---|
| Application that releases CO <sub>2</sub>   | Hydrogen production from methane reforming for fuels desulphurisation   | Reduction of alumina to aluminium using graphite electrodes  | Reduction of limestone to calcium oxide  | Reduction of iron ore to iron using coke  |
| Chemical reaction producing CO <sub>2</sub> | $CH_4 + H_2O \rightarrow CO + 3H_2$<br>$CO + H_2O \rightarrow CO_2 + H_2$   | $2Al_2O_3 + 3C \rightarrow 4Al + 3CO_2$  | $CaCO_3 \rightarrow CaO + CO_2$  | $2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$<br>$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$  |
| Decarbonisation approach                    | Use turquoise hydrogen or green hydrogen to avoid the reforming reaction; or feed the reformer with biomethane instead of natural gas | Use carbon from turquoise hydrogen production instead of carbon from fossil fuels to make the electrodes | Replace a portion of the limestone with alternative materials such as calcined clay to make clinker for cement | Use turquoise hydrogen or green hydrogen instead of coke; or substitute coke with carbon from turquoise hydrogen production |
| Reactions for the decarbonised process      | As above using renewable methane  | As above using renewable graphite electrodes   | Above reaction can only partially be avoided   | As above using renewable carbon, or use hydrogen:<br>$Fe_2O_3 + 3H_2 \rightarrow 2Fe + 3H_2O$                               |
| Other industries with similar applications  | Ammonia, Urea, Methanol, Gas-to-liquids   | Gold and silver refining, electric arc furnace to melt scrap steel                                       | Lime making<br>Refractory bricks, $MgCO_3 \rightarrow MgO + CO_2$  | None  |