



中信泰富特钢
CITIC PACIFIC SPECIAL STEEL

InnovCative Coupling of Hydrogen- full Oxygen-Intelligent combustion for Near-Zero Carbon Special Steel

氢氧智慧燃烧新技术耦合创新助力高端特殊钢近零碳制造

CITIC Pacific Special Steel

Leo Luo

2025-12-02



CITIC Pacific Special Steel

- **Highly specialized special steel manufacturer with 9 subsidiaries.**



CITIC Pacific Special Steel

- All of subsidiaries layout along Yangtze River and seaside, with the headquarter in Jiangyin city, Jiangsu province .
- Public company Listed in SZ stock (000708).



CITIC Pacific Special Steel

- **Low-carbon and Sustainability is our core strategy .**



“Green Manufacturing Manufacturing Green”

As one of the leading steel manufacturers in the world, CITIC Pacific Special Steel is always committed to climate protection and implementation of customer's expectation. we have been pursuing reduction of CO2 emissions on a larger scale and fulfillment of Corporate Social Responsibility (CSR).

——Qian Gang, Chairman, CITIC Pacific Special Steel Group

CITIC Pacific Special Steel

- In March.2022, “**Decarbonization Roadmap**” had been issued worldwide to build green competitiveness.

➤ **Vision and responsibility:**

“Green Manufacturing Manufacturing Green”

➤ **Strategy&Goal :**

To achieve “Carbon Peak” Before 2030,

To achieve “Carbon Neutral” before 2060

➤ **Action program:**

Scientific and technological innovation to build green competitiveness



CITIC Pacific Special Steel

- “Green manufacturing Manufacturing Green ”
Innovative action programmes supports climate ambition.

Green Manufacturing Technology

“绿色制造”-技术

节能减排技术 Energy Conservation

- 资源综合应用，清洁生产 C循环经济
- 余热回收
- CCUS

极致能效技术 Extreme Energy Efficiency

- 数智技术、极致电炉技术、极致燃烧
- 技术精益生产技术

先进颠覆性CO₂减排技术 Advanced Low-carbon Metallurgy Technology

- 智慧高炉技术
- 氢冶金技术
- 氢燃烧技术
- 电气化加热技术

Green Manufacturing Product

“绿色制造”-产品

优质产品支撑钢铁使用量降低

Special steel to support reduction of steel usage

- 高强轻量化、长寿命
- 高稳定性、高同质性

优质产品支撑下游加工减排

Special steel to support reduction of emission in downstream processing

- 近终型、高尺寸精度
- 低合金添加
- 免热处理或轻微热处理

Manufacturing Green Product

“制造绿色”-产品

支撑风电、光伏、水电等清洁能源产业链发展绿色材料 Special Steel to support the Development Of Clean Energy:

- 氢能
- 风电
- 水电
- 核电

绿色产业链协同 :协同合作共赢未来

GREEN SYNERGY: Synergy and Cooperation Win Future Together.

CITIC Pacific Special Steel

- **“Scientific & Sustainable decarbonization via cooperative innovation”**
Initiative pushing carbon reduction and economic benefit to go hand in hand.



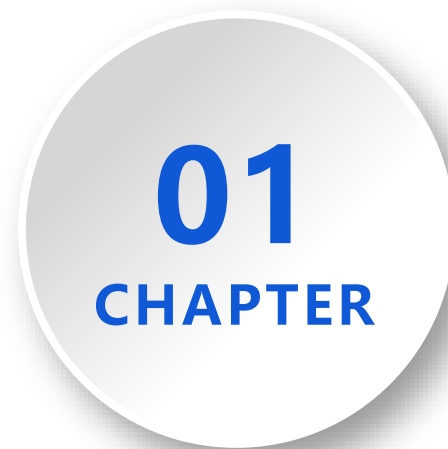
"2024 World Steel Association LCA and Industrial Chain Collaborative Innovation for Low-Carbon Development Conference"

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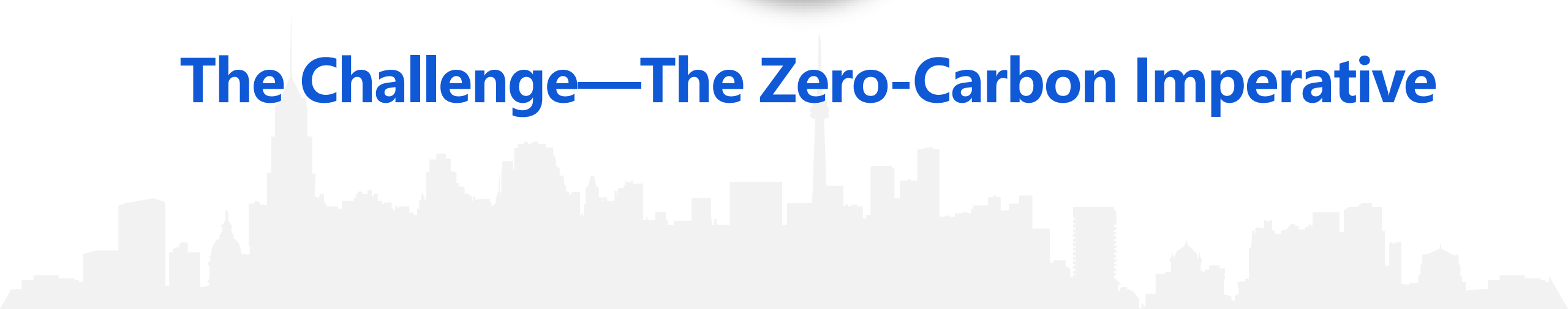
- 1. The Challenge — The Zero-Carbon Imperative**
- 2. The Solution — Combustion Coupling Innovation**
- 3. The Validation — Data & Performance**
- 4. The Future — Vision & Horizons**



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The Challenge—The Zero-Carbon Imperative



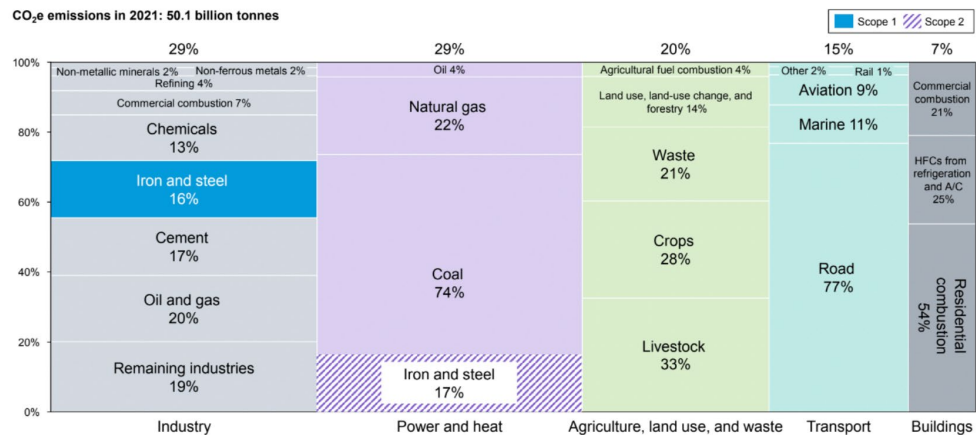
Climate Change 'Biggest Threat Modern Humans Have Ever Faced' .



Low-carbon and sustainable development is definitely the way forward in the future.

The steel industry serves as a cornerstone in the global low carbon transition.

- It is essential that the steel sector reduces its carbon emissions in order to fulfil the goals set out by the Paris Agreement.
- Steel as the basic material must keep development and progress so as to support low-carbon transformation.

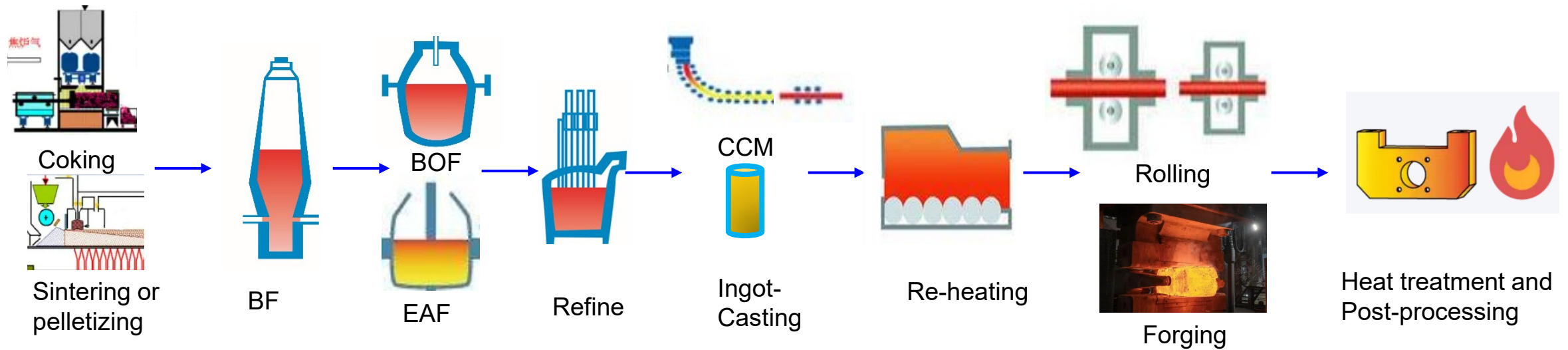


Steel sector scope 1 and 2 emissions account 10% of global emissions
source:<https://business.columbia.edu/insights/climate/cki/steel>



Steel as basic material support the development of advanced equipment for low-carbon transformation

The traditional metallurgical theory and technology based on carbon-oxygen reaction are the main cause of high carbon emissions



It is essential to improve the metallurgical theory and technology aimed for low-carbon.

"Replacing 'C' with 'H' " has emerged as the linchpin for the steel industry to achieve near-zero-carbon manufacturing.

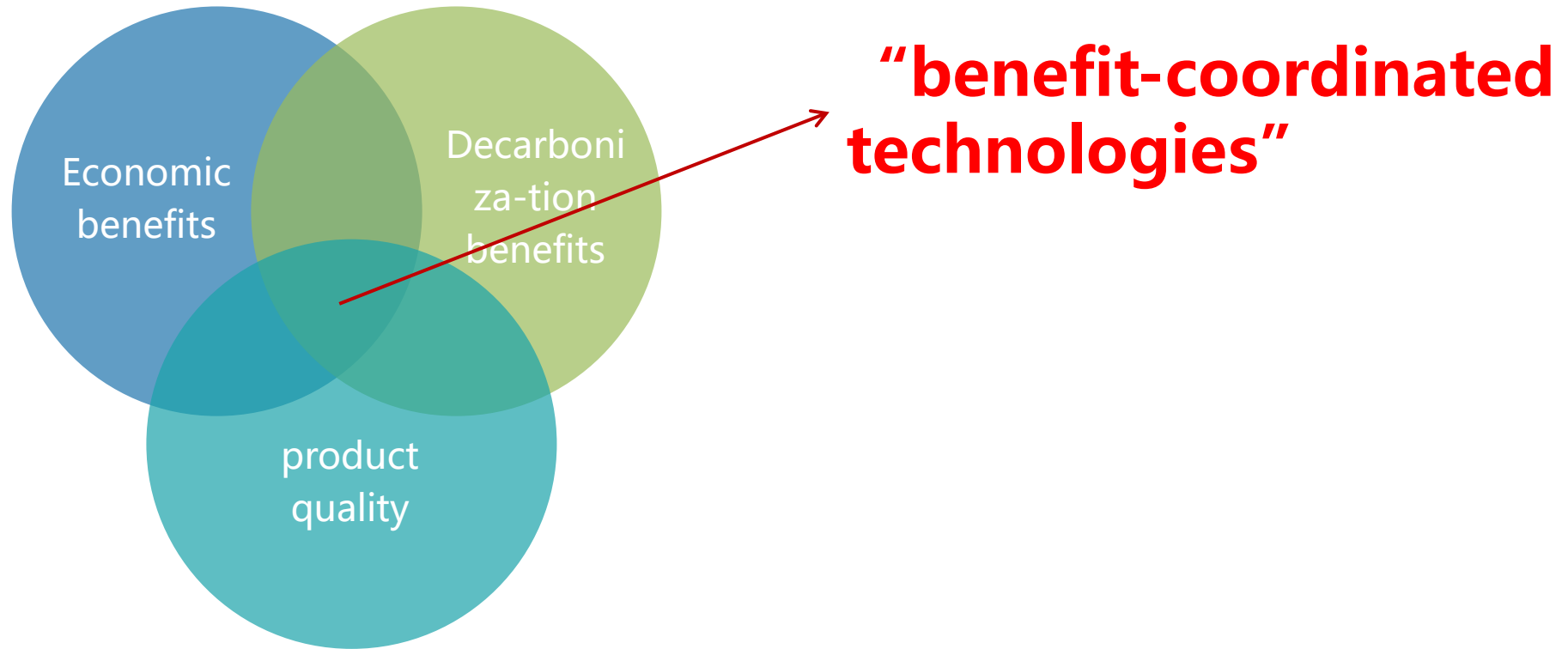


S.N	Key R&D Project for "Replacing 'C' with 'H' "
1	Advanced special steel for clean energy equipment(Including for Hydrogen)
2	Hydrogen Tech. (covering entire hydrogen Energy Industry Chain)
3	Hydrogen Metallurgy Technology
4	Hydrogen combustion
5	Hydrogen energy storage

Clean energy and hydrogen technology are crucial supports.

Combustion: The Industrial Heart of Steelmaking

— A Core Lever Controlling Cost, Decarbonization, and Product Quality



Efficient and high-quality heating is crucial for the performance, quality, energy conservation, and environmental sustainability of special steel.

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02 CHAPTER

The Solution — Combustion Coupling Innovation



Explore the mysteries of near-zero-carbon manufacturing related to combustion.



Pure Hydrogen
Zero-CO₂
Combustion



Productivity
and Efficiency

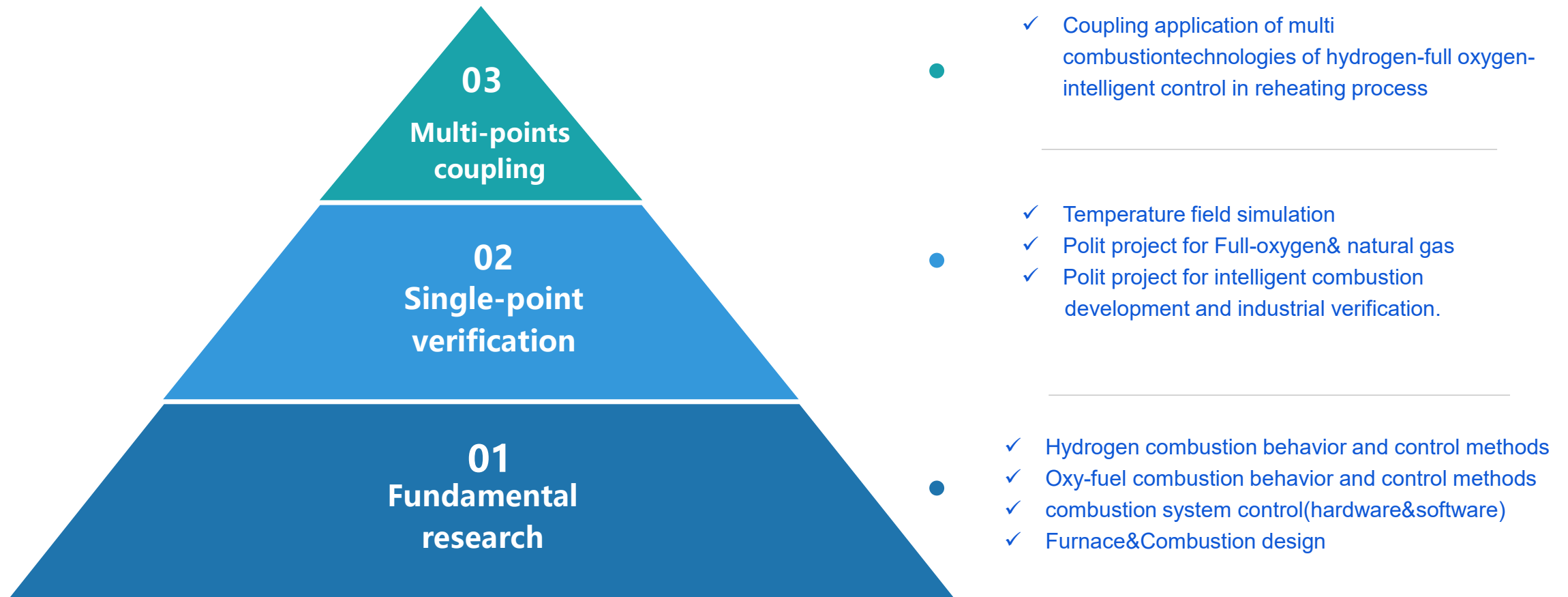


zero
CO₂
Production

NO adverse effects on
the process and the
quality of special steel.

While conducting research on individual technologies, such as hydrogen combustion behavior and control methods, industrial verification and multi-technology coupling should also be carried out.

Three level R&D system consisting of basic research, single-point verification, and multi-point coupling



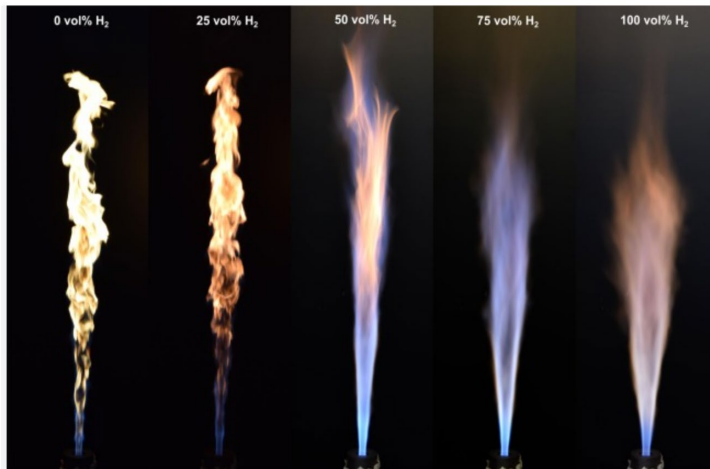
Hydrogen — the cornerstone of zero-carbon combustion

- **Hydrogen combustion behavior**

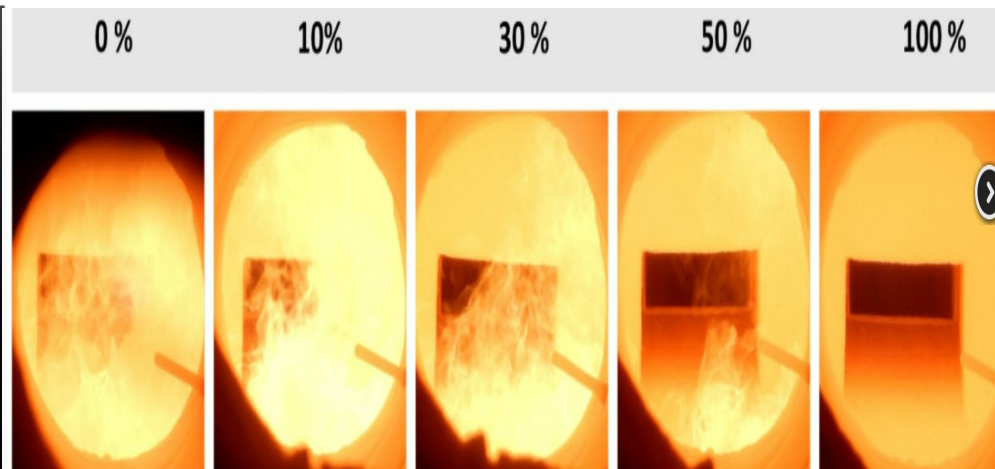
- ✓ high energy density, high combustion efficiency and zero carbon emissions
- ✓ Flammable, explosive, and prone to leakage
- ✓ Fast burning speed, high temperature, flameless, and hydrogen embrittlement for facility

- **New hydrogen combustion burner**

- ✓ Non-premixed combustion with low-flow dynamic flow restriction
- ✓ Burner AI Self-Testing System, Burner Dynamic Change Detection
- ✓ Make combustion safer, more controllable and more reliable;



Full-oxygen combustion with increased H_2 concentration



Air-Fuel combustion with increased H_2 concentration



All-hydrogen combustion burner

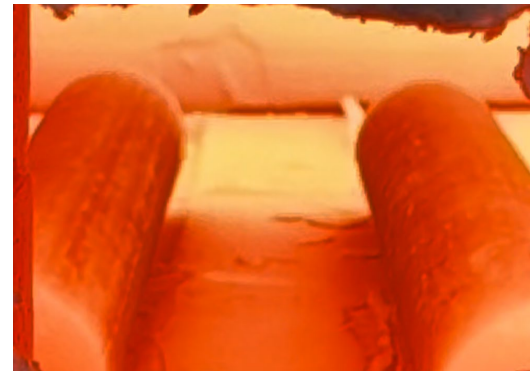
Oxy-fuel combustion — a multiplier for efficiency and environmental protection.

- **Oxy-fuel combustion Behavior**

- ✓ high thermal efficiency, low fuel consumption, no nitrogen oxides
- ✓ low burner lifespan, uneven heating under low gas flow conditions
- ✓ difficult to control furnace atmosphere and steel quality due to flue gas composition changes

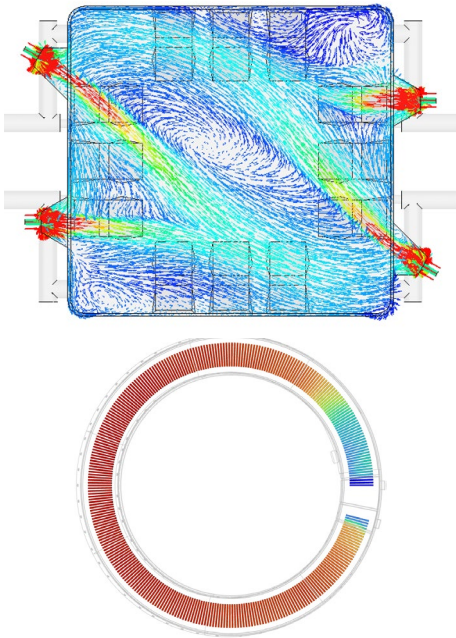
- **New combustion burner and control system**

- ✓ The novel design enables low-flow flameless combustion, eliminates carbon deposition.
- ✓ Heat transfer modes and control system
- ✓ Independent & precise control of individual burners

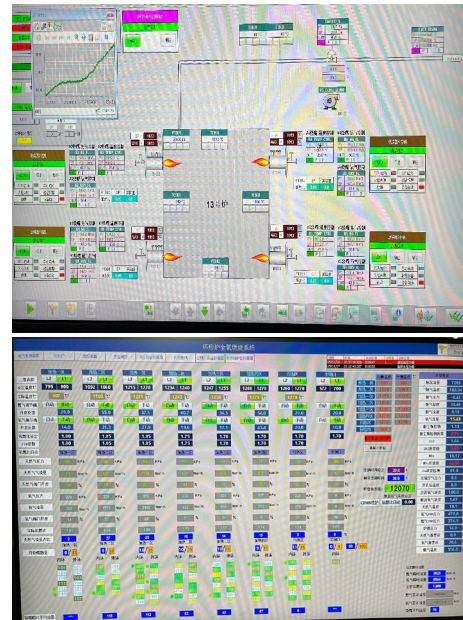


Intelligence — the stable and optimized brain of the system

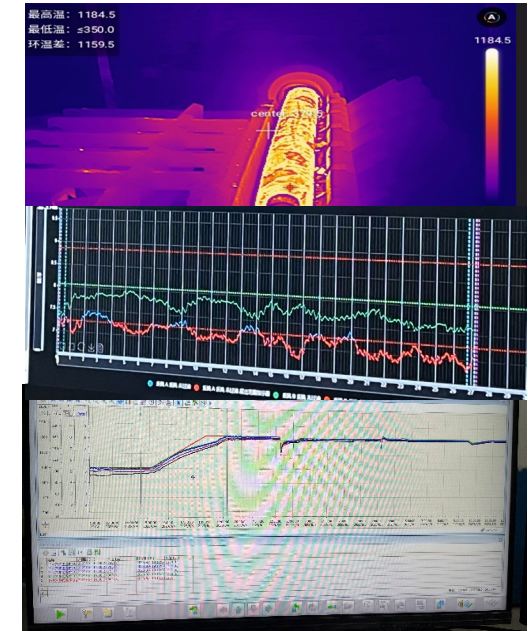
- Software and hardware work together to make up the full "Intelligent Combustion" system, turning it into a kind of living whole that can sense itself, make decisions, get better over time, and even evolve.
- **Hardware:** Combustion process sensor, Process and environmental sensors, Precision control valves and actuators, Intelligent burner, DCS.....
- **Software:** SCADA ,Data history database,Digital Twin Platform,MPC,artificial intelligent.....



Customized simulation calculation



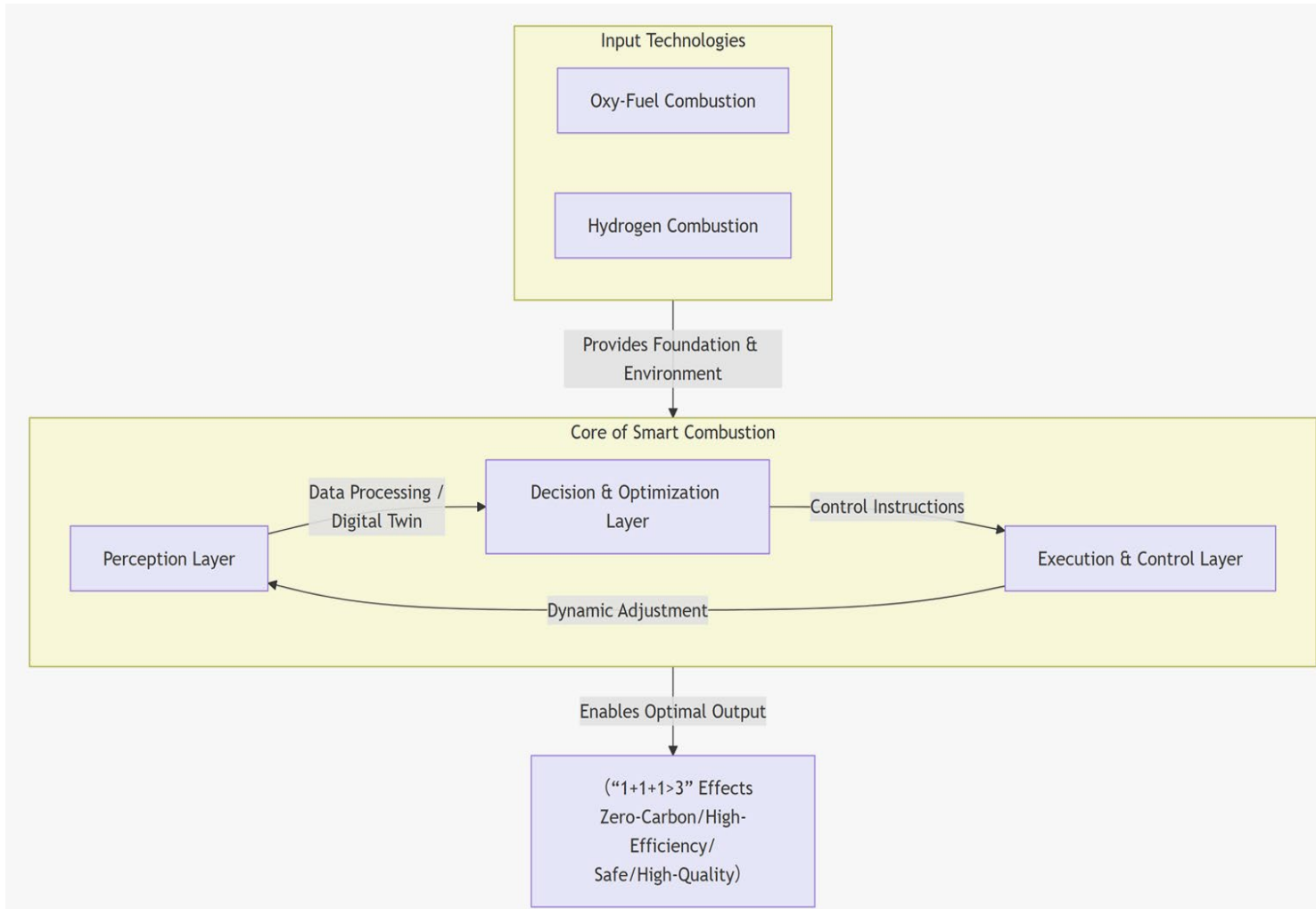
AI data feedback adjustment



Three-dimensional pre-positioned
3D data combination

Coupled Innovation: Systemic Breakthrough of $1 + 1 + 1 > 3$

Coupling relationship diagram

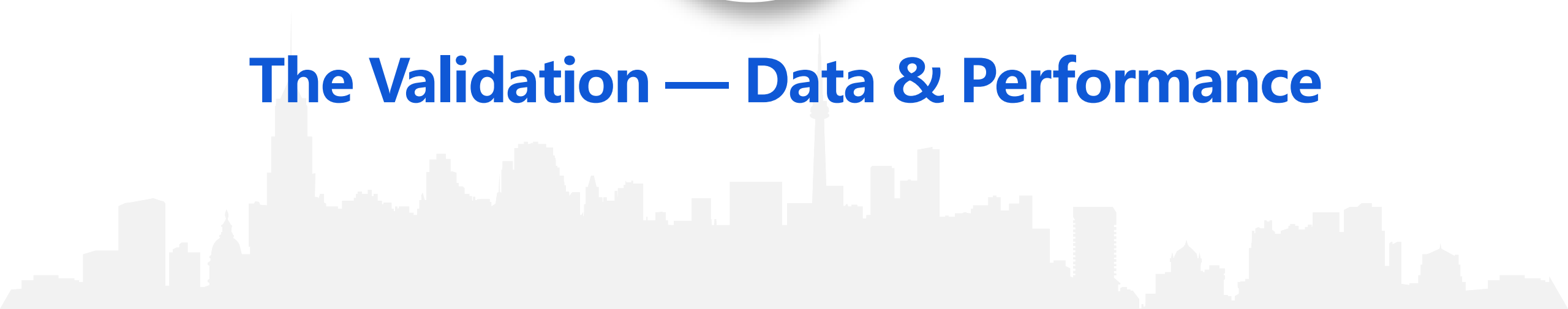


- Through systematic integration and intelligent regulation, the three combustion technologies are deeply coupled to achieve a qualitative transformation from "complementarity" to "synergy" .

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The Validation — Data & Performance



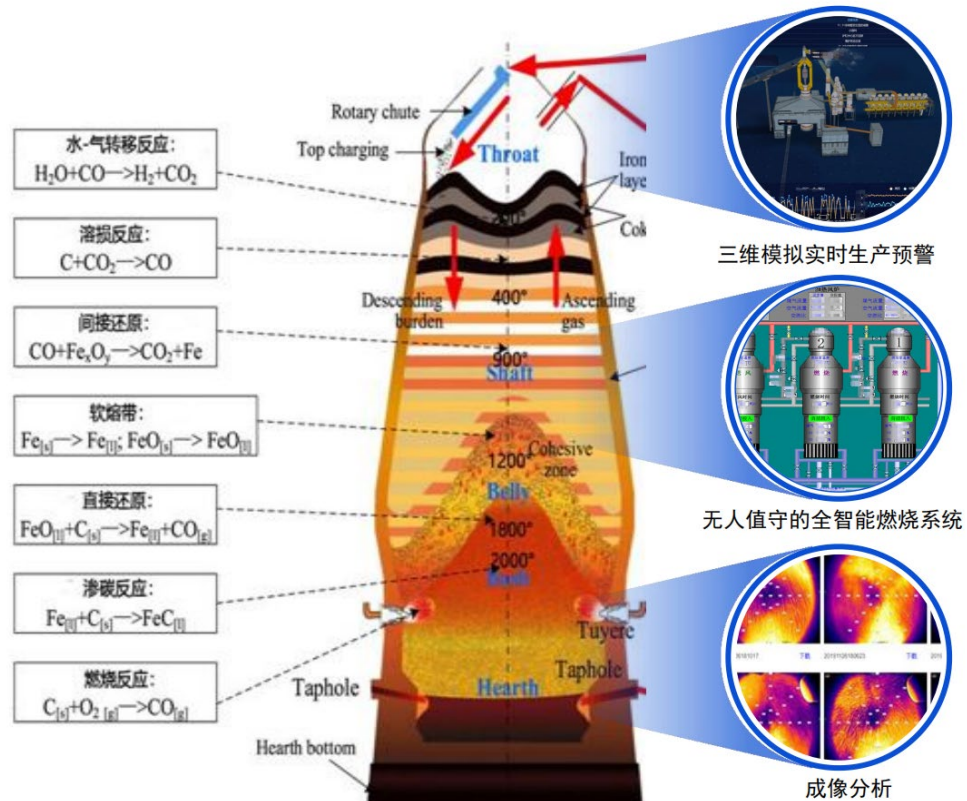
Engineering study and verification separately for Oxy-fuel combustion, intelligent combustion



Category	Metric	Improvement
Environmental	NOx emissions	$\leq 100 \text{ mg/m}^3$ ($\downarrow > 50\%$)
Operational	Fuel consumption	$\downarrow 28\%$ (initial target: 20%)
	Natural gas saved	6M m^3 /year ($\approx 7,200 \text{ tce}$)
	Flue gas volume	$\downarrow > 70\%$
	Scaling loss	$\downarrow 0.15\text{-}0.2\%$
Economic	Gas cost savings	¥1.74M/year
	Gov't subsidy	¥8.35M
	Power savings	5.8 kWh/t-steel
quality	Temperature uniformity:	$\leq \pm 10^\circ\text{C}$,
	reduction of iron oxide scale	$\geq 10\%$

Polit project for Oxy-fuel combustion : TPCO 168# Mill Annular Furnace

Engineering study and verification separately for Oxy-fuel combustion, intelligent combustion



Furnace temperature anomaly reduced **84.8%**



Substandard molten iron rate decreased **23.4%**



Coke consumption decreased **19.1%**

Pilot project for Intelligent Combustion : JYXC steel Blast Furnace

Typical Sub-project: Coupling application of multi combustion technologies of hydrogen-full oxygen-intelligent control in reheating process



Site:Daye Special Steel Company

Product: Bearing Steel for Wind turbine bearing

Process route: EAF -refine-Ingot casting-
reheating-rolling-heat treatment-rough grinding-
delivery

(Green Energy+100% recycled steel)

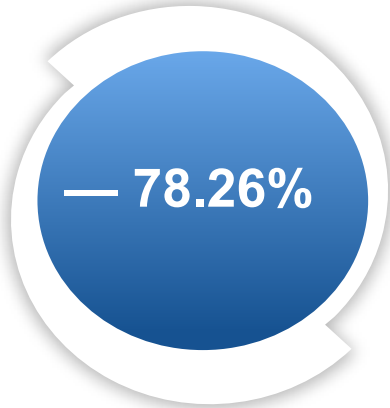
Typical Sub-project: Coupling application of multi combustion technologies of hydrogen-full oxygen-intelligent control in reheating process

Project effect evaluation by LCA with Scope: Scope1+Scope 2

Item	Operation Condition	Process Consumption (Nm ³ /tsteel)	Process CO ₂ (kgCO ₂ e/t steel)	Process CO ₂ emission reduction (kgCO ₂ e/t steel)	Process CO ₂ emission reduction (%)	product CO ₂ emissions intensity (Scope1+Scope2) (kgCO ₂ e/t steel)	Reduction of product CO ₂ emissions intensity (Scope1+Scope2) (%)	Process Cost-Saving (RMB/tsteel)	Process Cost-Saving (%)	Note
Conventional reheating soaking pit	Mixed gas+air+ Normal control	Mixed gas : 450	443.79							
New reheating soaking pit (Routine Operation)	Industrial by-product hydrogen+ all Oxygen+ intelligent control	Coke oven gas: 85.22 Oxygen: 76.51	96.48	347.31	78.26%	817.47	29.97%	95.81	35.20%	1. Before CO ₂ emissions intensity of product: 1158.78kg CO ₂ e/t (Scope1+Scope2,using 100% recycle steel,mixed gas)
Net-Zero Emission soaking pit	Green hydrogen+ all Green Oxygen+ intelligent control (Green Energy)	Green hydrogen: 108.97 Green Oxygen: 54.48	0	443.79	100.00%	386.21	53.46%	-42.66	-44.61%	1. Green hydrogen price:2RMB/Nm ³ 2. Before CO ₂ emissions intensity of product: 830kg CO ₂ e/t (Scope1+Scope2,using 100% recycle steel+100% Green energy +mix gas)

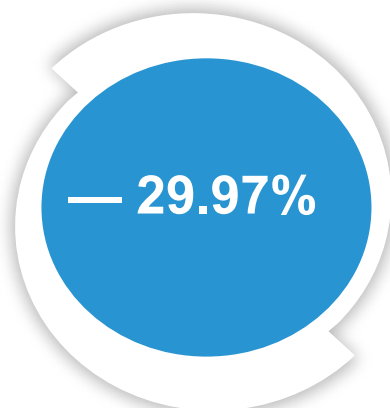
Typical Sub-project: Coupling application of multi combustion technologies of hydrogen-full oxygen-intelligent control in reheating process

- **Economic Mode : with Industrial by- product hydrogen**



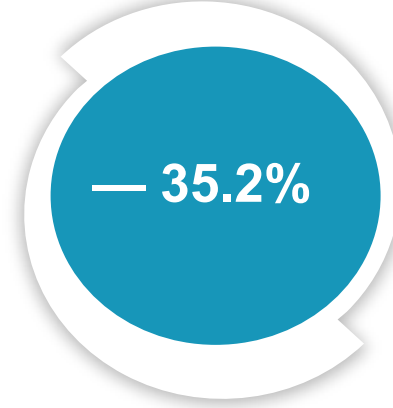
Process CO₂ emission

96.48 kgCO₂e/t steel ,
reduced by 78.26%



Product CO₂ emission

817.47kgCO₂e/t steel, reduced
by 29.97%



Cost

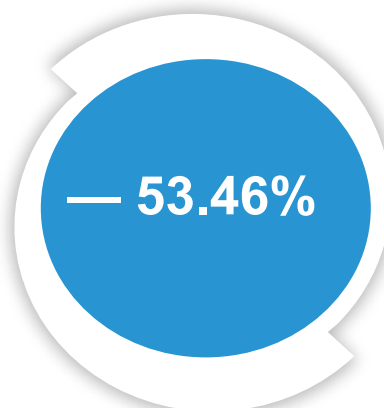
saving by 35.2 %

Typical Sub-project: Coupling application of multi combustion technologies of hydrogen-full oxygen-intelligent control in reheating process

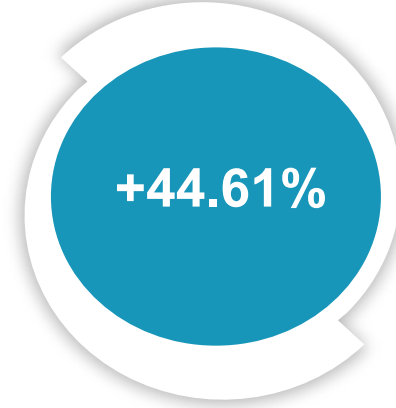
- **Net-Zero Emission Mode : with Green hydrogen**



Process CO₂ emission
0 kgCO₂e/t steel , reduced
by 100%



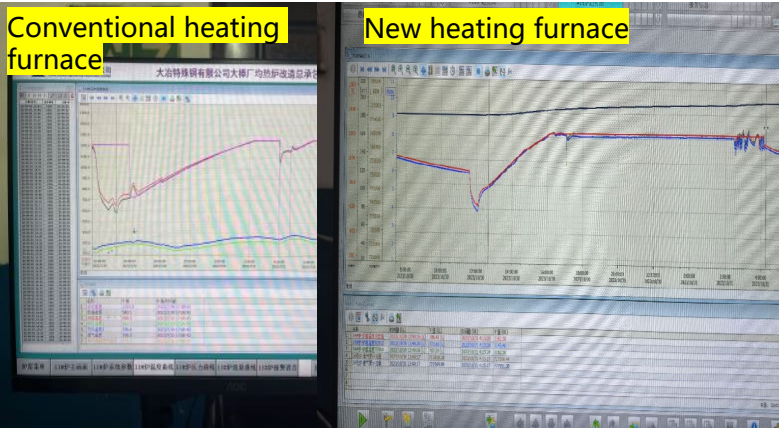
Product CO₂ emission
386.21kgCO₂e/t
steelsteel, reduced by 53.46%



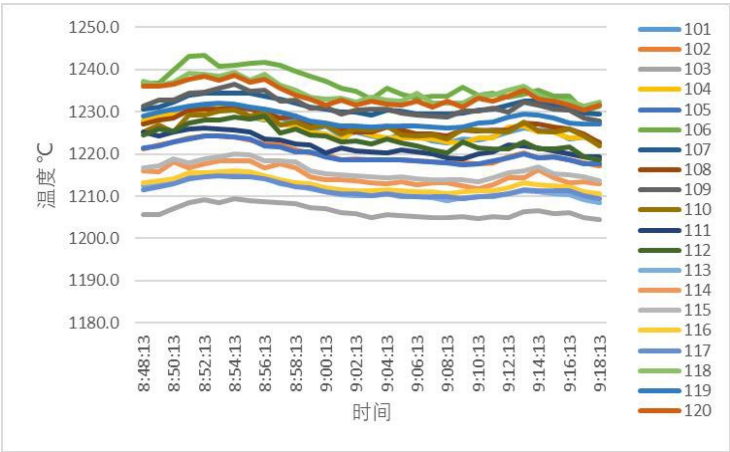
Cost
increased by 44.61 %

Typical Sub-project: Coupling application of multi combustion technologies of hydrogen-full oxygen-intelligent control in reheating process

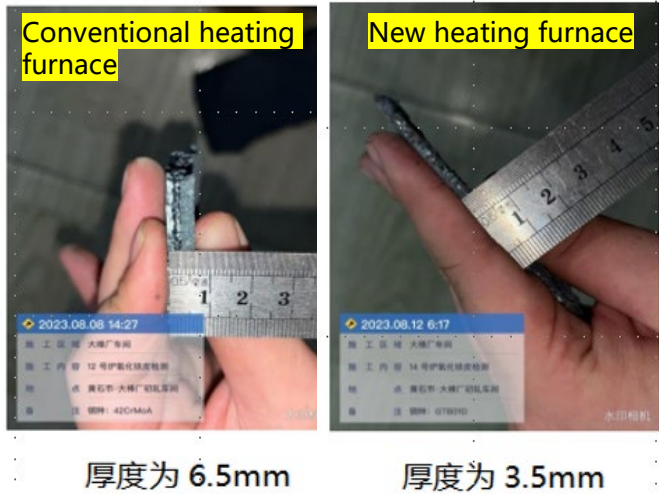
- **Combustion quality performance**



Heating rate: Increased by 22.73%, reducing the time billets stay in the furnace, shortening the production cycle and increasing output.



Temperature uniformity: (+23.9°C to -26.4°C), providing more precise process temperature control.

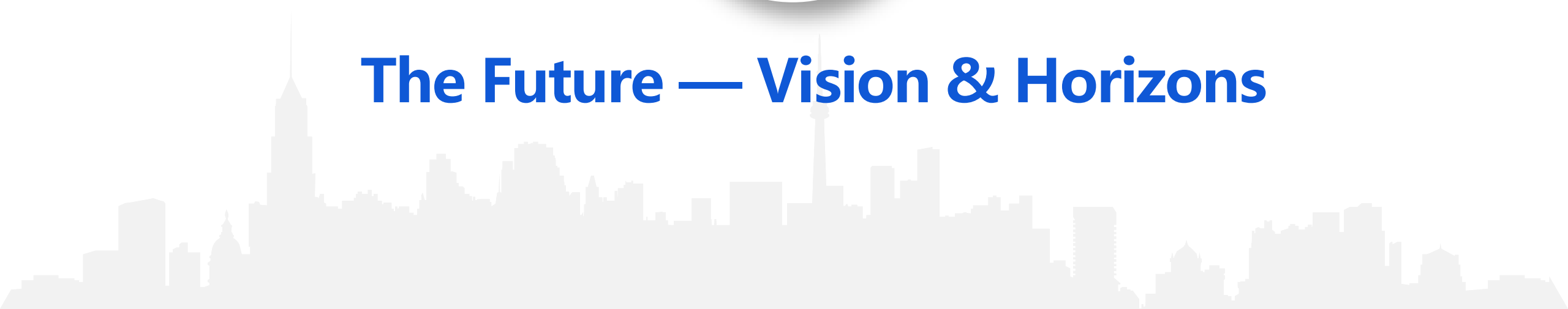


Iron oxide scale: average thickness less than 2mm, thickness reduction approximately 31.7%.

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The Future — Vision & Horizons



Acknowledgements

Jiangyin Xingcheng Special Steel, Daye Special Steel, Tianjin Steel Pipe, Germany Linde, Naging Linpu, CITIC Energy Conservation, Sinosteel Thermal Energy Design Institute.



Cooperation & Expectation

In the future, we look forward to strengthening research and collaboration in the field of combustion with all sectors of society, working together to build a green, low-carbon, and sustainable future.



Better Together



绿色制造 制造绿色

Green Manufacturing Manufacturing Green