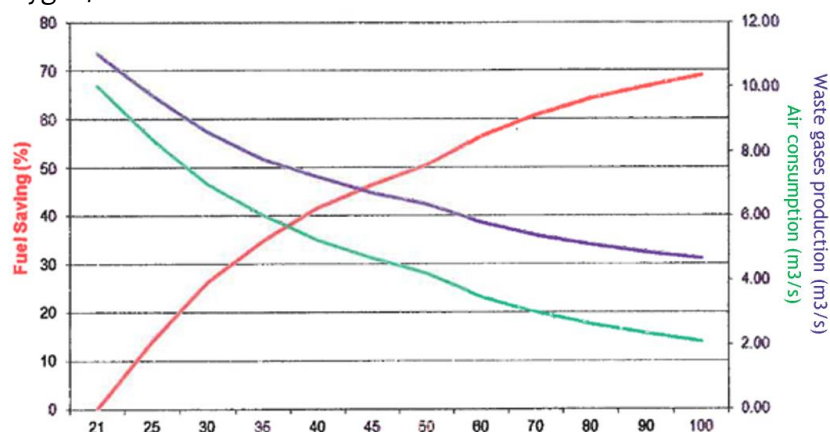


## Annex to amendment 1 on industrial gases: technical details on the use of oxygen in the steel industry

Using pure oxygen instead of air for the combustion of fuels helps to improve the energy efficiency of furnaces as energy for heating the nitrogen ballast is no more needed, thus the fuel consumption and direct CO<sub>2</sub> emissions are reduced. As nitrogen is no more needed, using pure oxygen for combustion also leads to the reduction of volume of combusted gas/arising gas (gas arising from the combustion), which means that less gas volume needs to be transported. This translates to reduction of electricity consumption of the fans. This technological improvement is used in the steel industry. In this regard, oxygen is used in furnaces of the integrated steel route to reduce the consumption of self-generated gases and natural gas in the furnaces for iron and steel production and in the heating and reheating furnaces of the downstream steel processing.

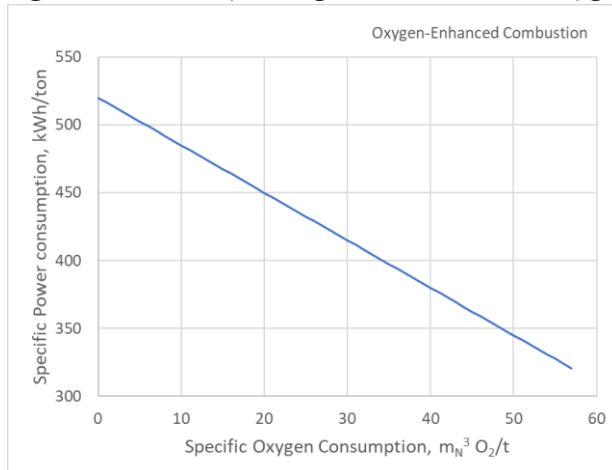
Pure oxygen is also being widely used in the secondary steel production route. Pure oxygen instead of air is used in so called oxy-fuel burners in Electric Arc Furnaces to improve energy and resource efficiency through substitution of electricity (see figure 2) and chemical energy (from combustion of natural gas); hence, compensation for both electricity and oxygen consumption is needed to ensure the level playing field. Oxy-fuel burners use pure oxygen instead of air for burning the fuel gas. They increase the productivity of the furnace (output) by increasing the speed of the melt and reducing the consumption of electricity and electrode material, which reduces GHG emissions. Electricity savings may range from 2.5 to 5.0 kWh/ m<sup>3</sup> of oxygen injected. The use of oxy-fuel burners has several other beneficial effects: it increases heat transfer, reduces heat losses, reduces electrode consumption, and reduces tap-to-tap time. Moreover, the injection of oxygen helps to remove different elements from the steel bath, like phosphorus, silicon and carbon.

**Figure 1:** Fuel savings and arising gas decrease during natural gas combustion from air/fuel to oxygen/fuel combustion



Source: Energy use in the iron and steel industry, EUROFER

**Figure 2:** Electricity savings as a function of oxygen usage in Electric Arc Furnace



Sources: CO<sub>2</sub> abatement in the iron and steel industry; Anne Carpenter, 2012; Oxyfuel combustion in the steel industry: energy efficiency and decrease of CO<sub>2</sub> emissions; Joachim von Schéele, The Linde Group Germany