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# Hisarna, an Opportunity for Reducing CO<sub>2</sub> Emissions from Steel Industry

Jan van der Stel, Koen Meijer, Stanley Santos, Tim Peeters  
Tata Steel, Research and Development

Pieter Broersen  
Tata Steel

CATO Meets the Projects  
Utrecht, The Netherlands

Together we make the difference



TATA STEEL

With support of the  
Ministry of Economic Affairs

ulcos

Hisarna  
Research & Development

RioTinto



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# Presentation Outline

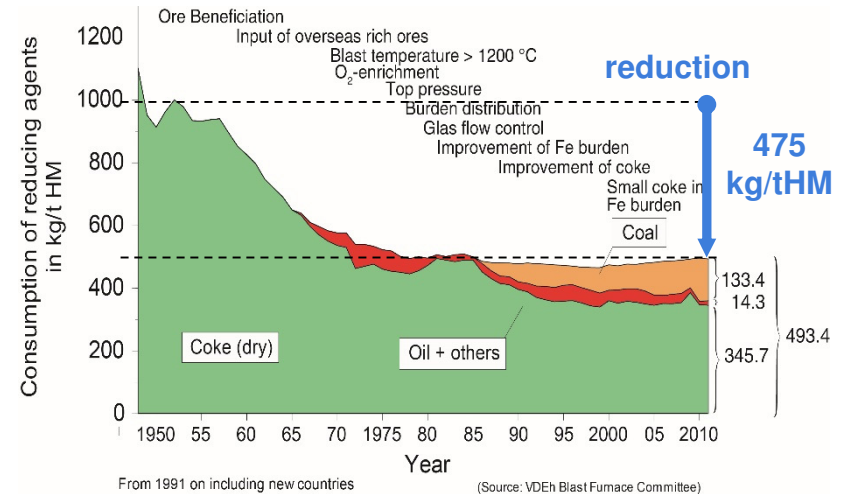


- ULCOS Programme
- HIsarna Development
  - The Hisarna process
  - Environmental benefits
  - Achievements
  - Scaling up
- Conclusions

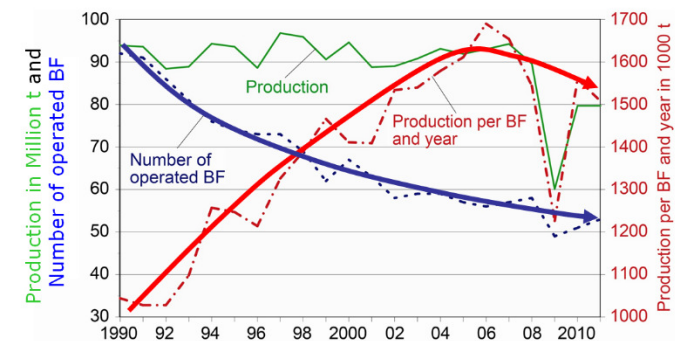
# Introduction



- Steel Industry
  - Energy and CO<sub>2</sub> intensive
  - Very high recycling rate
  - Capital intensive industry
    - Major facilities > 20 years life span
    - Large sites, large installations
- Trends in the past decades
  - Reduction in the number of blast furnaces in Europe
  - Increasing productivity
  - Close to theoretical minimum regarding reducing agents
  - BF is main producer of CO<sub>2</sub> within integrated steel works
  - Small possibilities to reduce CO<sub>2</sub> emissions with existing blast furnace operation



Evolution of Hot Metal Production in the EU 15



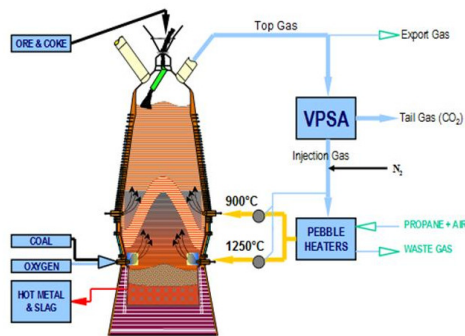
# ULCOS Programme

ulcos stands for **Ultra-Low Carbon Dioxide(CO<sub>2</sub>) Steelmaking.**

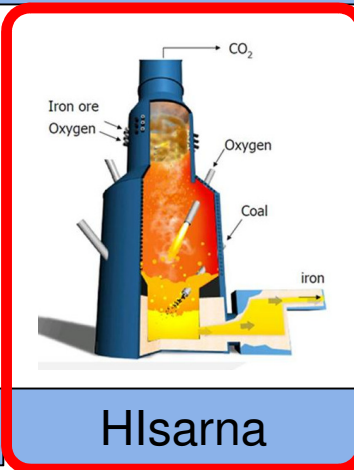
Coal and Sustainable Biomass

Natural Gas / Syngas from Coal Gasification

Electricity



TGRBF (ULCOS BF)



Hlsarna



ULCORED



ULCOWIN

ULCOS is a consortium of 48 European companies and organisations from 15 European countries that have launched a cooperative research & development initiative to enable drastic reduction in Carbon Dioxide(CO<sub>2</sub>) emissions from steel production.

Since the early 2000's, the steel industry has invested significant amount of resources in evaluating technologies that could reduce the carbon footprint of steel production

# Development of HIsarna Process



- In 2004 several European steelmakers proactively started the ULCOS project with the objective to achieve 50 % reduction of the CO2 emissions of steelmaking
- HIsarna is one of the four process development that originate from the ULCOS project.
- Since 2007 Tata Steel, Rio Tinto and ULCOS have been active developing this coal-based smelting reduction process.
- To date over € 60 Million has been invested in this new technology.
- The HIsarna process offers a combination of environmental and economic benefits.

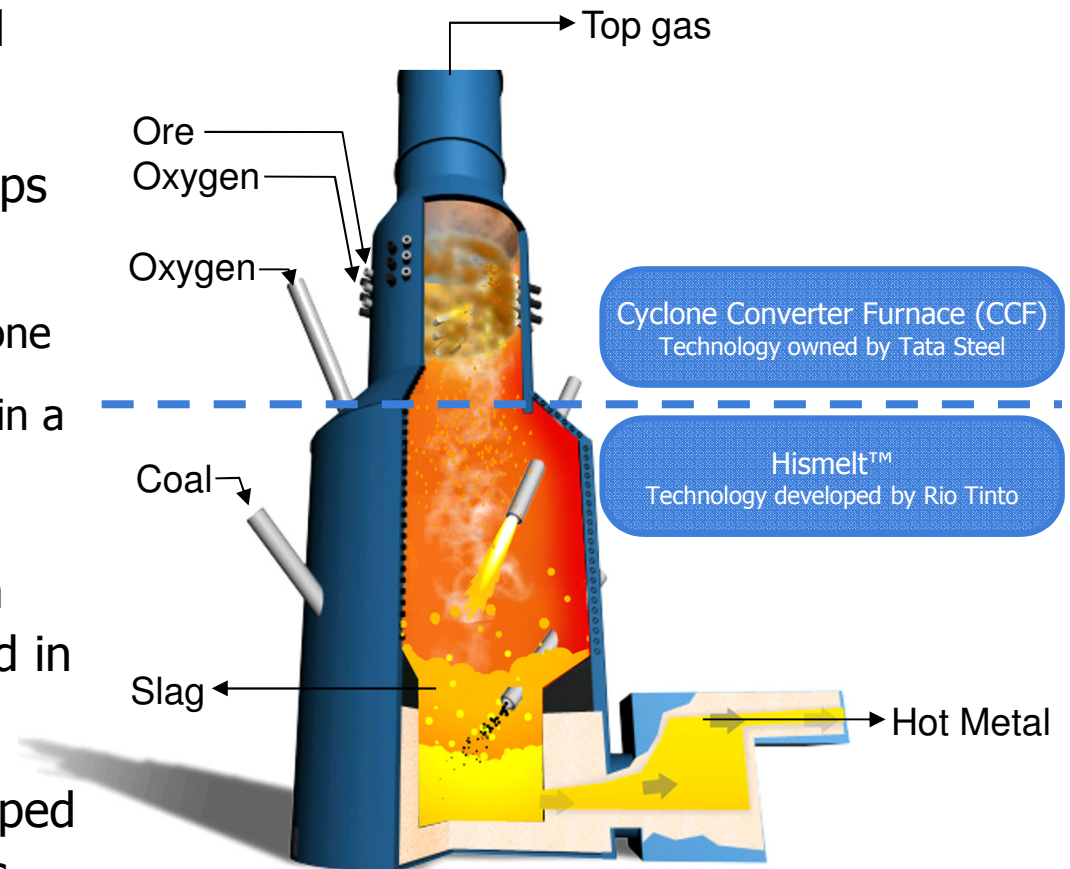


# The HIsarna Process

## Technology Background

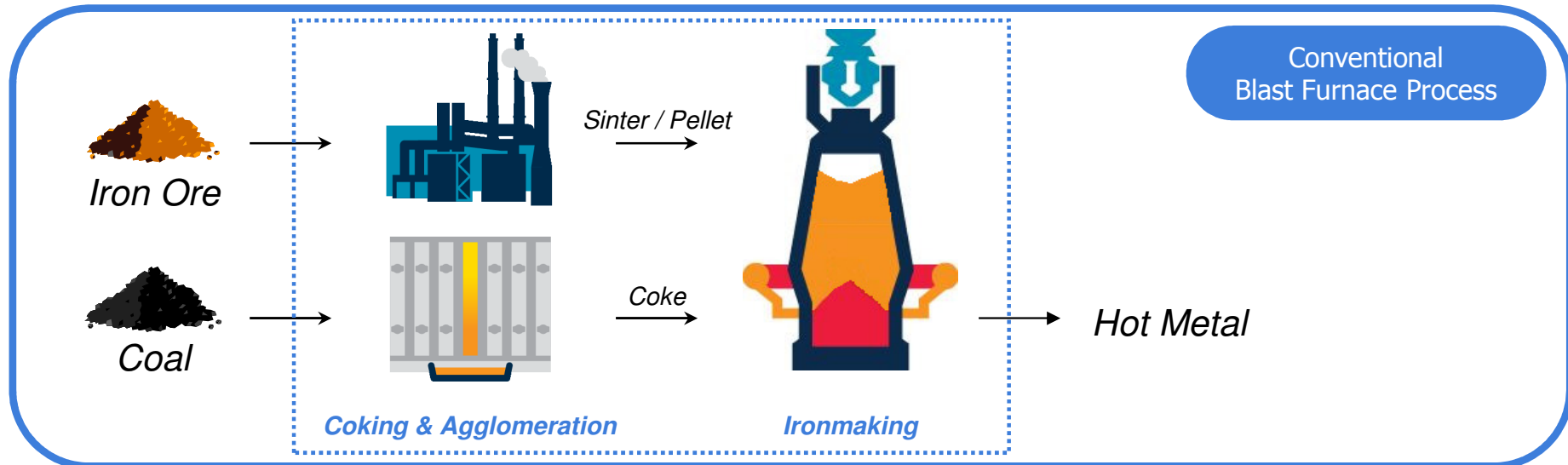
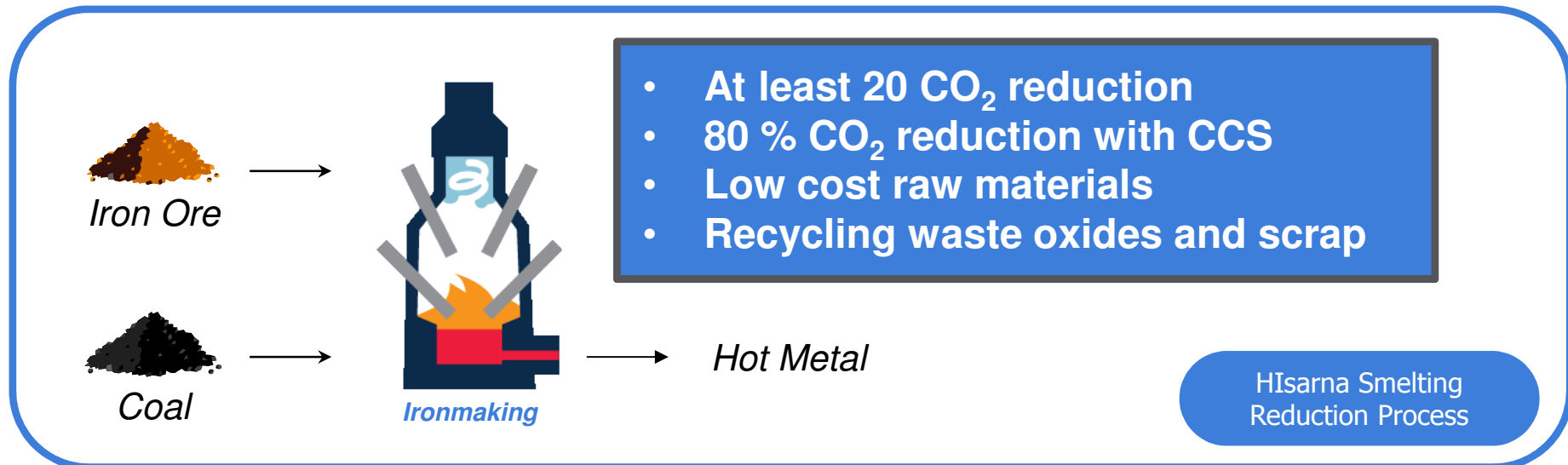


- The HIsarna process produces liquid hot metal directly from fine ore and (non-metallurgical) coal
- HIsarna consists of two process steps integrated in a single furnace
  - Pre-reduction and smelting in a cyclone
  - Final reduction and coal gasification in a Smelting Reduction Vessel (SRV)
- The smelter technology is based on HIs melt. This was further developed in Australia during 1980's.
- The cyclone technology was developed in Tata Steel IJmuiden in the 1990's



# The Hisarna Process

## One Step from Raw Materials to Hot Metal



# The Hisarna Process

## Environmental Benefits



In addition to the reduction of CO<sub>2</sub>, other gaseous emissions are also drastically reduced due to the elimination of cokemaking and sintering plants



	Emission Reduction*		
	CO <sub>2</sub>	NO <sub>x</sub>	SO <sub>x</sub>
Hisarna without CCS	20 %	70 %	60 %
Hisarna with CCS	80 %	90 %	85 %

\* Compared to BF/BOS/HRC route

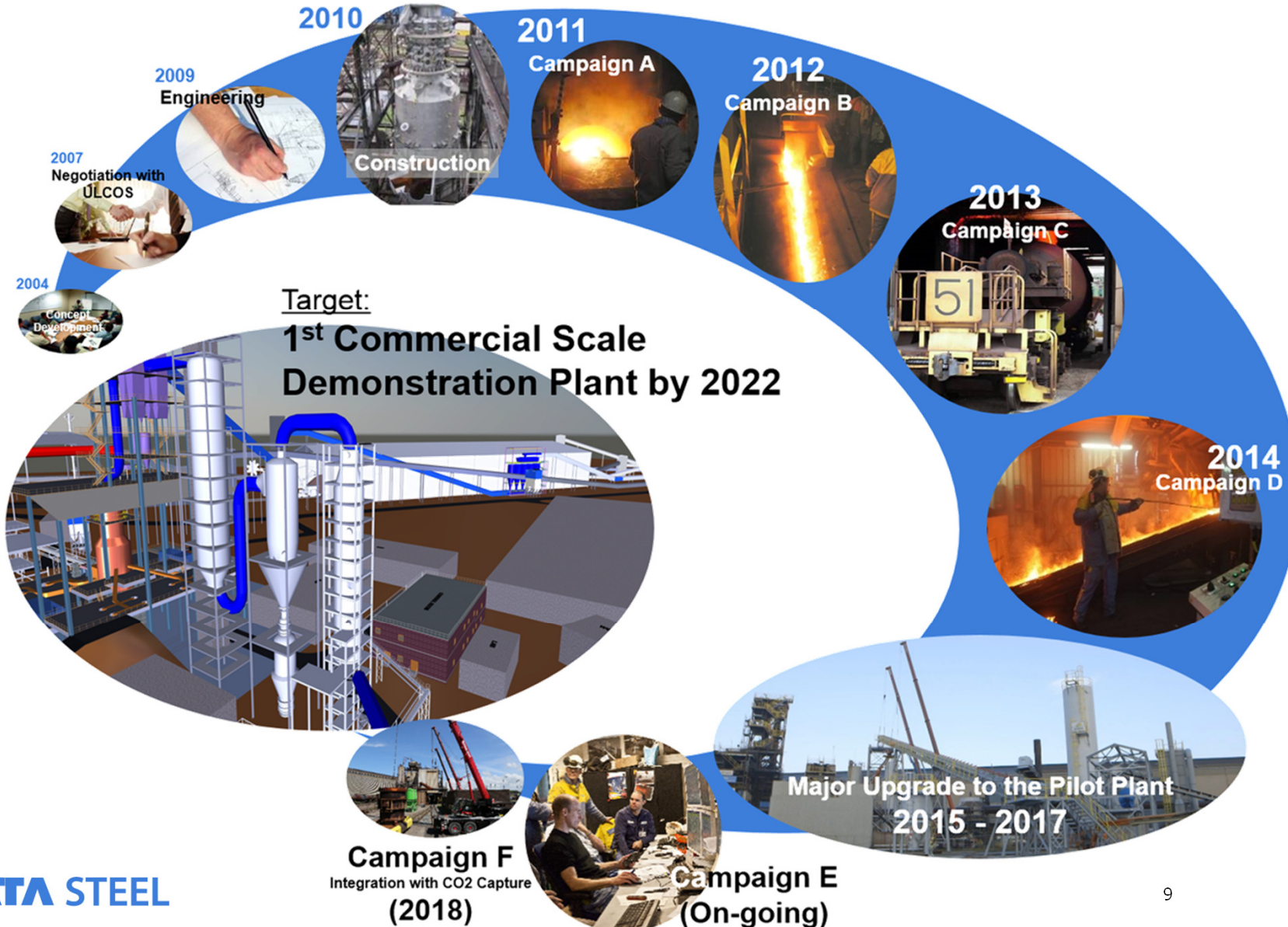
### Economic benefits

- Low cost coals
- Lower grade iron ores
- Lower Capex / Opex
- Lower stocks
- Energy saving



# The Hisarna Pilot Plant

Over 10 Years of Development

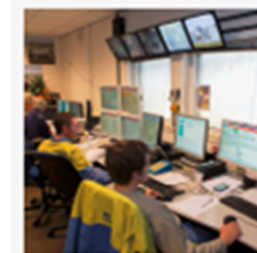


# The HISarna Process

## Key Development and Achievements



Year	Campaigns	Major Achievements
2011	CAMPAIGN A	<ul style="list-style-type: none"> <li>- Feasibility of the new process</li> <li>- First hot metal tap (May 2011)</li> </ul>
2012	CAMPAIGN B	<ul style="list-style-type: none"> <li>- First long operating period achieved</li> <li>- Use standard raw materials</li> <li>- 80% productivity target reached</li> </ul>
2013	CAMPAIGN C	<ul style="list-style-type: none"> <li>- Use of steam coal (23%VM)</li> <li>- Use of Low grade ore (&lt; 30% Fe)</li> <li>- First hot metal delivered to the BOF plant</li> <li>- Achieve good plant availability</li> <li>- Productivity target reached</li> </ul>
2014	CAMPAIGN D	<ul style="list-style-type: none"> <li>- 30% of hot metal produced made into steel</li> <li>- Use of high volatile steam coal (39% VM)</li> <li>- Use of high Zn waste oxides</li> <li>- Use of scrap and ore concurrently</li> <li>- Target coal consumption achieved</li> </ul>
2015-2017		<ul style="list-style-type: none"> <li>- Major plant upgrade (€25 million investment)</li> </ul>
2017	CAMPAIGN E	<ul style="list-style-type: none"> <li>- Start of the endurance test (Sept. 2017)</li> </ul>

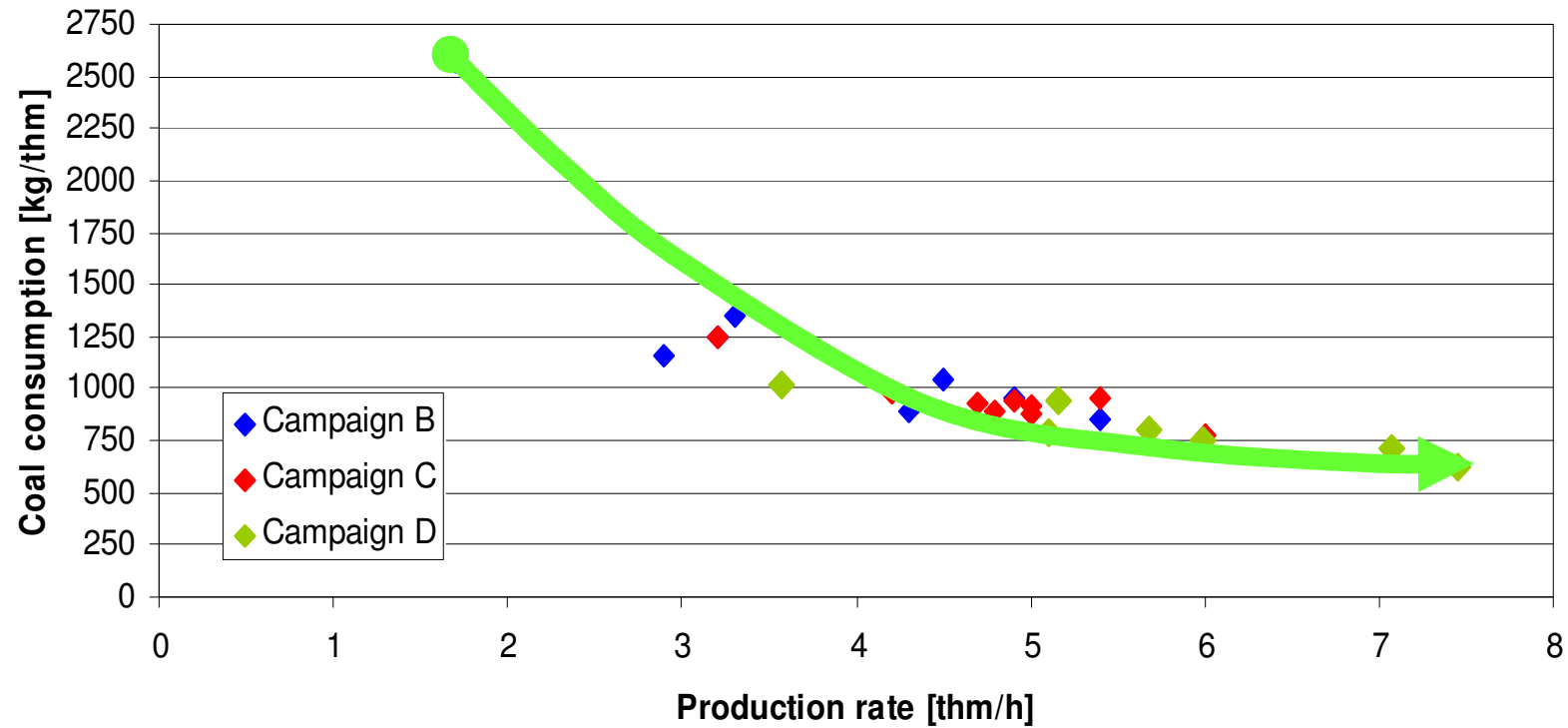


# The HISarna Process

## Campaign Results: Coal Consumption (Pilot Plant)



HIsarna pilot plant

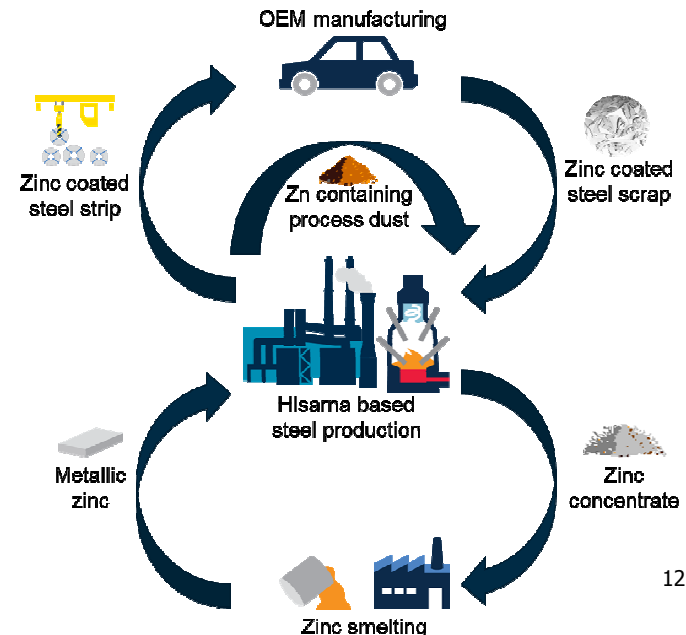
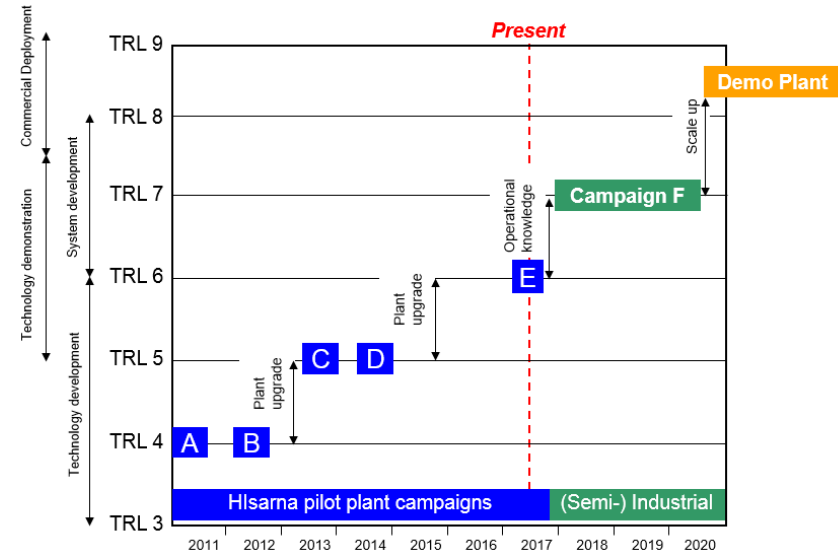


# The Hisarna Process

## Campaigns E & F – working toward 1<sup>st</sup> commercial demo plant



- Financial support project partners, EU and Dutch Government
- Plant Upgrades – involving substantial investment of ~25 M€:
  - Dedicated coal and ore preparation facilities
  - Improved instrumentations and control systems
  - Improved off-gas de-dusting (secondary)
- Campaign E (current campaign)
  - Key Objectives:
    - Long duration testing of process and equipment (TRL 5 → TRL 6)
    - To demonstrating CO<sub>2</sub> reduction of 35%
    - Capture ready off-gas
  - **Now Operational! (Started in September 2017)**
- Campaign F (from 2018 onward):
  - Transfer of the plant responsibility from R&D to the manufacturing organisation
  - During campaign F the implementation of CO<sub>2</sub> capture is foreseen (2019)



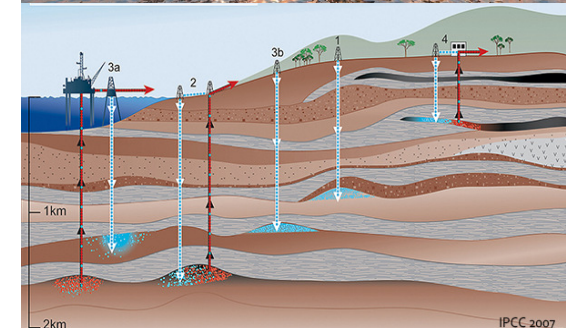
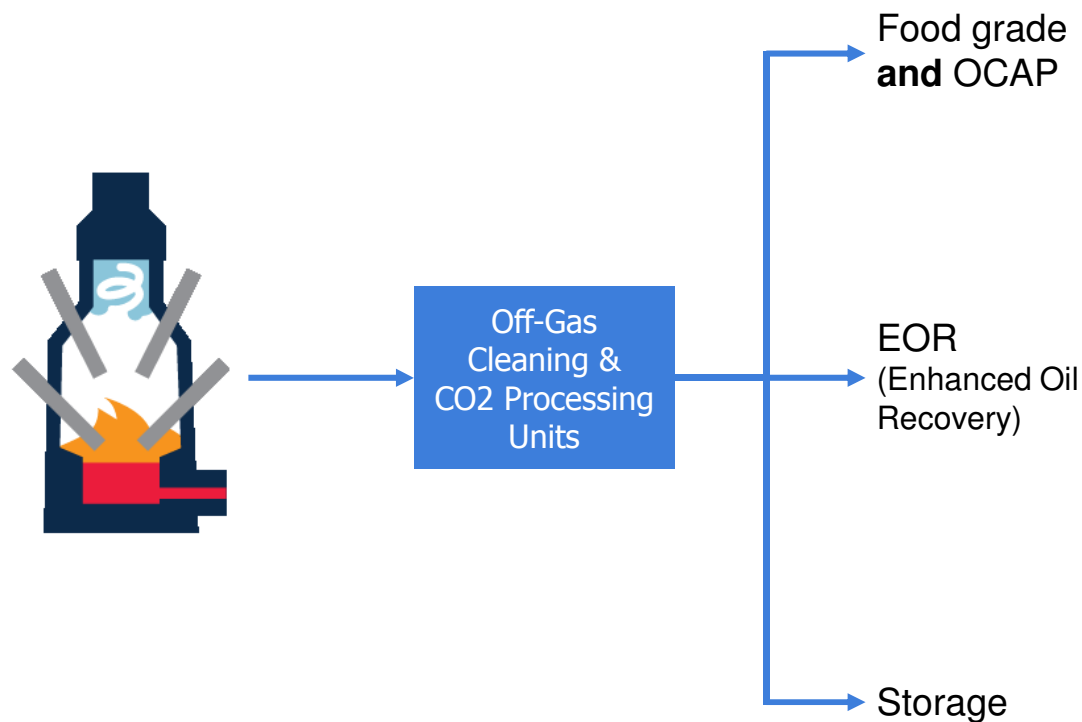
# The Hisarna Process

## CO<sub>2</sub> Capture & Utilisation or CO<sub>2</sub> Capture & Storage

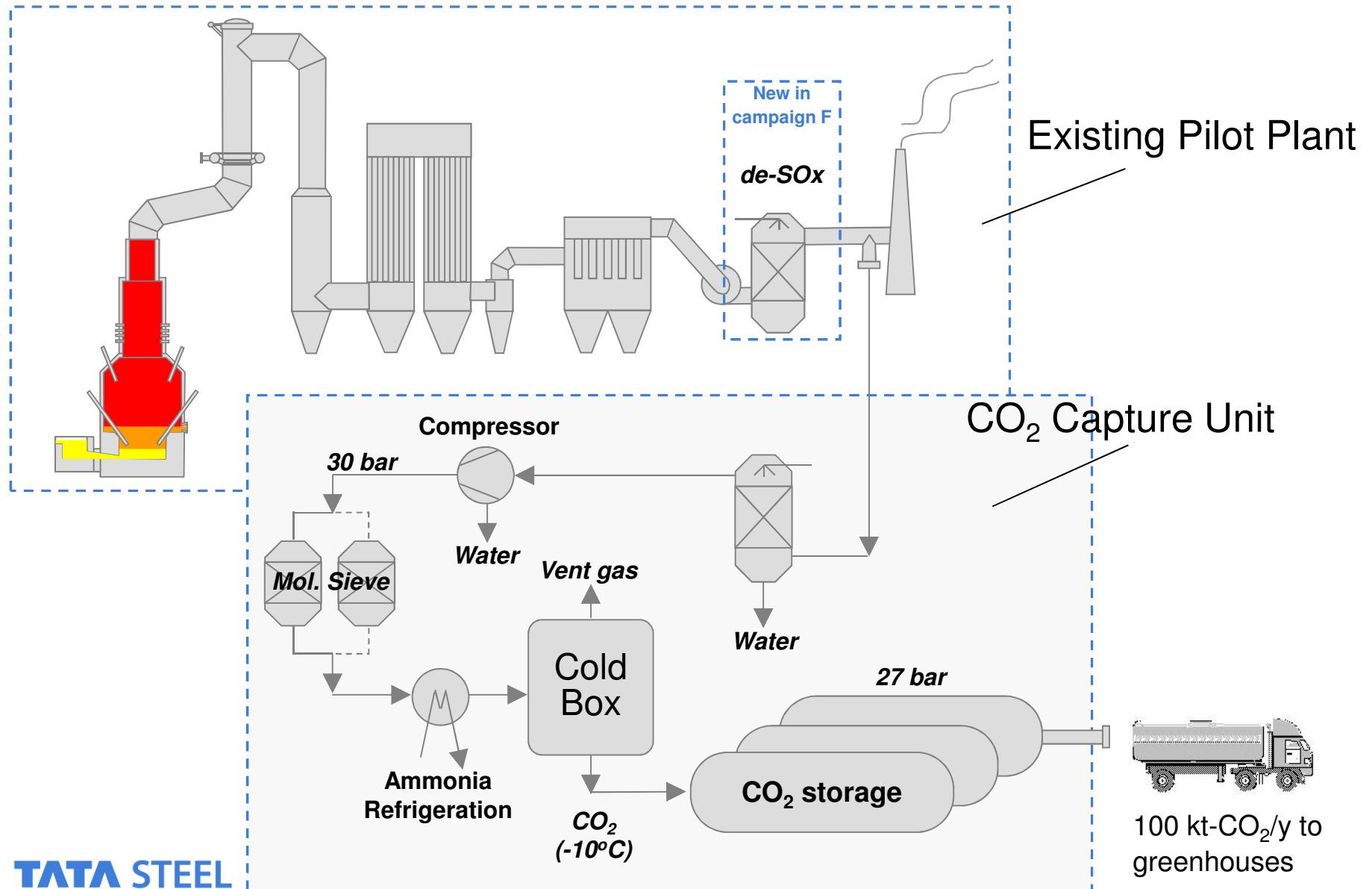


- Collaboration with TNO under Dutch CATO – TKI Programme
- TNO carried out a techno-economic assessment of CCS/CCU options for the Hisarna Demo plant.

- Dependent on CO<sub>2</sub> Specifications (i.e. Purity)



# Hisarna Pilot Plant with CO<sub>2</sub> Capture Unit

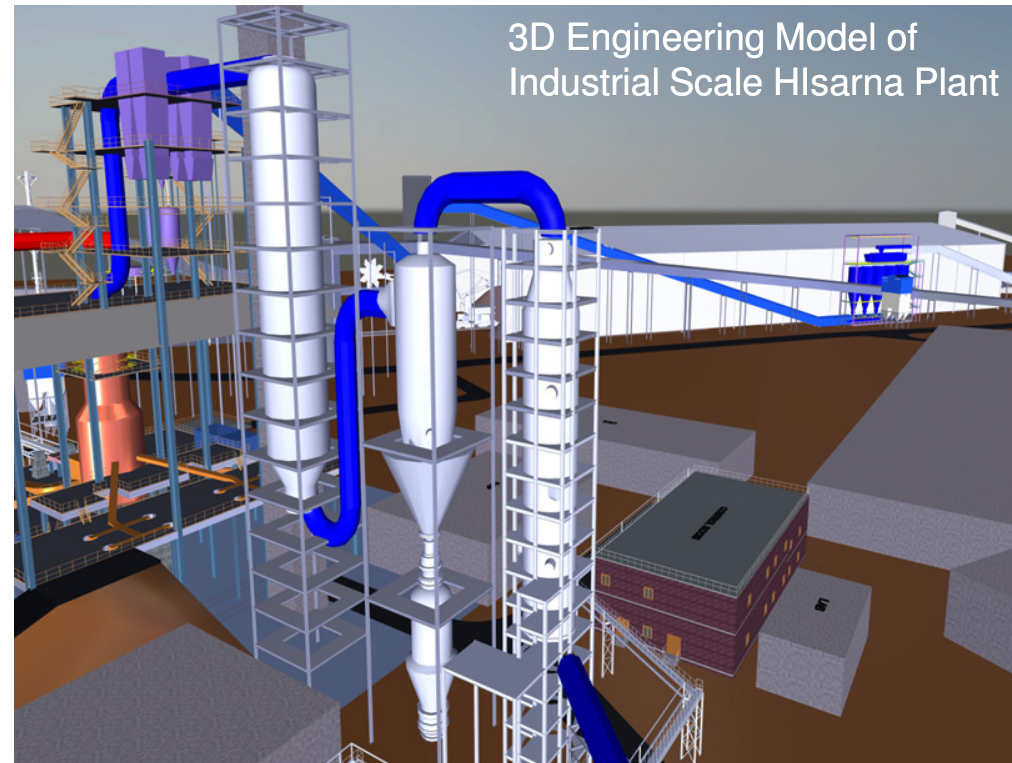


# The HIsarna Process

## Scaling-up to 1st Demonstration Scale



- Conceptual Engineering for industrial demonstration scale has started.
- A demonstration plant of industrial size (0.5 – 1.0 M thm/y) a substantial investment.
- The success of such a demonstration project that involves substantial risks depends on:
  - Cooperation and support from industrial partners (such as ULCOS)
  - Adequate public funding



# Concluding Remarks

- Since the early 2000's, the steel industry has put in a significant amount of investment in R&D to reduce their carbon footprint further:
  - Extensive work in making the blast furnace carbon lean and CO<sub>2</sub> capture ready (i.e. TGRBF).
  - New alternative processes (i.e. HIsarna) are being developed to intensify the steel production process.  
HIsarna is CO<sub>2</sub> capture ready.
- Tata Steel and the ULCOS consortium have successfully demonstrated through the various large scale pilot plant campaigns that HIsarna could achieve at least 20 to 35% reduction (without CCS) and >80% reduction (with CCS).