Digital Twin: Drive and Optimize Your Decarbonization Journey towards Green Steel

Yale Zhang, Ge Sa, and Sunil Kumar

Hatch, Canada

Company Introduction

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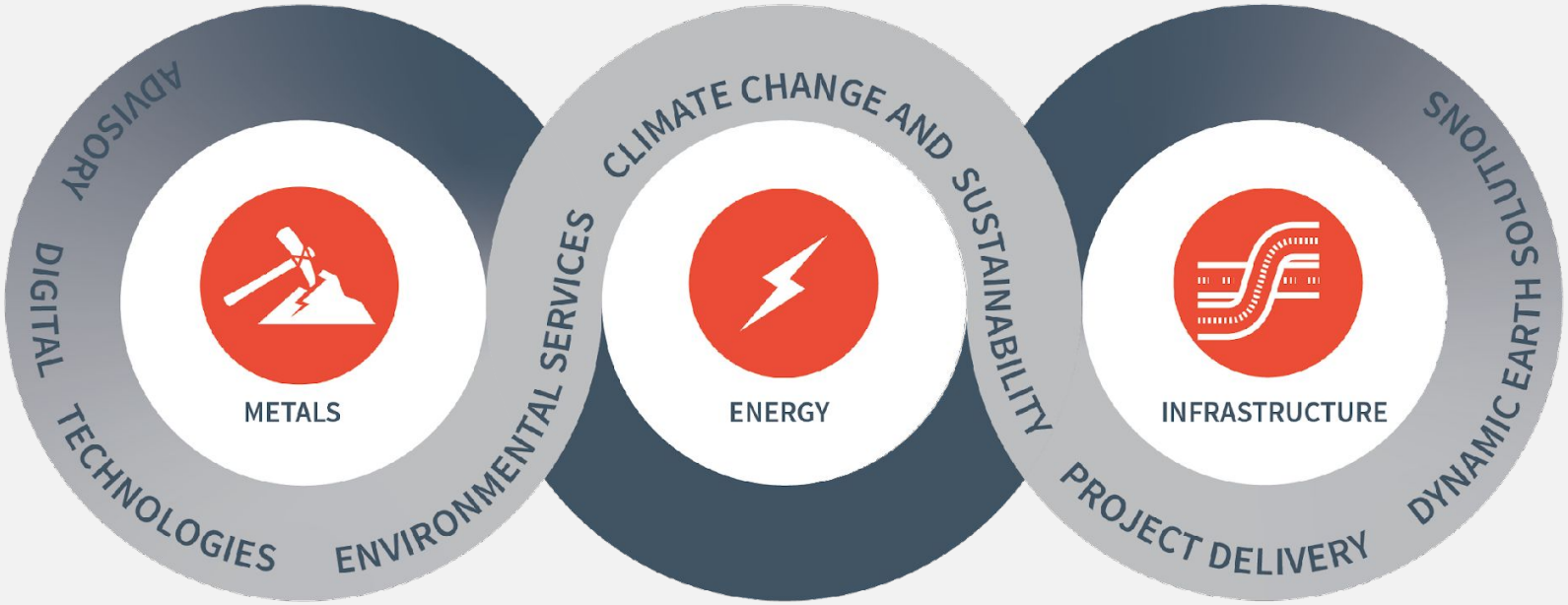
Our business



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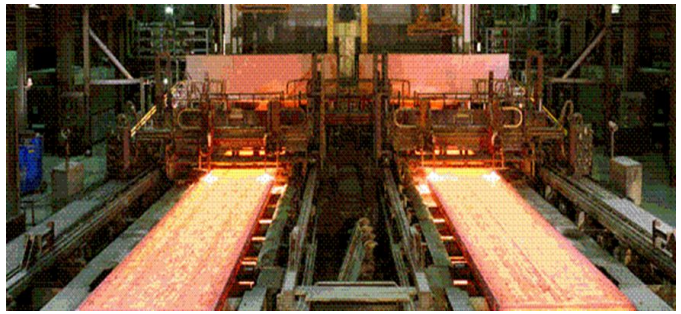
Iron and Steel Capabilities

Strategy Development

- Corporate/business unit strategy development
- Market research and analysis
- Technical and commercial due diligence
- Corporate development and organizational restructuring
- Competitive analysis and marketplace positioning
- Merger and acquisition planning
- Capital investment analysis

Technical Consulting

- Process audits, technology evaluation
- Operations Support
- Product quality enhancement
- Simulations and Modeling
- Debottlenecking
- De-carbonization
- Digital Solutions
- Asset Management
- Environmental Engineering
- Customized training
- SEAD (CFD, FEA)



Project Delivery

- Project Management
- Front End Loading
- Detailed Engineering
- Procurement
- Project Cost Estimating, Scheduling and Cost Control
- Safety Management
- Construction Management
- Training and Start-Up Services

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Hatch Select Iron and Steel Clients

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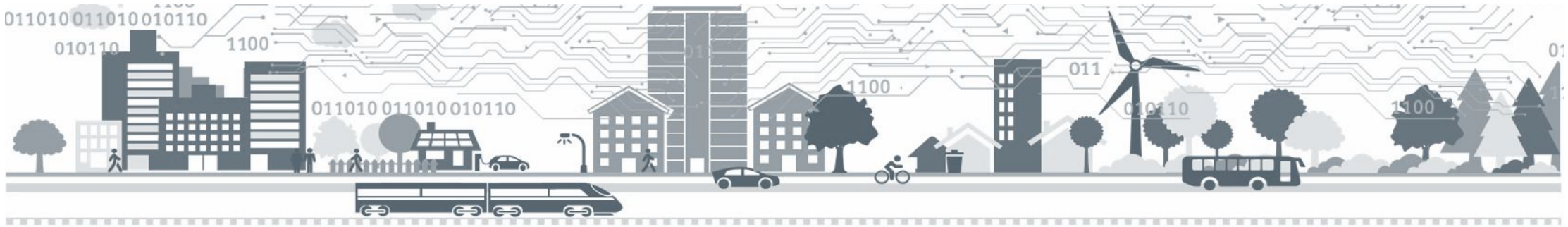
Outline

- Today’s challenges and industry trends
- Understand digital twin technology
- Our Vision on Carbon Twin
- Industrial Case Studies
- Conclusions

Our industry is changing at an unprecedented pace

- Climate change has quickly become the focal point of both challenges and opportunities for today's iron and steel industry.
- The industry-wide focuses have shifted from pursuing mainly efficiency and economic objectives to balancing with environment-centric KPIs.
- Steelmakers are targeting reduced energy consumption, higher use rate of recycled materials such as steel scrap and a lower level of CO_2 emission, and at the same time responding to stakeholder's pressure on visibility of product carbon footprint.
- Industry 4.0 and digital technologies are transforming both the steel business and production and can play a significant role in decarbonization.

Leverage Digitalization for Decarbonization



Metropolitan areas and industrial centers require very much energy

- Housing
- Industry
- Transporation
- Infrastructure
- ...

Digitalization

- Optimize processes (digitally)
- Streamline activities & avoid mistakes
- Providing products & services resource efficiently
- ...

Digital Decarbonization

Digital Decarbonization extends current climate-impacting digitalization approaches

Digital Twin

Optimized combination of energy systems from all convincing variants, with

- **Emissions**
- Consumption
- Costs

From Digitalization to Digital Decarbonization

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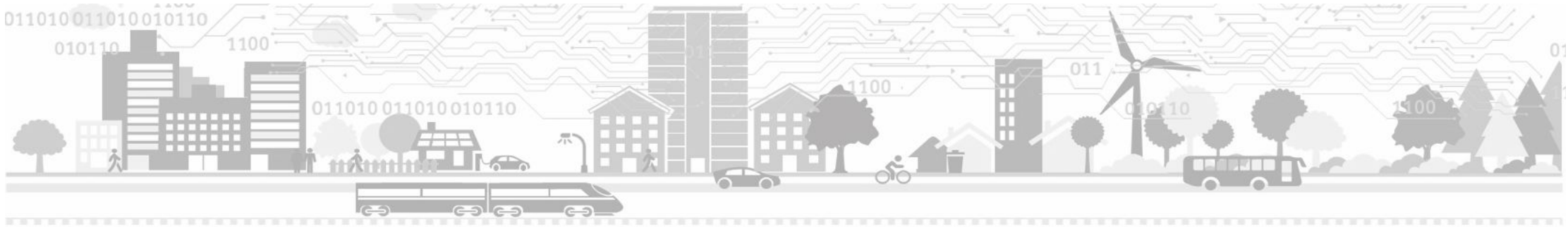
Leverage Digitalization for Decarbonization



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From Digitalization to Digital Decarbonization

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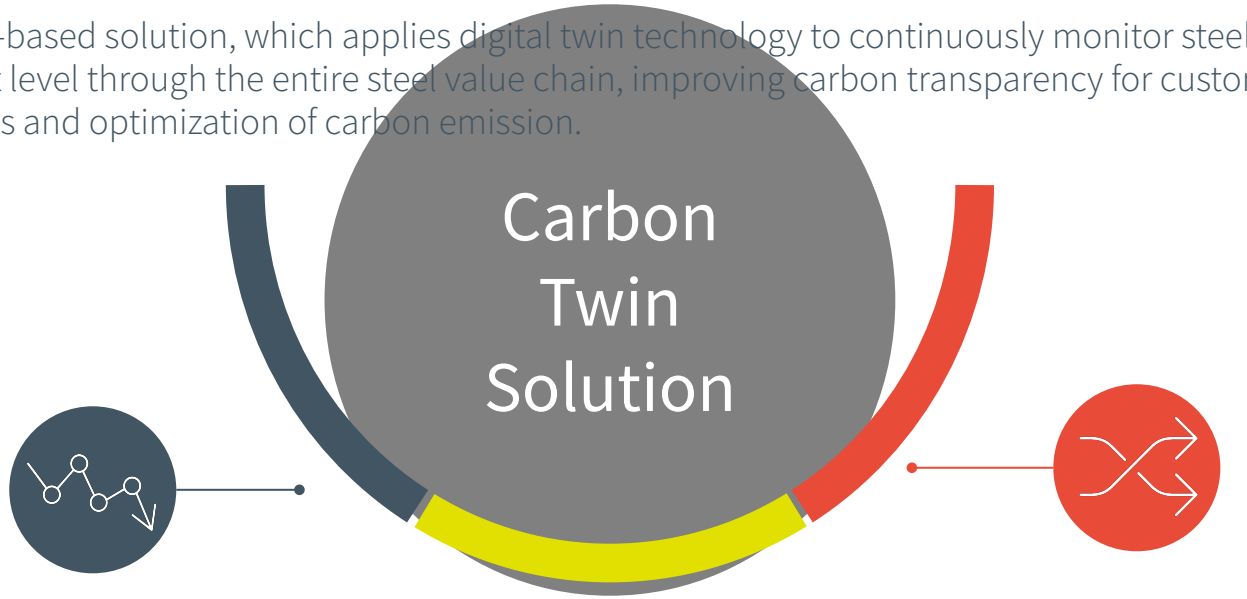
Digital Twin

"A digital twin is a dynamic, digital representation of physical assets or systems, which combines multiple modeling technologies (i.e., first-principles model, data-driven model and 3D visualization model) and real-time data to draw meaningful insights and help improving human decision-making"

Our Vision on Carbon Twin for Steel

A cloud-based solution, which applies digital twin technology to continuously monitor steel product carbon footprint at the product level through the entire steel value chain, improving carbon transparency for customers and enabling efficient reporting, analytics and optimization of carbon emission.



1. Carbon Footprint
Calculate and monitor carbon footprint in near real-time at product level based on raw materials consumptions (Scope 3), direct measurement data pipeline and integrated first-principle models across multiple processes along the value chain to create a reliable and transparent GHG emission disclosure to customers and stakeholders.

3. Carbon Optimization
Introduce carbon taxes and tariffs, and green premiums and financing into the integrated steel value chain cost modeling, offering the opportunity to optimize overall profitability and value-in-use by considering process, logistics, and emission constraints, and determine the best strategy to achieve balance between production cost and carbon emissions.

2. Carbon Insight
Conduct what-if analysis through various digital twin models to assess the impact of different decarbonization technologies, flowsheet variations, process and operation decisions, raw material selection, product development on GHG emissions reduction, to support decarbonization roadmap development and project implementation priorities.

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Value Proposition around 3 Pillars of Sustainability

Steelmaker

Track and monitoring product-to-product carbon footprint across steelmaking value chain

Value gained through efficiency improvement to generate custom reporting automatically

Reduce carbon emission via real-time data visualization and AI-based predictive analytics

Bottom-line profit improvement through integrated production cost and carbon emission optimization

Meet SEC/sustainability reporting and government procurement requirements

Potential premium due to certified low carbon footprint of steel products

Improve public relationship by serious actions on product carbon footprint tracking, reporting, reduction and optimization

Contribute to final product carbon footprint management through global supply chain

Improve carbon transparency on a granular level for customers, regulators and investors for scope 3 reduction and disclosure

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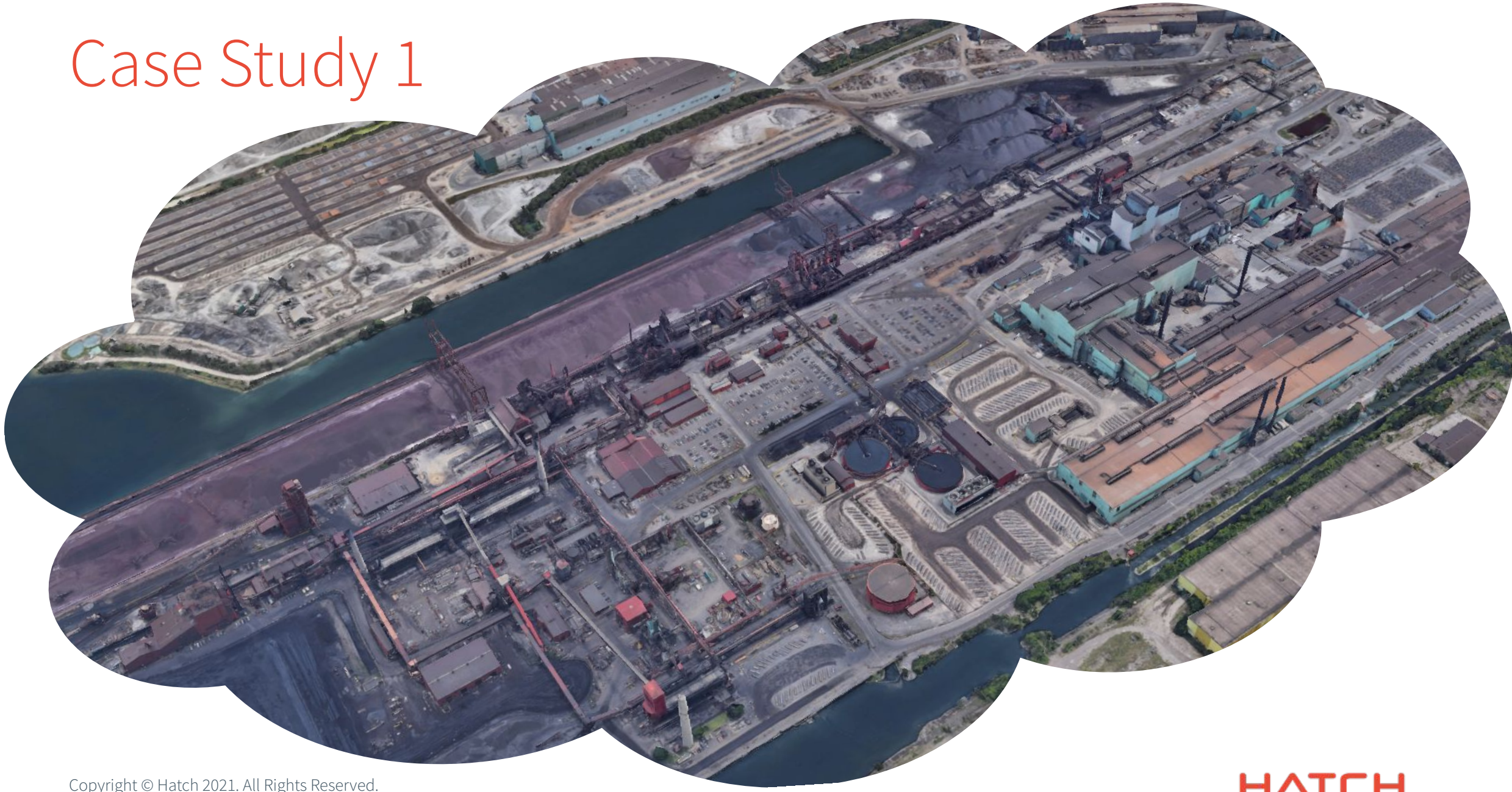
Case Study 1



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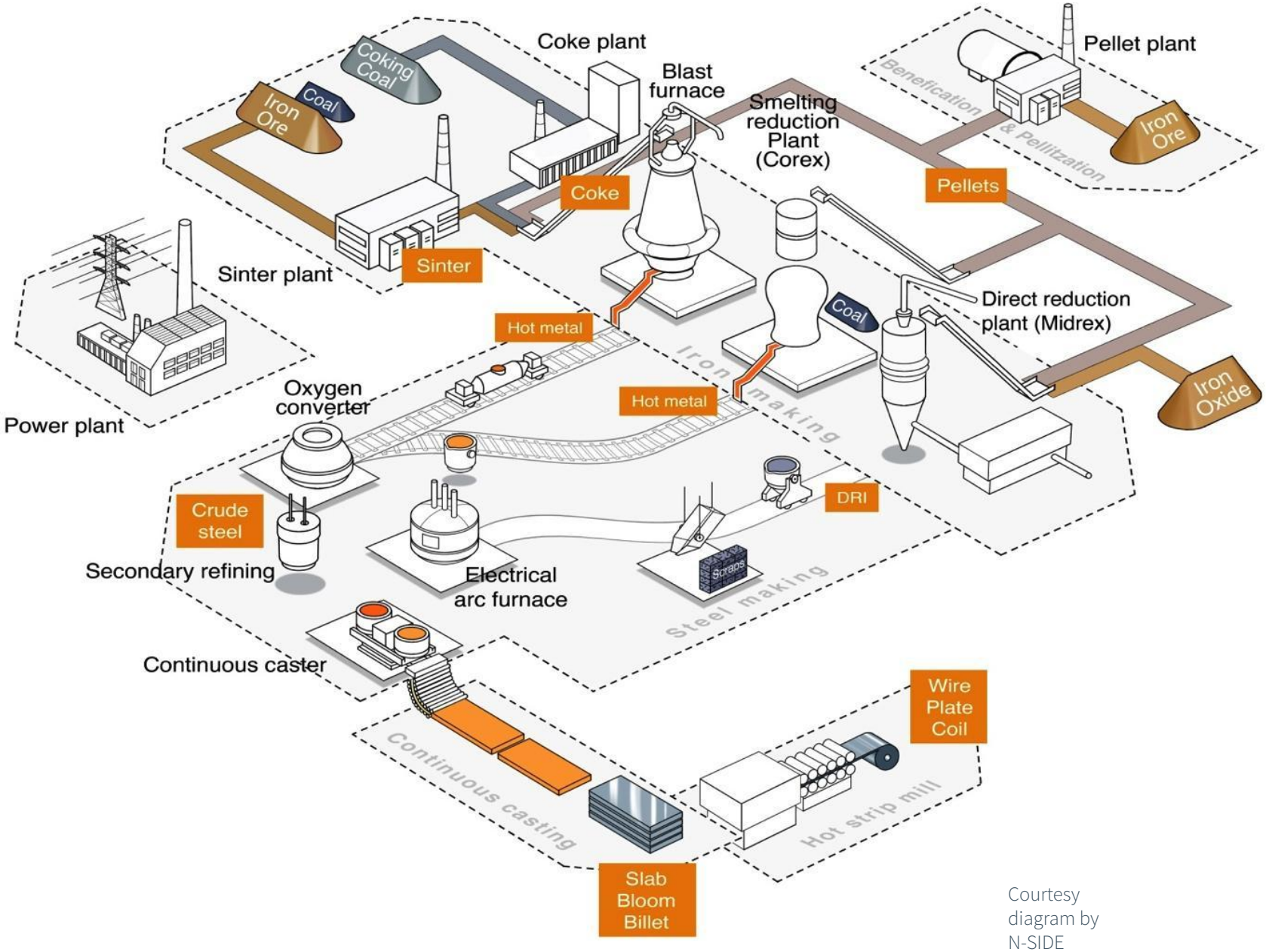
Complex steel value chain

- One big challenge in decarbonizing the iron and steel processes is the complex upstream and downstream interactions and effects of adopting new technologies on the entire value chain.
- The above is further complicated by rapidly changing external conditions such as raw material & carbon pricing, virtual power purchase agreement, and grid emission factors.



Courtesy diagram by N-SIDE

How digital twin can help to investigate the complex steel value chain for decarbonization?

- Working closely with several major resource companies and steel producers, Hatch developed a digital twin model across the entire iron and steel value chain, starting with iron ore agglomeration and ending at liquid steel, based on first principle, mass and energy balances of individual metallurgical processes.
- By developing multiple unit processes and each with multiple process configurations and decarbonization options, this model can simulate many of the most common proposed low-emission process flowsheets.

Type of Iron Ore Feed	Ironmaking Technology	Ironmaking Reductant	Post-DR Operation	Steelmaking Technology	Other Considerations
Sinter Fines	Shaft-based DR Process	Natural Gas Only	Hot-charging □ HDRI	EAF Steelmaking	Quality and volume of slag
BF-grade Pellets		Hydrogen Reduction with NG Carburization	Hot-briquetting □ HBI	BOF Steelmaking	Scrap addition point and ratio
DR-grade Pellets	Fluidized-bed DR Process				Solid waste recycling option
Lump Ore		Hydrogen Only	Electric Smelting Furnace (ESF) Melter □ hot metal / pig iron	ESF Steelmaking	CCUS options
					Biocarbon / biomass usage

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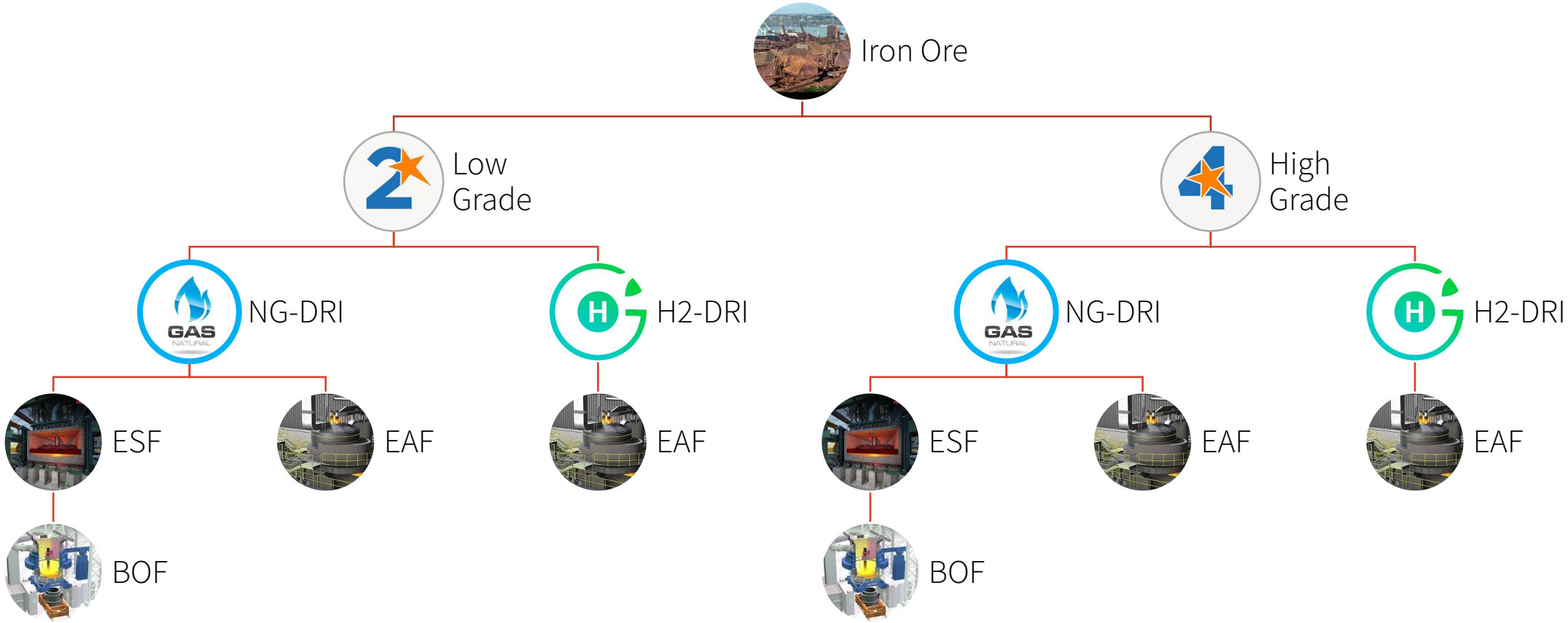
An Illustrative Example



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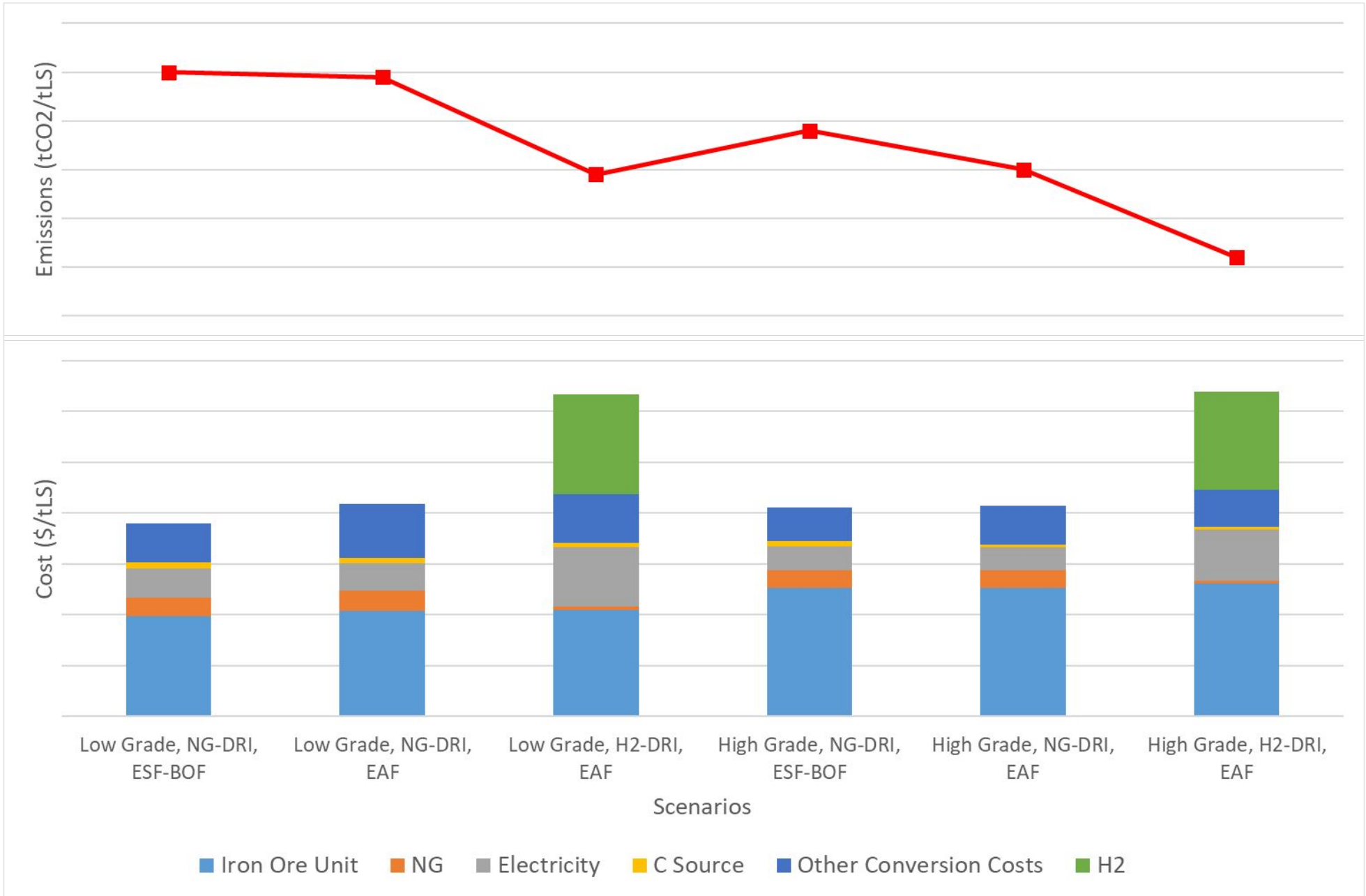

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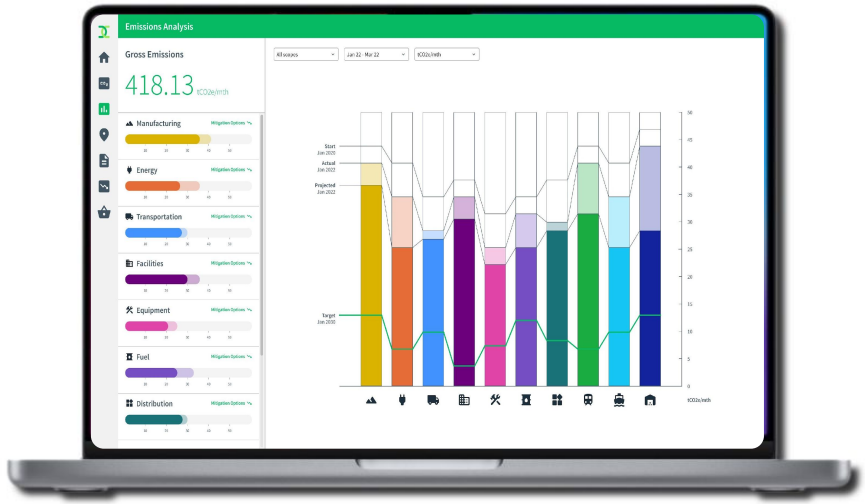
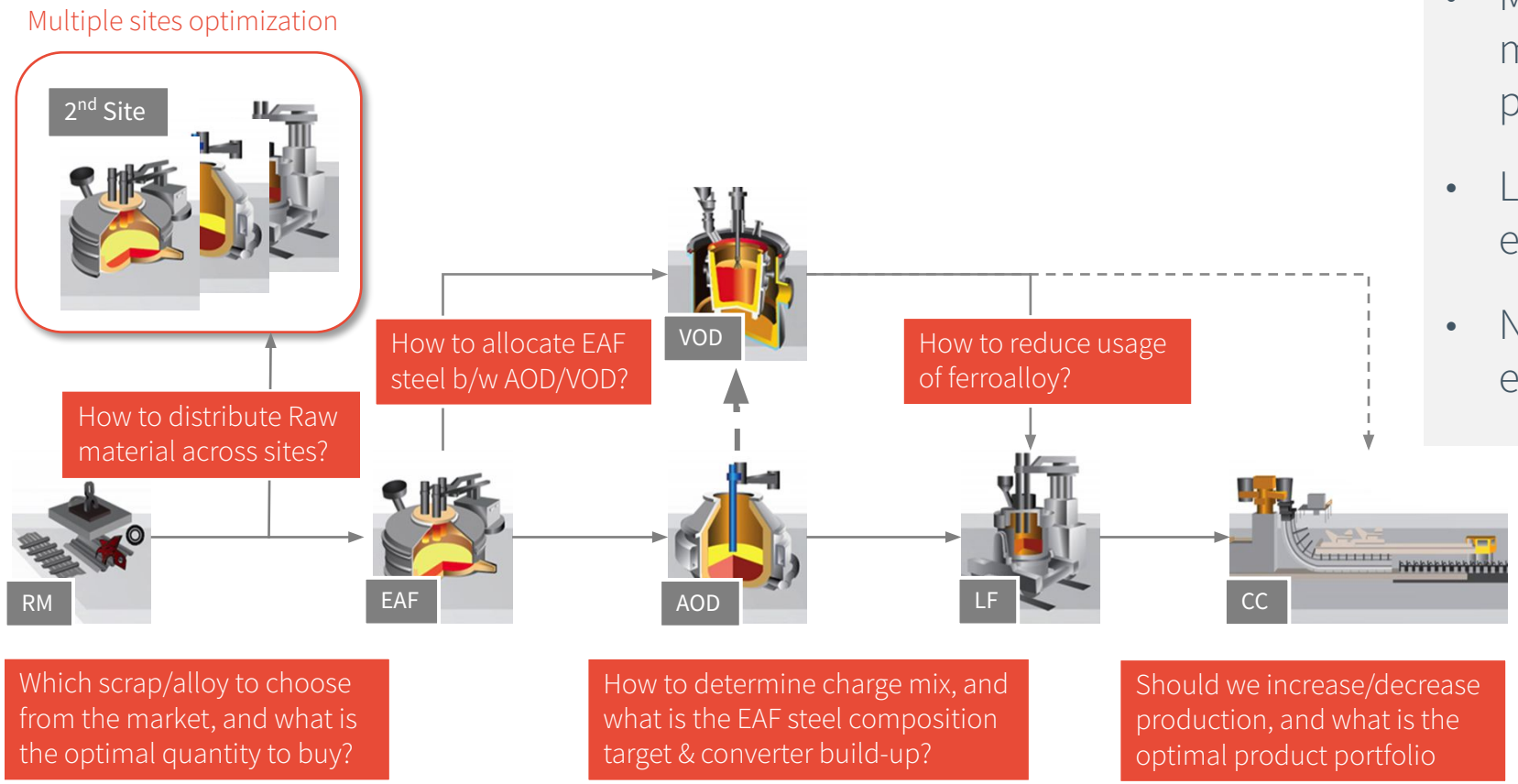
Benefits

- The application of the model, coupled with in-depth technical and economic analysis, was able to help inform the clients on the preferred way to proceed on their respective decarbonization journeys.
- For iron ore producers, an integrated value chain digital twin helped them in understanding how the decarbonization of the iron- and steelmaking processes affects upstream ore demand and specifications.
- For established steel producers, the digital twin can help them quickly compare the various decarbonization options available in a comprehensive way, as well as their cost / emission benefits.
- For stakeholders driven by technology and solution development, this digital twin serves as a holistic analytical tools to identify key hurdles along the value chain, such that focused efforts can be devoted to coming up with the most cost-effective solution.



Case Study 2

Major Challenges in Stainless Steelmaking Processes



- Multiple decisions need to be made simultaneously subject to process and logistic constraints.
- Lack of a holistic view on end-to-end process value chain.
- No visibility to impact on CO2 emission.

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Meltshop 4.0 Solution and Features

Raw Material (RM) Optimization

Evaluate RM in a holistic value chain and decide the best procurement strategy	Suggest the optimal RM mix for different steel grades based on market conditions

Process & Product Mix Optimization

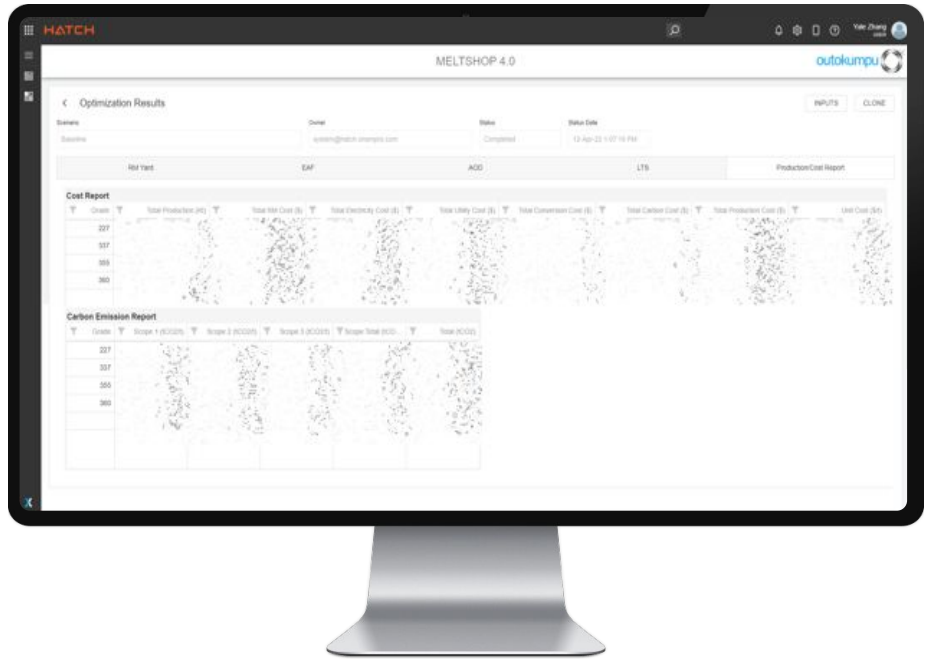
Decide the optimal process parameters such as EAF steel chemistry targets	Optimize overall profitability to determine a better product mix s.t. contract obligations

CO2 Emission Optimization

Calculate Scope 1, 2 and part of Scop 3 carbon emissions for entire value chain	Strike a balance between production cost & CO2 emission in one optimization problem

Optimization Scenario Analysis

Conduct what-if scenario analysis on various optimization strategies	Compare different scenarios easily and identify cost saving opportunities



An integrated production cost and carbon emission optimization solution helping stainless steelmakers save 3-10 $/t in production cost.

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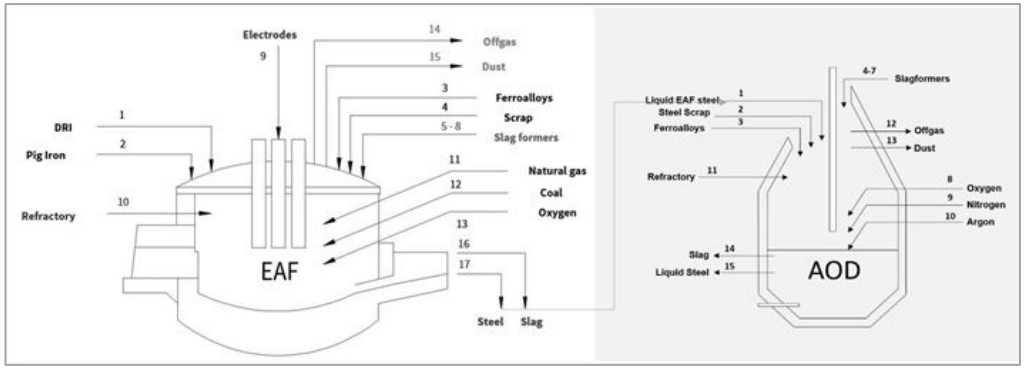
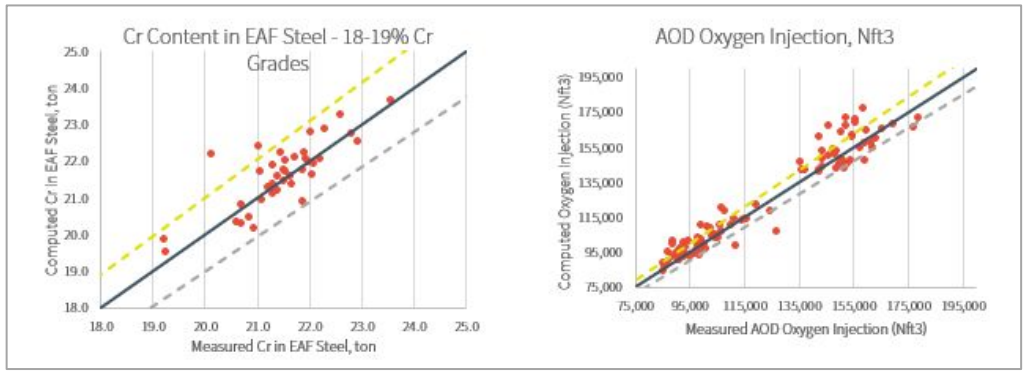
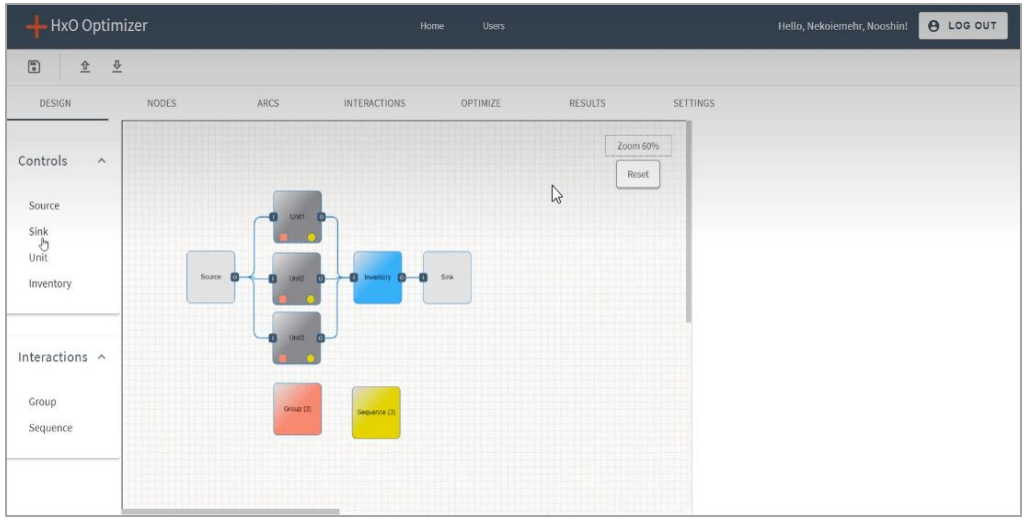
Digital Twin Modeling and Optimization Technology

- Process modeling and calibration approach





- Hatch's own software product dedicated to advanced planning and scheduling
- Built-in features for metallurgical reactions, resource allocation, capacity, inventory and logistic management.



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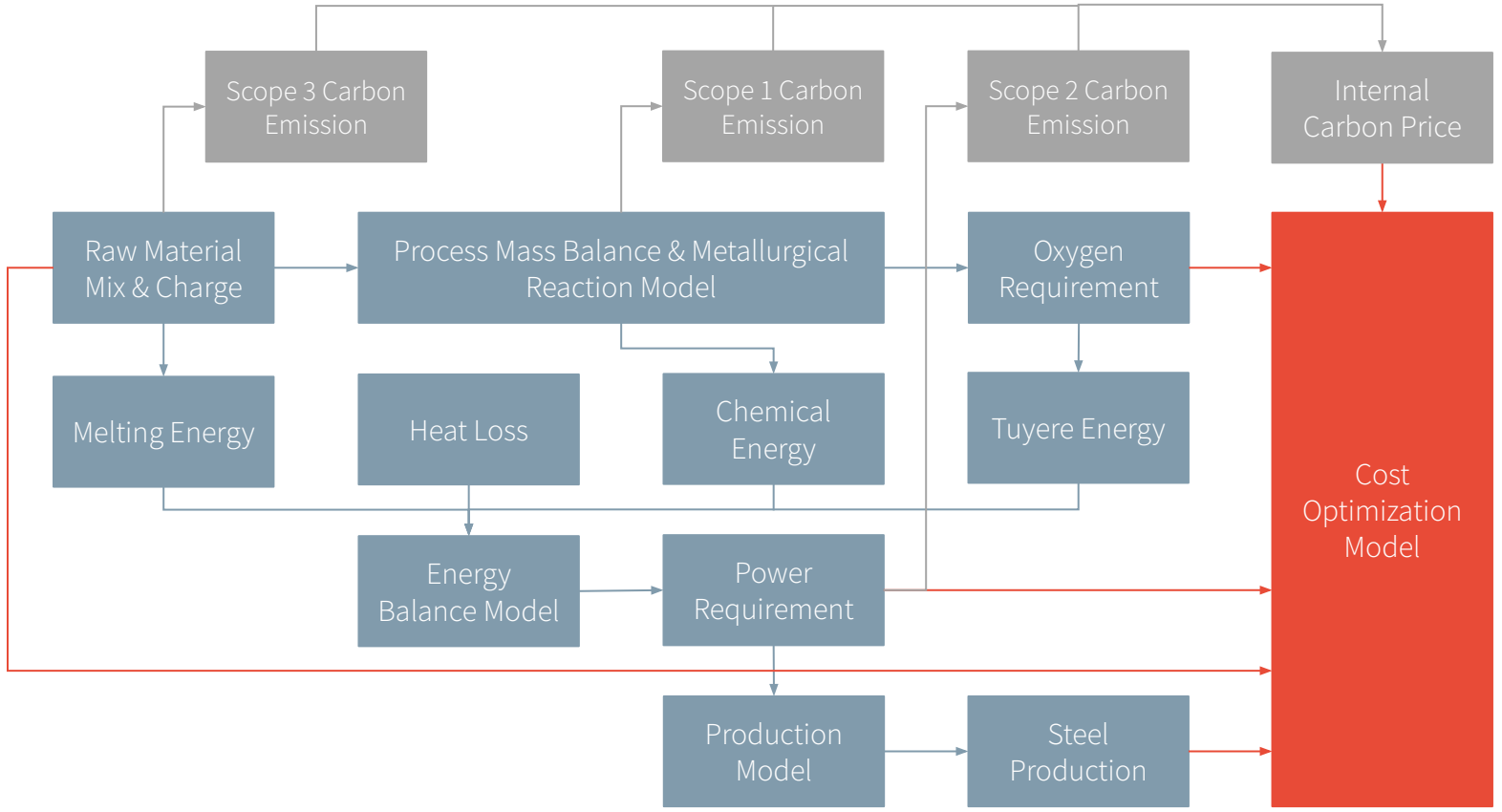
Integrated Cost and Carbon Emission Optimization



1. Visibility of carbon footprint for various steel grades
2. Trade-offs between production cost and carbon emissions
3. Analysis and insight of the impact of carbon tax/price

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Conclusions

- Carbon Twin can help drive and optimize steel plants' decarbonization journey from the following three aspects:
  - Product carbon footprint monitoring and tracking
  - Carbon reduction scenario analysis
  - Integrated cost and carbon emission optimization
- Benefits
  - Streamline reporting processes and meet regulatory requirements
  - Improved carbon transparency at product level for scope 3 reduction and disclosure
  - Better assessment of various decarbonization technology for roadmap development
  - Increased bottom-line profitability

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Thank you.

For more information,
please visit www.hatch.com

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