Artificial Intelligence and Machine Learning applications for EAF Optimization

Mariana Viale
Guillermo Fernandez
Emmanuel Placier

Company Profile

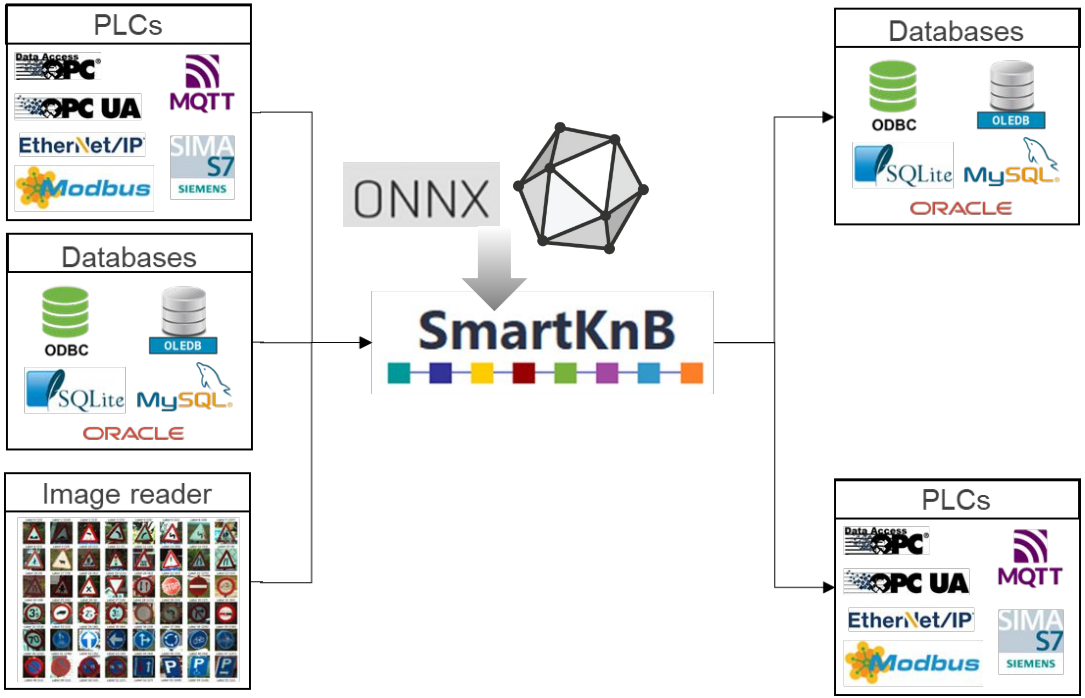
- Started in 1986 as a pioneer on digitalization of the complete electric steelmaking process
- +80% of EAF production in North America uses AMI technology
- 170+ References around the world, presence in over 50 countries in 5 continents
- Since 2021 established partnership with Showa Denko

SmartKnB

User-friendly graphic programming interface to develop complex solutions

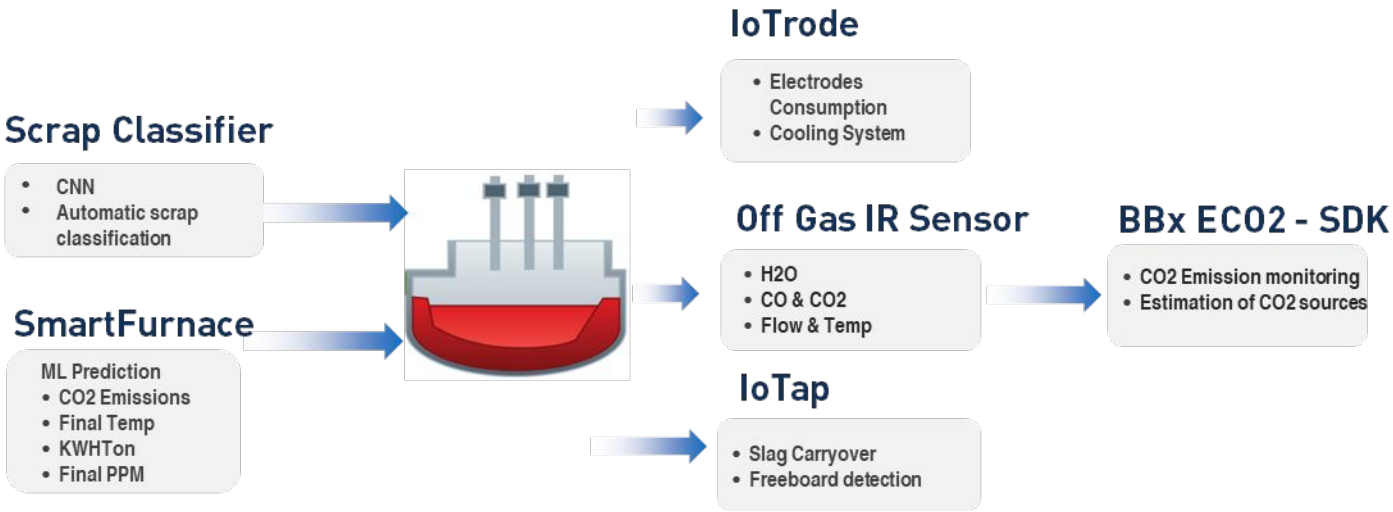
- Merge data from different sources.
- Allow design of complex logic.
- Implementation of machine learning models .
- Develop customized HMI .
- Generate preprocessed logs.
- Send set points, recommendations and alarms .

Process Engineer can develop applications without Software engineers' support



Developed Products

AI developments that help to reduce the CO2 generation at the EAF



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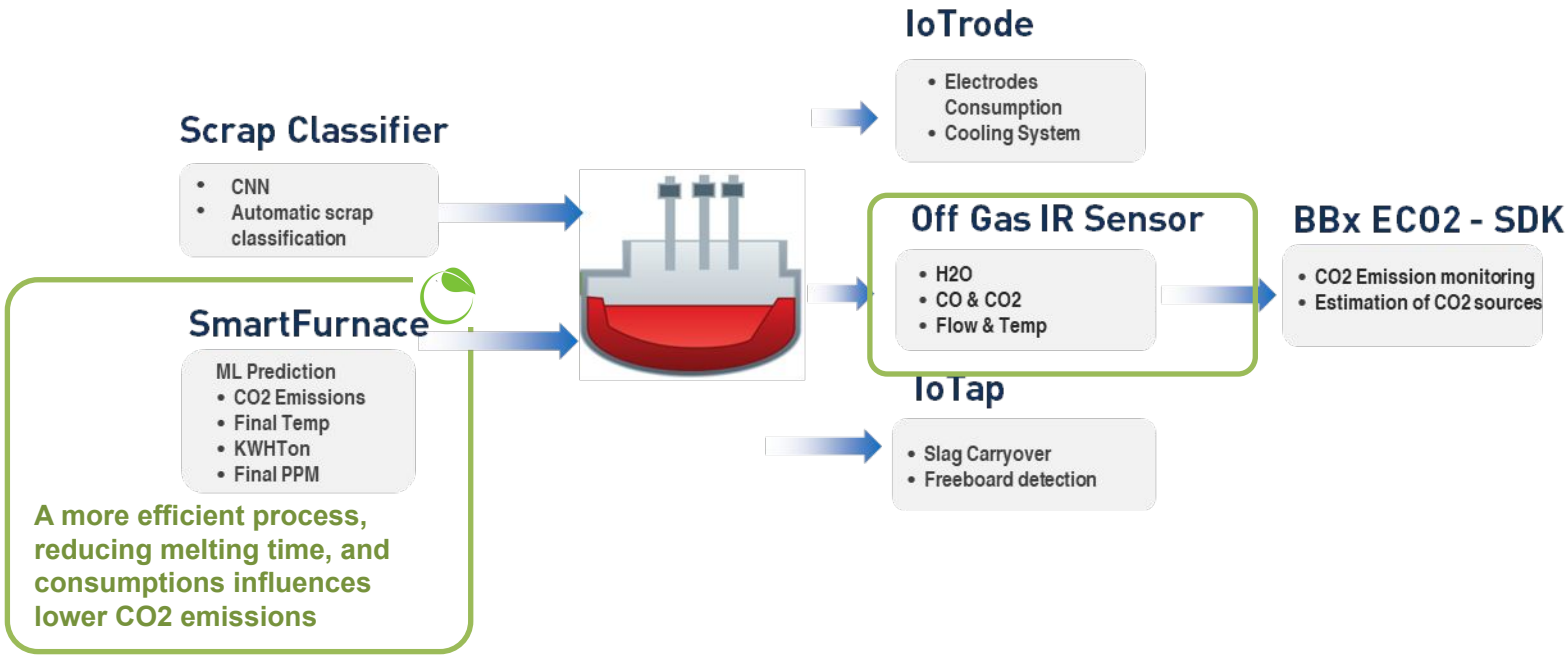
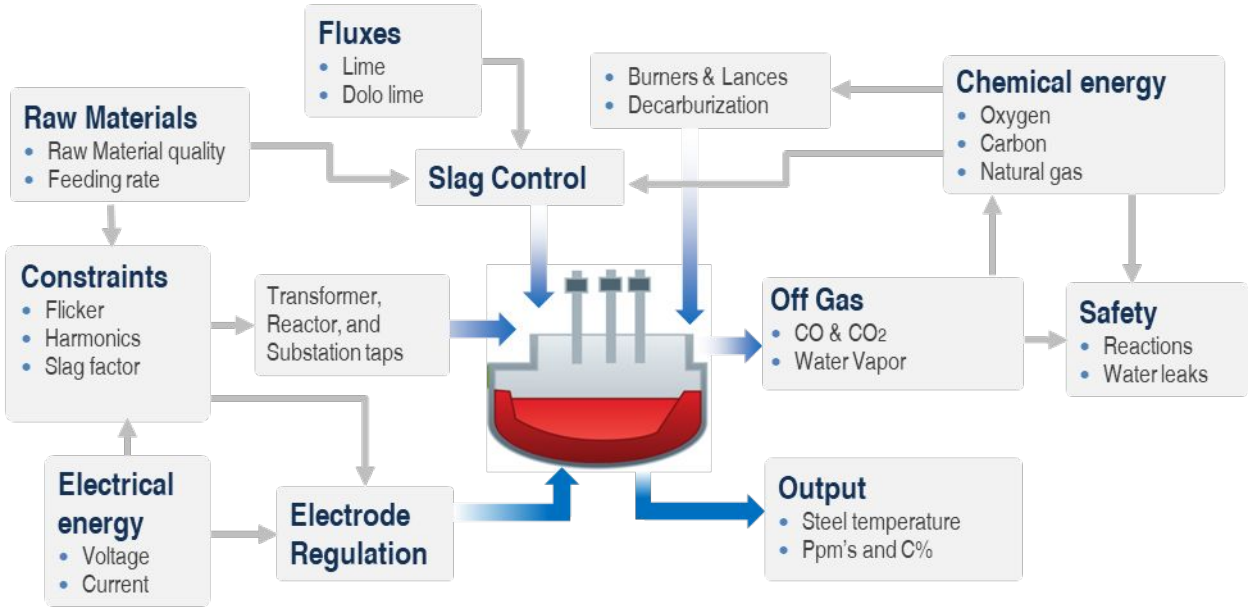


SmartFurnace



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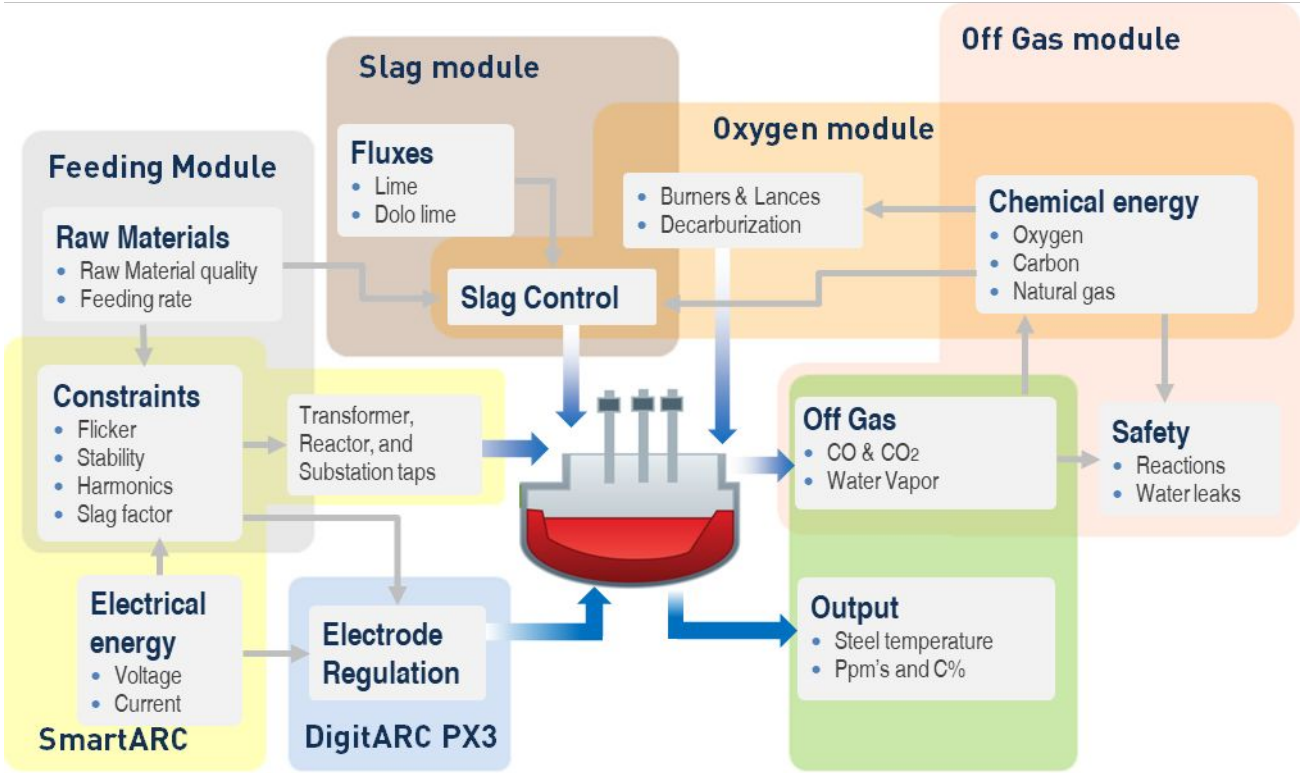
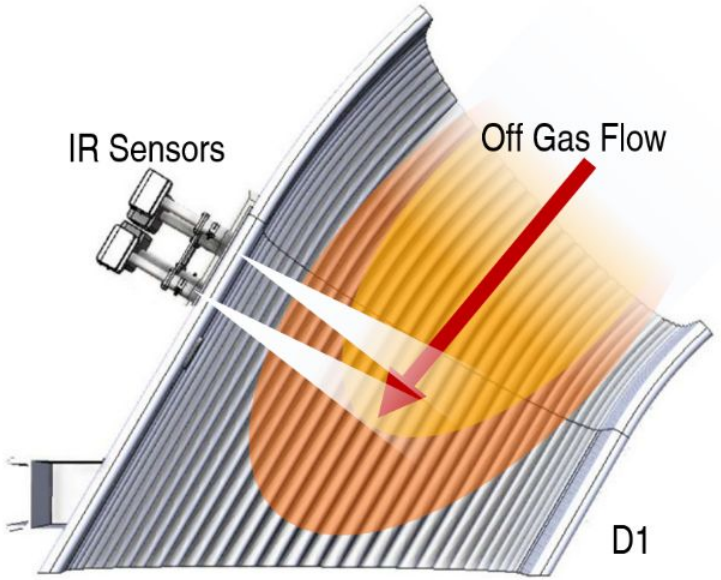


Infrared Sensor

- CO, CO2, H2O, Velocity, Temperature
- Modular design allows only desired gases to be measured
- Minimum opening of the duct wall of 12 to 20mm
- Wider measured gas sample
- No need to recalibration once it is operational
- Measuring range speeds of 3 m/s up to 100 m/s
- Purge air to prevent dust or particle blockage



SmartFurnace – Furnace Optimization

Depends on the Furnace

- EAF physical characteristics
- Equipment (Transformer, hydraulics, etc.)
- Product made
- Network limitations
- Operational Practices

Depends on priorities

- Productive (Speed)
- Efficient (Cost)

Flexibility to adapt to new conditions

Developed Products

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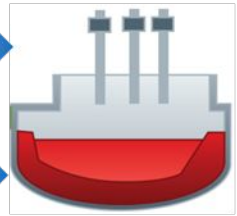
Scrap Classifier

- CNN
- Automatic scrap classification

SmartFurnace

ML Prediction
- CO2 Emissions
- Final Temp
- KWHTon
- Final PPM



IoTrode

- Electrodes Consumption
- Cooling System

Off Gas IR Sensor

- H2O
- CO & CO2
- Flow & Temp

IoTap

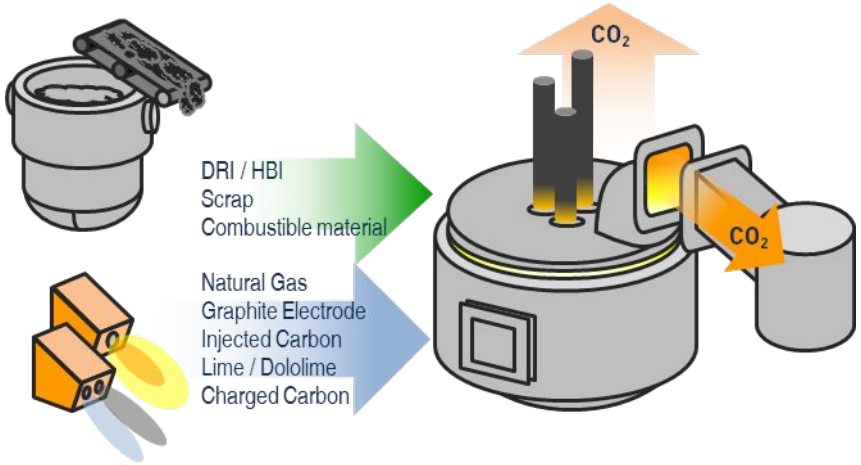
- Slag Carryover
- Freeboard detection

BBx ECO2 - SDK

- CO2 Emission monitoring
- Estimation of CO2 sources

First step to reduce is to measure.
With CO2 feedback from the Off Gas optimized use of chemical energy is possible

BlueBoX - Eco2′ - “Managing CO2 Emissions”



Understand your EAF CO_2 profile…..

Measure

How much CO_2 is generated in the EAF? Quantify & Trend CO, CO_2, and flow rate in real time

Analyze

Do you know the source contribution? Model CO_2 source generation

Control

How do you improve? Data Analysis & Reporting capability, Evaluate impact of raw materials sourcing changes

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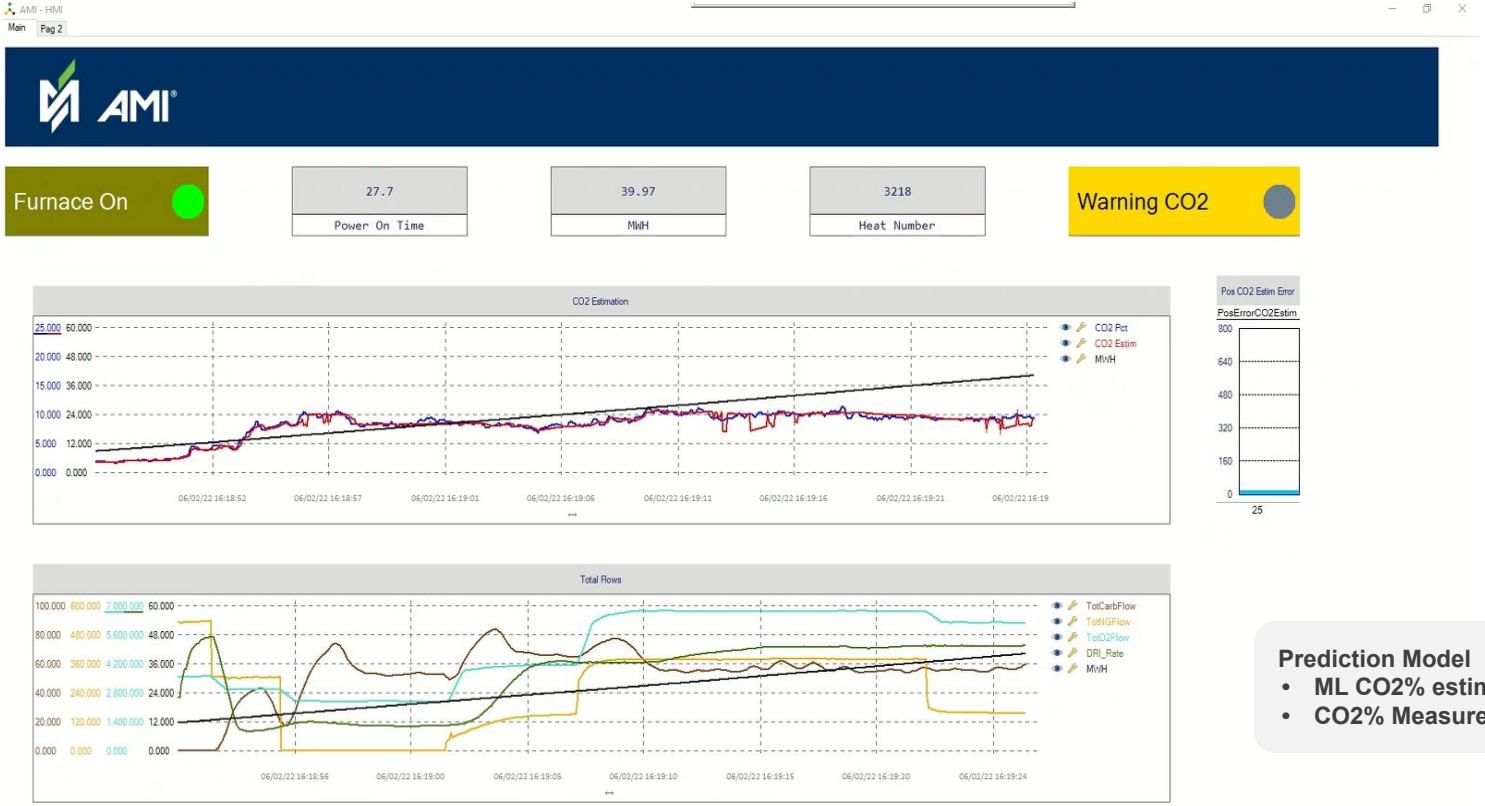

Prediction Model

- **ML CO2% estimation**
- **CO2% Measurement**

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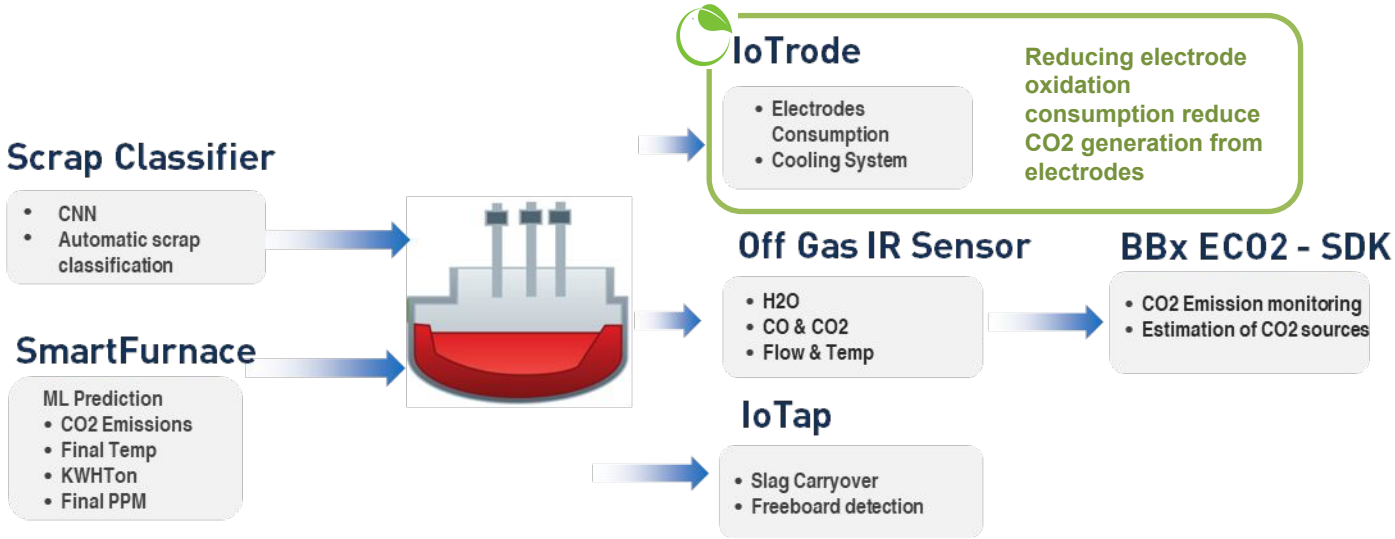
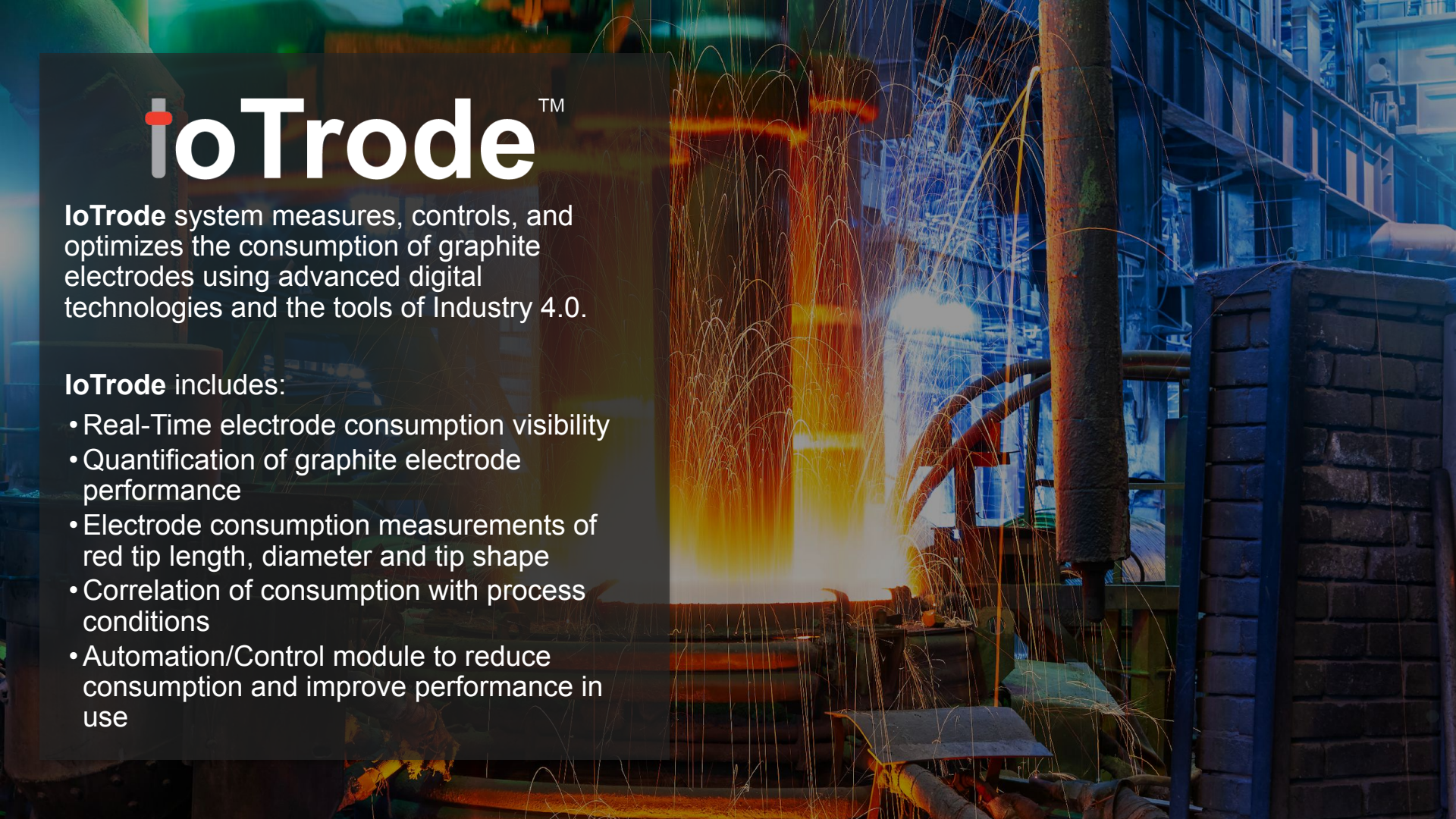




IoTrode™

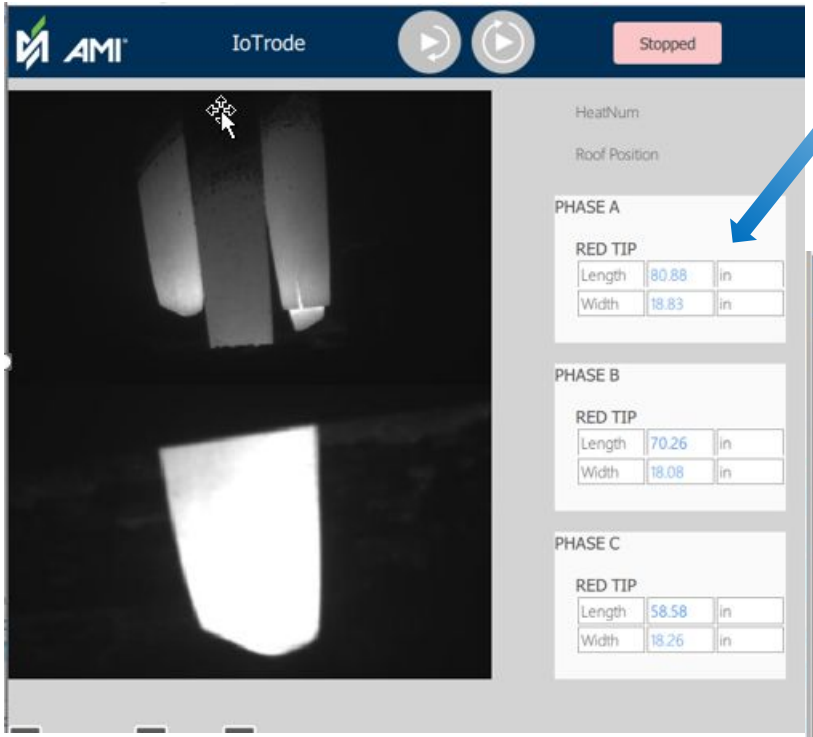
IoTrode system measures, controls, and optimizes the consumption of graphite electrodes using advanced digital technologies and the tools of Industry 4.0.

IoTrode includes:

- Real-Time electrode consumption visibility
- Quantification of graphite electrode performance
- Electrode consumption measurements of red tip length, diameter and tip shape
- Correlation of consumption with process conditions
- Automation/Control module to reduce consumption and improve performance in use

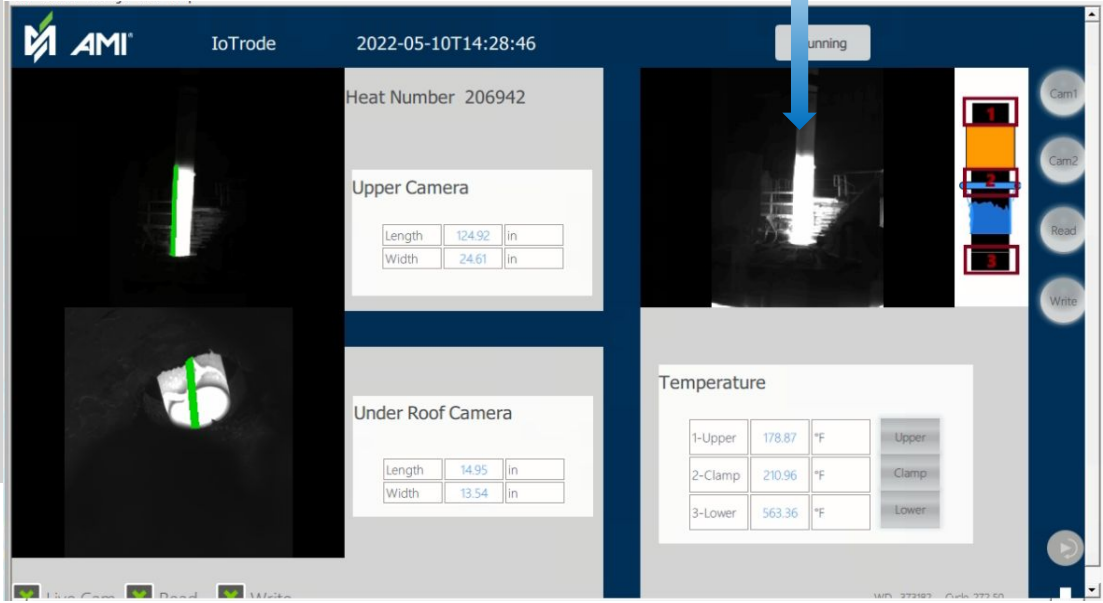
High definition cameras

- Red Tip measurement
- Butt Loss Detection
- Gapping and cracking detection



Infra Red Cameras

Conductivity and Temperature anomalies detection

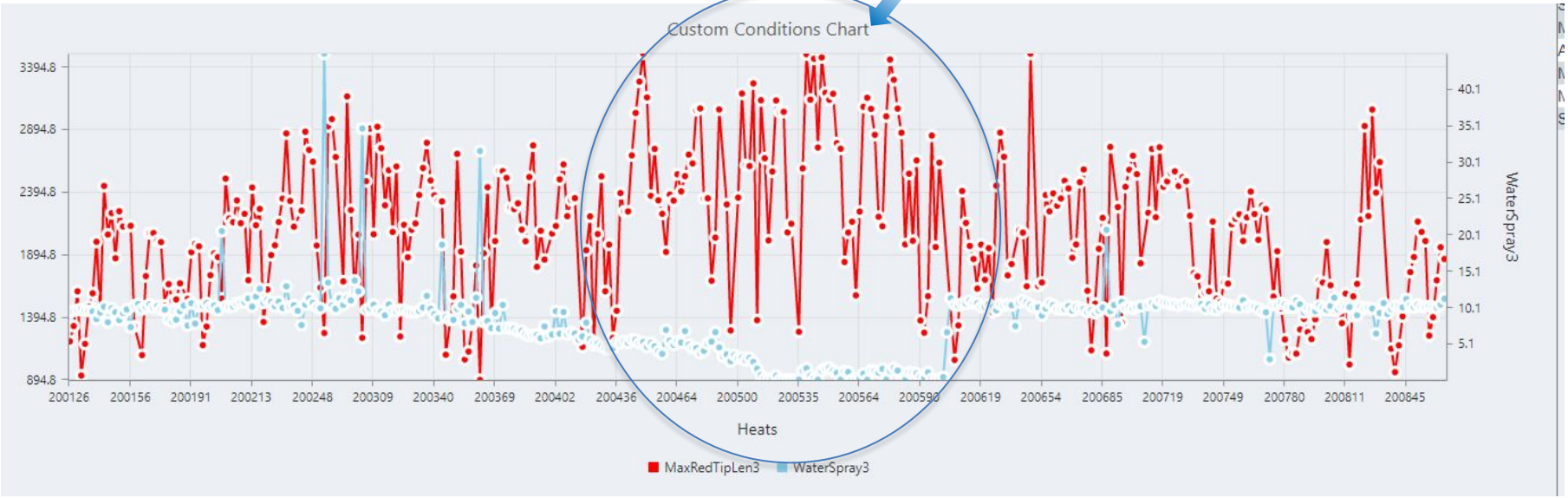


Custom Conditions

Custom Charts

Select the type graph and the variables available to show.
Select period of time to analize

Low water spray
Longer red tip
More oxidation



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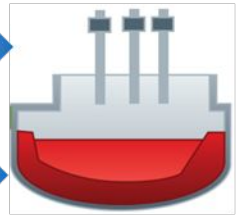

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IoTap

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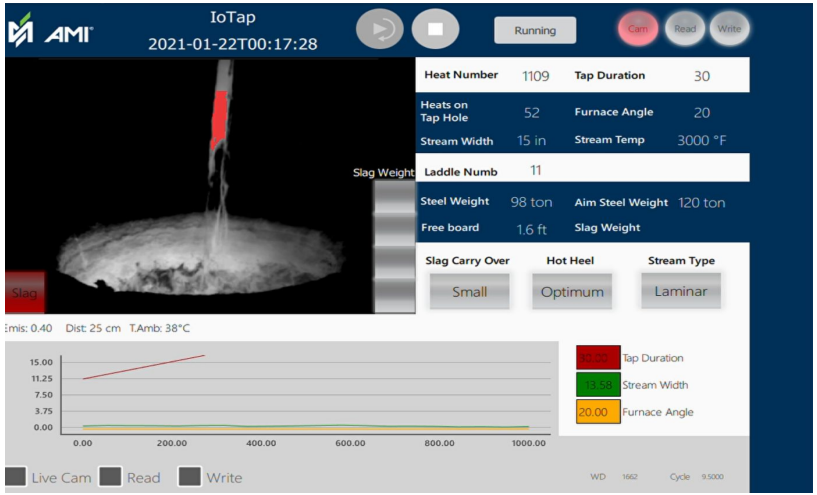
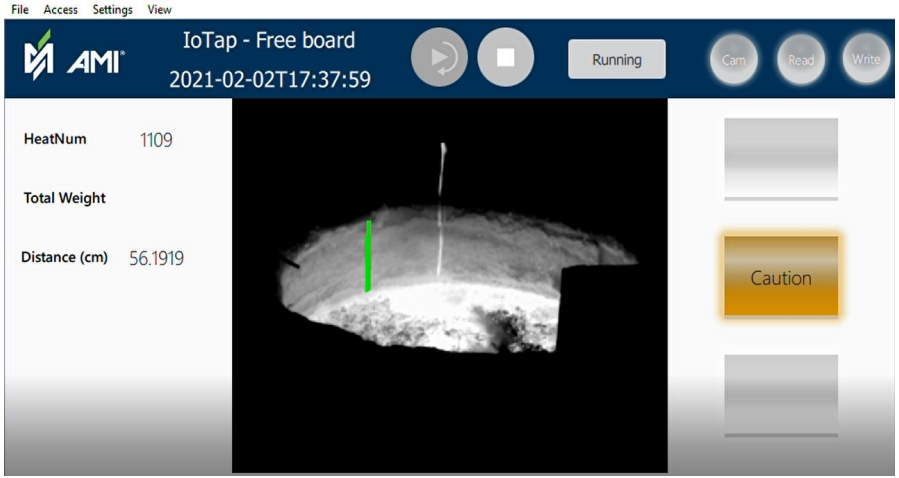
- Freeboard detection

Reducing Slag Carryover reduce the LMF treatment time saving CO2 generation

Slag Carryover



Freeboard Detection



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Knowing the exact scrap composition allow better control and less CO2 generation

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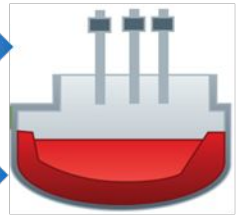

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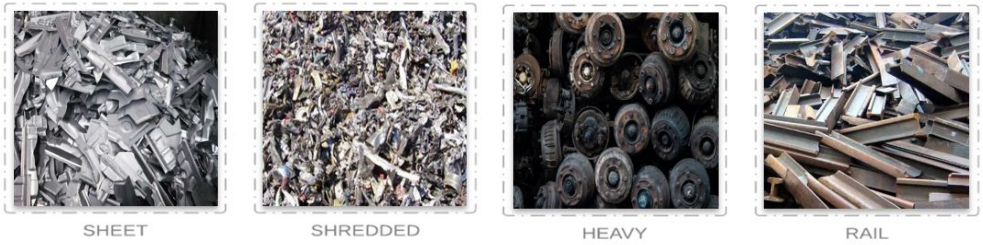
*USA Patent

IoBucket

Objective: Estimate the scrap distribution in the bucket using a 3D camera and vision software

- Scrap volume measurement when charged in the bucket
- Detection of big pieces
- Scrap classifier according to density and quality
- If weight is available, density is verified



IoConveyor

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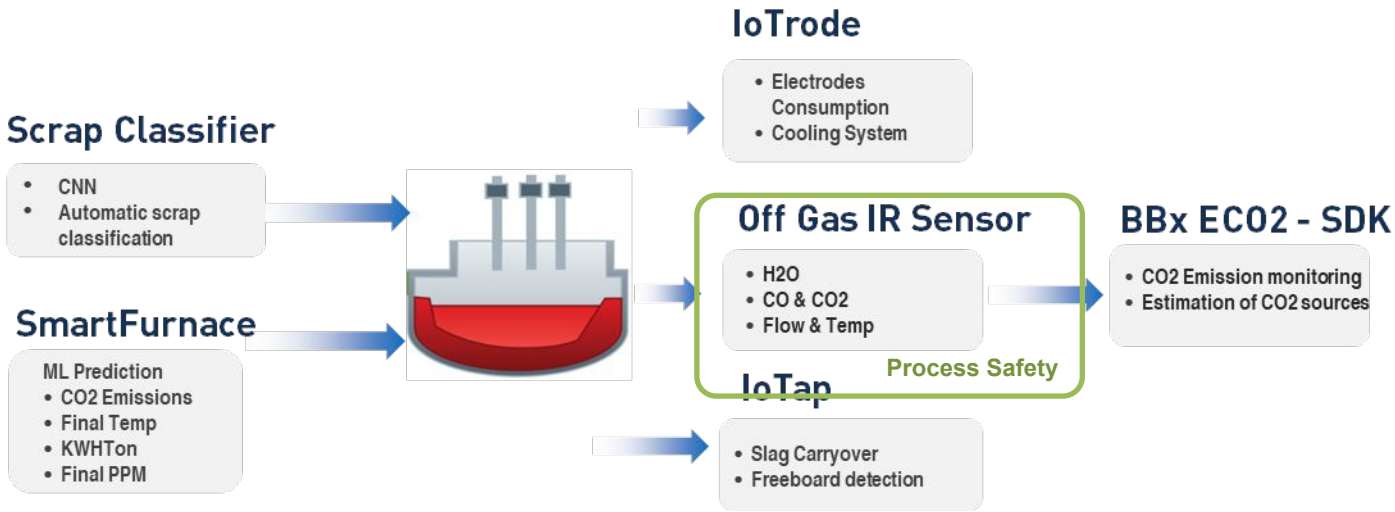
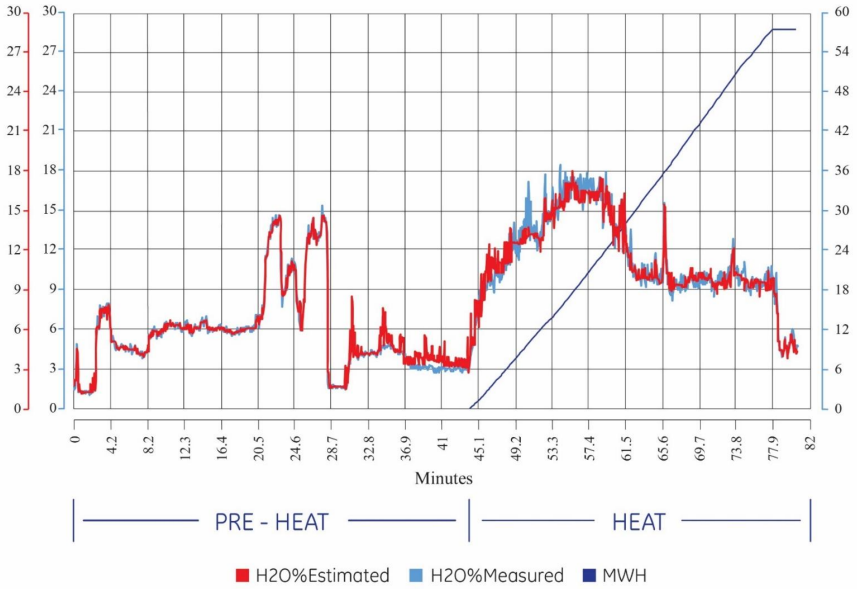


Abnormal Water Vapor Detection



H2O Estimation

- ML model predicts the H2O at each stage.

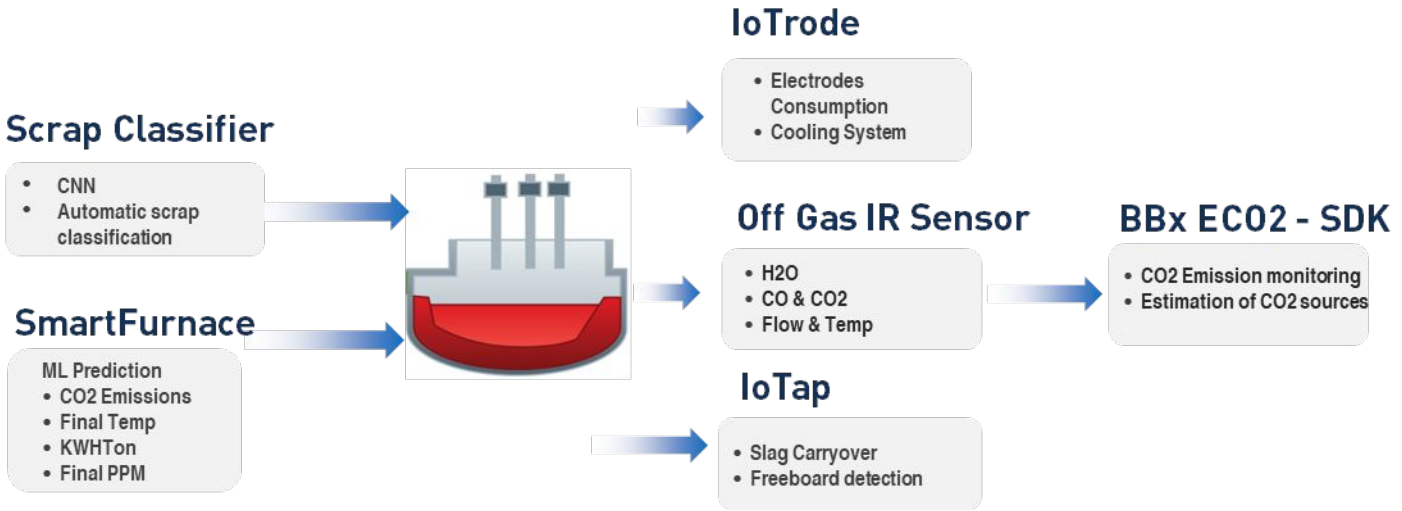
OffGas Sensor

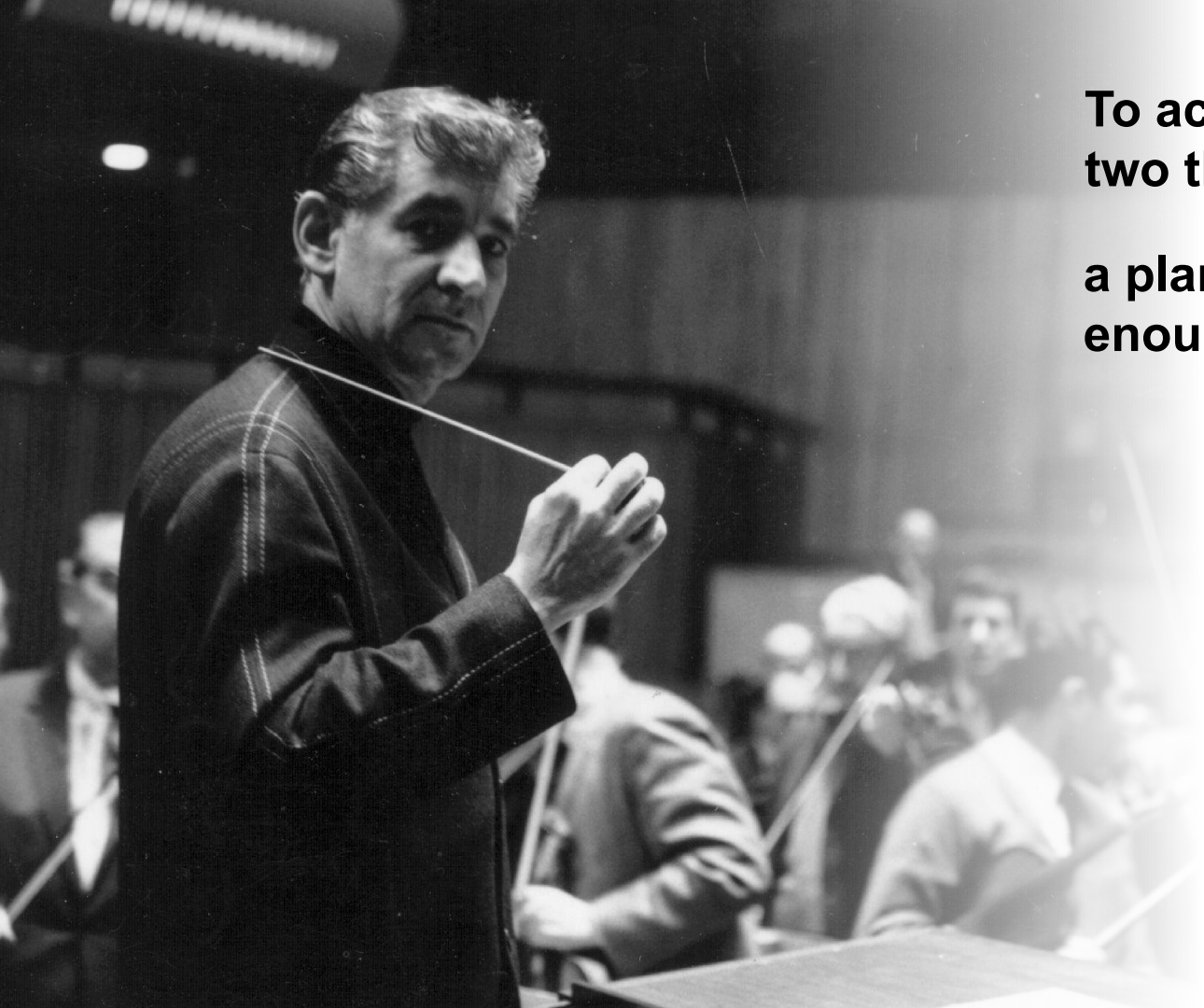
- Offgas sensor feedback is used to compare against prediction

100% certainty in detection of leaks of 20 liters/min or more

Abnormal Water Vapor Detection

Technology for safer, cleaner and efficient steelmaking





To achieve great things, two things are needed:

a plan, and not quite enough time

Thank you!

AMI