

# **EU-Latin America Dialogue on Raw Materials**

## **Swerea MEFOS**

**– a metallurgical research institute suited to meet future  
demands from the modern society**

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# Swerea MEFOS: Less risks...

- **Top class pilot plant facilities** combined with strong simulation tools and advanced measurement techniques
  - Unique site and equipment
  - Independence and confidentiality
- **Powerful research teams** on international level with industrial and academic experience
  - “from raw material to shaped metal”
  - 60 researchers/experts + 27 skilled operators
  - Large scale pilot trials
  - Metallurgical processes
  - Process integration
  - Burner and furnace technology
- **International networks** to influence and to become influenced
  - National
  - Europe > ESTEP, RIES, A.SPIRE, EU Steel Industry(HLG), EIP, KIC, CRM Innonet, ETP-SMR
  - Global > International clients/partners/academia, WSA, IN, PRC, JP, AUS, CA,



# Swerea MEFOS





# Our people

## Industrial experience

16 experts 10+ years of industrial experience

## Post graduates

4 professors, 18 PhD

## We are

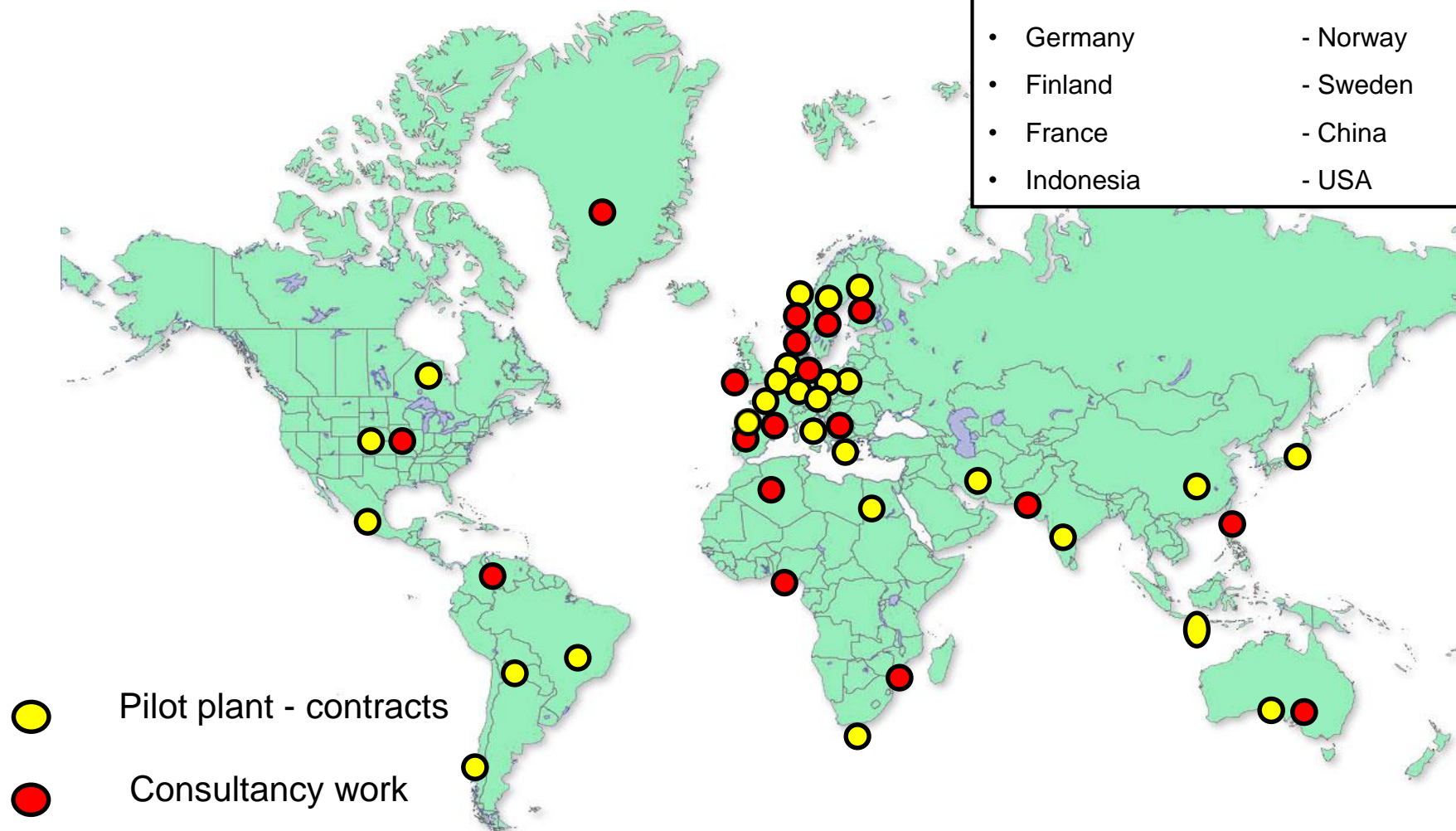
64 metallurgists/project managers  
23 engineers, technicians  
13 IT, market, econ., admin



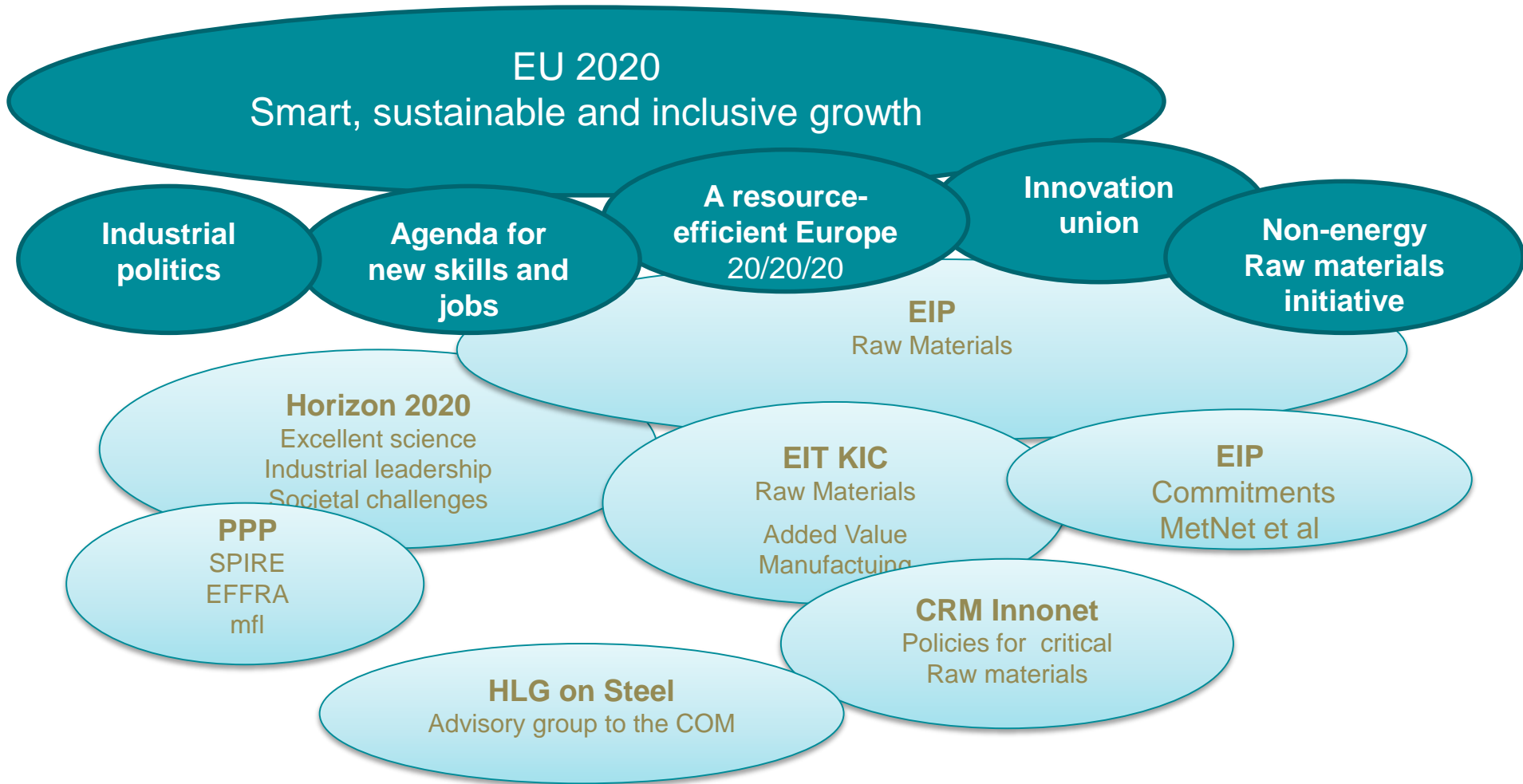
# Multinational activities

## Contracts 2009–2013

- Brazil
- Denmark
- Germany
- Finland
- France
- Indonesia
- Japan
- Canada
- Norway
- Sweden
- China
- USA



# ....and in Europe





# The pilot plants





# LKAB EXPERIMENTAL BLAST FURNACE



Volume: 8,2 m<sup>3</sup>

Hearth diameter: 1,2 m

Production/day: 36 ton

Height: 14 m

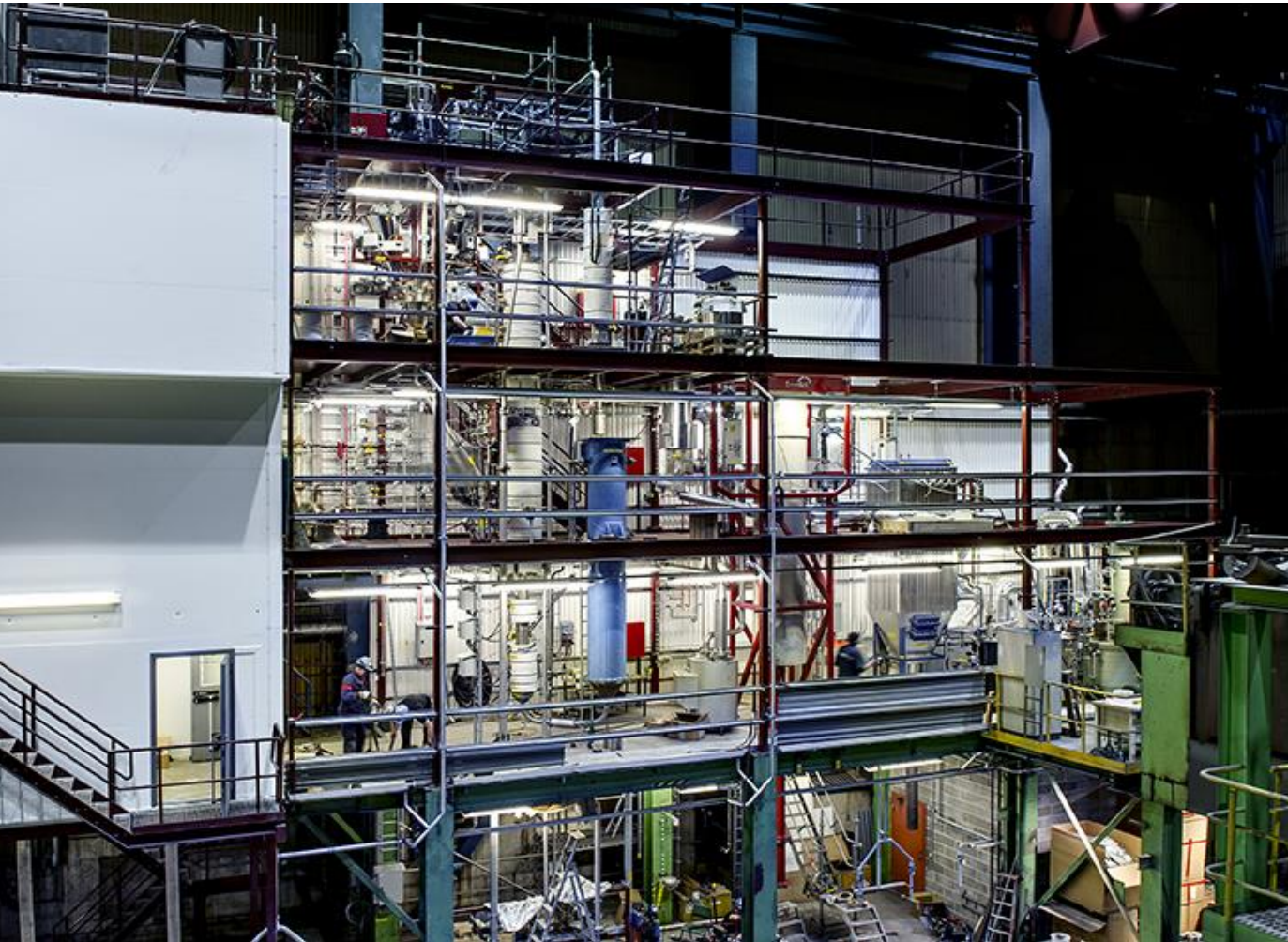
Blast temperature: 1200°C

Red. agent consumption:  
510 kg/ton HM

HM composition:  
4,1-4,7% C; 0,6–1,2% Si;  
0,03-0,1% S



# Fluid Bed Pilot Reactor



- **Calcination**
- **Drying**
- **Reduction**
- **Roasting**
- **Gasification**
- **Catalytic combustion**

A photograph of a male worker in profile, wearing a white hard hat with the name 'Sten Angström' on it, and a dark blue safety jacket with orange accents. He is looking towards a large industrial machine on the left. A very bright, intense light source, possibly a laser or a high-temperature process, is visible within the machine, creating a large, glowing white area. The background is dark and filled with various cables and industrial components.

# Challenges.....



# Challenges

## Raw materials

- More complex raw materials
- Lower grades
- Fluctuating raw material quality

## Energy

- Renewable energy
- Need for recovery of low grade energy

## Environment

- More strict regulations
- New areas of regulation

## Costs

- Increased global competition



# Opportunity – Waste

Waste occurs in many forms



Industrial waste

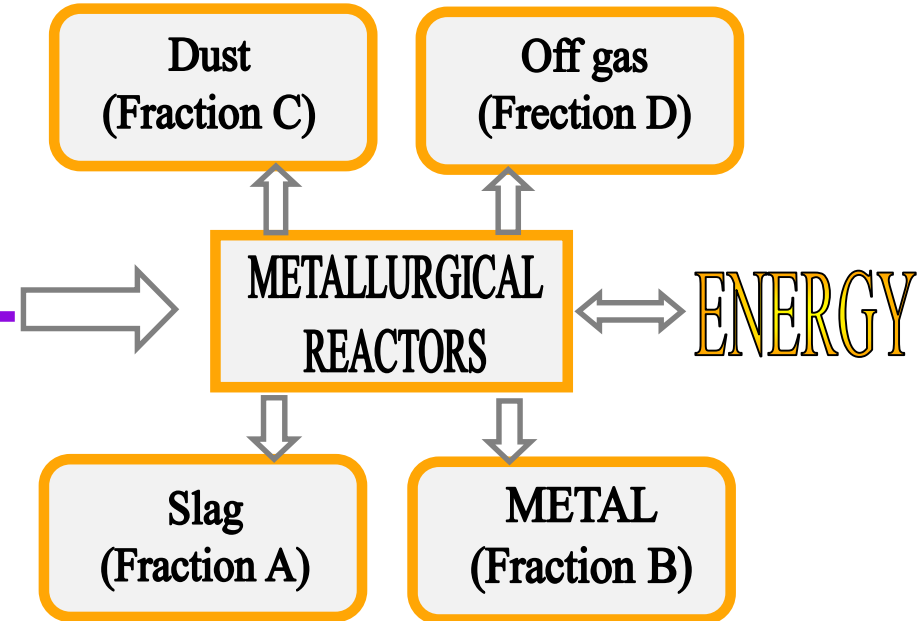


You and me



# Recycling

Processing secondary materials using metallurgical principles and reactors

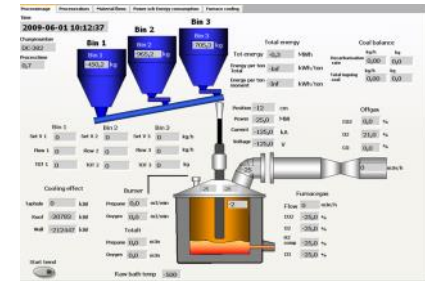


A:  $\text{CaO}$ ,  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{MgO}$ ...

B:  $\text{NiO}$ ,  $\text{FeO}$ ,  $\text{MnO}$ ,  $\text{V}_2\text{O}_3$ ,  $\text{Cr}_2\text{O}_3$ ,  $\text{P}_2\text{O}_5$ ,  
 $\text{Cu}$ ,  $\text{Co}$ ,  $\text{Mo}$ ..PM, PGM's

C:  $\text{ZnO}$ ,  $\text{PbO}$ ,  $\text{Na}$ ,  $\text{K}$ ,  $\text{Cl}$ ,  $\text{Cd}$ ,  $\text{Hg}$

D: C-H-O, plastics/textile/fluff





Heat size	ca 5 tonnes
Furnace shell diameter	2.6 m
Furnace inner diameter, lined	1.8 m
Electrode diameter	250 mm
Inner hole diameter	70 mm

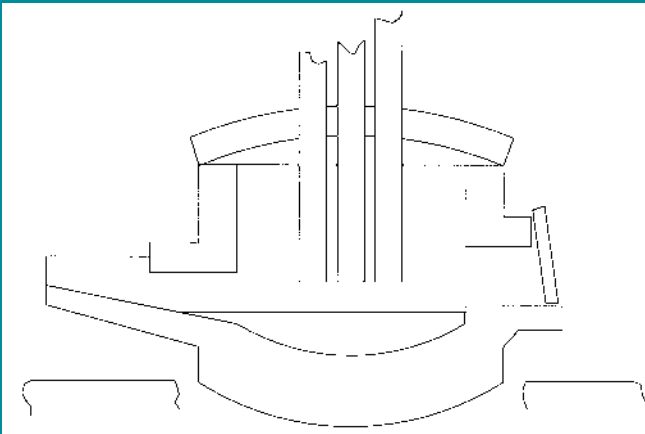
- ☐ Titania slag smelting from ilmenite
- ☐ V- and Fe- extraction from V-Ti rich iron ore concentrate
- ☐ IPBM- process (processing of wastes and residues)
- ☐ VILD-process (recovery of vanadium from steel slag)
- ☐ FeVMn slag processing,
- ☐ Zn recovery from EAF dust
- ☐ FeCrNi recovery from steel industry byproduct
- ☐ Direct medium carbon ferroalloys
- ☐ Mn-slag production from residue
- ☐ Silicon processes
- ☐ FeNi from Ni-ore and dust
- ☐ FeNiMo/V<sub>2</sub>O<sub>3</sub> catalyst smelting
- ☐ AshArc – treatment of flyash
- ☐ Organic wastes,



# The EAF

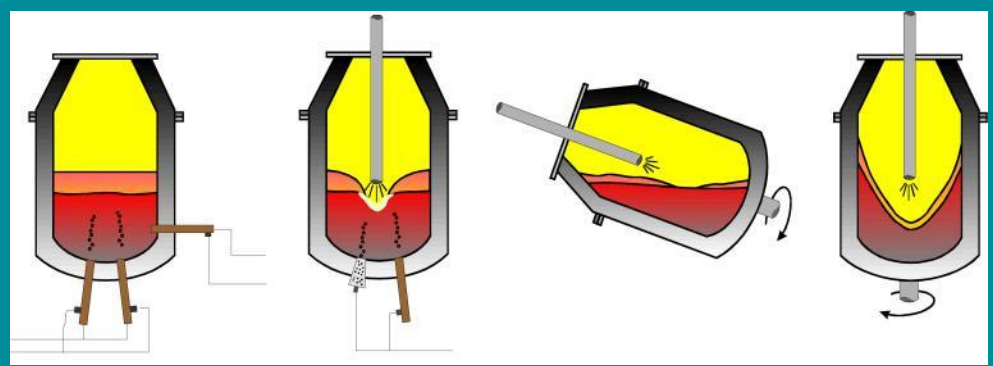


- FeVMn from slag
- Mn-steel
- FeTi
- FeNi
- Catalyst smelting
- EAF dust recycling
- Dioxin/NOx control



Heat size	12 tonnes
Transformer	4.9 MVA
Furnace shell diameter	2.8 m
Furnace diameter, lined	2.1 m
Electrode diameter	250 mm
Oxy fuel burner	

# Universal converter



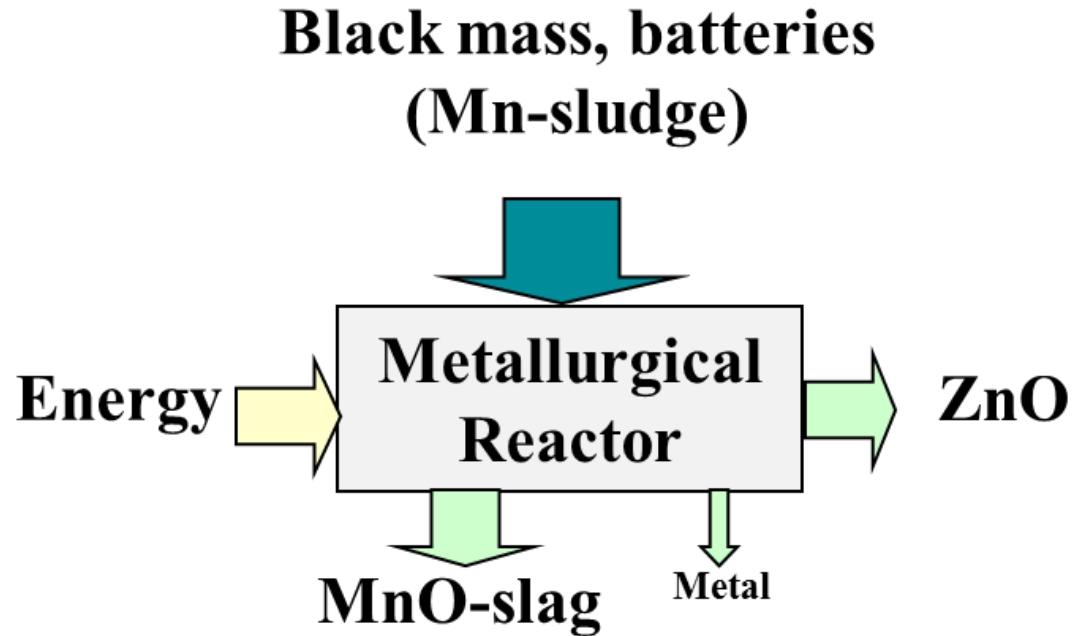
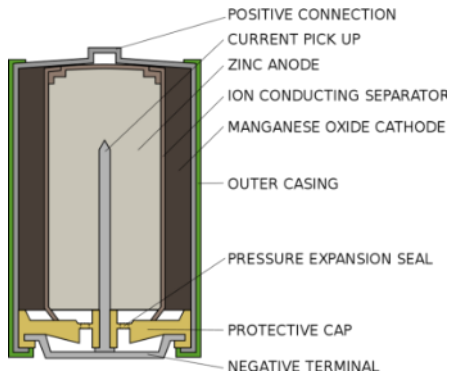
- All kinds of converter processes
- Kaldo process
- MCFeMn by deC
- Mn-steel process
- Clinkering of Mn-sludge
- Coal gasification
- Mineral smelting (Pb-Zn)
- Wastes from metal industry
- Al recovery from dross
- Destruction of liquid hazardous chemicals

Heat size	6 tonnes
Rotating speed	6-30 rpm
Furnace diameter, unlined	2.0 m
Furnace diameter, lined	1.0-1.4 m
Furnace volume, lined	3.8 m <sup>3</sup>
Oxygen gas flow	0.5 m <sup>3</sup> n/sec
Propane/Oxy fuel burner	



# Recycling – example of a “new” process

Recovery of Zn and Mn from spent alkaline batteries and Mn-sludge



# Challenges of wastes

Dust

Sludge

Slag

Spent refractory

Mill scale

Scarfings

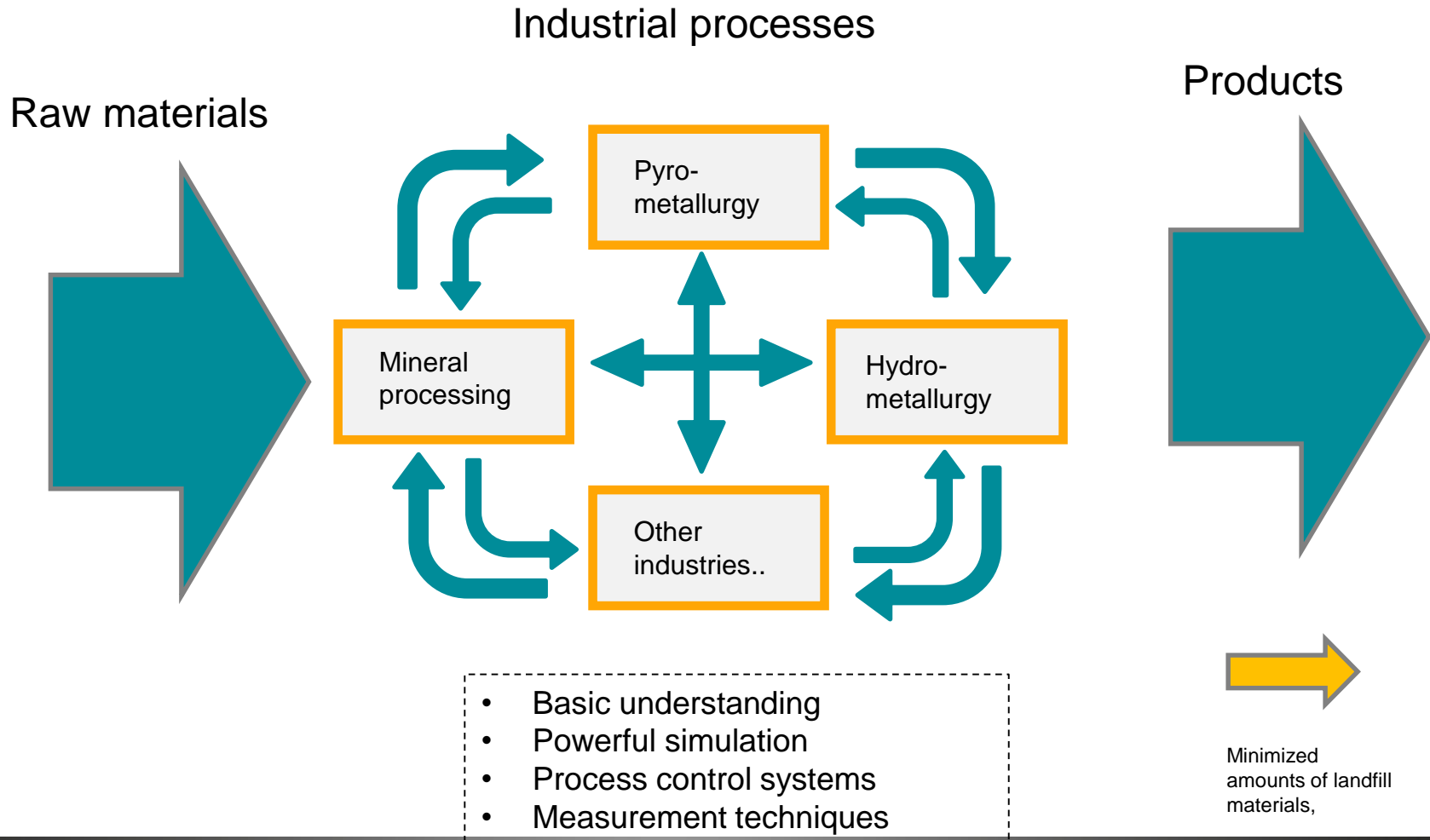


Pretreatment and processing of the waste material necessary for a efficient recycling.

- analysis of the chemical and physical properties
- analysis of technological properties
- analysis of needed processing



# Process Integration – system analysis



# Recycling of BOF slag in steel production

**Slag rate increased  
but limestone rate**

***Is reduced***

Coal/coke

**BOF slag  
recycling  
increased**

***P limit is maintained***

*BF pellet*

HM

**LS**

### Steel slab

Allow **higher P** in hot metal with higher BOF slag additions

## Reduce the dolomitic lime rate to improve P-removal



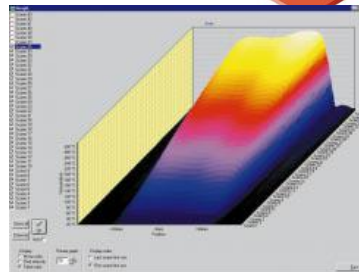
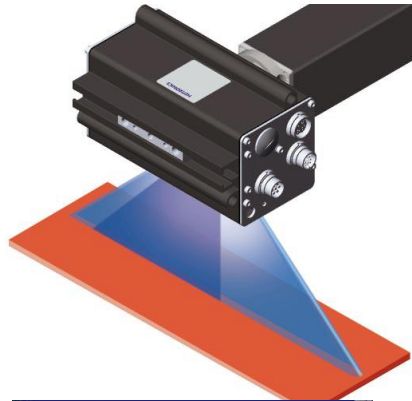
# Measurement

## Furnaces

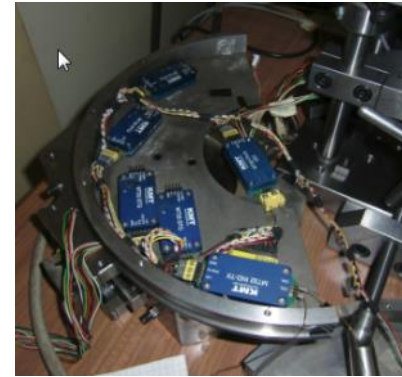


- Measurements/ tests of:
- Temperature
  - Atmosphere
  - Burners, type/ efficiency
  - Scaling
  - Fuels

IR pyrometer with  
line-scanner 250  
points every second

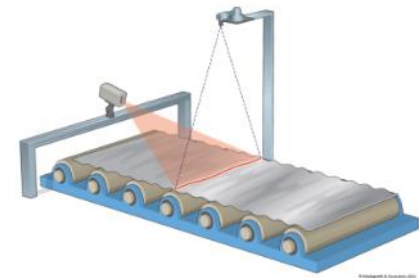


## Rolling mills, Forging, Straightener



Measurements of:

- Process parameters: Loads, Forces, Moments etc.
- Temperature
- Dimensions
- Friction
- Roll gap
- Flatness



### Process Control

Labview, Matlab

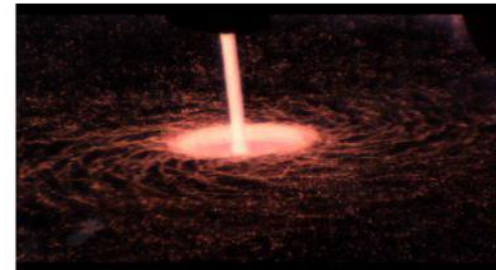
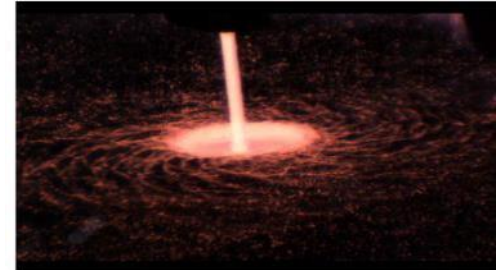
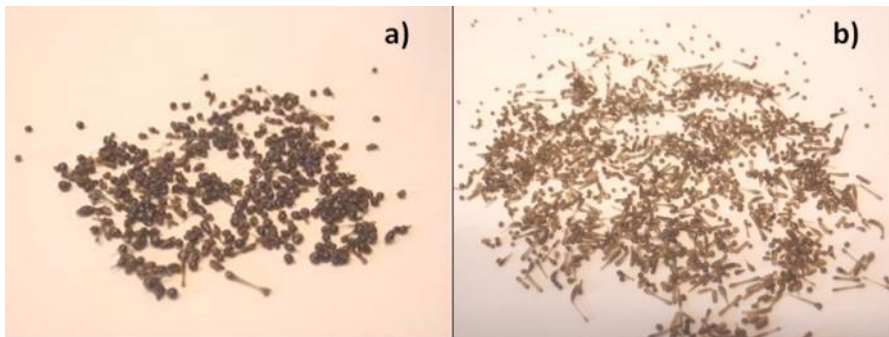
Signal analysis, data handling etc.

# Example - Energy and Environment

## Dry granulation of BF-slag with rotating cup

Develop a novel process of dry granulation of BF-slag

- Energy recovery
- Produce a commercial slag product

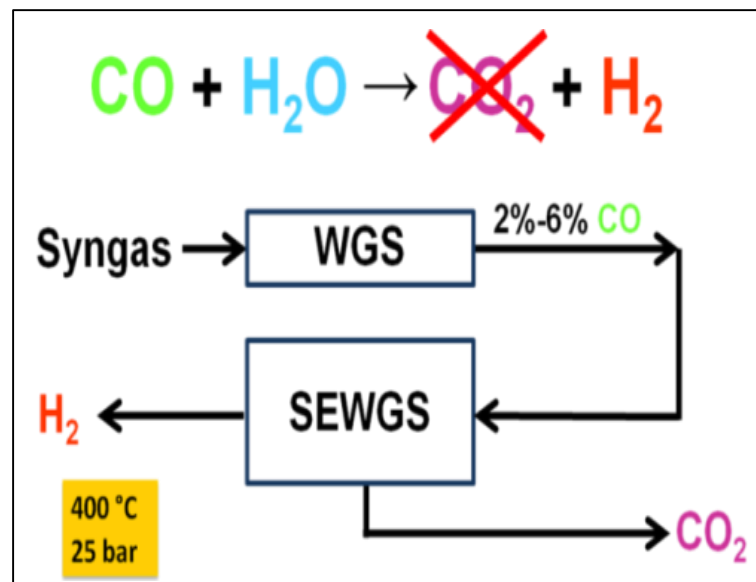
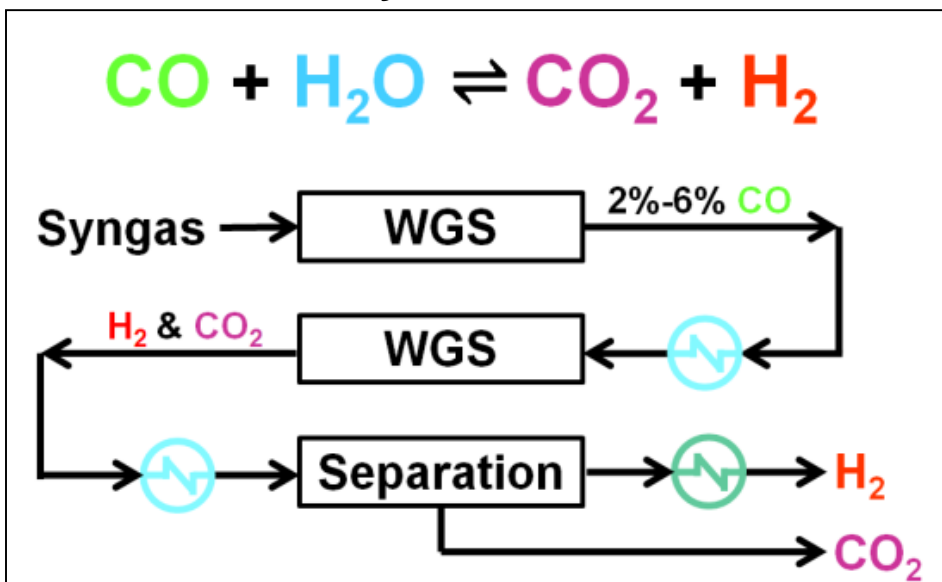




# Horizon 2020 LCE-2014 – Stepwise

**Project description:** SEWGS is a solid sorption technology for CO<sub>2</sub> capture from fuel gases in combination with water-gas shift and acid gas removal.

- **Higher carbon capture rate** – i.e. lower carbon intensity, 85% reduction
- **Higher energy efficiency** – i.e. lower energy consumption for capture (SPECCA ), 60% reduction
- **Better economy** – i.e. lower cost of CO<sub>2</sub> avoided, 25% reduction

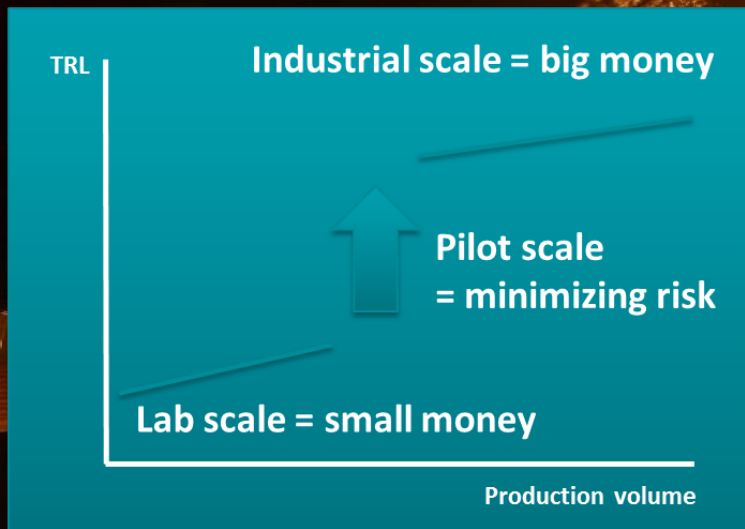


# Metnet - European Pilot Plant Network for Extractive Metallurgy and Mineral Processing

A Raw Material Commitment approved by the European Innovation Partnership for Raw Materials

Metnet = easily accessible pilot facilities minimizes risk

Metnet provides facilities and partnering for processing projects along the whole value chain



	WP:s	Project A	Project B	Project C	Project D	.....	Project X
1							
2							
3							
Pilot tests	METNET	METNET	METNET	METNET	METNET	METNET	METNET
5							



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  - Global > International clients/partners/academia, WSA, IN, PRC, JP, AUS, CA,

# Perfect location.





Thank you!

**Scientific Work for Industrial Use**  
[www.swerea.se](http://www.swerea.se)





















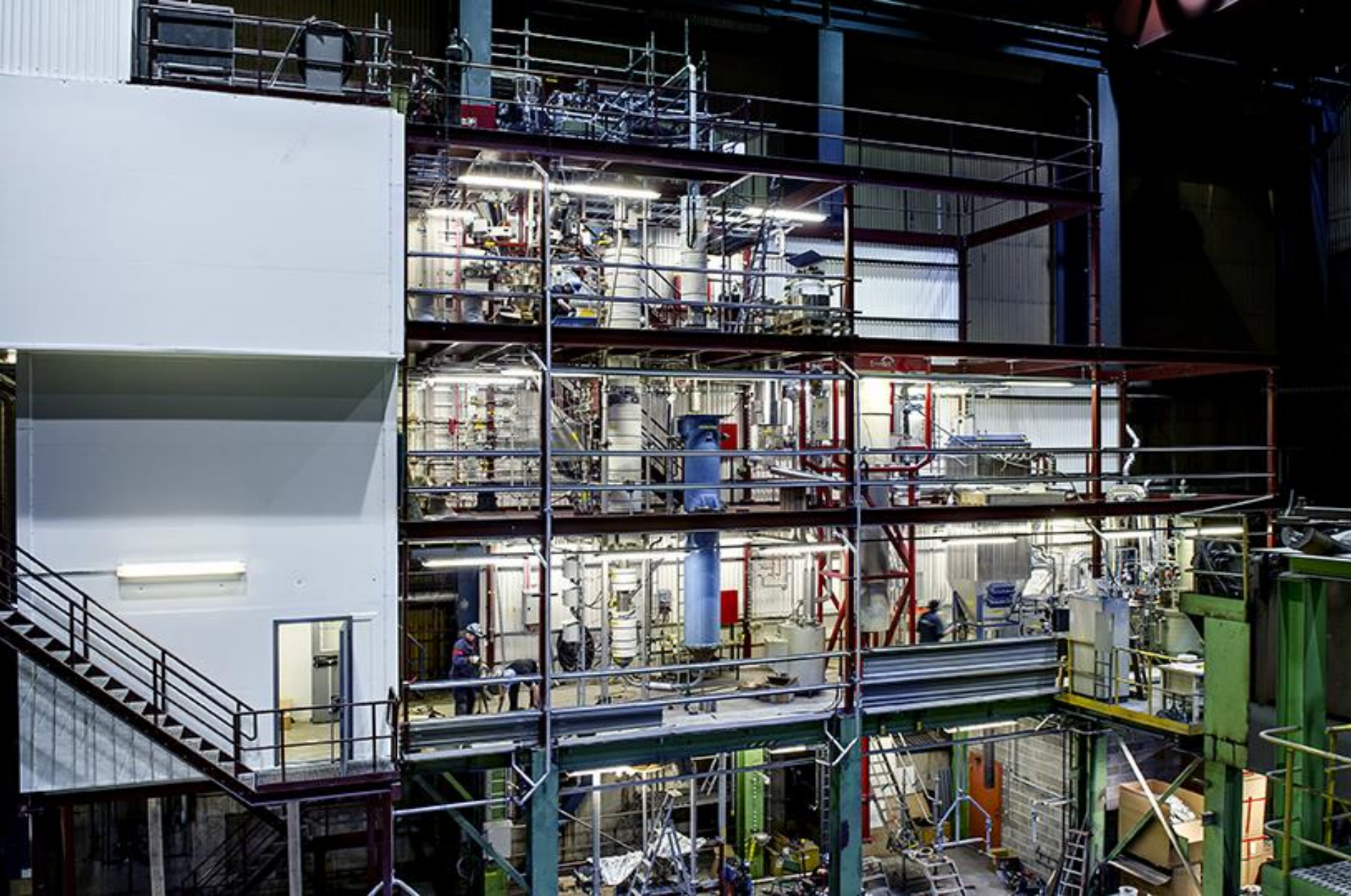
































# Swerea MEFOS core:

- **Large scale** (metallurgical/forming) pilot tests
- **Metallurgical and forming** processes from raw material to shaped metal
- **Process integration** – Systems analysis and value in use
- Independence and confidentiality (when necessary)

