

# HISARNA

## Building a sustainable steel industry

Care for the environment is one of Tata Steel's core values. Tata Steel is committed to contributing to the creation of a sustainable society through product and process innovations.

Tata Steel is one of the most CO<sub>2</sub>-efficient steel companies in the world. Since 1990, we have reduced the amount of energy required to make one tonne of steel by more than 30%. Our ambition is to be a CO<sub>2</sub> neutral steel producer from 2050. That is why we are committed to the development of groundbreaking technologies that make steelmaking radically more sustainable.

The European steel industry has made great strides in reducing CO<sub>2</sub> emissions. The options

for further reducing CO<sub>2</sub> emissions and energy consumption are limited. Further significant progress is only possible through the development of breakthrough technologies.

In 2004 a group of European steel companies, with the support of the European Union, started the ULCOS (Ultra-Low CO<sub>2</sub> Steelmaking) project. The objective was to identify technologies that will reduce CO<sub>2</sub> emissions per tonne of steel by 50% by 2050. Hisarna is one of those promising technologies.

The Hisarna test installation was built on the Tata Steel site in the Netherlands in 2010. Various tests have been carried out since the first trial campaigns in 2011. In 2018, the installation became part of the production chain and the fifth pilot campaign was successfully concluded in 2019.

### Hisarna:

- Shows the commitment of the European steel industry to structurally reduce CO<sub>2</sub> emissions
- Reduces CO<sub>2</sub> emissions by at least 20%
- Reduces energy consumption by at least 20%
- Reduces emissions of nitrogen, sulphur oxides and nitrogen oxides
- Leads to a more efficient use of raw materials and residual materials ideal for capturing and storing or using CO<sub>2</sub>
- Lowers the operating costs of steelmaking





## World leader

When it comes to making responsible steel, with the lowest possible energy consumption and the lowest possible CO<sub>2</sub> emissions, Tata Steel in IJmuiden is a world leader.

## Game changer

Tata Steel in IJmuiden has devised and developed a technology to make steel in the future with 20% less CO<sub>2</sub> emissions: Hlsarna. Scientists and steel manufacturers from all over the world are closely following the development of Hlsarna. Hlsarna has every possibility of growing into a real game changer in the steel industry.

Hlsarna is an alternative to the blast furnace process. To be able to make liquid pig iron in a blast furnace, it is necessary to pre-process

ores and metallurgical coal (the raw materials) into sinter (light chunks of iron ore), pellets (marbles of iron ore) and coke. The Hlsarna process makes these steps superfluous: in the Hlsarna installation, the raw materials can be used in powder form and be directly converted into liquid pig iron.

## Collaborate

Tests have been carried out in the Hlsarna pilot plant since 2011. The results are promising. It has now been demonstrated that the process works and is stable. Liquid pig iron, produced in the pilot plant, has been successfully processed into steel. The testing and further development of the technology is being carried out in collaboration with ArcelorMittal, thyssenkrupp, voestalpine and technology supplier Paul Wurth.

## Next step: upscaling

In 2018, Hlsarna became part of the production chain in IJmuiden. The next stage is to design, build and test an industrial-scale pilot plant. This step is necessary in order to be able to commercialise the technology and to make steelmaking ever more sustainable. Tata Steel is considering building a second larger test plant in India. If testing on an industrial scale proves to be a success, it will be another five to ten years before the technology can be put on the market commercially.

New steel companies can then immediately adopt this technology. Existing steel companies will be able to phase out current technology gradually. The ambition is to have a Hlsarna factory on an industrial scale in IJmuiden by 2030. Thanks to our cooperation with India, we can speed up that process.

## Support

Developments of large-scale breakthrough processes, such as Hlsarna, in which a process from idea to industrial commercialisation is realised, are not possible without support from European and national governments. Due to the scale and the challenging process conditions, Hlsarna is a development project covering many years, involving up to hundreds of millions of euros.

The development of Hlsarna has received support in recent years from the Research Fund for Coal and Steel, the European Horizon 2020 programme, the EIT Raw Materials and the Ministry of Economic Affairs and Climate in the Netherlands. The most recent development step within the Hlsarna project was carried out with a subsidy from the Ministry of Economic Affairs and Climate (EZK), accompanied by the Netherlands Enterprise Agency, together with National EZK subsidies and the Energy Top Sector.

## Up to 80% less CO<sub>2</sub>

Tata Steel, in collaboration with various other partners, is investigating the feasibility of CO<sub>2</sub> capture, use and storage (CCUS, Carbon Capture, Utilisation and Storage) in the Netherlands' North Sea Canal Area. Used in combination with the Hlsarna process, this could reduce CO<sub>2</sub> emissions by 80%. An additional advantage is the complete disappearance of emissions of nitrogen (NO<sub>x</sub>), sulphur oxides and particulate matter.



## FACTS ABOUT HISARNA

### Developed by Tata Steel

The cyclone part (top part) of the Hlsarna installation was developed by Tata Steel in IJmuiden. The lower part, the melt reduction vessel, was originally developed by Rio Tinto. Tata Steel has fully owned all patents on Hlsarna technology since 2017.

### Revolutionary breakthrough technology

Hlsarna is a revolutionary breakthrough technology. The impact is comparable to the introduction of continuous casting in the last century, which made the process steps of block casting and block rolling superfluous. These were almost completely phased out in the steel industry within 30 years.

### Preheat furnace to 1,200 degrees

Before production commences, the reactor in the Hlsarna pilot plant is preheated to around 1,200°C. A layer of liquid pig iron is then poured into the melting vessel to start the process.

### About the name Hlsarna

The name Hlsarna is a combination of the old Celtic word for iron ("Isarna") and the name of the melting vessel ("Hlsmelt").

### Production capacity

The maximum production capacity of the Hlsarna pilot plant in IJmuiden is 60,000 tonnes of liquid pig iron per year. For comparison: Blast furnace 7 in IJmuiden produces 10,000 tonnes per day. After successful upscaling, Tata Steel in IJmuiden has the ambition to build an industrial scale factory.

### Investments

Major investments have been made for the development of Hlsarna, the majority of which have come from Tata Steel and the partner companies, with the support of the Dutch and European governments.

## THE ADVANTAGES OF HISARNA

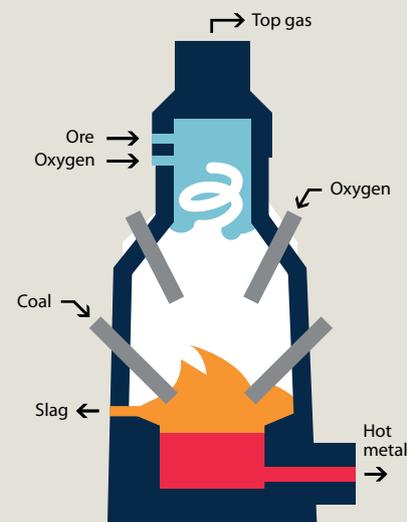
### Reducing environmental impact

The main environmental benefits of Hlsarna are: the reduction of energy consumption and CO<sub>2</sub> emissions by at least 20% and the greatly reduced emissions of hydrogen, sulphur dioxide and nitrogen oxide. When capturing CO<sub>2</sub> emissions, also these emissions will be completely reduced. In addition, a wider range of residual products from the steel production process can be re-used in a Hlsarna installation, thereby closing the cycle of steel production even further.

### Reduction of production costs

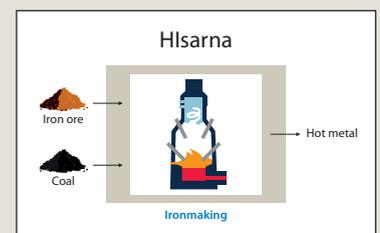
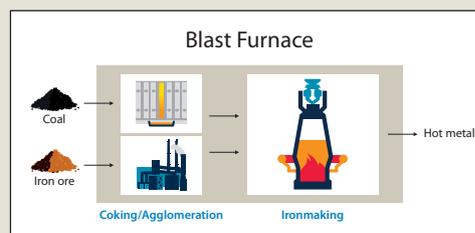
The Hlsarna production process is more efficient than the current process because it no longer requires pre-processing of the ores and metallurgical coal. Complete production steps can be phased out: no more coking, sintering and pellet factories are needed. Eliminating those also saves a lot of energy, which is good for the environment and reduces costs. Finally, the Hlsarna process makes use of a much wider range of ore and coal grades, which means that steel producers can make the same high quality of steel with cheaper and more available raw materials.

### How does Hlsarna work?



Hlsarna consists of a reactor which maintains a temperature above the melting point of iron throughout, so that the injected iron ore immediately melts and is converted into liquid hot metal. The very high temperature of the process gases in the melting vessel is further increased in the cyclone at the top of the reactor by the addition of pure oxygen, which reacts with the carbon monoxide present.

The turbulence in the cyclone helps the hot gas to melt the iron ore, which is injected at the top of the vessel. The iron ore then drips to the bottom of the vessel, where the powdered coal is injected, causing the oxygen in the iron ore (= iron oxide) to bind to the carbon, creating liquid hot metal, which can then be drained off.



## SHORT REVIEW & LOOKING FORWARD

2004



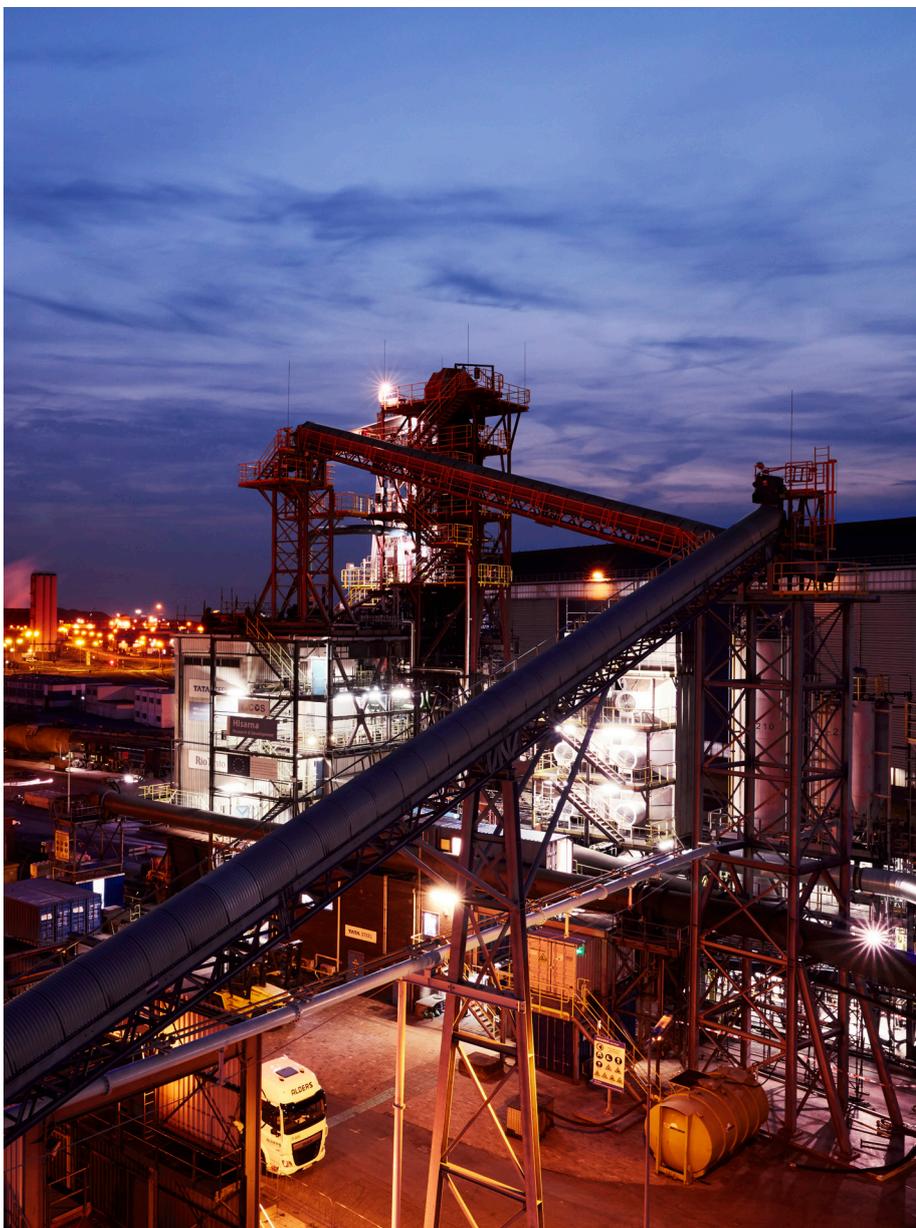
With the aim of drastically reducing CO<sub>2</sub> emissions in steel production, the European ULCOS project was started in 2004. A large group of steel companies, research institutes and engineering firms worked together to develop new technologies for the production of steel with greatly reduced CO<sub>2</sub> emissions. Four technologies have emerged from this project, of which Hlsarna is the most developed and most promising.

2010 - 2014

The Hlsarna test installation was built on the Tata Steel site in IJmuiden in 2010. A number of tests have been carried out since the first experiments in 2011, and have demonstrated that the process works technically and that it meets expectations for energy efficiency and the raw material mix. In 2012, Tata Steel managed to produce liquid pig iron in a stable process for a longer period of time. And in 2013 steel was made for the very first time using this liquid pig iron.

2016 - 2018

In 2016, the pilot installation was adapted to allow long-term tests in continuous operation. The installation has been radically changed. Short experiments have been carried out to show that a CO<sub>2</sub> saving of 35% is possible, even without carbon capture technology. This was made possible in part by the use of sustainable biomass and scrap. A test has also been carried out to show that the process gas released can be so rich in CO<sub>2</sub> that it is suitable for direct CO<sub>2</sub> capture.



2018 - 2019

In 2018, the Hlsarna installation was included in the IJmuiden production chain. This also started the endurance test, to demonstrate that the Hlsarna installation can also produce pig iron for long consecutive periods. In addition to high process stability, it had to prove high plant availability and reliability. These objectives have been achieved. The longest run within this trajectory lasted 19 days – producing 2,000 tonnes of pig iron.

2020 and further

Tata Steel is considering building a second larger test plant in India. If testing on an industrial scale proves successful, it will take about five to ten years before the technology can be put on the market commercially. The ambition is to have a Hlsarna factory on an industrial scale by 2030.

More information about Hlsarna: [www.tatasteeleurope.com/en/innovation/hlsarna](http://www.tatasteeleurope.com/en/innovation/hlsarna)

Hlsarna factsheet nr. 2/2020

