

New Breakthroughs in Lean Ultra High Strength Sheet Steel through EAF-CSP route Guaranteeing Outstanding Formability and Steel Quality.

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First Steelmaking Facility in NA to achieve site certification from Responsible Steel in 2022, the industry's first Global Certification initiative for responsible sourcing and production of Steel.



OSCEOLA

★ St. Louis

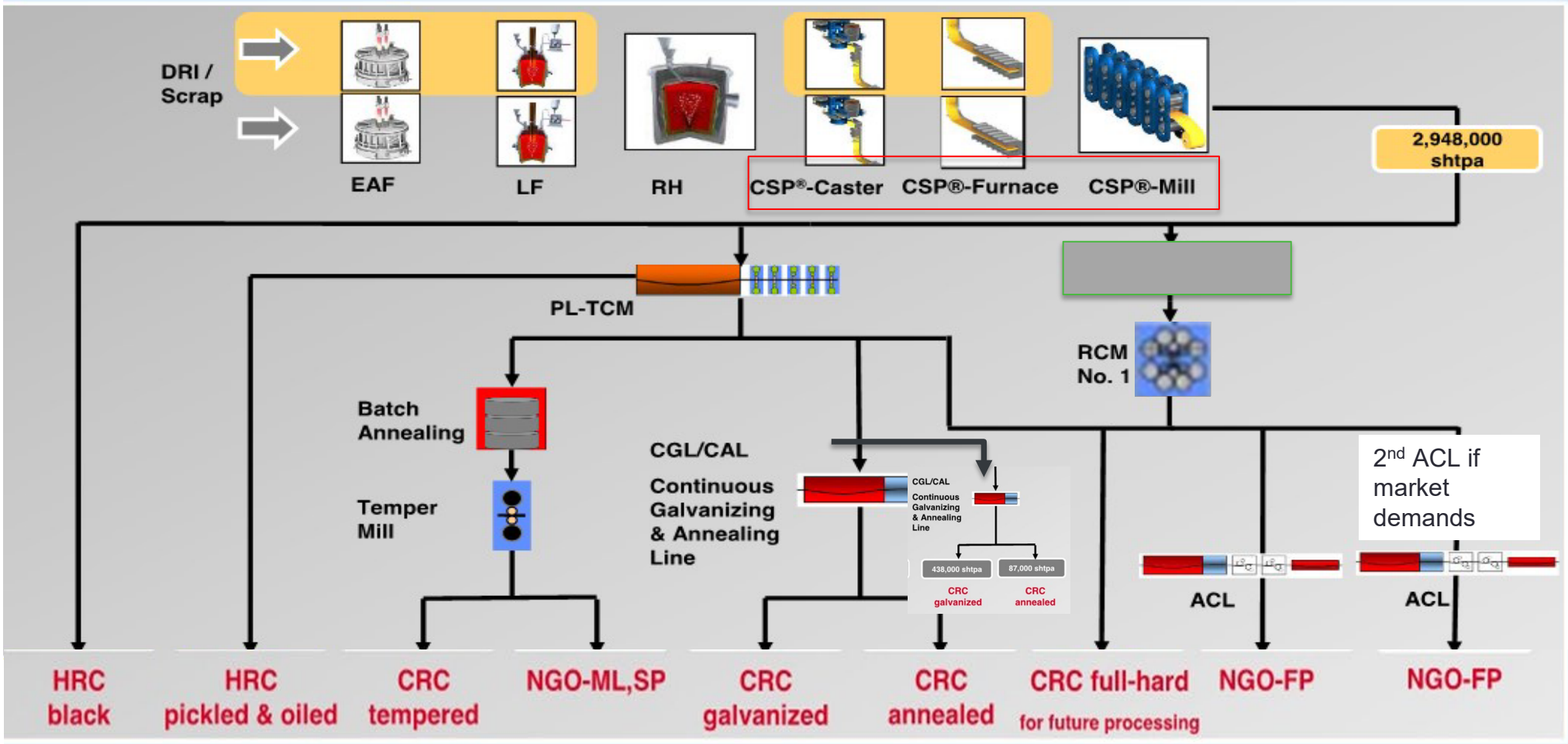
★ Nashville

★ Memphis

★ Little Rock

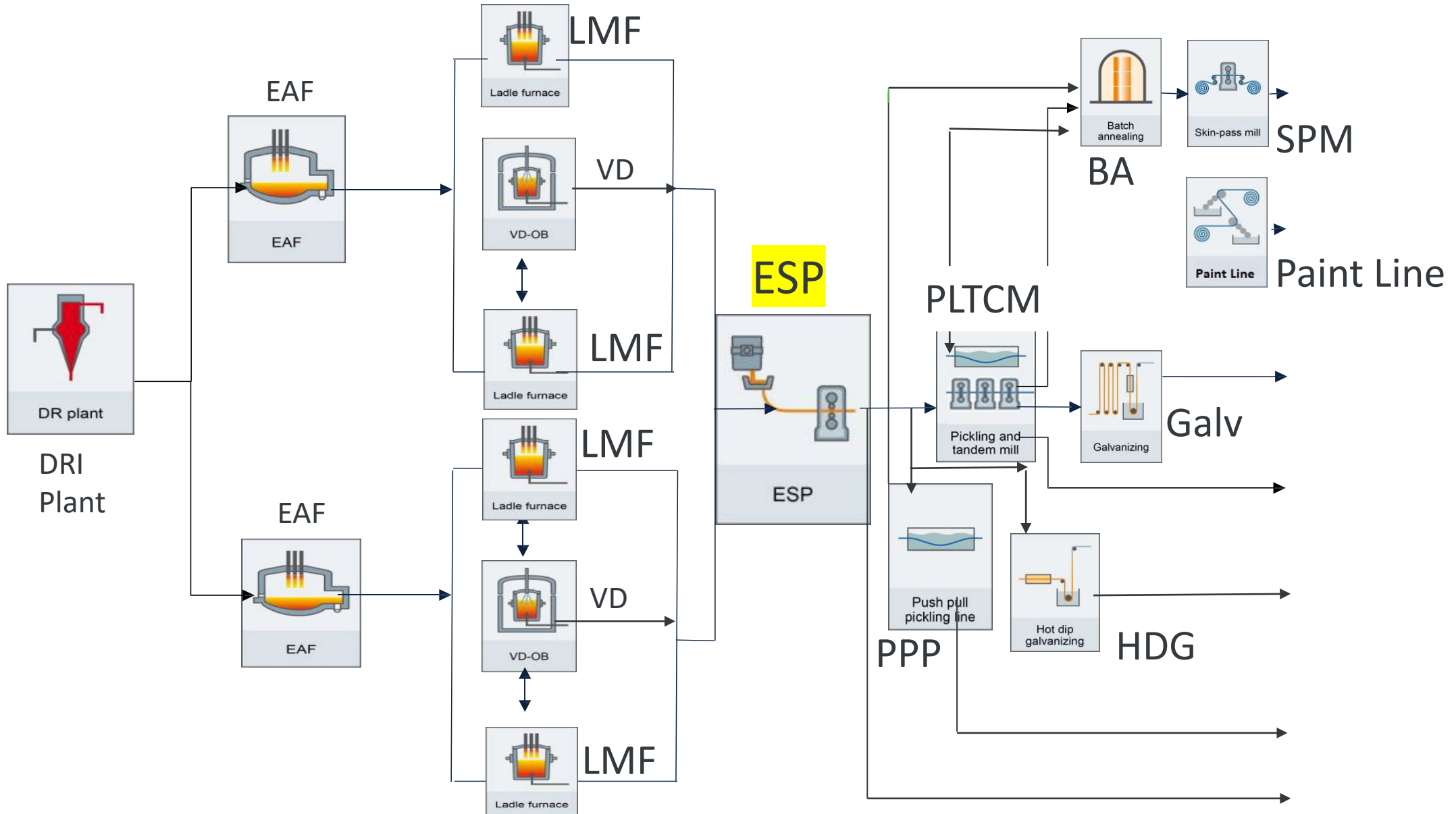


BRS CURRENT PRODUCTION LINE UP 3.0 MT



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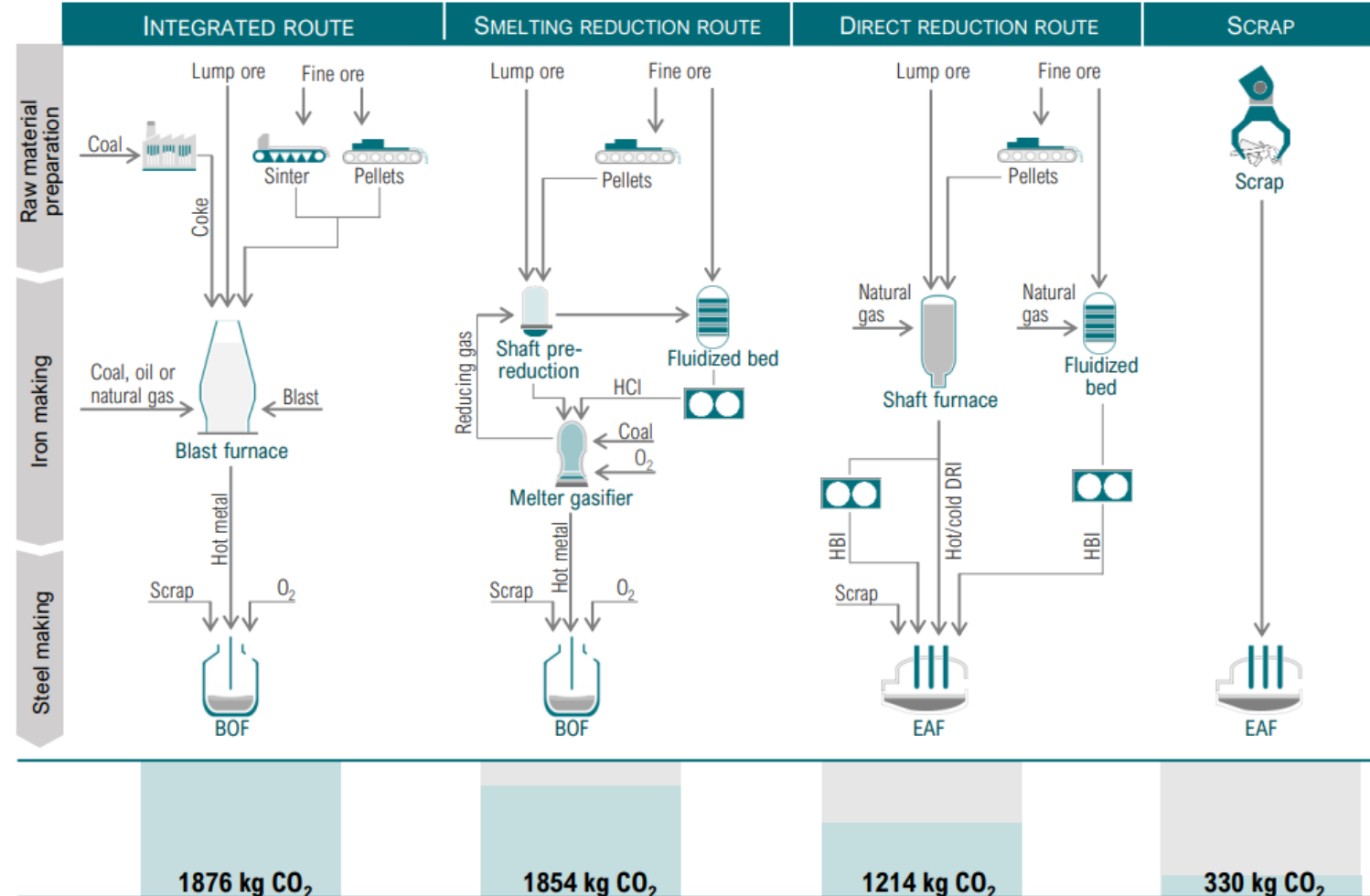
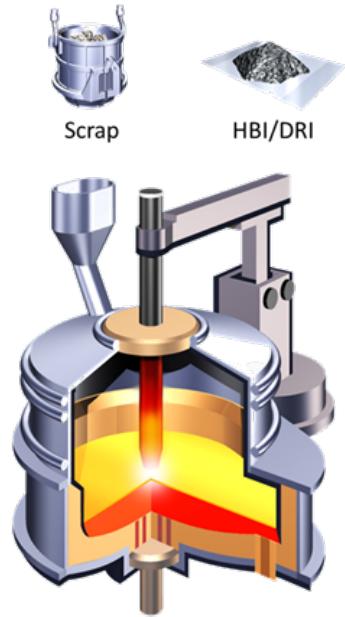
BRS 2 Line Up: 2.8MT



Big River Steel – EAF Steelmaking and CO₂ Reduction



A Total of 6MT of Steel Production
All through EAF



Emissions per t crude steel

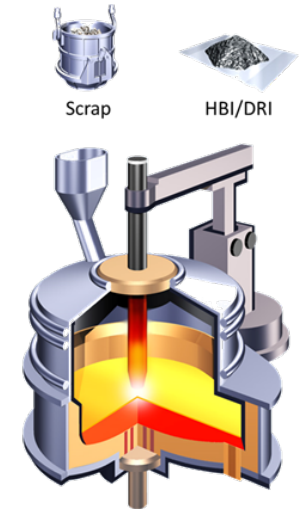
Reference: Stahlinstitut VDEh

Emissions from EAF almost 1/6th of Integrated Route of Steelmaking

Our Process at Big River Steel _____ 410kg /ton of HM

Some Unique Features at BRS

- **DC furnace technology** for reduced flicker and high-power input rates with low secondary electrical losses
 - ❖ Foamy Slag Practice ensures **Shielding of Arc, heat conservation**
 - ❖ **Higher Heat Efficiency,**
 - ❖ Increased **Refractory Life,**
 - ❖ Minimize **Nitrogen intake**
- **Eccentric Bottom Tapping (EBT)** to tap heats nearly slag free in 35-45 minutes or less
- **Designed to operate on scrap** or using continuous roof feeding of DRI/HBI
- Sufficient furnace volume to accept Single bucket scrap charge
- Sidewall injection devices for foaming slag and chemical energy



Big River Steel – EAF Steelmaking

Our EAF Charge mix

- Scrap
- Pig Iron
- HBI

Cu is the main driving element to decide the charge mix

- **Low Cu** Charge mix
 - Virgin Metallics, Pig + HBI < 42%
 - Scrap
- **High Cu** Charge mix
 - Virgin Metallics, Pig + HBI < 30%
 - Scrap

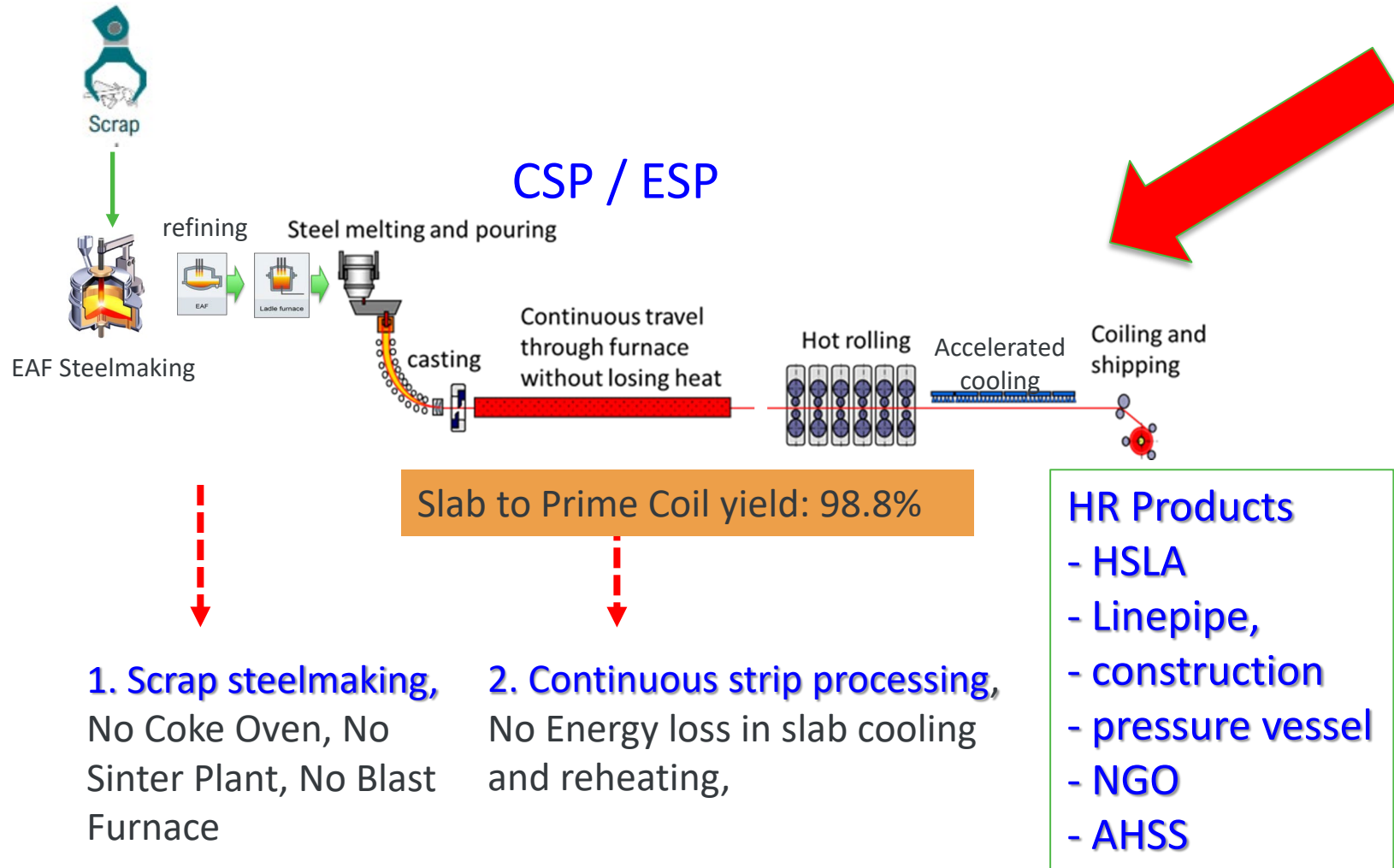
Nitrogen Control through Charge Mix and Degassing

Challenges & Opportunities for CSPs

- *Too many Recipes*
- *Switching back and forth between Recipes*
- *Scheduling*
- *Order Book and Grades*

Big River Steel – Process and Product Innovations

Further Downstream Energy Savings



Because of Continuous nature of Processing Immense Technological Opportunities exist in Leaning Down Chemistries and Casting difficult-to-cast AHSS Steels and make Breakthroughs

Lets talk about One

Product Development Breakthrough: Background

Current Perspectives in Auto Steel Demand

- Higher Strength,
- Higher Formability specifically high edge stretchability
- Low-C Steelmaking i.e., Greener steel

Steels with > 450MPa > More than 54% of Lightweighting



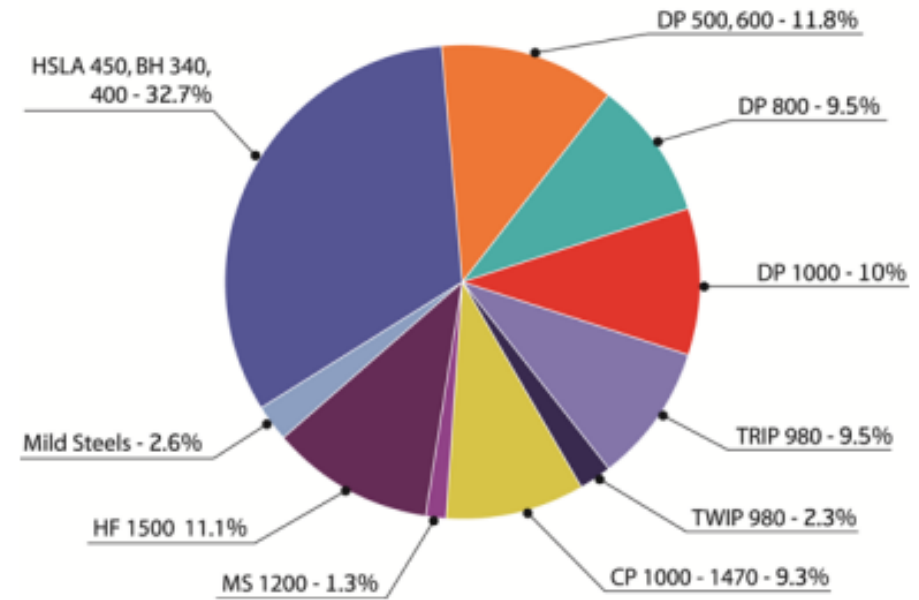
25% with HSLA/AHSS steels
with Tensile Strength up to 800MPa



Catered by

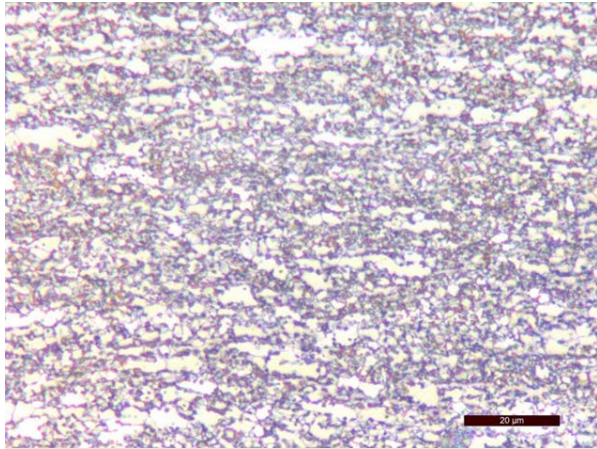
- HSLA, Dual-phase steels, MP (Multi-phase),
FB (Ferritic-Bainitic steels)

FSV BEV Steel Types
as % of Body Structure Mass

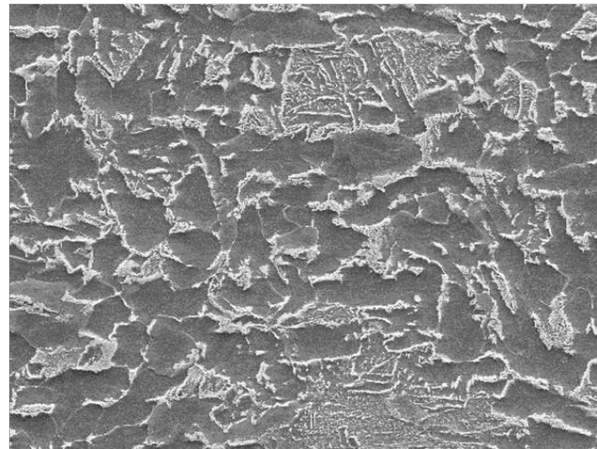


Worldautosteel.org

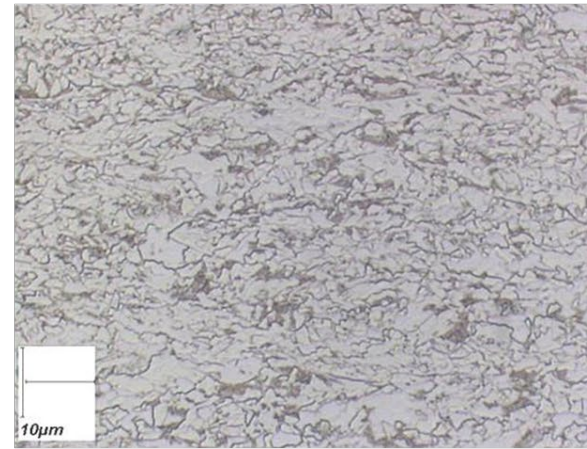
Product Innovation Breakthroughs: Background



Dual-Phase (F+M)



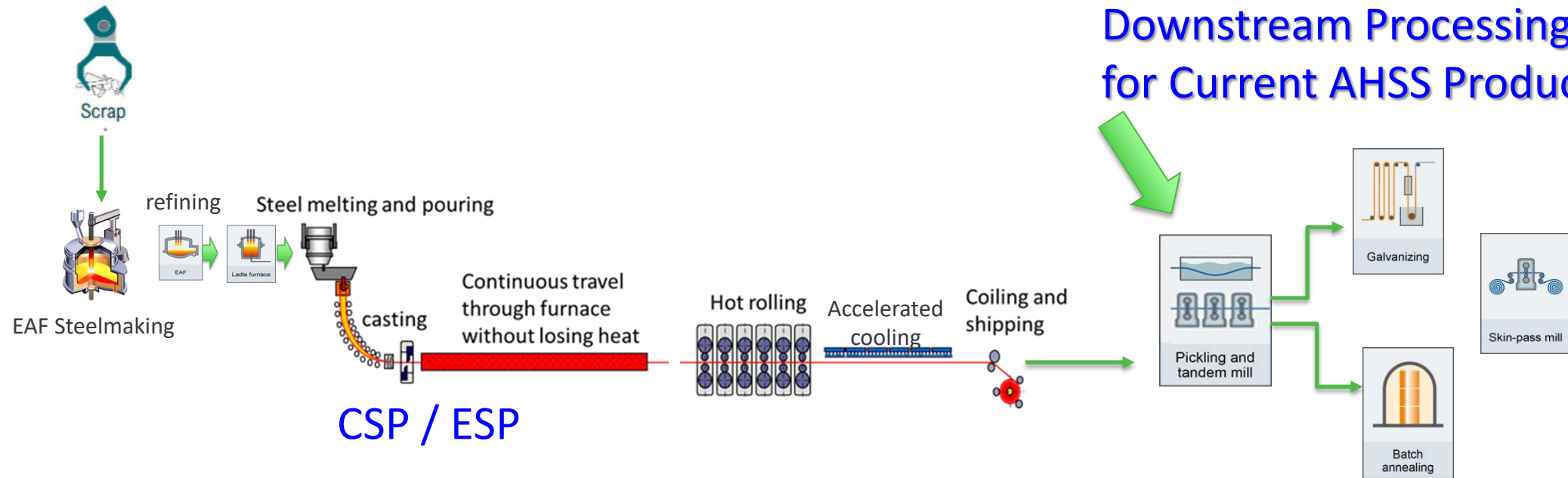
Ferritic-Bainite (F+B)



Complex phase (F/B/M/RA)

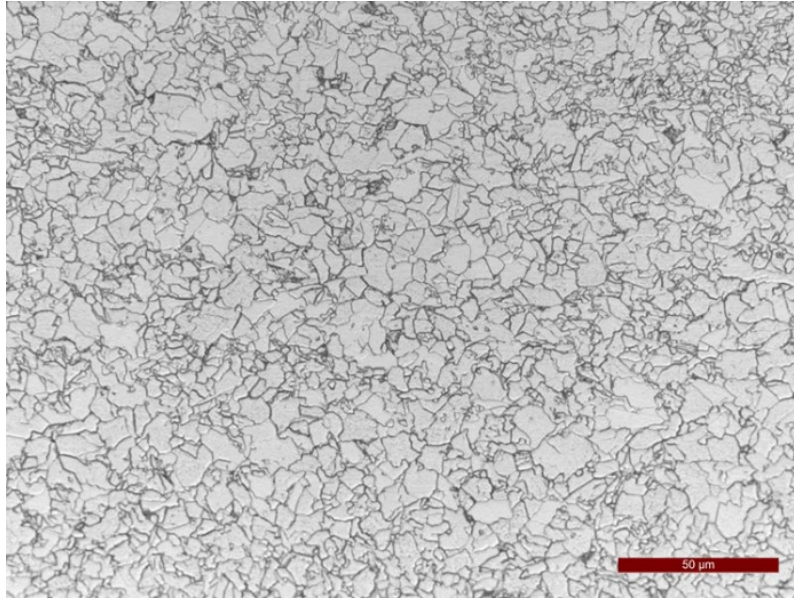
High Cost of Alloying -
High Cost of Production -
High Maintenance Steels

Downstream Processing Needed
for Current AHSS Production

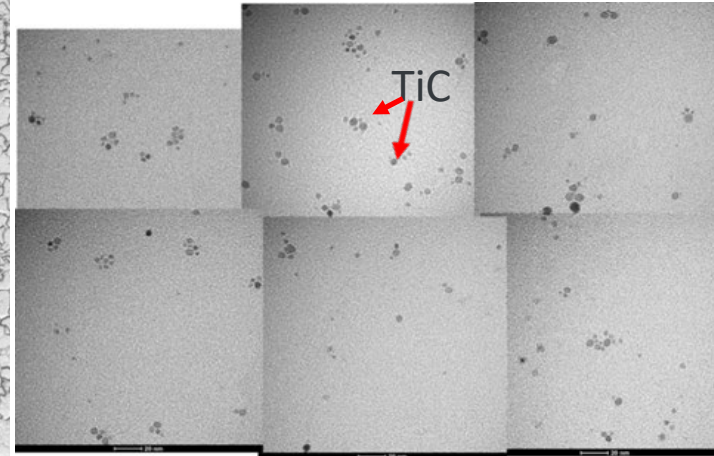


Product Development Breakthrough

A Lean, Low-Carbon, Completely Ferritic Steel Strengthened by Nano-precipitates has been developed to cater to AHSS steels with up to 780MPa tensile Strength and Outstanding HER. Promises to replace costlier, highly alloyed and process-expensive DP, CP, FB Steels.



Fine Ferritic Matrix, $d_{av} \sim 4\mu m$



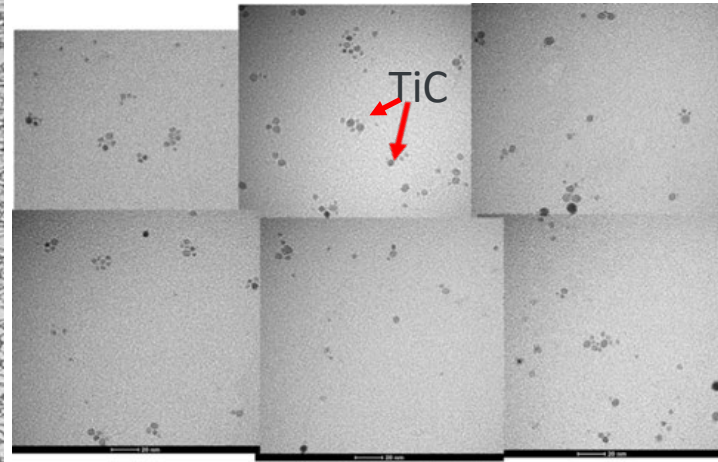
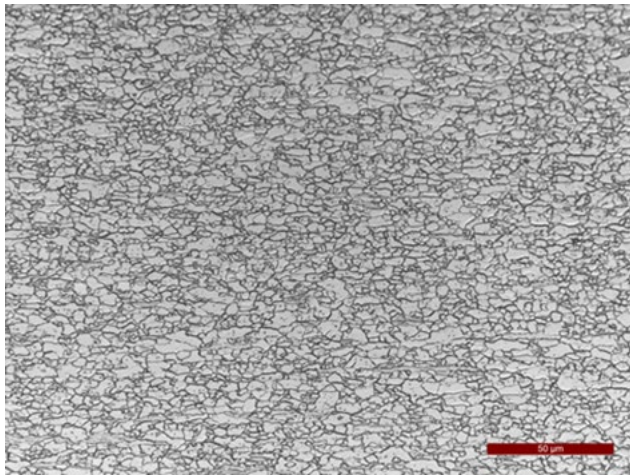
TiC Nano-precipitates, 4nm

Advantages

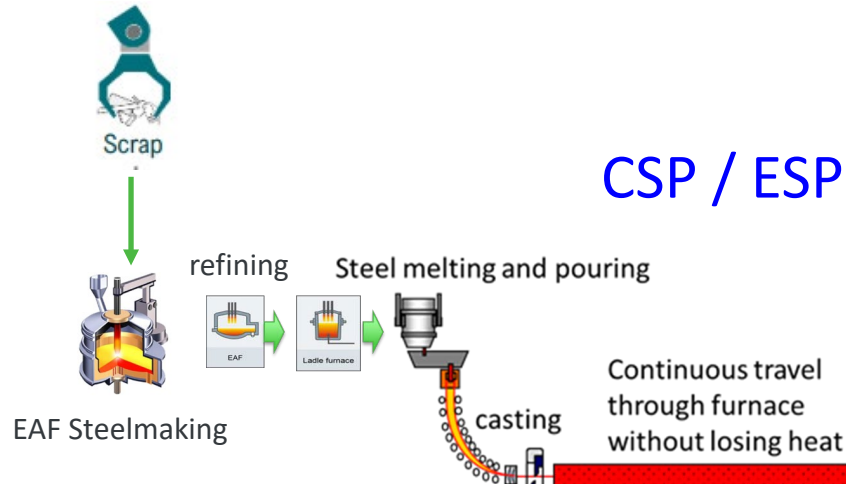
- ❖ No-centerline segregation,
- ❖ No banded microstructure,
- ❖ No second phase hard constituents,
- ❖ Least Carbon Equivalence for enhanced, easy weldability

Steel	C	Mn	P	S	Ti	N
SP590-SP780	0.060	1.10-1.50	0.015	0.003	0.10 -0.15	0.009

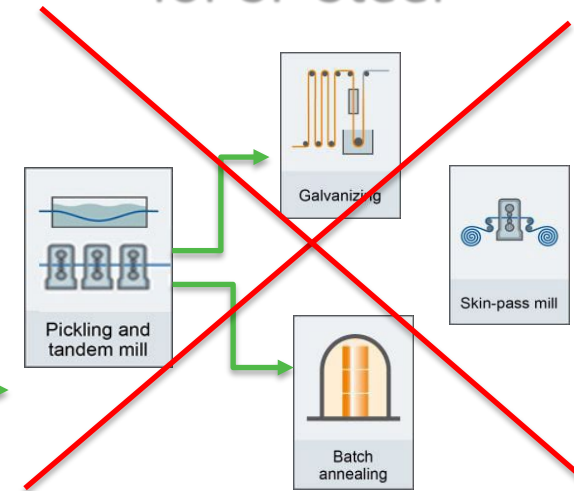
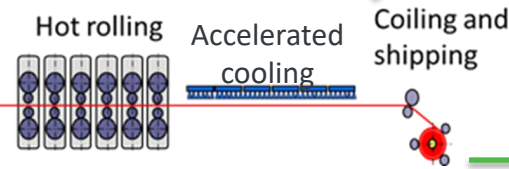
Product Innovation Breakthroughs: SP Steel



SP Nano-Precipitate Strengthened Steel

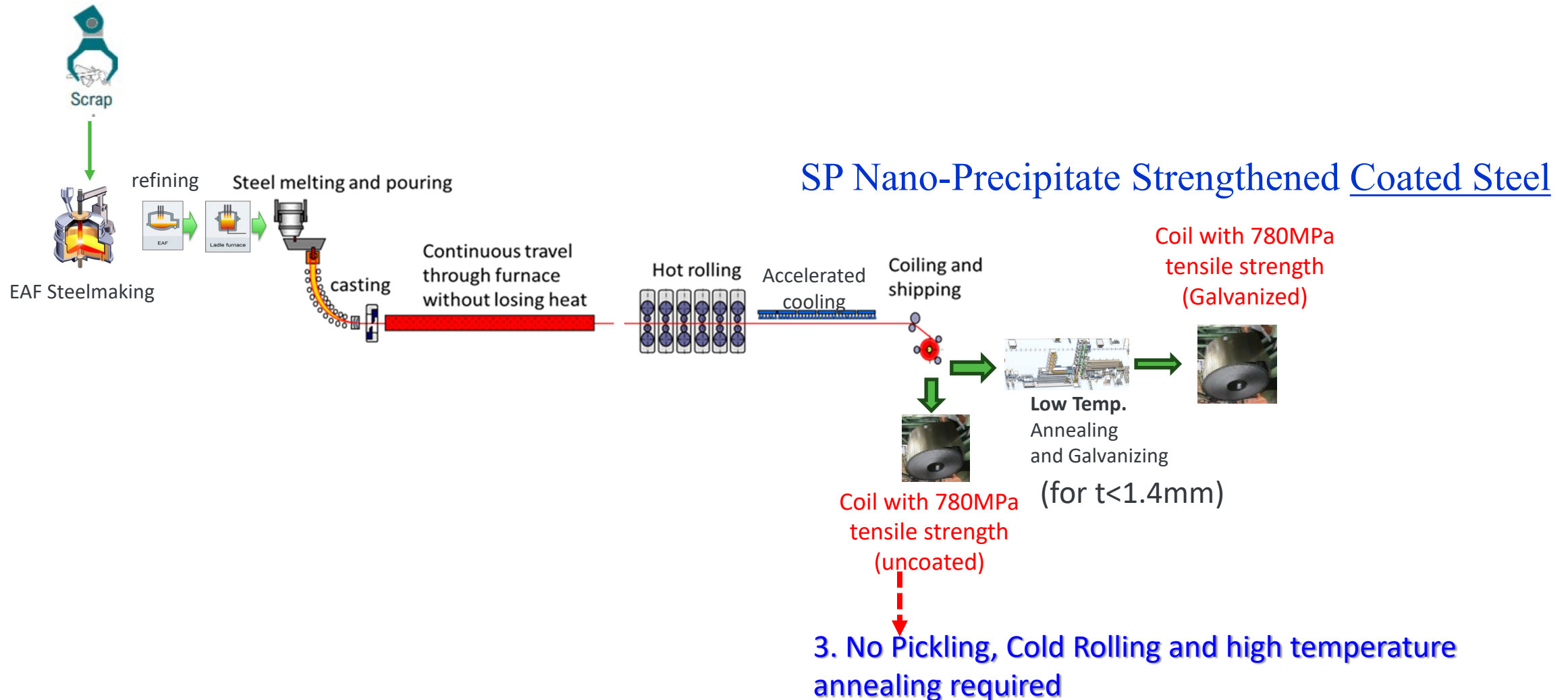


No Downstream Processing Needed for SP Steel

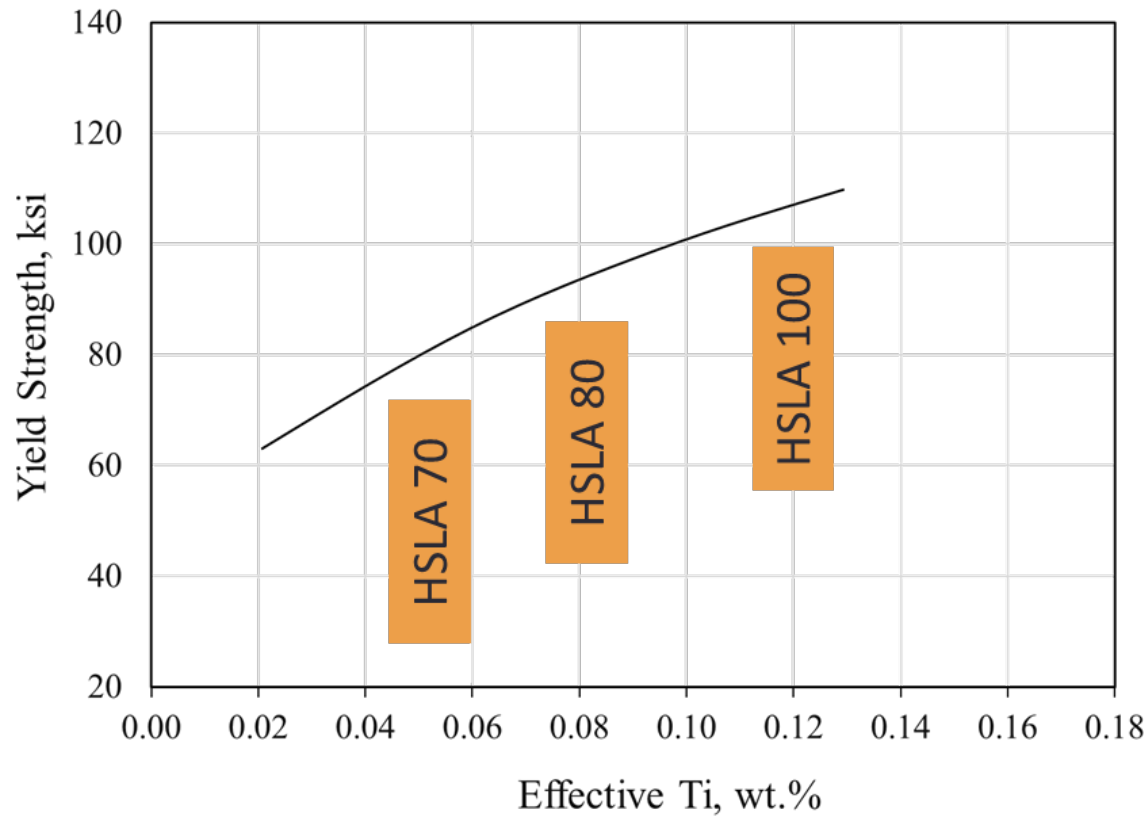


- Energy Saving,
- Process elimination,
- Lead time reduced

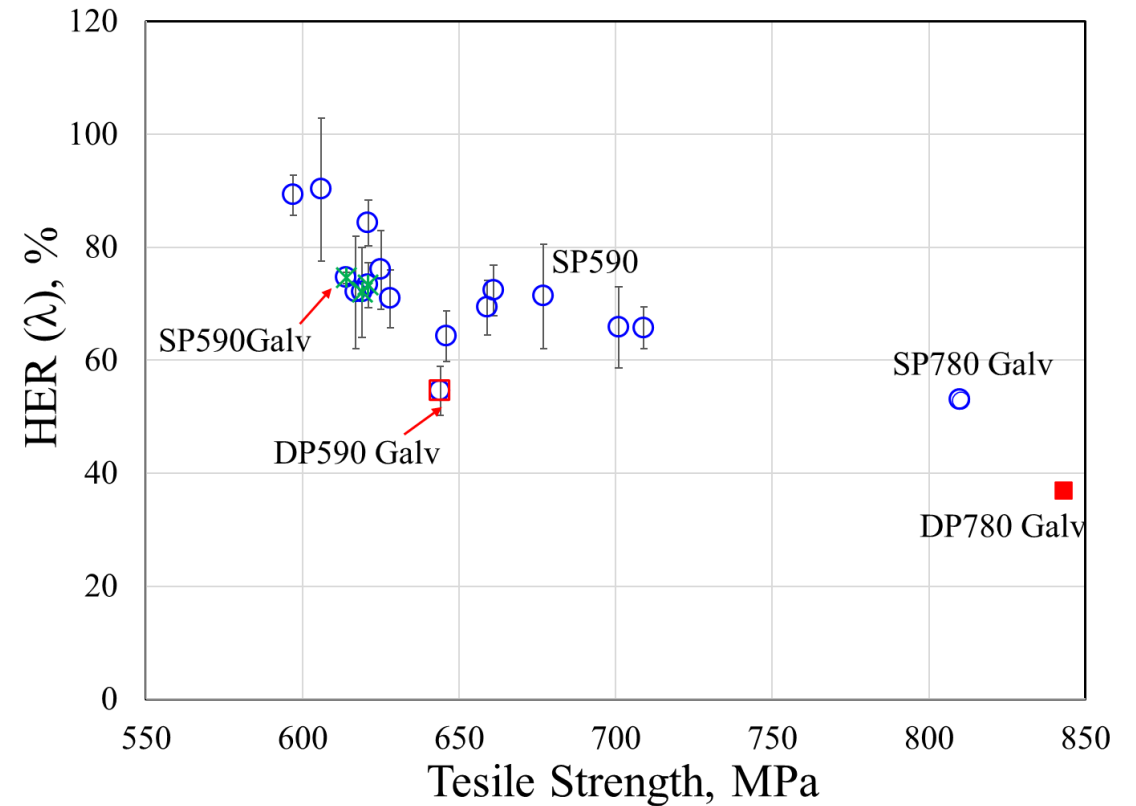
Product Innovation Breakthroughs: SP Steel



Product Innovation Breakthroughs: SP Steel



SP Nano-Precipitate Strengthened Steel



Outstanding Stretchability

Steel	C	Mn	P	S	Ti	N
SP590-SP780	0.060	1.10-1.50	0.015	0.003	0.10 -0.15	0.009

SP Steel – Applications Demonstrated

Structurals and Machinery:

UHSS 100, Gauge 4.5mm-10mm
 Product Successfully commercialized
 and used in structural, machinery
 applications



Automotive



SP780 : Component of a Car Seat Retractor



SP 600 : Component of a Car
 CR500LA Seat



SP 650 : Front Link
 CR550LA

Summary

- A Technological Breakthrough in Product Processing could be achieved in designing a chemistry and processing for a **Lean, Very Low-Carbon Nano precipitation-strengthened, Single Phase** Ferritic Steel to produce steels up to 780MPa tensile Strength in Hot Rolled and Coated Condition and also achievable in fully processed and coated condition.
- The Steel can be offered in most applicable gauges in HR and HR+Coated condition as well as fully processed condition and **eliminates need for downstream processing**.
- The steel exhibited outstanding mechanical, formability, bendability and weldability properties in both **HR and CR fully processed and Coated Condition** and promises to be a **game changer**.
- The New Steel has the Potential to replace medium-strength **DP steels, CP and MP steels** up to 780MPa tensile strength in both coated and uncoated condition.
- Most Importantly, the development of this Steel is achieved through **EAF-CSP route** and hence the greenest of all that is produced with similar strength.

Publications, Recognitions and Awards

Publications

1. Iron and Steel Technology, Oct 2022, pp. 60-72
Development of Nano-precipitation Strengthened Cold-Rolled Batch-annealed HSLA Sheet Steels (>490MPa Yield Strength) with Superior Formability.
2. SAE Int., 2023-0100612, 2023
Forming Characteristics of Nano-precipitation Strengthened Cold-Rolled Batch Annealed HSLA Sheet Steels (>490MPa yield strength)
3. Iron and Steel Technology , September 2023
Fundamentals for Developing Nanoprecipitation-Strengthened Thick Gauge HSLA 550 Steel Through a Flex CSP Mill

Awards

- **Steelie Award for Innovation of the Year 2023**
- Fastmarket Global Innovation of the Year (Products) Award in 2021,
- Won AIST Gilbert R Speich Award in 2022 for best Physical Metallurgy Paper

Patents

- ***HSLA Single Phase Ferritic Nano-strengthened steel with 100ksi min yield strength – patent approved***
- High Strength Low Alloy Sheet Steels with minimum yield strength of 500MPa produced using batch annealing –applied
- High Strength Low Alloy Sheet Steels with minimum yield strength of 550MPa produced using batch annealing –applied
- High Strength Low Alloy Sheet Steels with minimum tensile strength of 780MPa – applied

Thank You