



SMART Metallurgy Approach in the Secondary Steel Sector

This presentation explores the transformative potential of SMART metallurgy in the secondary steel sector. We will delve into how sensing, modeling, automation, refining, and transformation can revolutionize steelmaking.

Understanding the Secondary Steel Sector

Primary Steelmaking

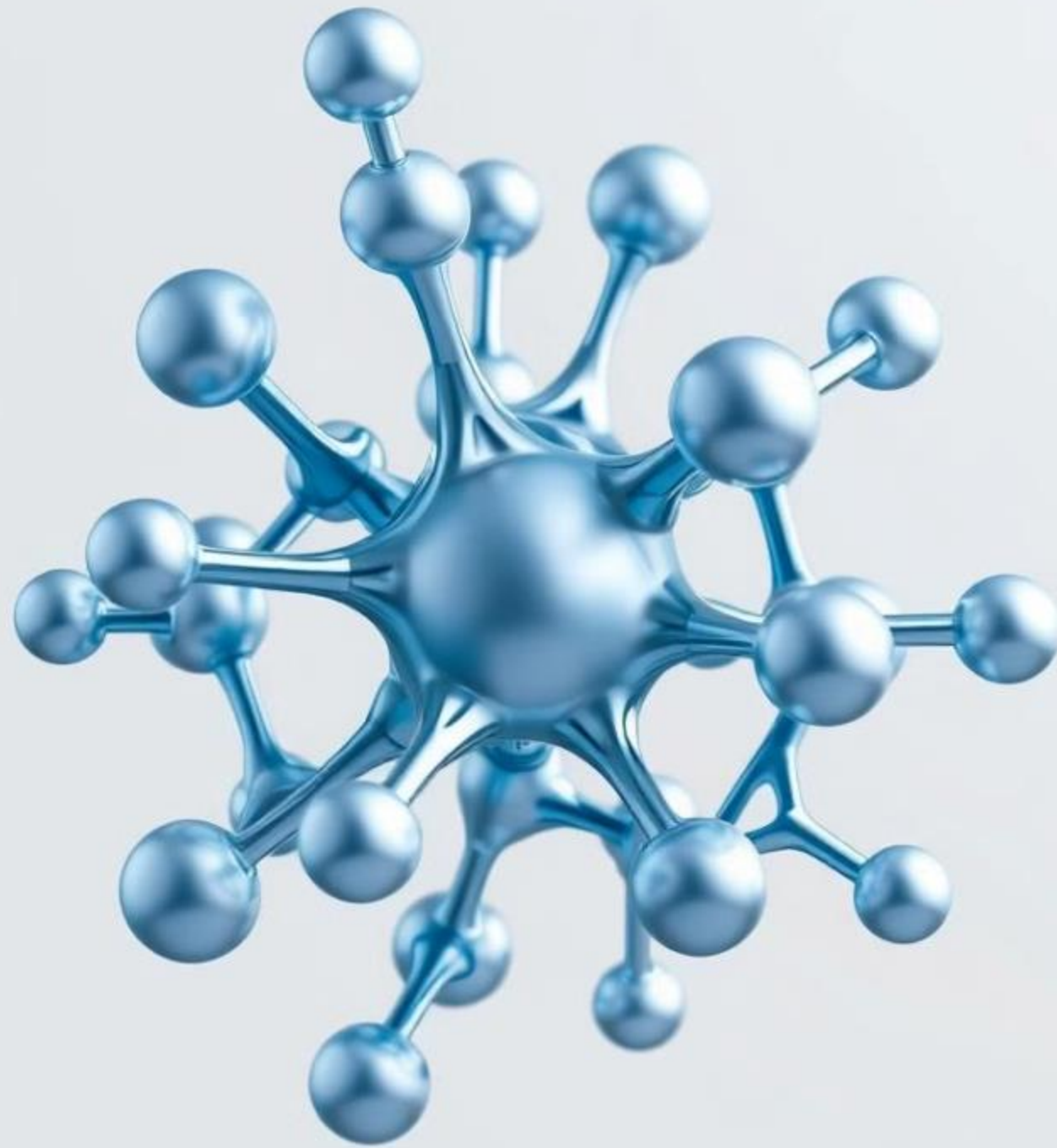
Involves production from iron ore. This is a resource-intensive process.

Composite Steelmaking

Combines primary and secondary routes. This offers a balance of cost and quality.

Mini Mills (Secondary)

Uses recycled scrap steel as feedstock. This is an environmentally conscious approach.



The Metaphysics of Steel

Before diving into the SMART approach, let's consider the fundamental nature of steel. Its properties dictate its applications. Understanding this is crucial for advanced metallurgy.

Decoding SMART Metallurgy

1 Sensing

Sensing of Signals from the field instruments is important. These give inputs for Calculation/ Analysis.

One potential area of research could be real-time monitoring of steel composition (Spectrometry/ Resistance cups (Approx. analysis) and continuous temperature measurement in EAF/LF/VD and Tundish

2 Modeling

Based on the inputs received from Sensing devices, algorithms are made and advanced simulation done to optimize processes. Also predictive models can be made and data driven decision making can be proposed

3 Automation

Inputs received from Models, are being used to automate the processes for improving process efficiency and reducing errors. Robotic Automation is to be done in areas which are unsafe for humans (Slide gate, Cranes, Mills.

4 Refining

Refining of the Automation models to deliver accurate results based on ML Employing machine learning techniques to identify and interpret relationships between critical variables, enabling the enhancement of intricate and nonlinear systems

5 Transformation

Transformation of Acquired raw data into actionable inputs enabling real time decision making & driving process improvements



SMART Applications in the Steelmaking Process



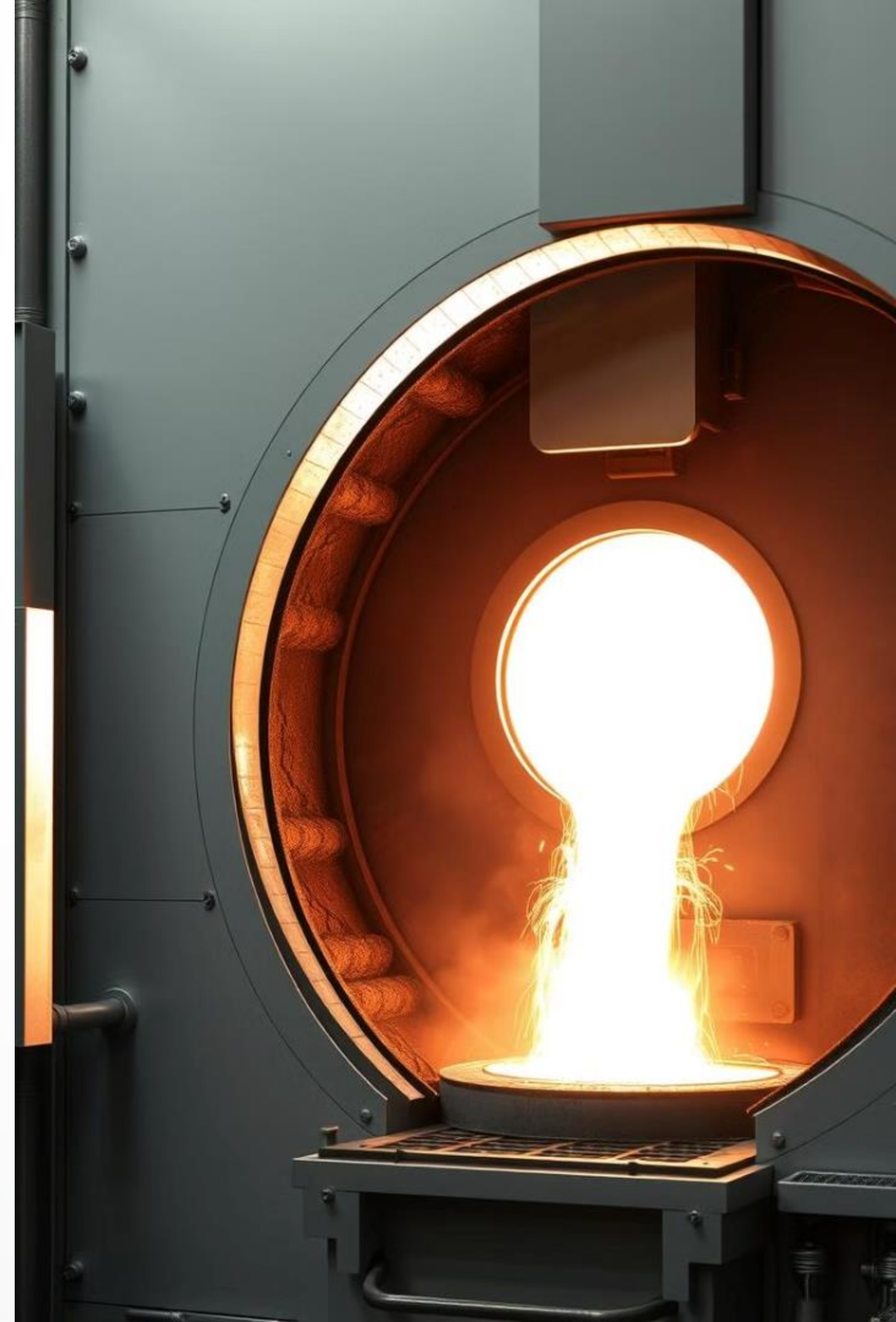
Scrap Melting (EAF)

Efficient melting of scrap in electric arc furnaces.



EAF Parameter Insights

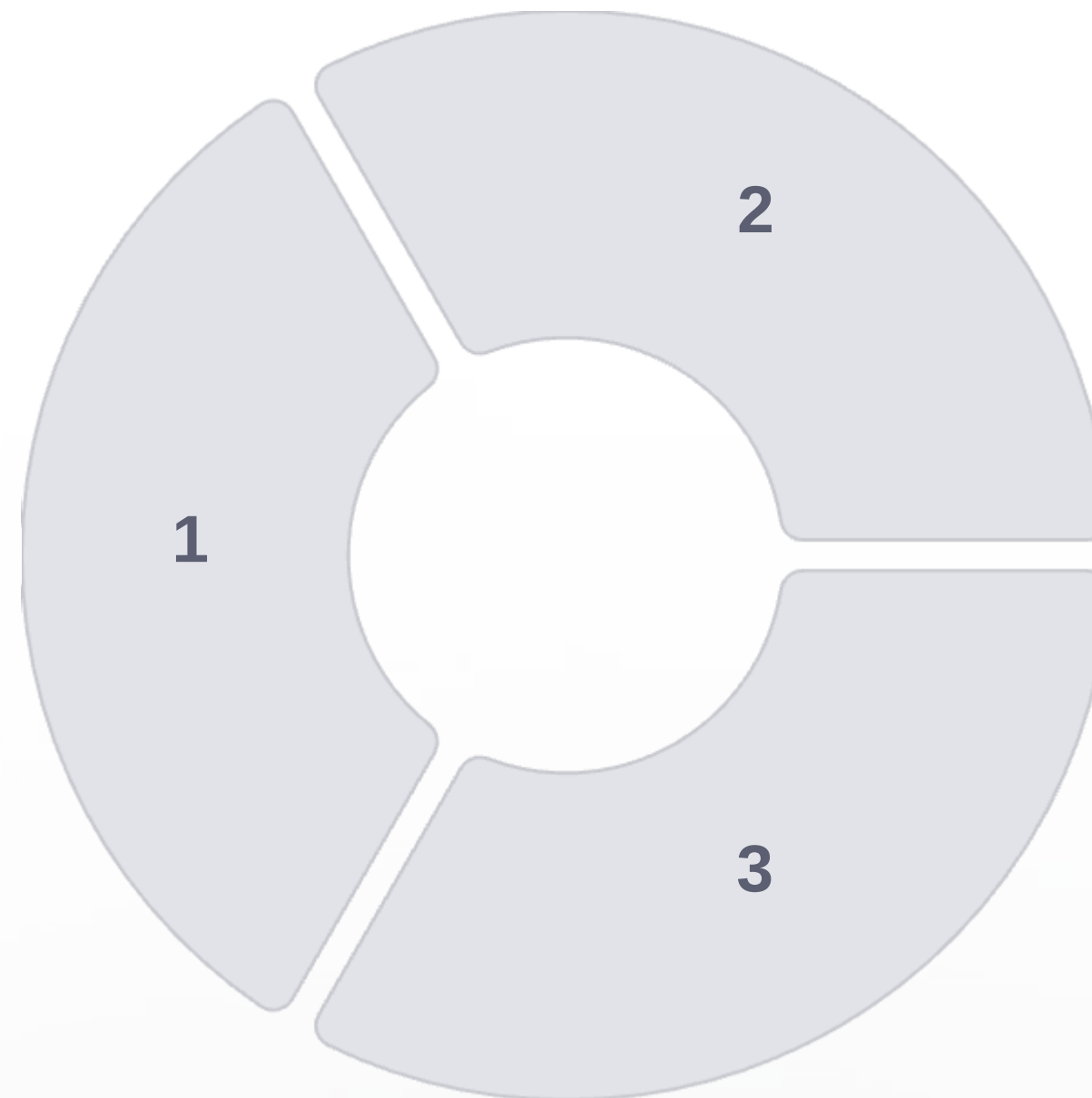
- Automation of Temperature and Steel Sampling
- Automation for Charge Mix Optimisation w.r.t. Charge and Nitrogen content
- Tap Changing/ Melting of Charge mix w.r.t Scrap type and Tap power



LRF: The Heart of Refining Optimization

Synthetic Slag

Offline-Online Custom-designed slag for Better refining characteristics of steel. Precise control of steel chemistry based on Flux type, Chemistry of steel and real time Temperature.



AI-Based Tools

Based on the Slag Characteristics, prediction of Slag compositional additions is the need of the hours

Customized Properties

Achieving desired mechanical properties in the final steel product.



VD: Vacuum Degassing Advancements

1

VD Optimization

Advanced control systems for vacuum degassing.

2

Gas Removal

Sensors and machine learning to control Oxygen, Nitrogen and hydrogen levels based on steel chemistry especially activity coefficient of surface active elements.

3

Steel Quality

Techniques to improve overall steel quality.



Caster Smart Metallurgy Approaches

Automation / Robotic Solutions for casting floor area

Automatic Temperature/ Sampling/
Shroud cleaning and Shroud fixing

Solidification Modeling

Automation of Cooling water, Sprays,
EMS, MSR and other parameters
based on variables during casting.

Defect Prediction

Based on Deviation in casting, event logging
analysis for defect prediction.
ML based learning algorithms



Caster Smart Metallurgy Approaches

Technical Assist software

A Software that can predict what to do in case of sensor/ equipment/ process issue

Online defect detection

- Camera/ Laser based for dimensions
- Camera/ Laser curtain based for surface defects
- Ultrasonic/ Radiography based internal defects

Caster yard Management

- Monitoring of Blooms and Slabs for movement and Traceability
- Defective billets can be tracked for location and rolled accordingly

Conclusion: The Future of Steel

The Indian steel industry is at a nascent stage. Adopting the SMART framework requires energy, focus, and collaboration between metallurgists and AI experts.

To thrive in this era, we must refine steel more effectively and at a competitive price to face global competition.

