

The adaptable and efficient EAF

- is the all-in-one solution existing?

- The diversity of different types of electric arc furnaces available on the market is huge.
- Each of the big global suppliers have minimum two rather three or even four different kind of electric arc furnaces in their portfolio for carbon steel solutions only.
- Local supplier solutions coming on top.

What are the real differences between the EAF types?

Which EAF for which raw material scenario?

What is the market situation in 10 or 15 years?

Which EAF fulfills future regulations in automatization and

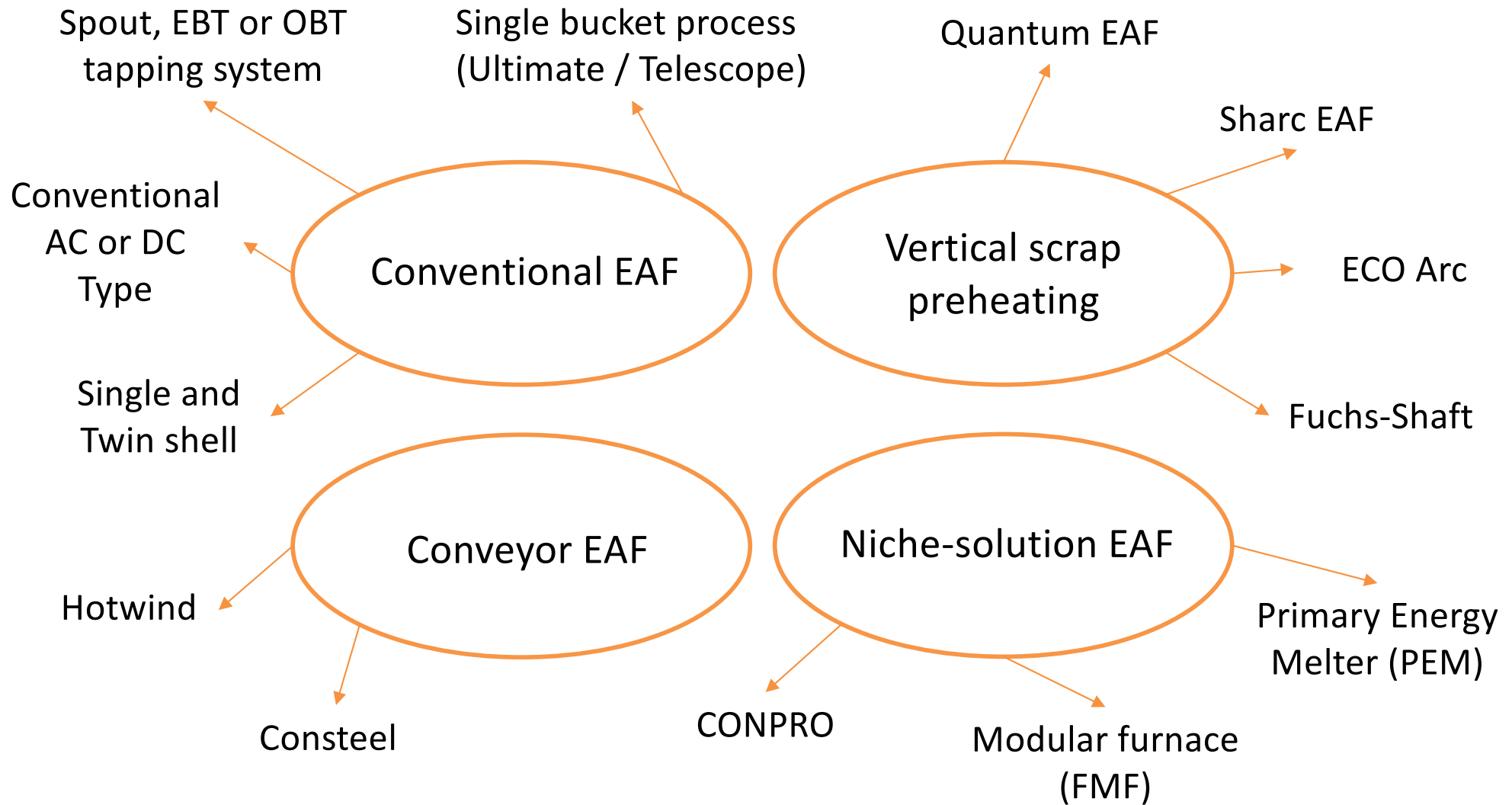
Main influences and effects driving the decision:

- Capital investment
- Raw material flexibility and availability
- Product quality
- Environmental aspects
- Operational costs
- Productivity
- Industry 4.0 / Safety

environmental aspects?

Which EAF gives the best flexibility for all possible market situations?

Main types of EAF's

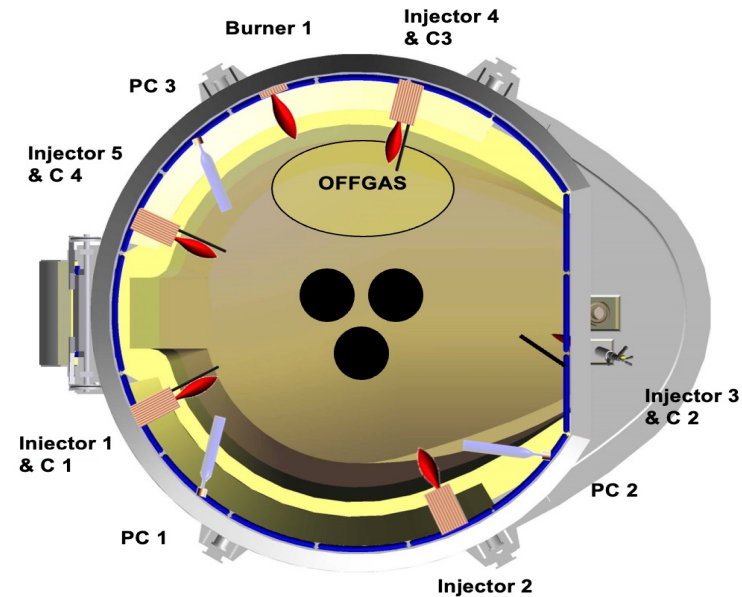


.....and many more!

Conventional EAF



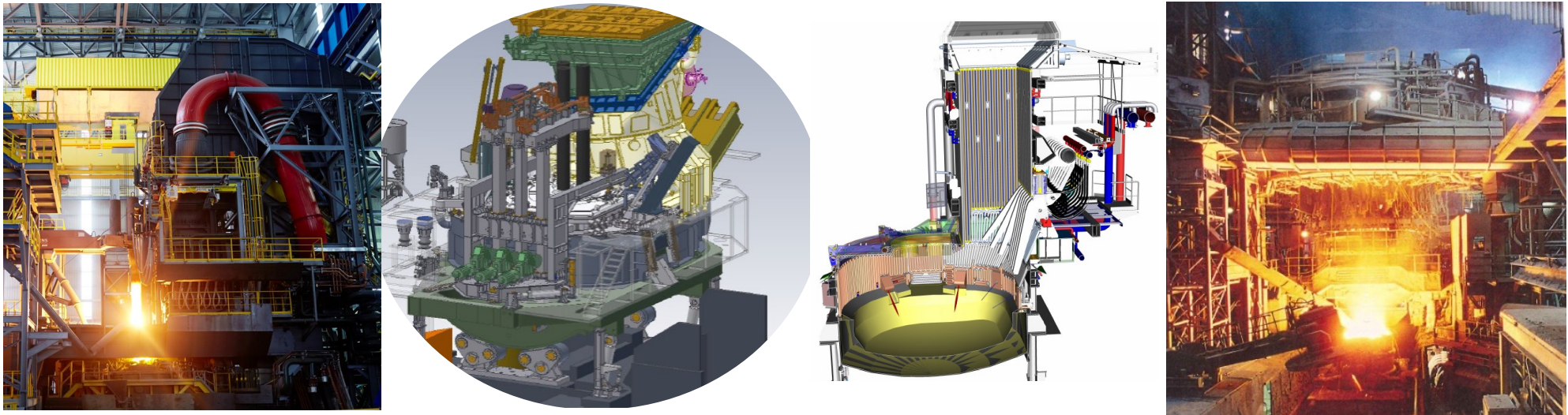
Example for chemical injection layout (180t)



- Modern conventional EAF's mostly AC-type with EBT tapping system
- Chemical injection system (side wall burner, oxygen injection, post combustion, door lances etc.) with carbon injection and sometimes lime injection
- Hot heel mostly 10-25% of tap weight (100-ton EAF => 20 t liquid heel)
- Transformer power typically 80-110 % of tap weight
- Mostly 2 bucket charging for scrap operation due to volume limitations
- Additional hole in roof allows continuous charging of additives and virgin material

Base of all EAF's and base for most raw material scenarios

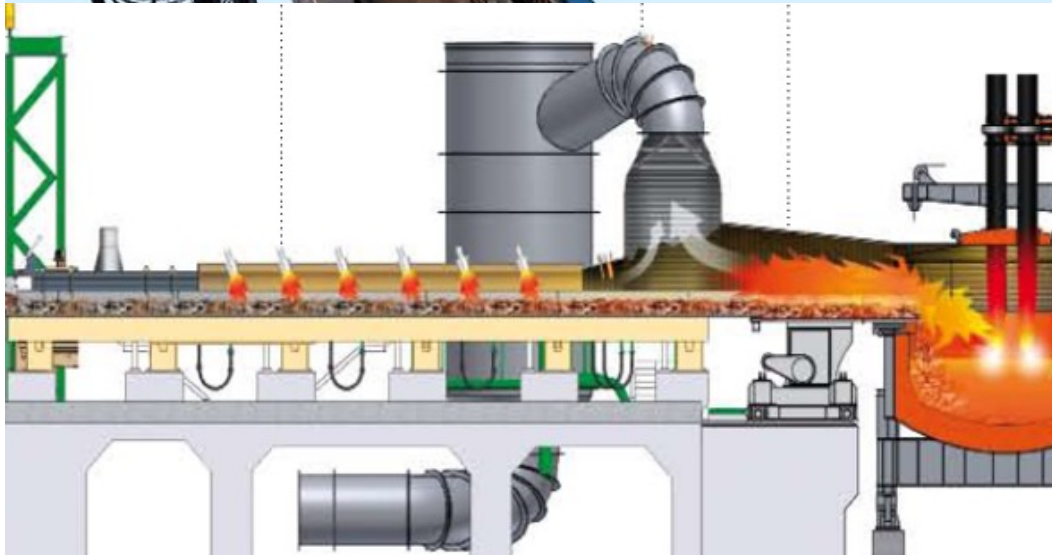
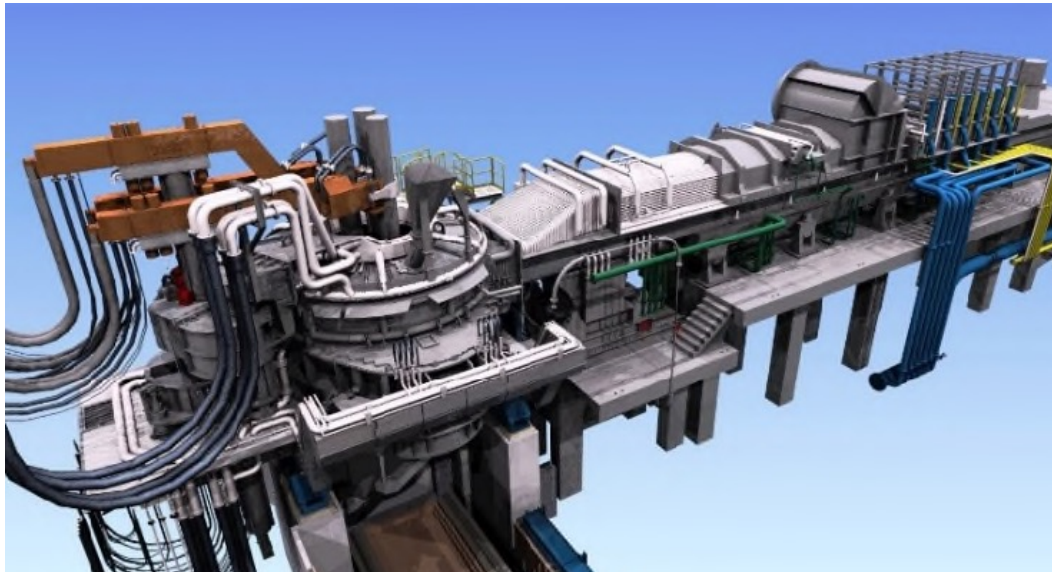
Vertical scrap preheating EAF



- Hot off gas is directed through the shaft where the scrap is preheated up to 650 °C
- Electrical energy consumption below 300 kWh/t is possible with a modern shaft furnace
- Off gas must be reheated with fuel / natural gas afterwards to ensure an acceptable environmental process.
- Very flexible for different productivity goals
- Additional maintenance effort for the shaft has influence on availability
- Virgin material through roof possible / especially at Quantum EAF thanks to big liquid heel / continuous flat bath operation

Summary: Beneficial for processes with 70-100% scrap usage where the electrical energy is expensive and/or natural gas/fuel is cheap. For more than 30% virgin material it gets more difficult and transformer power too low (pitch circle out of center)

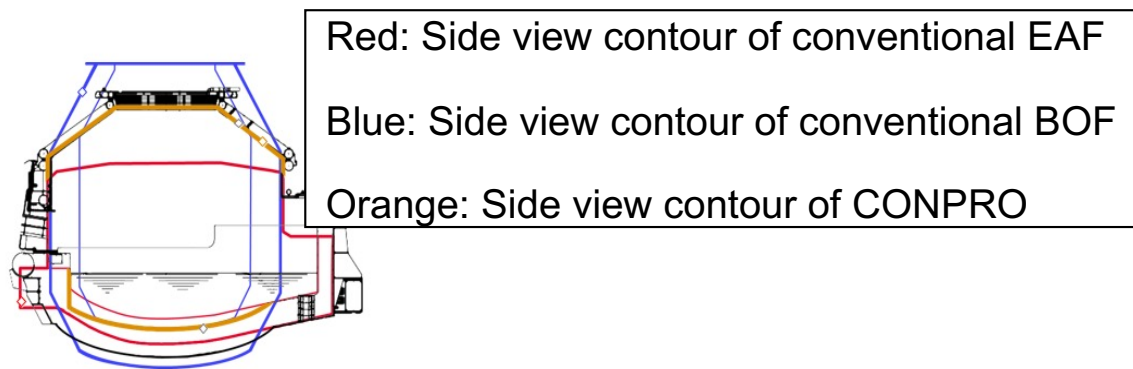
Conveyor EAF



- Conveyor transports the scrap to the shell
- Light preheating effect (200°C max before entering shell)
- Big liquid pool used – indirect melting / continuous flat bath operation
- No off-gas treatment needed due to limited heat transfer to scrap
- High maintenance effort for conveyor => availability
- Virgin material through roof possible
- Scrap yard layout and crane arrangement for conveyor important

Summary: Designed for scrap operation but virgin material usage until a certain amount (~50%) is possible without big limitations

Niche solutions EAF

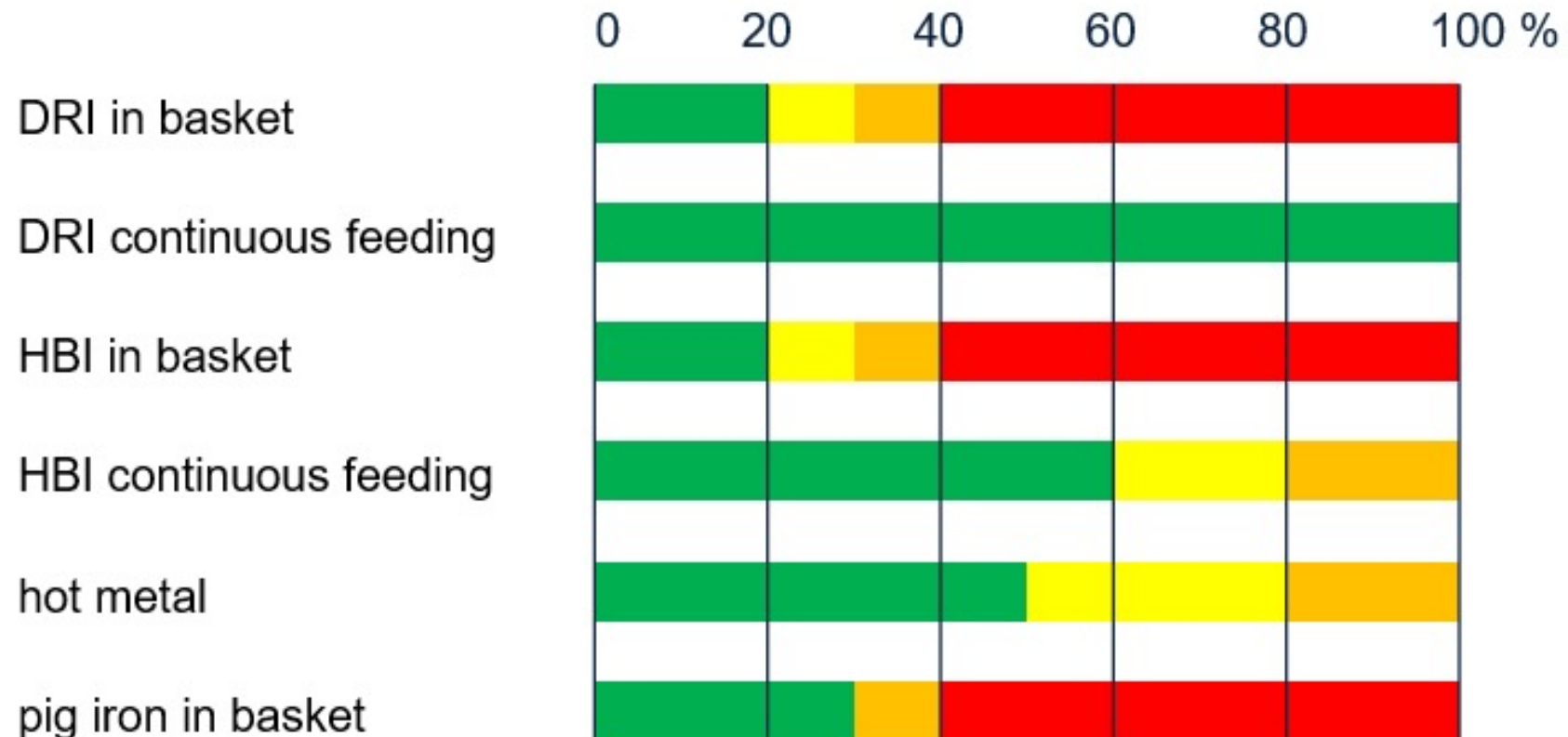


- Conpro and FMF should offer design solutions to mix BOF and EAF operation mostly for the transformation period of the integrated plants (increased HM operation first)
- Conpro (up left) is a hybrid solution – but many positive design features of each original furnace type getting lost
- The modular furnace (FMF / up right) is designed based on a similar idea with the negative point that the furnace must be rebuilt for an operation with less hot metal
- The idea of the primary energy melter (PEM / left) is melting solid material with chemical power (burners) until the liquid metal flows directly in a kind of Ladle Furnace
- The pilot results and the productivity figures don't make it necessary to talk about in detail



Talking about flexibility in raw materials and productivity – these EAF types do not meet the criteria's

Raw materials – “virgin” material



up to 100% scrap and any mixture with scrap is always possible

Green: possible without limitations
Yellow: possible with process adaptations / flexible EAF helpful to keep productivity etc.
Orange: possible with major adaptations / flexible EAF needed => no economical process possible
Red: not possible (icebergs / productivity / refractory) => impossible process for all kind of EAF

Raw materials: What is needed?

Powerful Transformer:	needed for DRI, HBI, Scrap
Powerful chemical package:	needed for PI, Hot Metal, continuous feeding, scrap melting
High upper shell:	more volume = high possibility for one bucket charging / post combustion in the EAF shell possible
Bigger in diameter:	support decarburization ratio / creates volume / avoids hot spots
Bigger hot heel:	fast melting period = less network disturbances like flicker / big liquid pool needed for virgin material roof feeding (DRI / HBI)



Powerful Transformer:	best implementation solution = CONVENTIONAL EAF TYPE as base (pitch circle in centre)
Powerful chemical package:	best implementation solution: CONVENTIONAL EAF TYPE as base ("round" shape and all material could be reached => top charging)
High upper shell:	most easy to implement at CONVENTIONAL EAF TYPE as base (dedusting connection / height and stability of electrode columns)
Bigger in diameter:	in principle everywhere possible
Bigger hot heel:	in principle everywhere possible

Thank you!



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