

Hisarna

Demonstrating low CO₂ ironmaking at pilot scale

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Cato Meets Projects
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Together we make the difference

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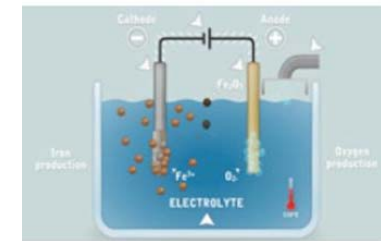
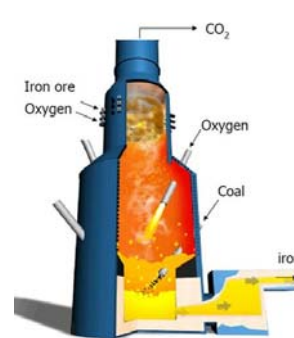
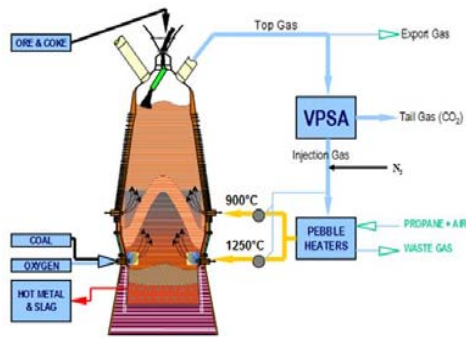
ULCOS Programme

ulcos stands for **Ultra-Low Carbon Dioxide(CO₂) 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 (CO₂) emissions from steel production.

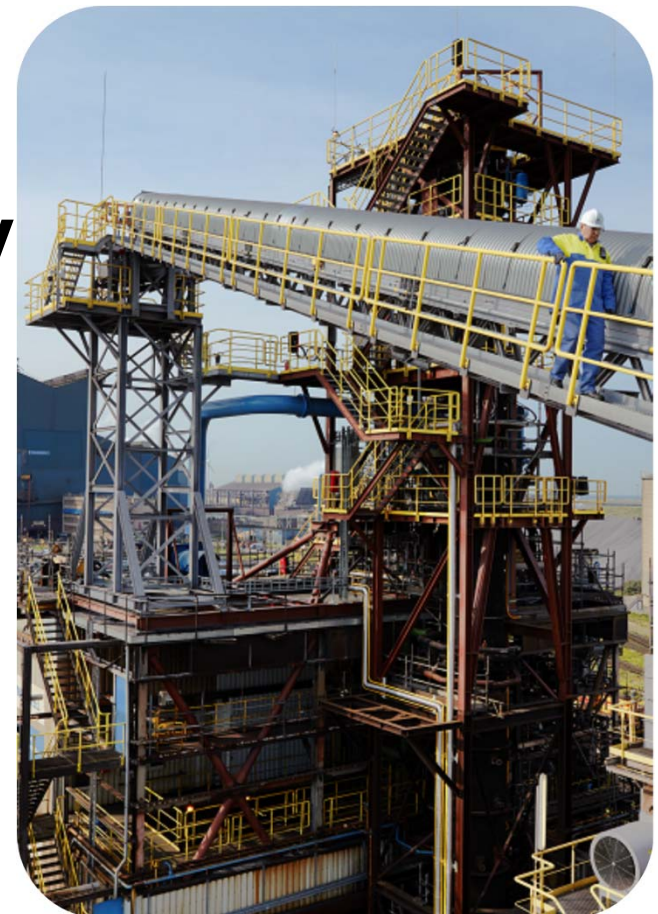
Since the early 2000's, the steel industry has invested significant amount of resources in evaluating technologies that could reduce the carbon footprint of steel production

~ € 75 million investment

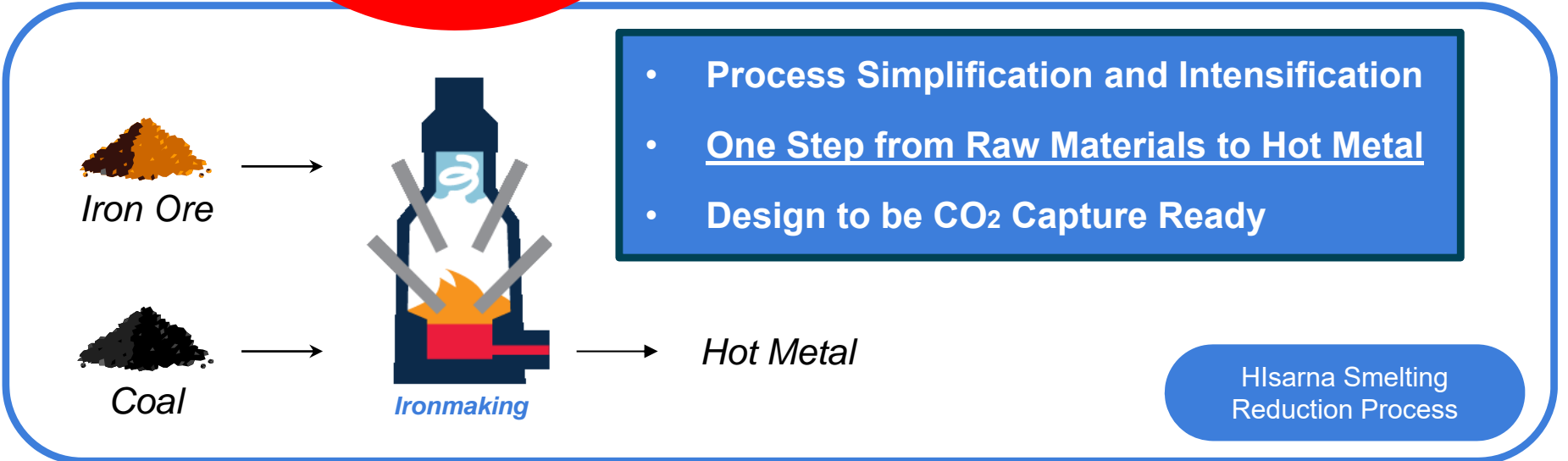
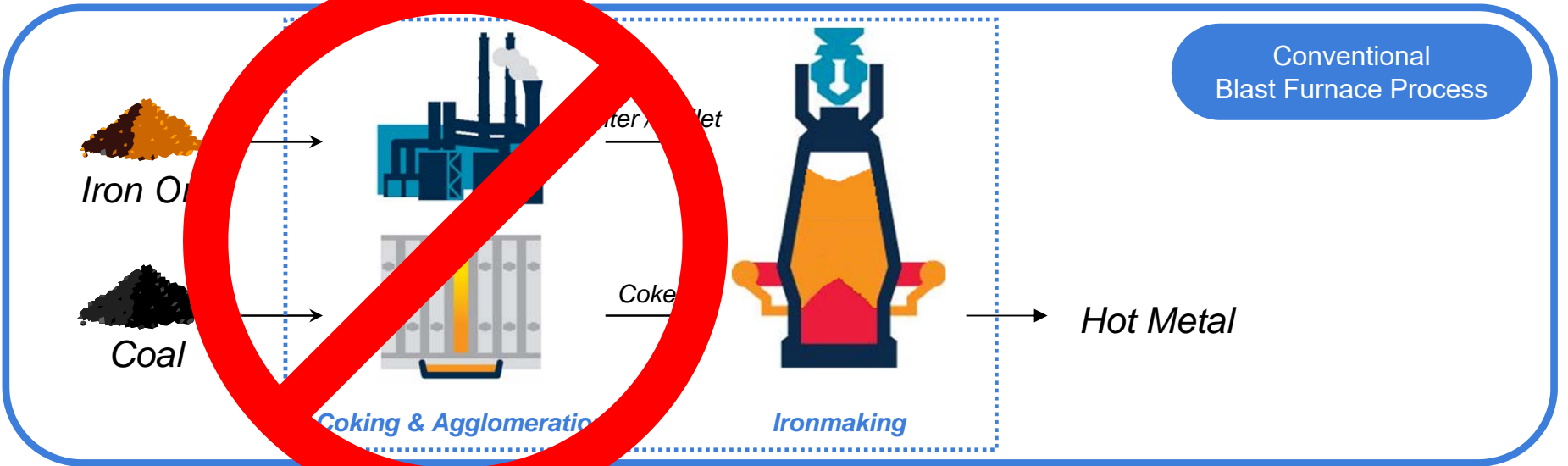
(with more than 10 years of development)

What is Hisarna?

- Smelting reduction ironmaking process
 - At least 20% reduction in CO₂ emission
 - At least 50% reduction with biomass & scrap
 - At least 80% with CCS
- **Game changing technology**
 - Reduce CO₂ and other emissions
 - No coking or ore agglomeration
 - Flexible raw materials use
 - Low P and low Si hot metal
 - Scrap use in the process
 - Zn recovery from process dust

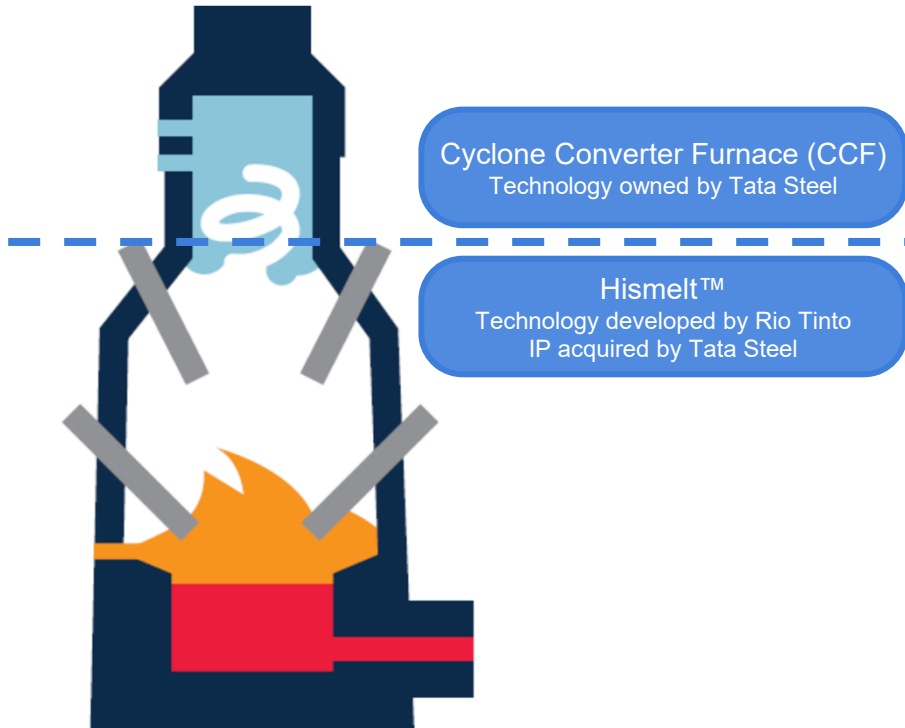


Hlsarna vs. Blast Furnace Ironmaking



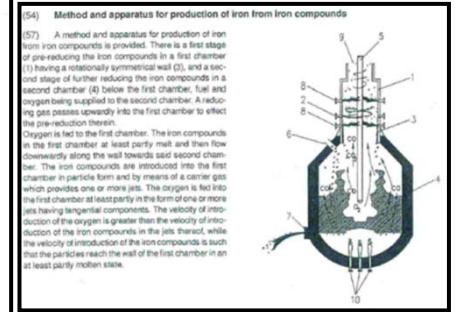
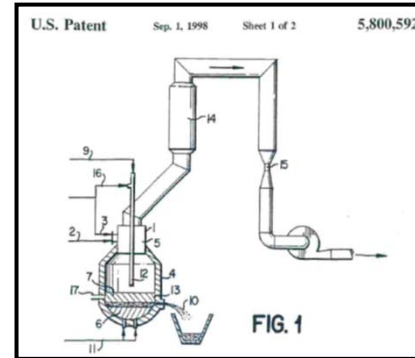
Hlsarna Development

Merger of CCF and Hismelt technology cooperation started in 2008



Cyclone Converter Furnace (CCF)
Technology owned by Tata Steel

Hismelt™
Technology developed by Rio Tinto
IP acquired by Tata Steel



Combined technology now fully owned by Tata Steel

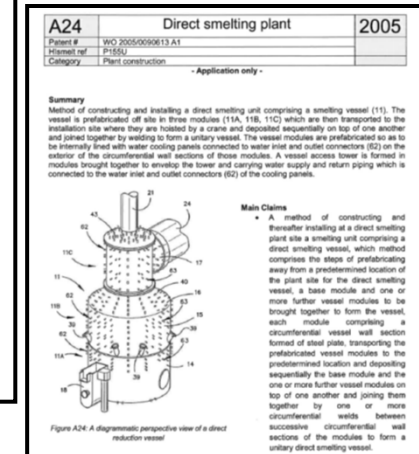
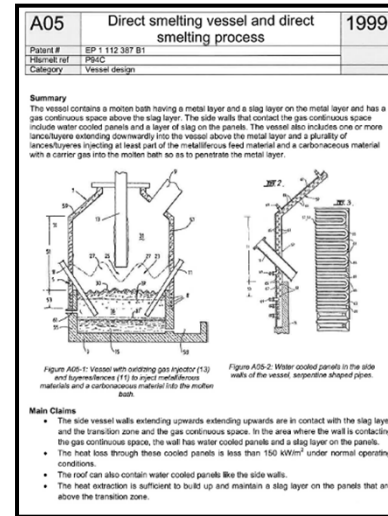


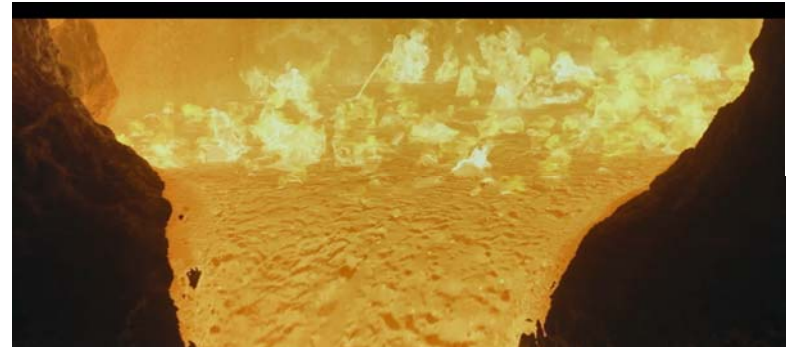
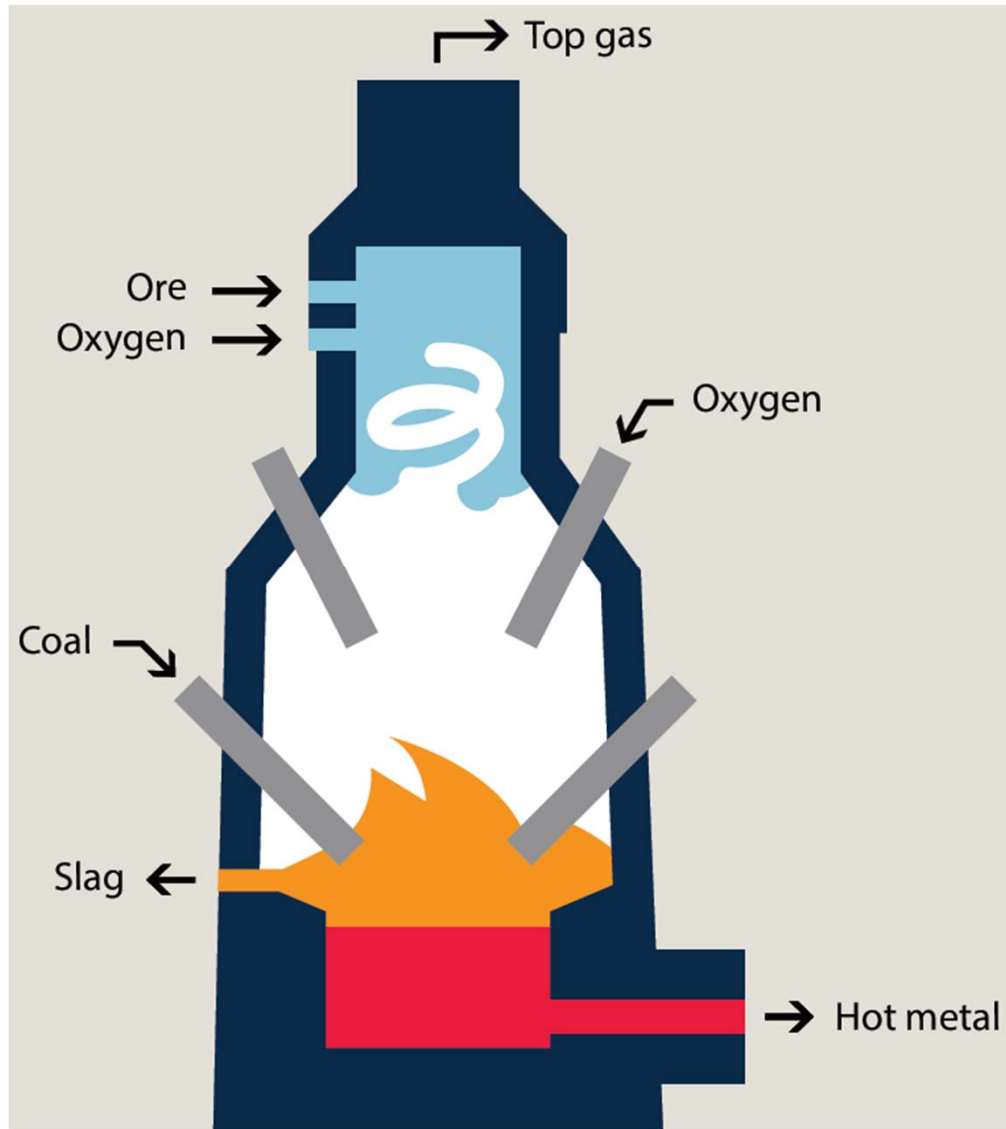
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Hisarna: Process Layout



Hisarna Pilot Plant

- 1 Alternative raw materials storage silos
- 2 Off-gas duct
- 3 Gas cooler
- 4 Coal and lime storage silos
- 5 Cooling towers
- 6 Bag filter
- 7 Secondary dedusting
- 8 Smelting cyclone
- 9 Smelting reduction vessel
- 10 Fore hearth
- 11 Control room
- 12 Coal grinding, drying and screening
- 13 Ore drying and screening
- 14 Raw materials storage
- 15 Offices
- 16 Workshop



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Hisarna Process

Key Development and Achievements

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



Hisarna Process – Progress & Achievement in 2017/2018

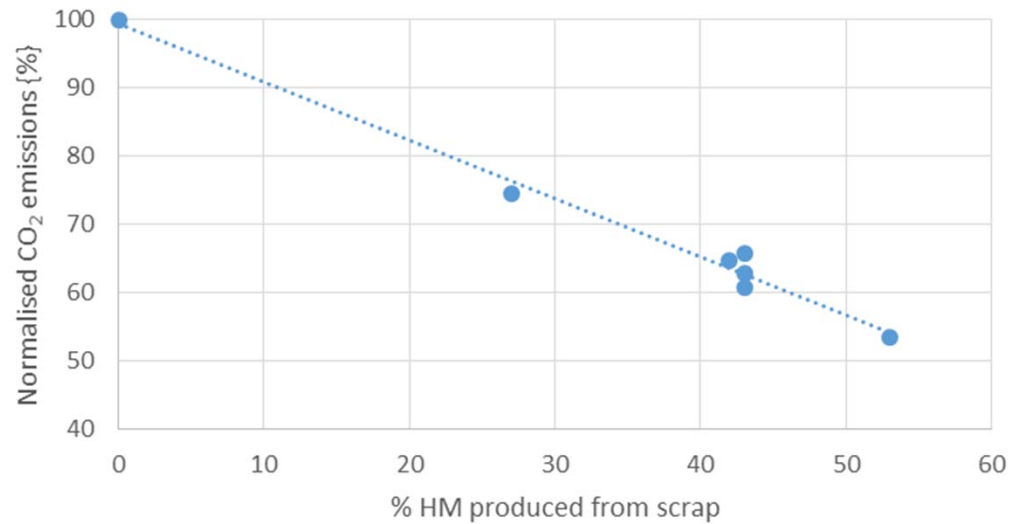
2017 - 2018

- Target:
 - Demonstrate CO₂ reduction of 35% without CCS
 - Use of 40% sustainable biomass
 - Use of 35% scrap
- Biomass:
 - Charcoal
 - Low ash, low density
 - Injected through 1 coal injection lance
- Scrap:
 - Shredded scrap and punching(s)
 - Semi-continuous feeding under gravity

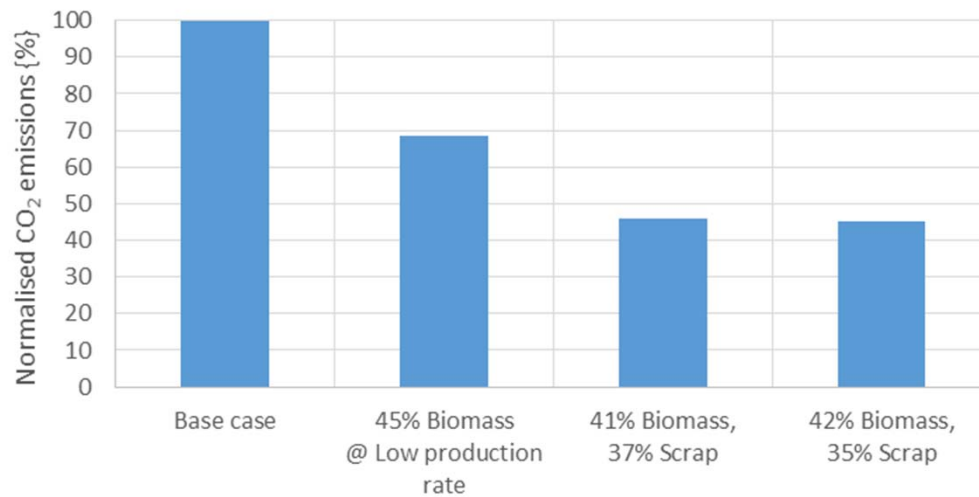


Hisarna Process – Use of Scrap Steel & Biomass

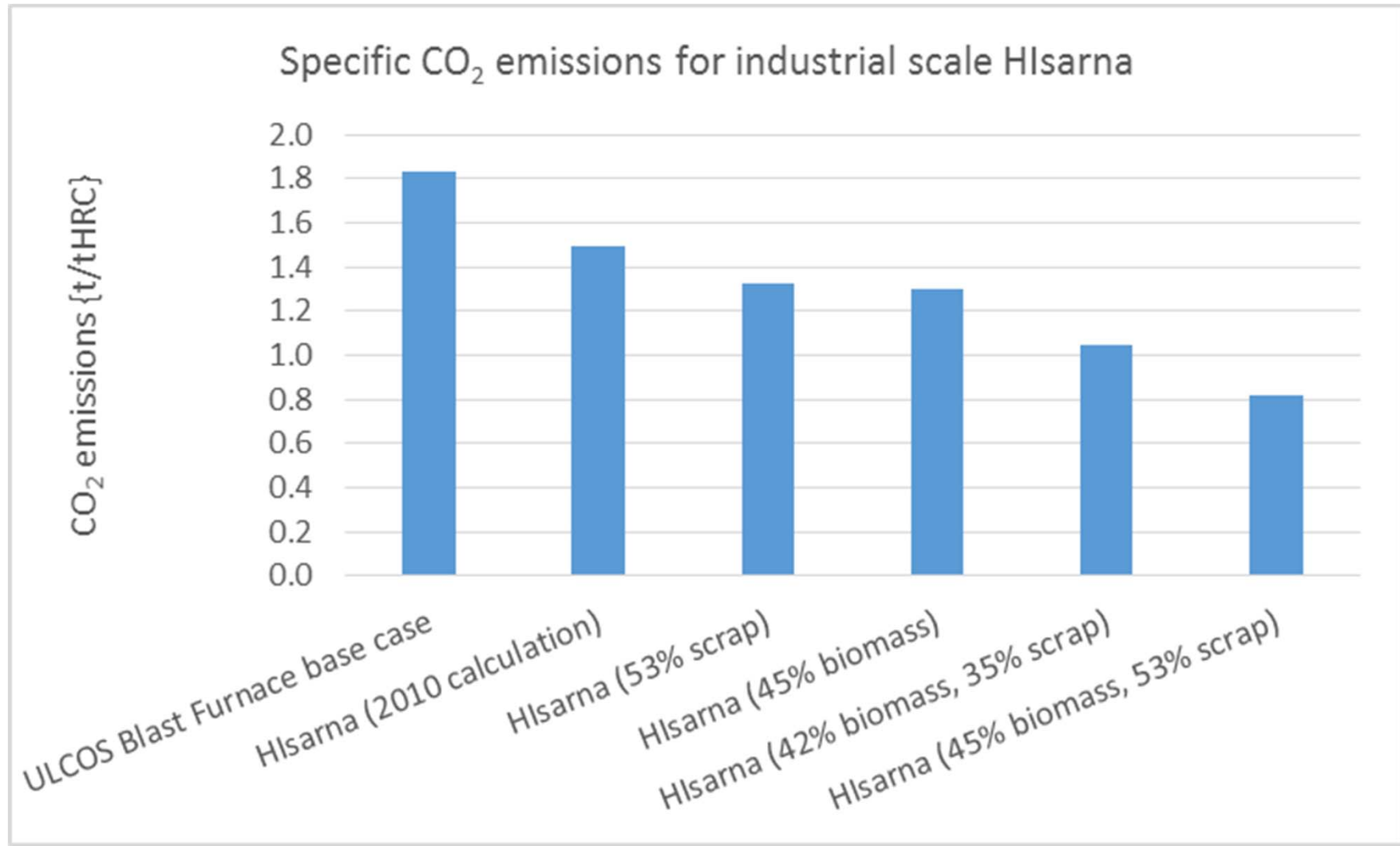
Hisarna pilot plant - effect of scrap on CO₂ emissions



Hisarna pilot plant - Effect of biomass and scrap on CO₂ emissions



Hlsarna CO₂ benchmark calculations



The Hisarna Pilot Plant – On-going Focus

- Current experimental work in pilot plant:
 - Funding from the Dutch Government via DEI (Demonstratie Energie Innovatie)
- Focus on operational & equipment aspects
 - Testing equipment endurance
 - Demonstrating long term process stability
- Further technology development:
 - Recycling of galvanised steel scrap
 - Recovery of Zn (circular economy)
 - CO₂ capture at the pilot plant
 - Demonstration plant engineering studies

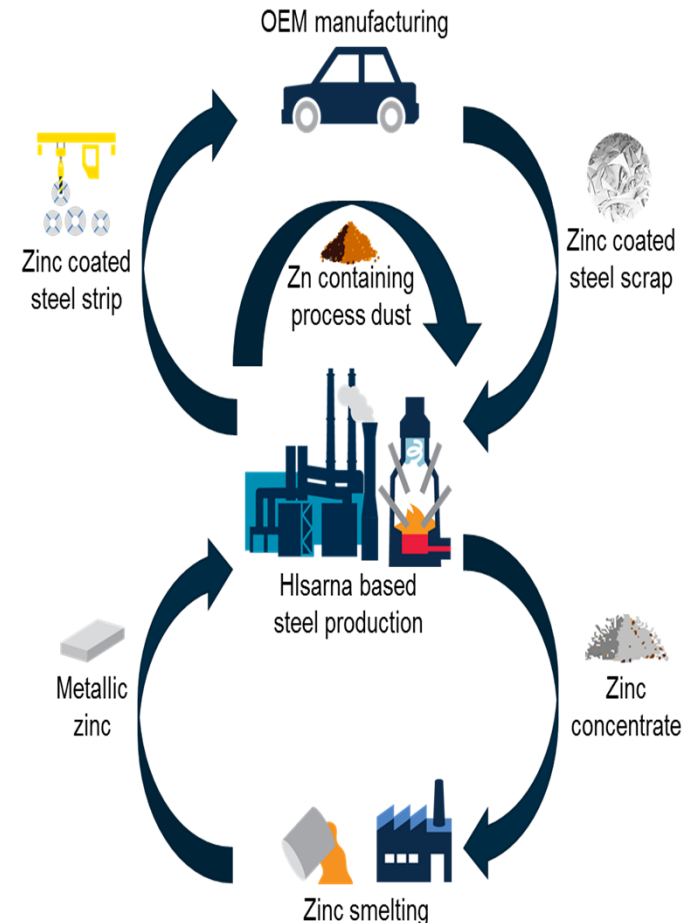


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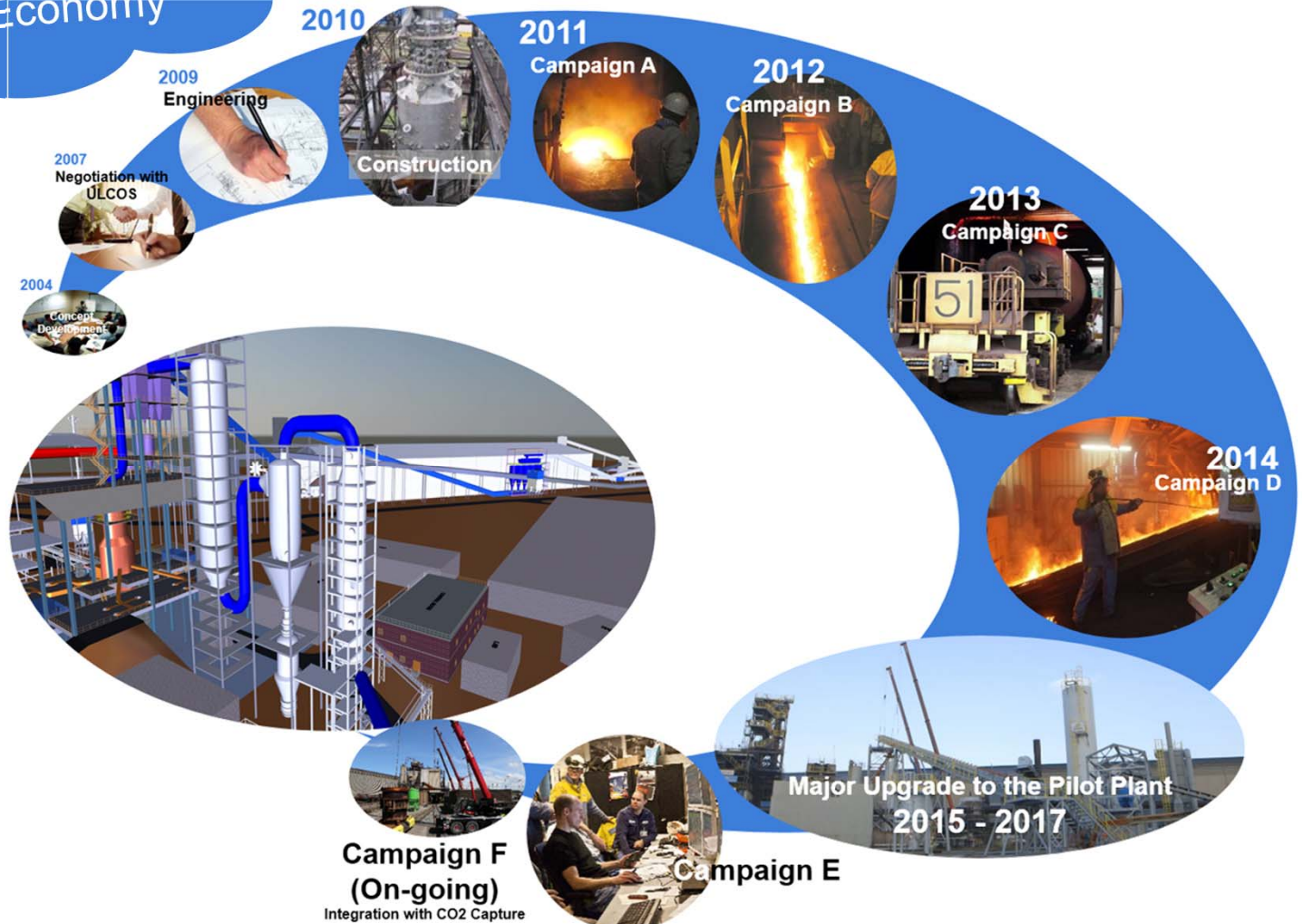


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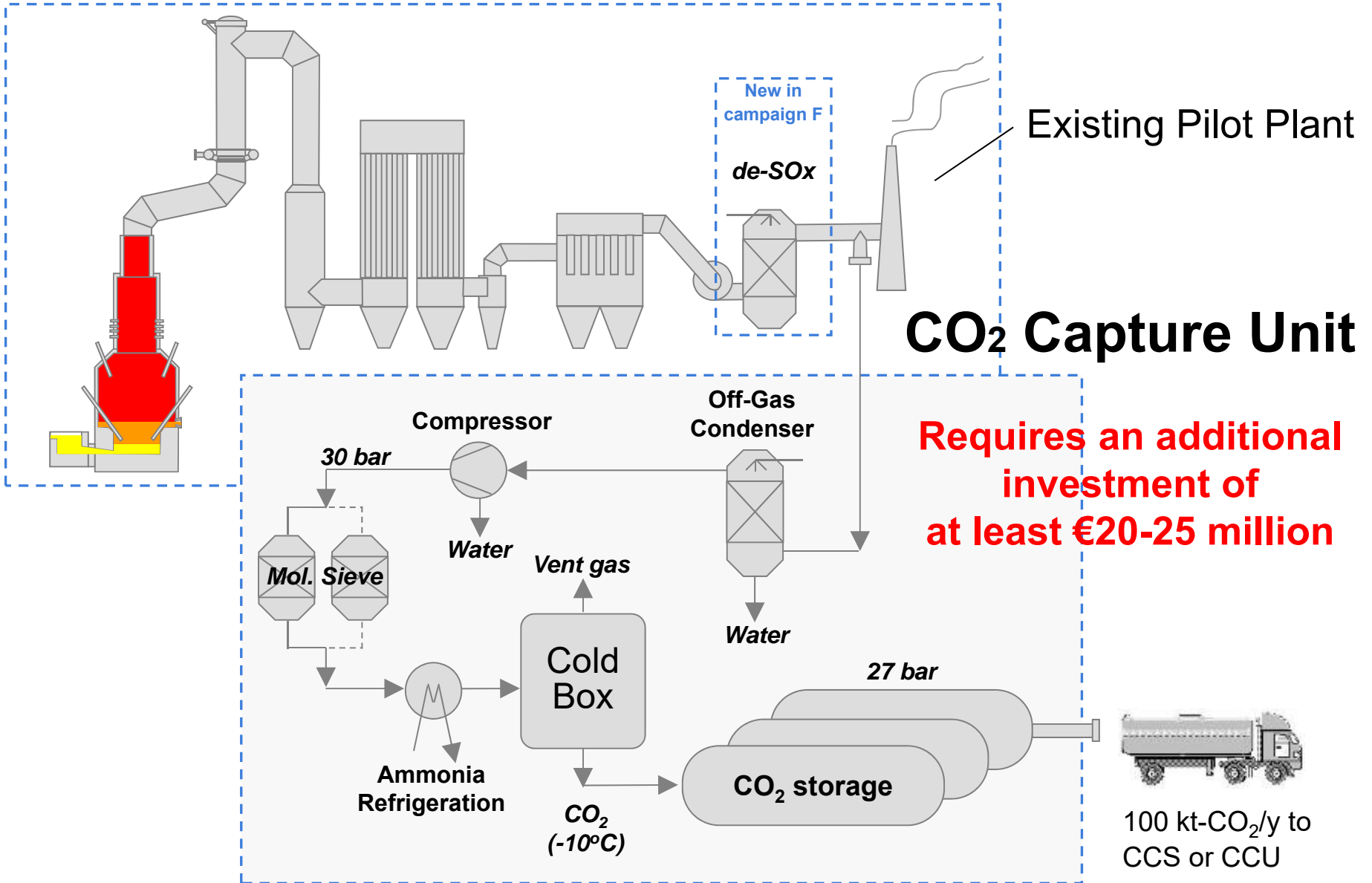


The Hlsarna Journey Continues...

CCS, CCU & Pilot Plant,
Circular Economy



Next Step: Realising Hisarna Pilot Plant w / CO₂ Capture

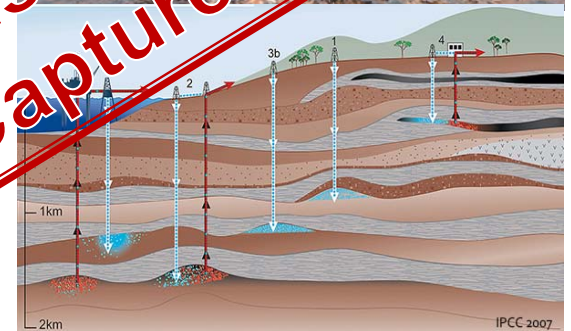
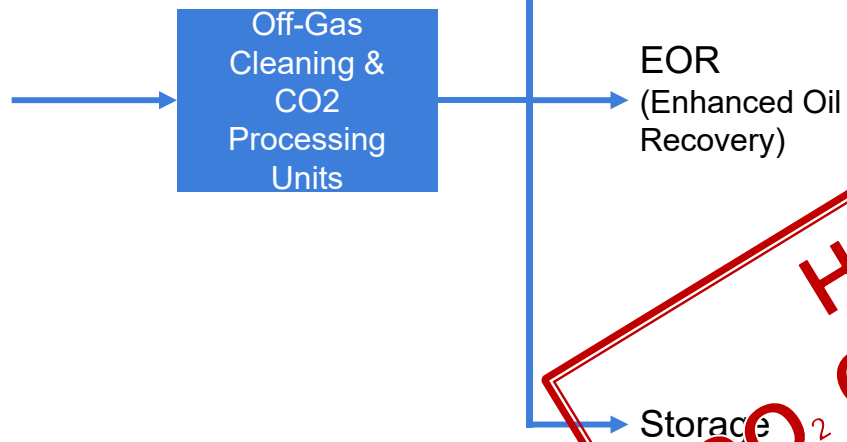


CO₂ capture and storage



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

- Cost of Capture (Processing of CO₂) could be in the range of 10 - 20 €/t CO₂
- Dependent on CO₂ Specifications (i.e. Purity)

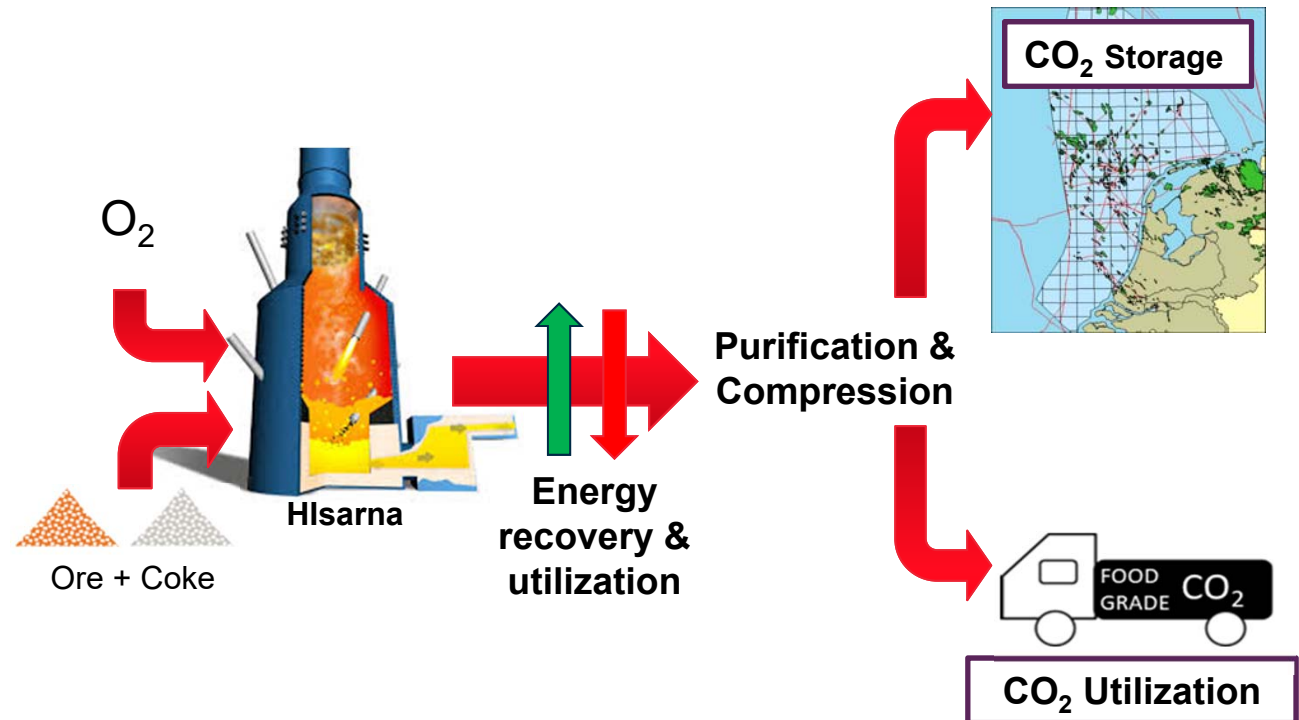


Hisarna is CO₂ Capture Ready!

Realizing the CCUS Value Chain for the Large Scale Hisarna Demonstration Project

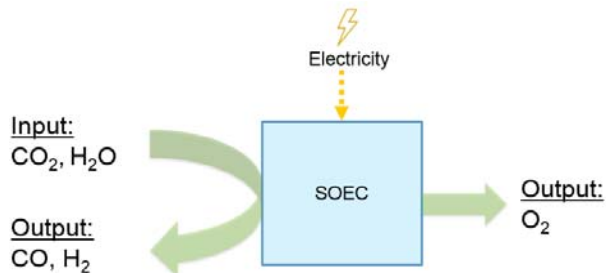
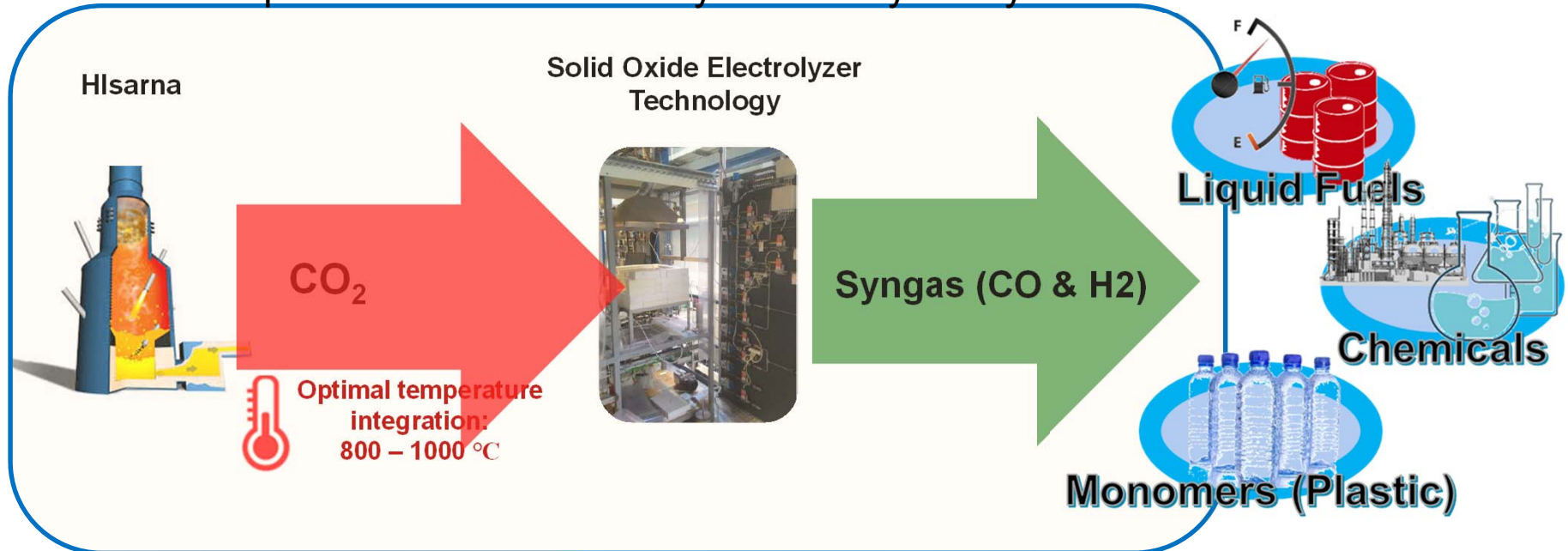
Activities in this project:

- Impacts of impurities on the CCUS chain
- Optimal utilization of the Hisarna off-gas thermal energy
 - CO₂ utilization
 - and/or steam/power generation
- Assessment of CO₂ storage options



Integration of CO₂ Utilization with Hlsarna

Scope of Work – Preliminary Feasibility Study



Aim to take advantage of the available waste heat and highly concentrated CO₂

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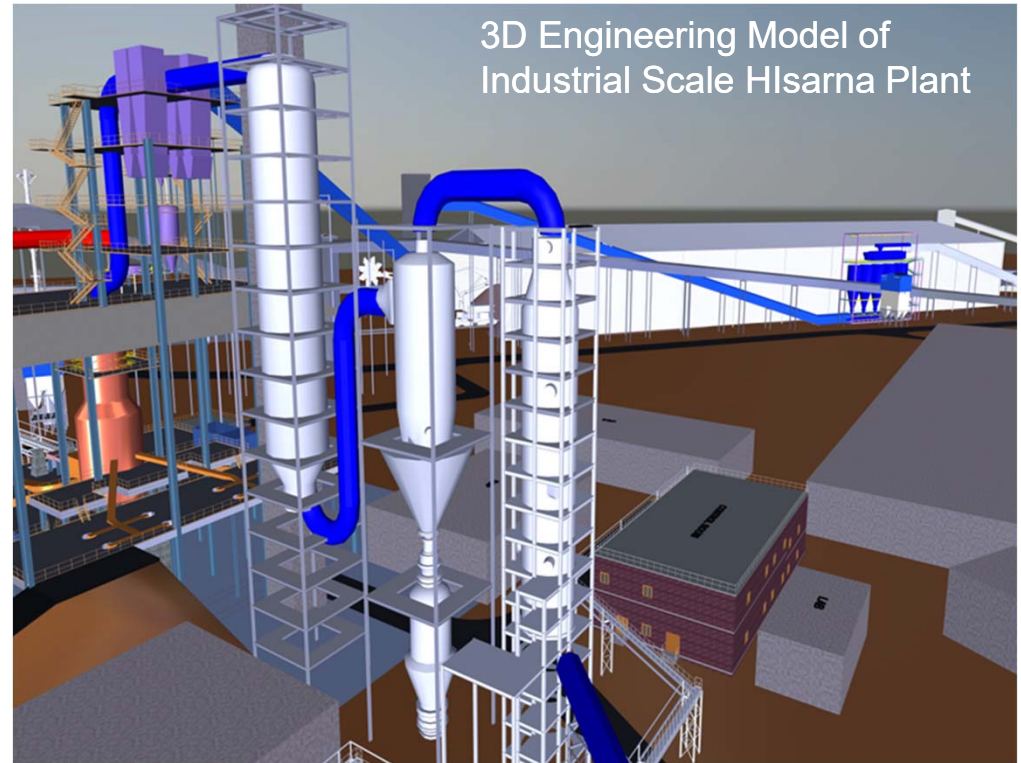
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Scaling-up to the 1st Demonstration Plant

The Final Goal

- Conceptual Engineering for industrial demonstration scale has started.
- A demonstration plant of industrial size (0.5 – 1.0 M thm/y) will require an investment of 300 -350 M€*
- 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



* Only the Ironmaking Process - Excluding CO₂ Capture & Storage and associated Air Separation Unit

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Concluding Remarks

- Hlsarna is a breakthrough technology for ironmaking offering both economic and environmental benefits
- The environmental benefits include
 - At least 20% reduction of CO₂ emissions without CCS/CCU
 - At least 50% reduction of CO₂ emissions with scrap & biomass
 - At least 80% reduction of CO₂ with CCS/CCU (CO₂ Capture Ready!!!)
 - Contributes towards circular economy
- Pilot plant campaigns have confirmed its technical and economic potential
- Conceptual engineering for large scale demo plant, 0.5 to 1.0 M t/y, has started
- Substantial investment is still required to realise Hlsarna into a game changer technology to reduce CO₂ emissions.
- This needs better funding mechanism (Dutch Government and EU) to support large scale demonstration of breakthrough technology. Bankability is an important keyword!

Key Take Away Messages ...

(Hlsarna Pilot Plant – Commitment, Achievement and Future Perspective)

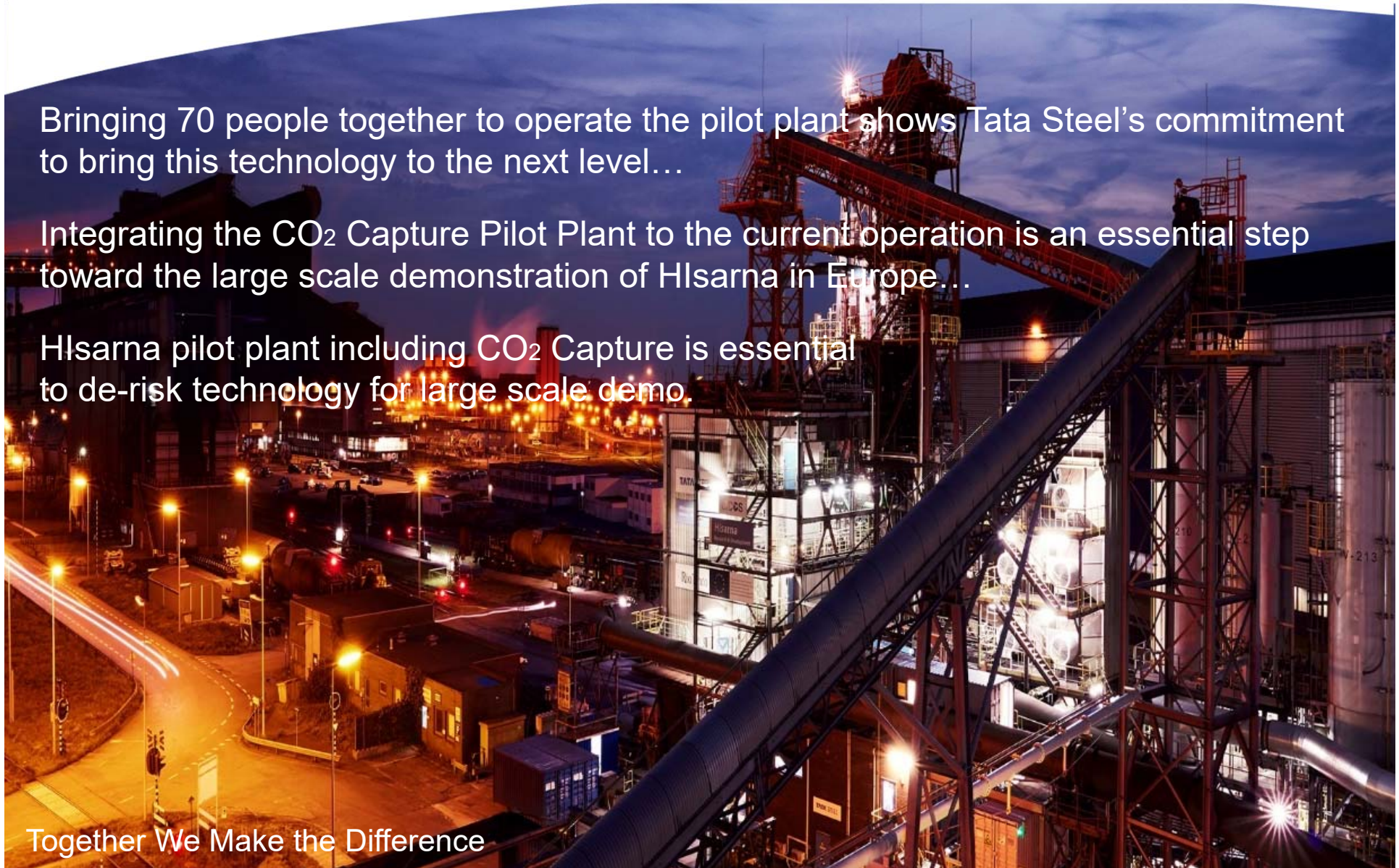


Bringing 70 people together to operate the pilot plant shows Tata Steel's commitment to bring this technology to the next level...

Integrating the CO₂ Capture Pilot Plant to the current operation is an essential step toward the large scale demonstration of Hlsarna in Europe...

Hlsarna pilot plant including CO₂ Capture is essential to de-risk technology for large scale demo.

Together We Make the Difference



Acknowledgement

The authors wish to acknowledge that this work was carried out with financial grants from the European Community and Dutch Ministry of Economic Affairs



Partners...



Technology...

Pilot Plant...

People...



Together We Make the Difference

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