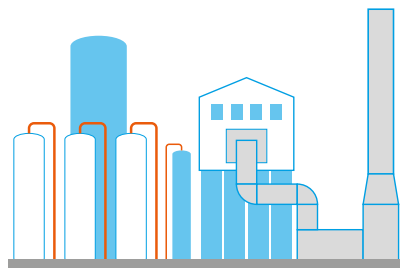
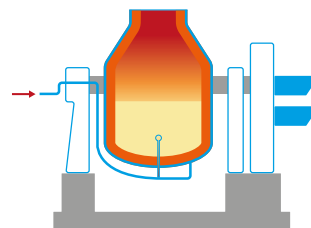


Notes:

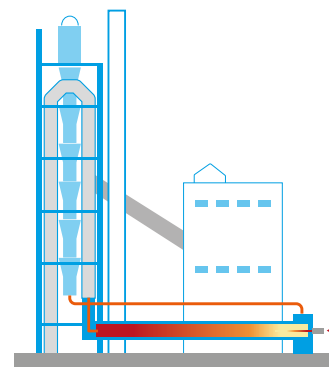
- CO₂ emissions are also associated with the energy and power requirements for this industry sector
- These can potentially be decarbonised with renewable power and electrical heating or microwaves
- CCS to capture CO₂ from the process and / or the associated energy production is possible



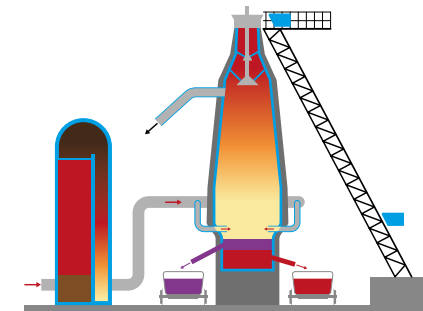
Steam Methane Reformer



Aluminium smelting



Calciner tower & clinker kiln



Blast furnace

	Oil refining	Aluminium smelting	Cement making	Iron making
Application that releases CO ₂	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 ₂	$CH_4 + H_2O \rightarrow CO + 3H_2$ $CO + H_2O \rightarrow CO_2 + H_2$	$2Al_2O_3 + 3C \rightarrow 4Al + 3CO_2$	$CaCO_3 \rightarrow CaO + CO_2$	$2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$ $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$
Decarbonisation approach for CO ₂ generated by the process	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 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: $Fe_2O_3 + 3H_2 \rightarrow 2Fe + 3H_2O$
Other industries with similar applications	Ammonia, Urea, Methanol, Gas-to-liquids	Gold and silver refining, electric arc furnace to melt scrap steel	– Lime making, as above – Refractory materials, $MgCO_3 \rightarrow MgO + CO_2$ – Glass making Na_2CO_3 , $CaCO_3$, $MgCO_3$	None