

A large industrial building with a blue sky background. The building has 'HYBRIT' written vertically on its side and 'FOSSIL-FREE STEEL' on a lower section. A tall chimney is visible on the right side of the building.

# HYBRIT pilot scale

Gunilla Hyllander  
General Manager Hybrit Development AB

**HYBRIT**  
▶▶▶ FOSSIL-FREE STEEL

A JOINT VENTURE BETWEEN SSAB, LKAB AND VATTENFALL



**SSAB**

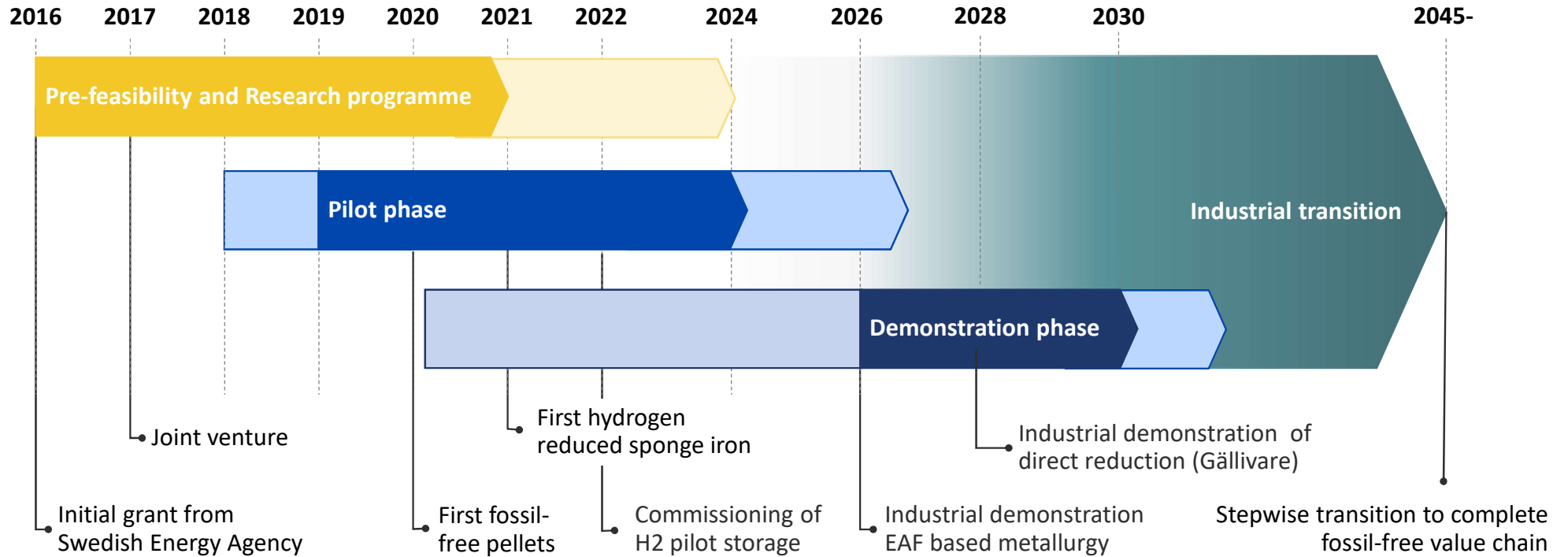
**LKAB**

**VATTENFALL**

**HYdrogen BREakthrough IRonmaking  
TEchnology**

**for a fossil-free future**

# HYBRIT timeline - From technical development to industrial transition



# Verification across the value chain - From ore to steel



IOP production with bio-oil

Malmberget  
Industrial scale

A large, cylindrical industrial silo with a complex network of pipes and ladders. The silo has the HYBRIT logo and 'FOSSIL-FREE STEEL' written on it.

H<sub>2</sub> sponge iron production

Luleå  
Capacity 1 ton/h

A modern, multi-story industrial building with a blue facade and the HYBRIT logo on the side.

Hydrogen production

Luleå  
Capacity 910 m<sup>3</sup>/h

Industrial equipment for hydrogen production, including large cylindrical tanks and complex piping.

Hydrogen storage in lined rock cavern

Luleå  
Volyme 100 m<sup>3</sup>

An entrance to a rock cavern, showing a large opening in a rocky cliff face with some equipment and a person nearby.

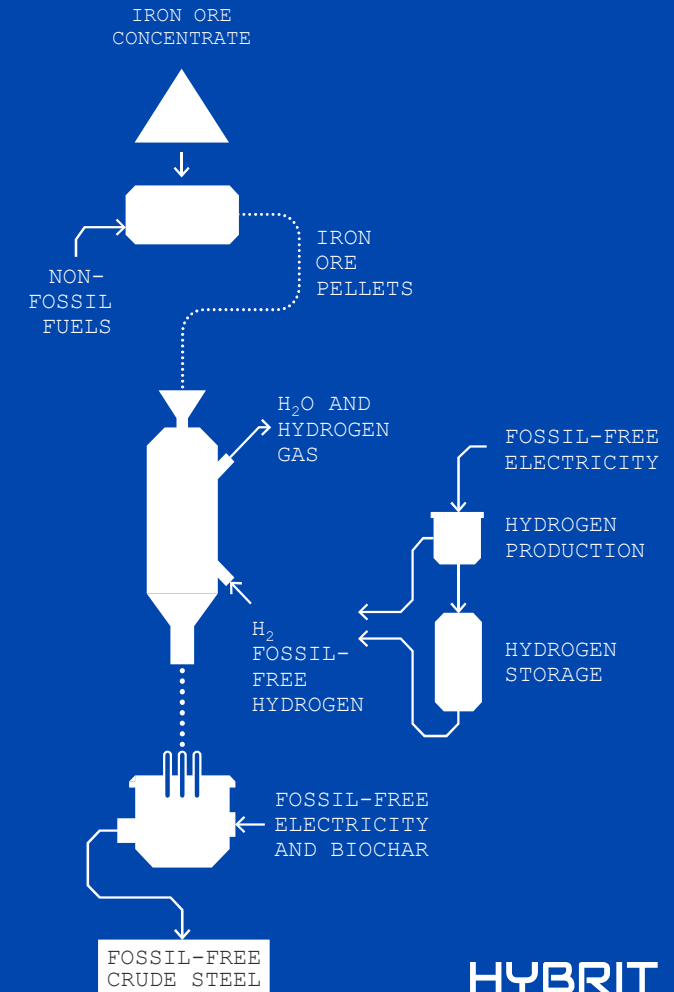
Melting in electric arc furnace

Luleå  
Batchwise 10 tons

An industrial electric arc furnace with bright orange light emanating from the top, indicating the melting process.

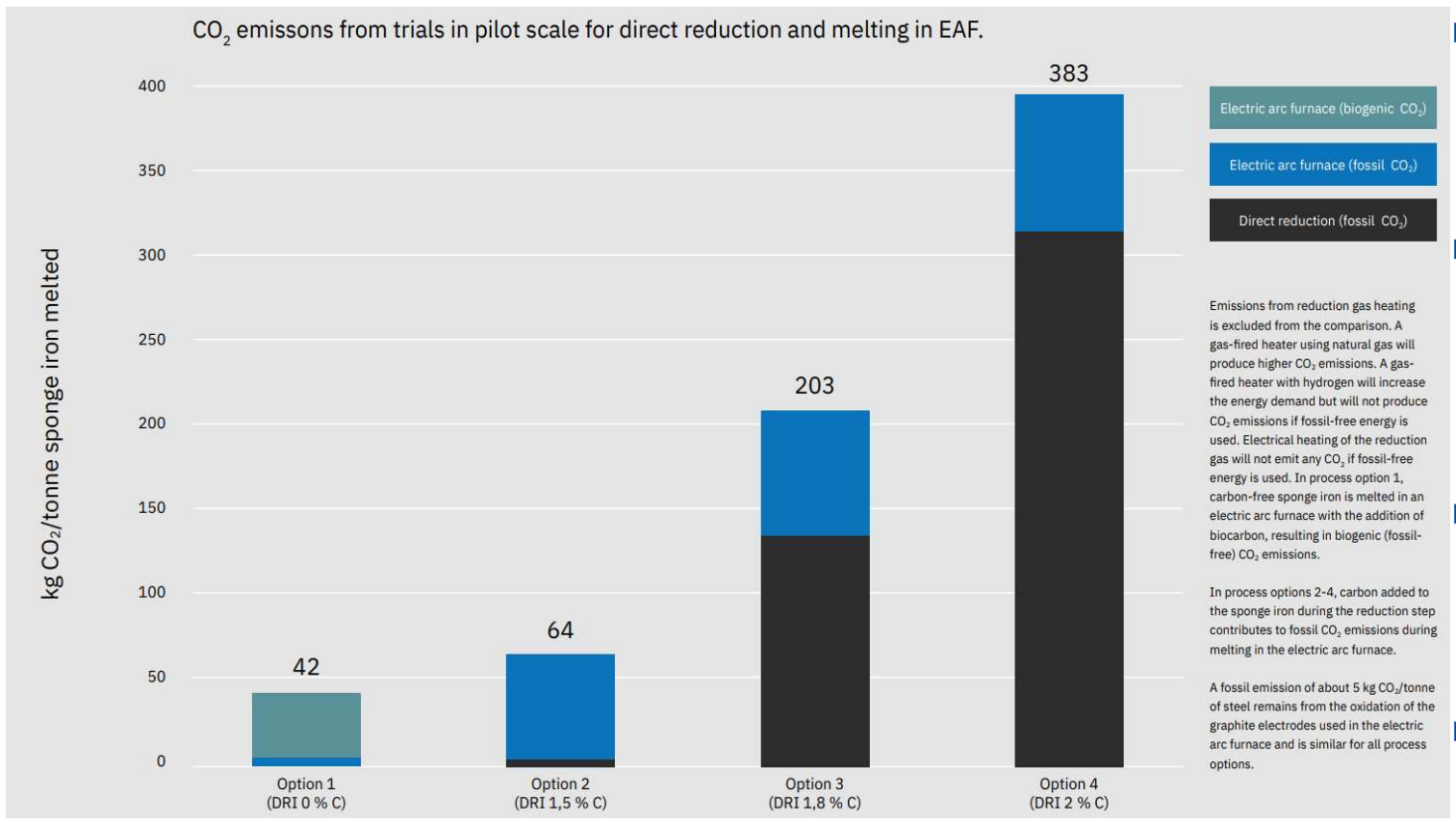
# Verified development at each step

- ▶ Fossil-free production of iron ore pellets
- ▶ Hydrogen-based direct reduction on a semi-industrial scale
- ▶ Provides a competitive iron and steel value chain
- ▶ Melting of fossil-free iron raw material in an electric arc furnace in co-operation with Swerim
- ▶ Hydrogen production and storage
- ▶ Industrial process practice established
- ▶ Innovation on time and within budget



# HYBRIT makes fossil-free iron and steel a reality

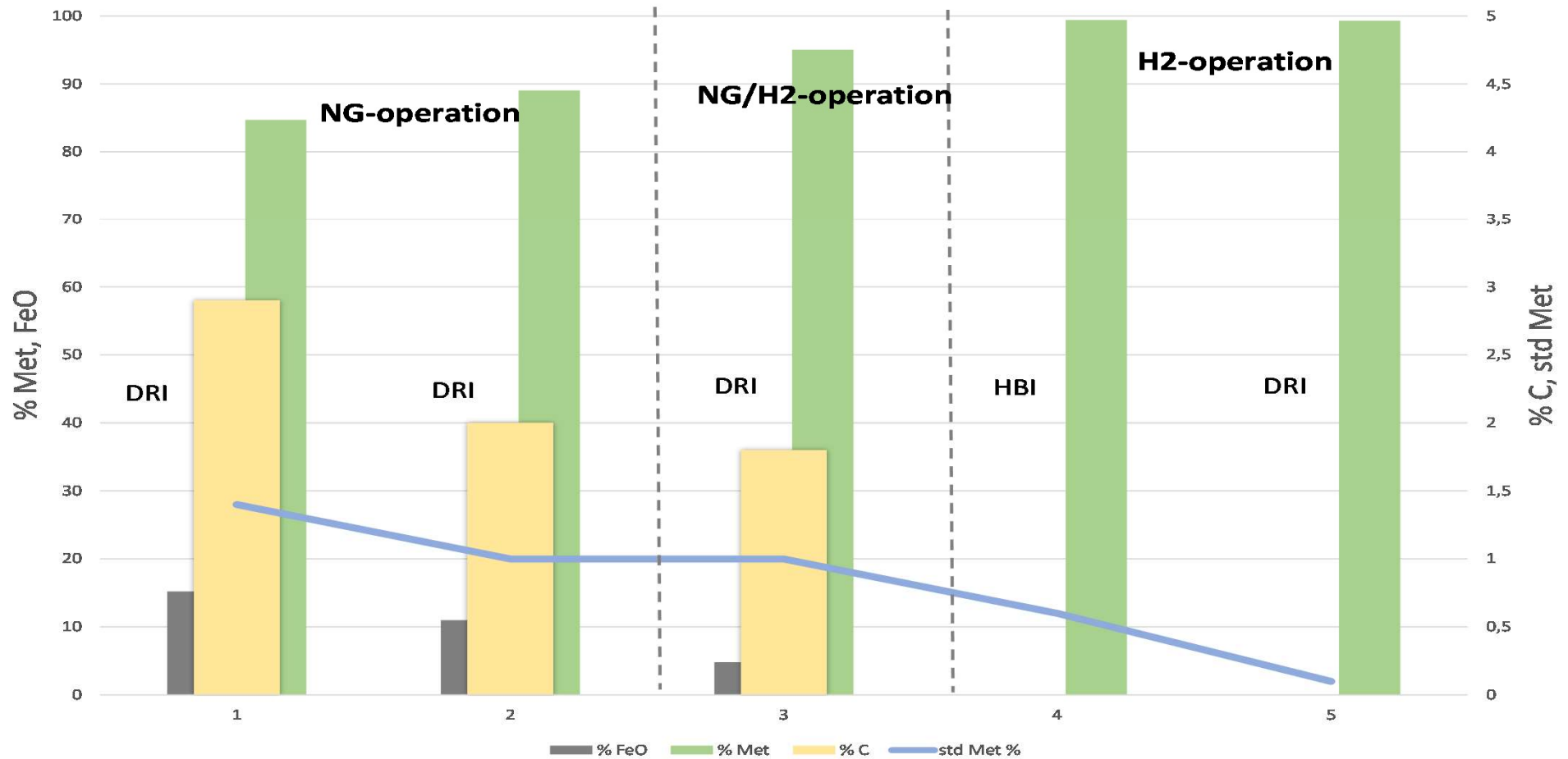
As a reference: State-of-the-art blast furnace process emits ~1,6 ton CO<sub>2</sub> / ton steel



- ▶ 1. Direct reduction of iron ore pellets using hydrogen only. **This is the main option of the HYBRIT process.**
- ▶ 2. Direct reduction of iron ore pellets using hydrogen only, but the sponge iron is carburised after the reduction step.
- ▶ 3. Direct reduction of iron ore pellets using mainly hydrogen and some natural gas during the reduction process
- ▶ 4. Direct reduction of iron ore pellets using conventional technology based on natural gas.

Emissions from reduction gas heating is excluded from the comparison.

# Hydrogen content during reduction - affects pilot DRI product quality



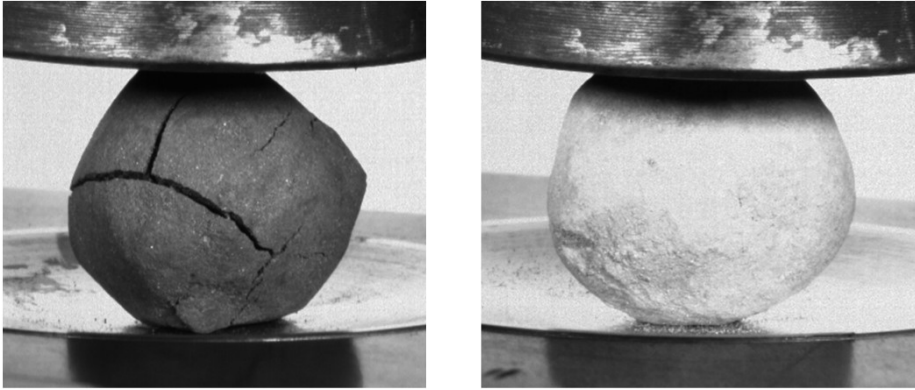
# New sponge iron product with unique properties

Sponge iron pellets reduced with hydrogen have significantly better transport, storage and melting properties compared to sponge iron reduced with conventional natural gas-based processes.

- ▶ Low iron oxide content and 0% carbon give the sponge iron robust mechanical properties.
- ▶ Tests also show that the product has very good and stable chemical properties.
- ▶ A high degree of metallisation (98-99%) means that there is very little iron oxide remaining.

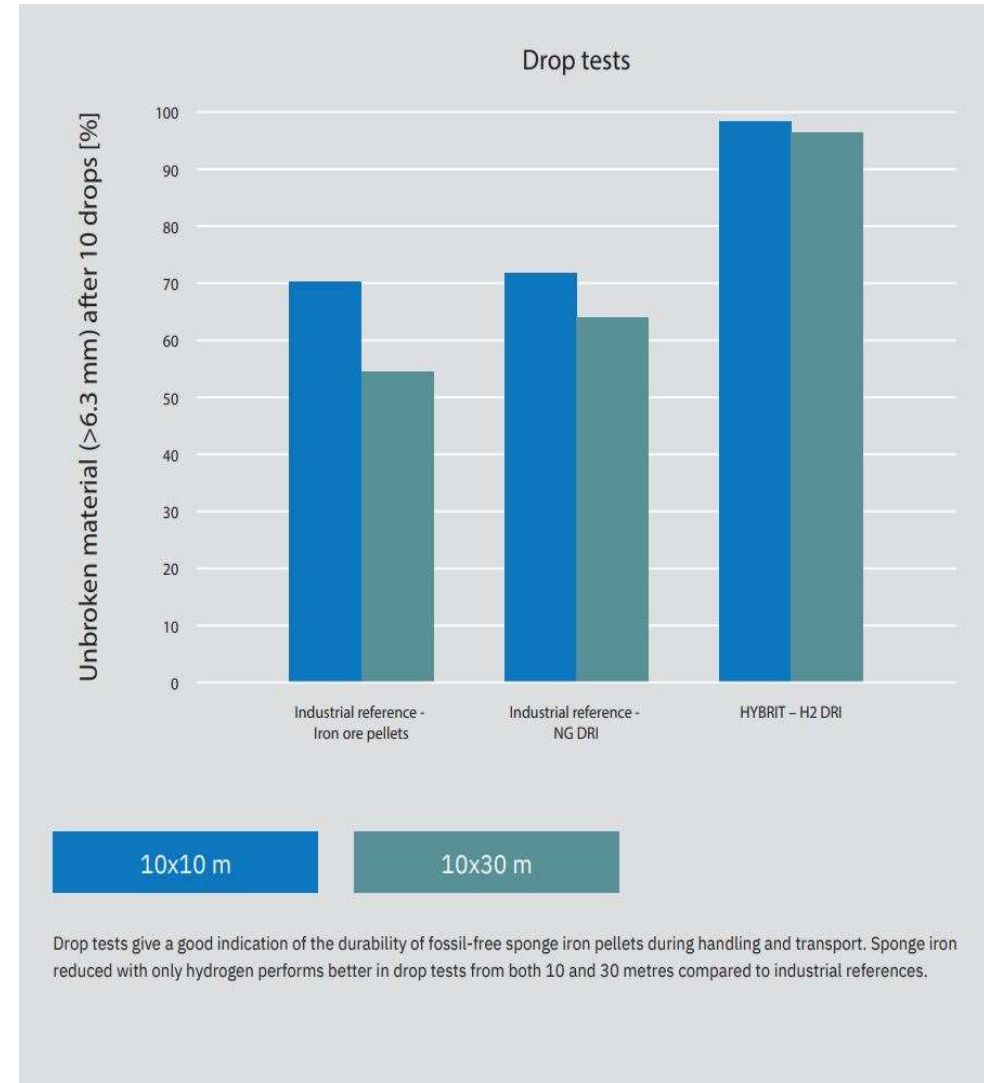


# DRI properties



Sponge iron pellets reduced with hydrogen have a high degree of metallisation (98-99%) and can have 0% carbon.

Measurements show that they have higher compressive strength than pellets produced with natural gas. They also shows high mechanical strength in drop tests.



# The main results of the project

Technology that enables  
efficient fossil-free  
steel production

0.0

Ton CO<sub>2</sub>e / tons of steel\*

- ▶ Validated through pilot scale trials throughout the value chain
- ▶ A new sponge iron product with unique properties
- ▶ Stepwise industrialisation within the owner companies starting in 2026

\* The process produces small emissions of carbon dioxide from the consumption of graphite electrodes and the addition of slag formers in the electric arc furnace. These emissions are less than 0.05 tonnes of CO<sub>2</sub>e/tonne of steel which is rounded to 0.0 tonnes of CO<sub>2</sub>e/tonne of steel. Typical value for ore-based steelmaking with blast furnace technology is 2.2 tonnes CO<sub>2</sub>e/tonne of steel.



# INCITE visiting HYBRIT pilot plants in Luleå 20240913

