



# tkH<sub>2</sub>Steel

First direct reduction plant  
with melting unit

Executive Summary



thyssenkrupp

## Transformation towards a climate-neutral society

There is no alternative to a climate-neutral society. With the Paris Climate Agreement, the international community has committed itself to limiting global warming. As a steel producer, thyssenkrupp can make a major contribution: The steel business currently accounts for around two percent of CO<sub>2</sub> emissions in Germany. With its goal of reducing emissions by 30 percent by 2030 and becoming a climate-neutral company by 2050, thyssenkrupp is taking on the responsibility that this involves. The company is thus making its contribution to a transformation towards a climate-neutral society.

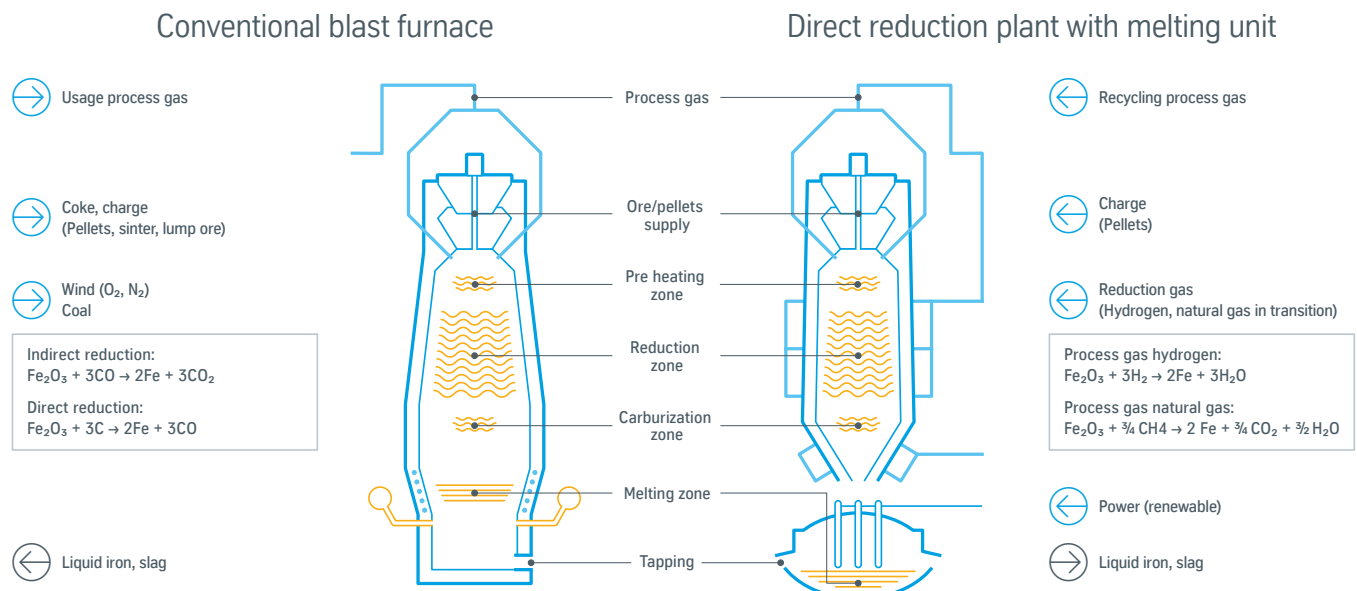
## Technological change in the steel industry

To date, steel production on the basis of iron ore has been closely linked to the use of carbon. The blast furnace route, which has been used for centuries, accounts for around 80 percent of the global steel production. Large quantities of CO<sub>2</sub> are produced in this process. Carbon can be replaced with hydrogen. thyssenkrupp is already testing the use of hydrogen in an existing blast furnace in Duisburg. In a first step, this will enable CO<sub>2</sub> emissions to be reduced in the short term, using the existing plants. A complete change in technology is necessary, however, to become completely climate-neutral. The steelmaking process must be redesigned.

## tkH2Steel: The innovative and cost-efficient path towards direct reduction

thyssenkrupp Steel has opted for the changeover to direct reduction plants, where natural gas or hydrogen can be used as reducing agents to produce sponge iron from iron ore. In this process, coal is no longer needed. While the use of natural gas reduces CO<sub>2</sub> emissions significantly, hydrogen reduces them to zero. The first direct reduction plant is to be commissioned in Duisburg in 2024 and will produce about 1.2 million tonnes of sponge iron, a solid product. Before the sponge iron can be processed in the steel mill, it must be molten. Initially this will be done in the blast furnace. From 2026 on thyssenkrupp will instead use a completely new, power-operated and innovative melting unit, thus completely replacing the first blast furnace. The upside is that the advantages of an integrated production site can be retained. Furthermore, this way comes with the lowest transformation cost and allows for maintaining the entire product portfolio.

### ➔ Centerpiece of transformation: Direct reduction plant with melting unit produces “electrical hot metal”



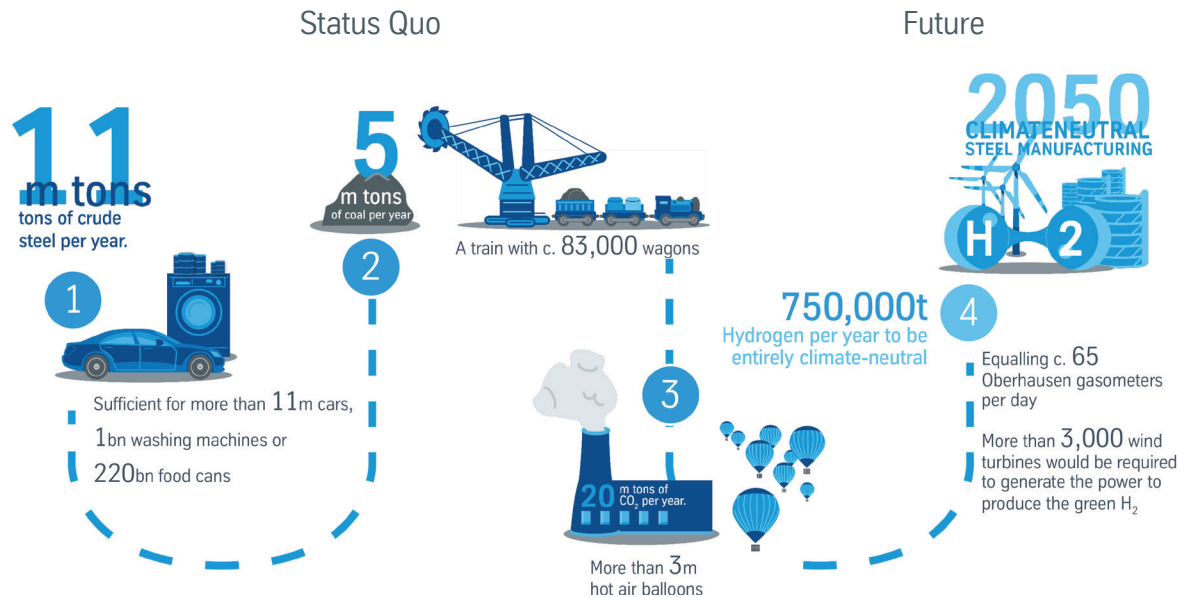
## Advantages of the Duisburg location – safeguarding jobs

Being Europe's largest steel location, Duisburg can play to its strengths also in future. Aside from the existing logistic links thanks to its proximity to the Rhine and direct links to road and rail networks, the Duisburg steel mill can be connected to important gas networks with little effort - and thus, in the future, to hydrogen networks as well. The new direct reduction plants and melting unit can be seamlessly integrated into the existing production network, so that the advantages of short distances to steel and rolling mills are retained. This safeguards job at the steel site Duisburg.

## Climate-neutral hydrogen – a key factor

The availability of green hydrogen, which is indispensable for the transformation of steel production, is a prerequisite for the climate-neutral steel industry. Moreover, the use of hydrogen in the steelmaking process is highly effective: one ton of green hydrogen avoids 25 tons of CO<sub>2</sub>. At the same time, huge amounts of hydrogen at competitive prices are needed, so that the political and regulatory framework conditions play an important role: Apart from the development and expansion of the domestic hydrogen capacities, international cooperation is indispensable. In addition, transport infrastructures must be expanded through pipelines and shipping routes.

## ➞ Overview regarding scale: status quo and going forward



## Framework conditions for investments – an integral prerequisite

The transformation of the steel production involves considerable financial investments: About one billion euros are necessary for the construction of a direct reduction plant including melting unit. Steel producers need state aid to help them make these investments. Various options can be considered, from strengthening and flexibilizing support programs to investment subsidies. No steel producer will be able to shoulder the climate transformation alone.

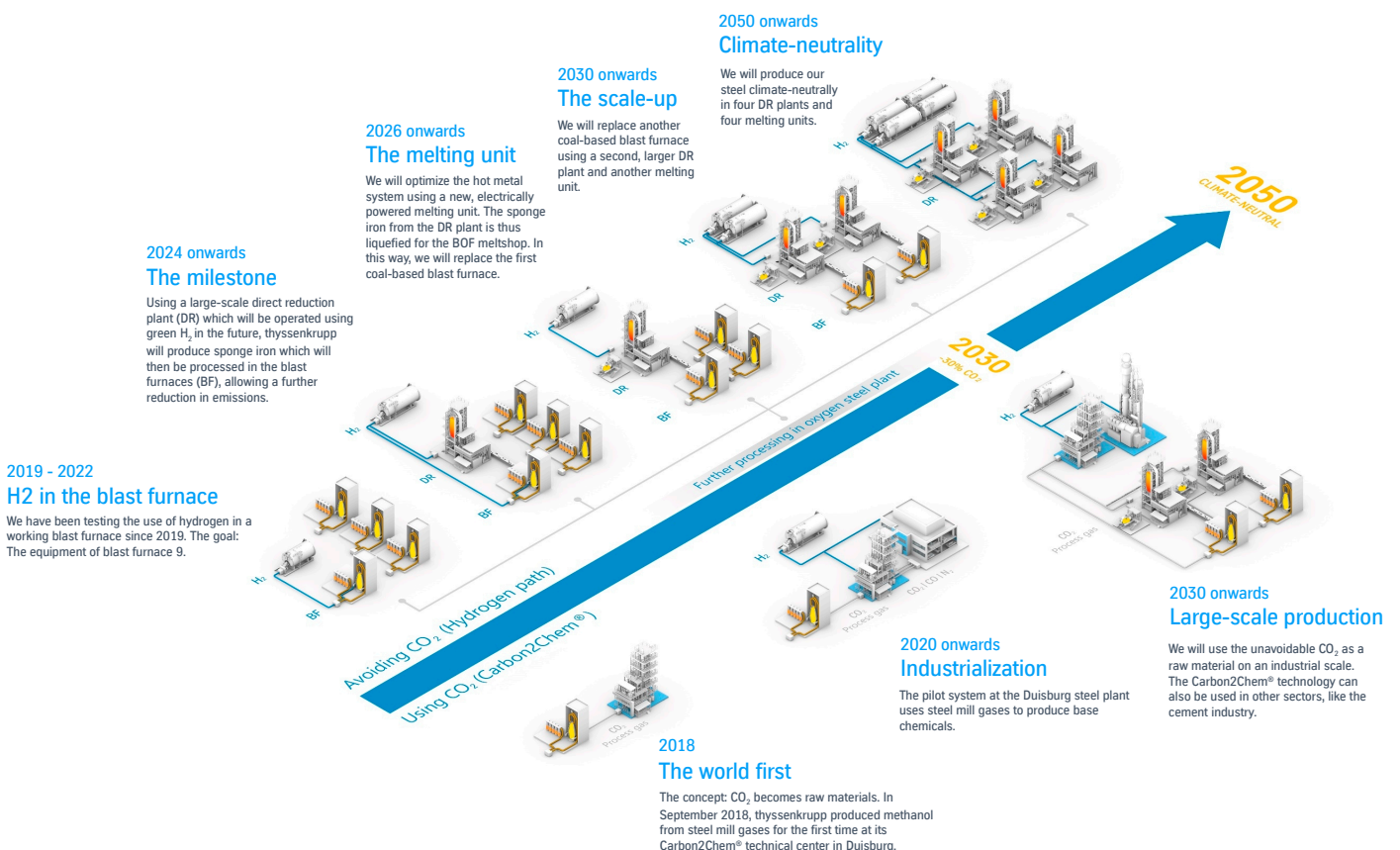
## Development of a market for green steel

Apart from the high investment costs, the production of green steel itself involves higher costs than the production of conventional steel. In this context, the main driver is the significantly higher price of hydrogen as against that for coal. It is therefore important to create incentives and instruments with the aim of establishing a market for green steel. The supply of green steel will increase continuously within the framework of the transformation of the steel production. thyssenkrupp will be able to supply the first quantities in 2022 (50,000 tons per year). This quantity will increase to some 950,000 tons from 2027. But only if green steel finds a ready market, will the transformation be successful.

## Milestones by 2050 defined

Further steps going beyond the first direct reduction plant will be necessary to achieve the climate goals by 2030 and 2050. From about 2030 on, thyssenkrupp therefore intends to operate a second plant incl. melting unit, thus producing as much as about 3 million tons of climate-neutral steel. Two more plants will then be built by 2050, gradually replacing the existing blast furnaces, in order to achieve the goal of climate neutrality by 2050. At the same time, the company will continue to focus on Carbon2Chem and the use of CO<sub>2</sub>, in order to capture the amounts of greenhouse gases that cannot be avoided through the use of hydrogen, and convert them into chemical products.

## ➞ Hydrogen for climate-neutral steel



## Continual adaptation of the climate strategy

thyssenkrupp will continually review and, if necessary, adapt its climate strategy in the light of technological developments and findings. In this context, it will stick to the principle to implement the climate transformation as efficiently and swiftly as possible. A first adaptation of the path is the use of novel melting units, which enable the integration of the direct reduction plant into the existing structure of the Duisburg-based metallurgical plant. This implies the decision that the company will not build any electric arc furnaces for the time being, which had originally been planned as downstream units. Moreover, the company has decided against equipping all blast furnaces in Duisburg for the use of hydrogen, given the probable limited availability of green hydrogen in the coming years. From 2024 on, available hydrogen will be used primarily on the new direct reduction plant.