

Global Research and Development

Volteron™

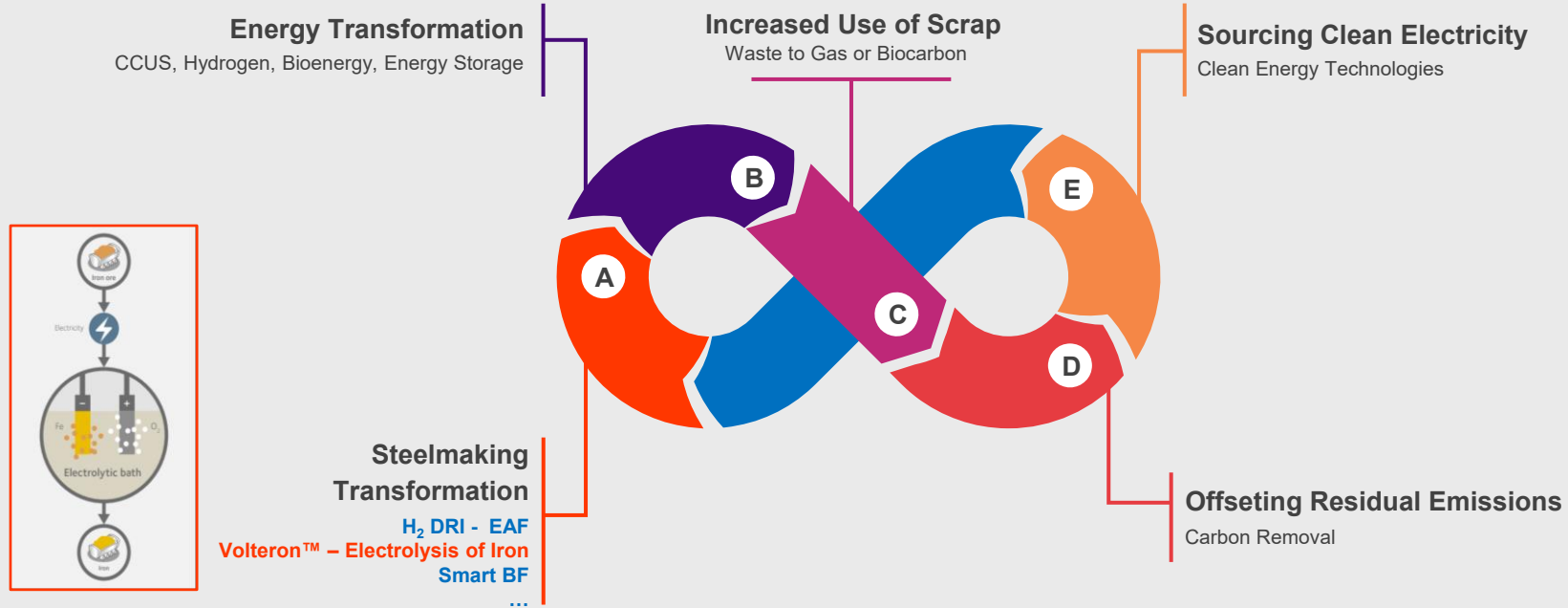


The path to net-zero steelmaking
thanks to low temperature iron
electrolysis

May 14th, 2025



Volteron™ is one of the paths to support ArcelorMittal's decarbonisation strategy



Steel and Aluminium Analysis, IEA (September 2024):

14% of estimated worldwide steelmaking production by electrolysis in 2050

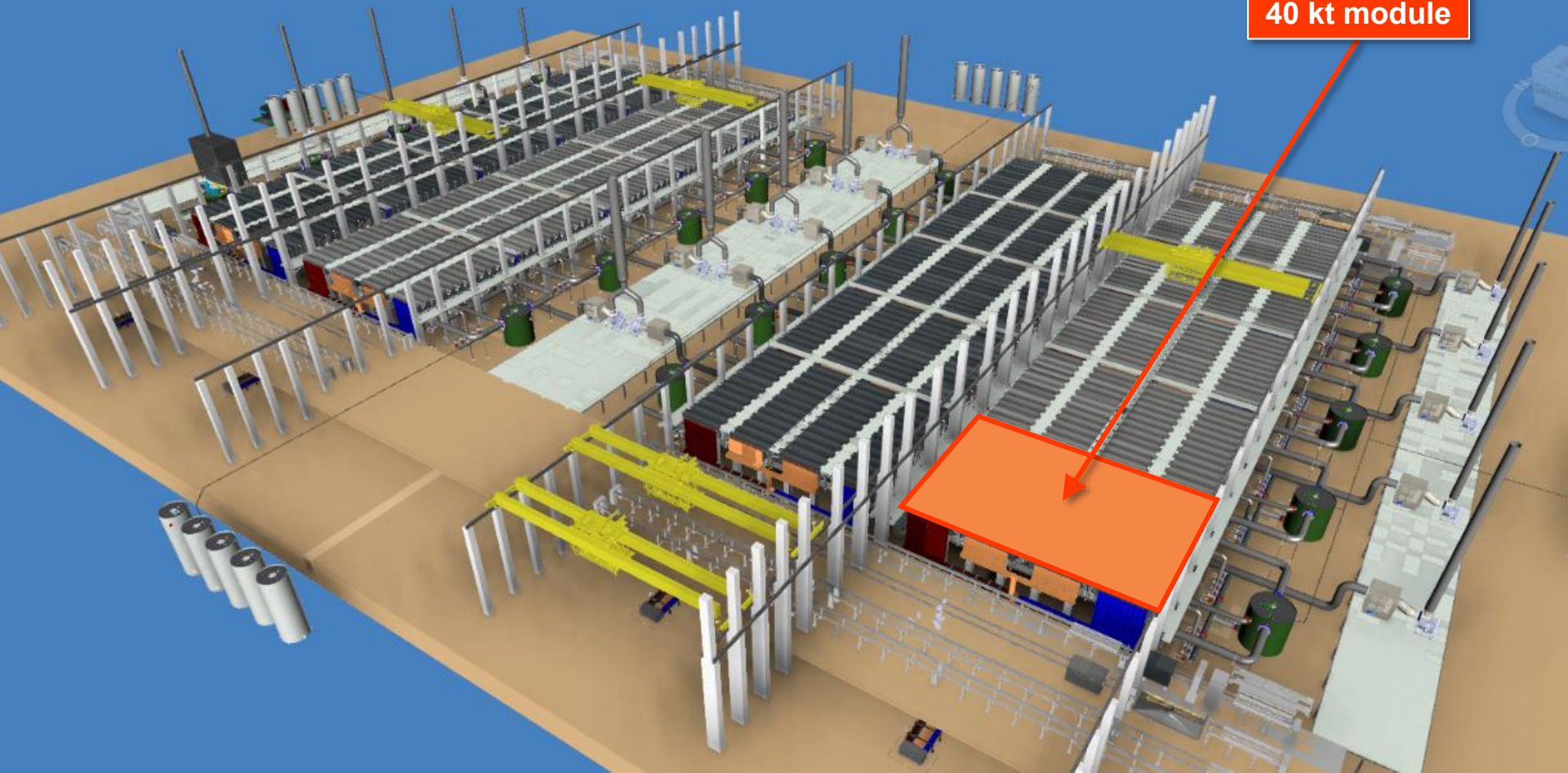
Volteron™: Where are we today?

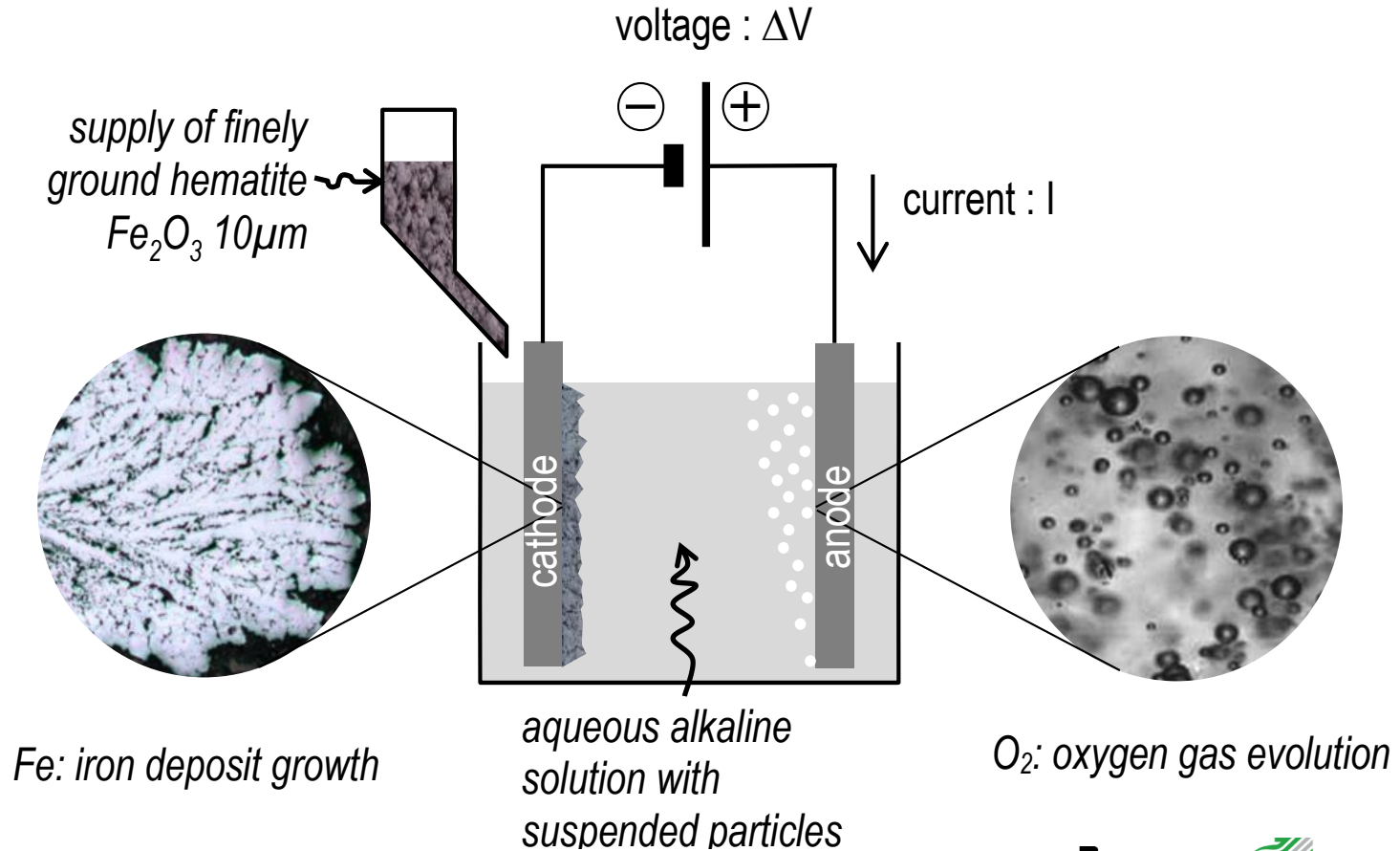


1 m² pilot commissioned in April 2025

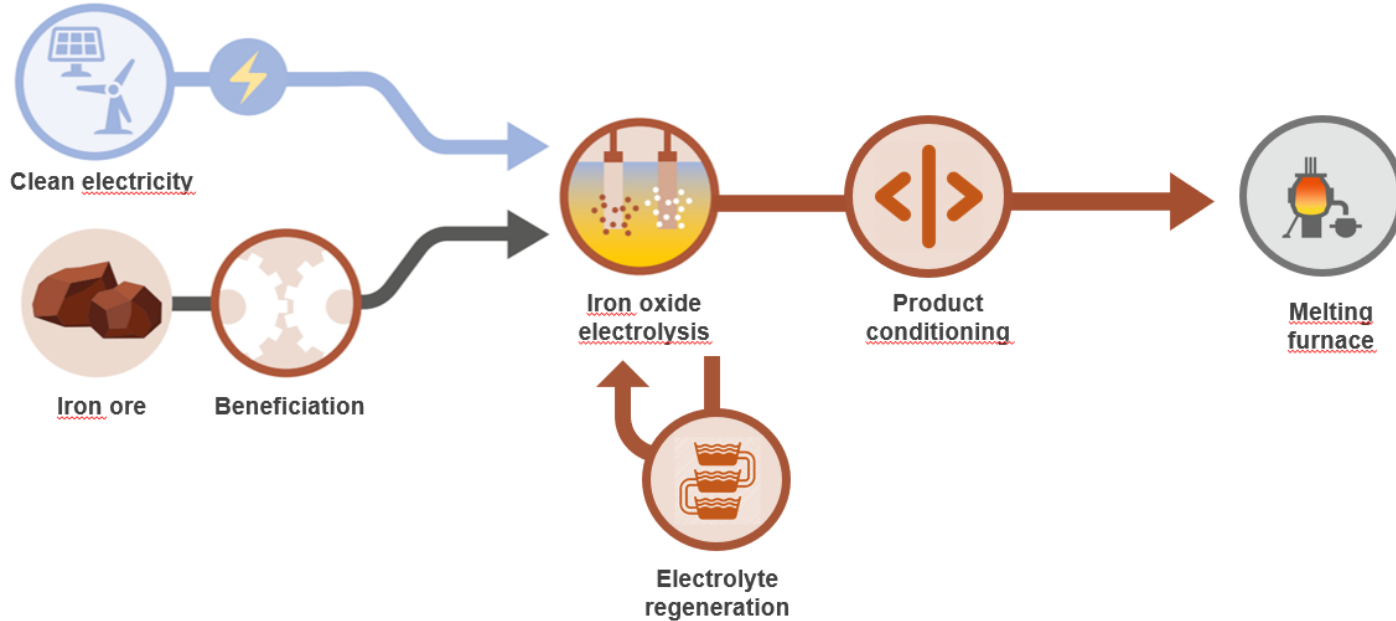
Volteron™ plant design: 800 kt/year

40 kt module



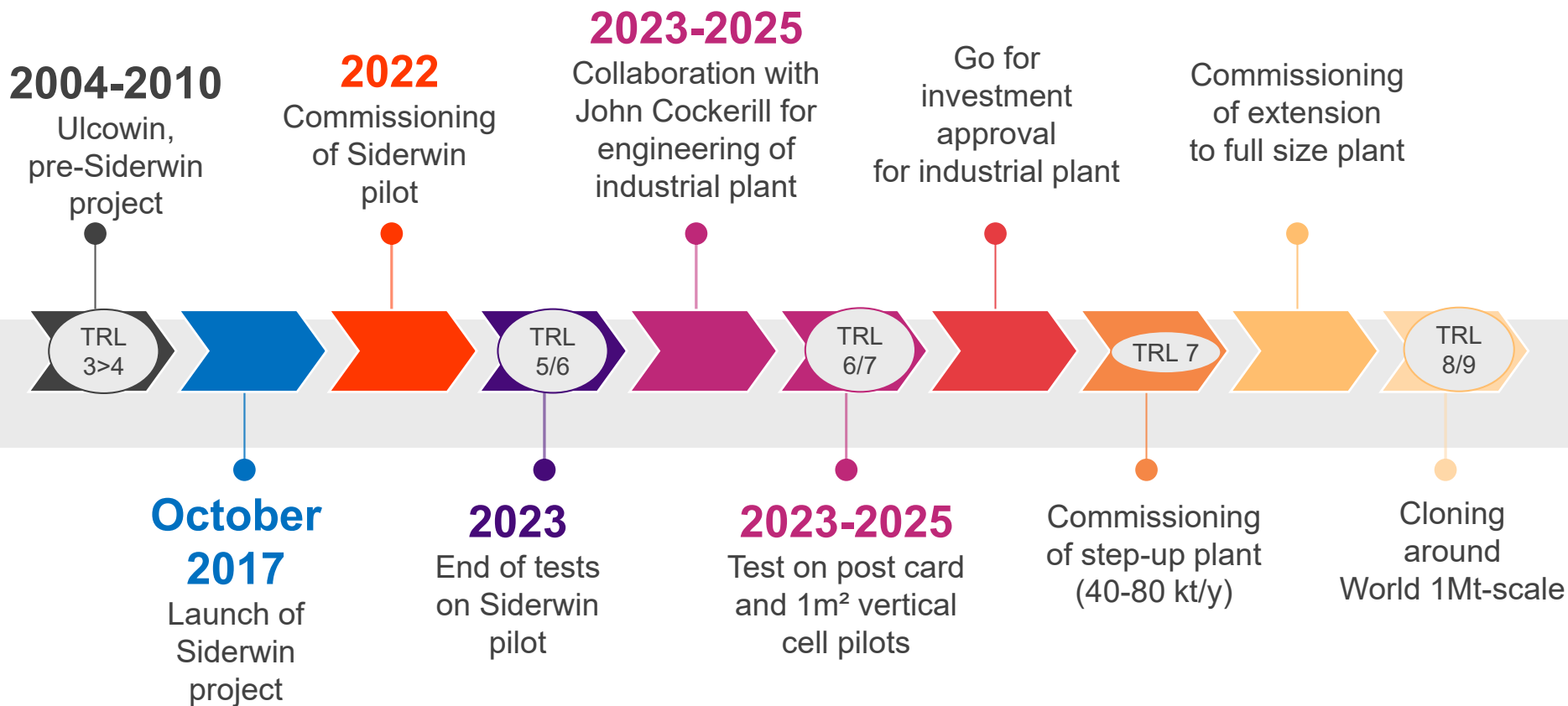


Volteron™ iron electrowinning steps from iron oxide to pure iron plate



Electrolysis process at low temperature (110°C) in an aqueous based electrolyte (50%NaOH)

ArcelorMittal's lead in Cold T^a Electrolysis → Volteron™



Energy efficiency 3729 kWh/ Ton of iron plate, for a proven Faradic Yield of 85% (initial industrial target)

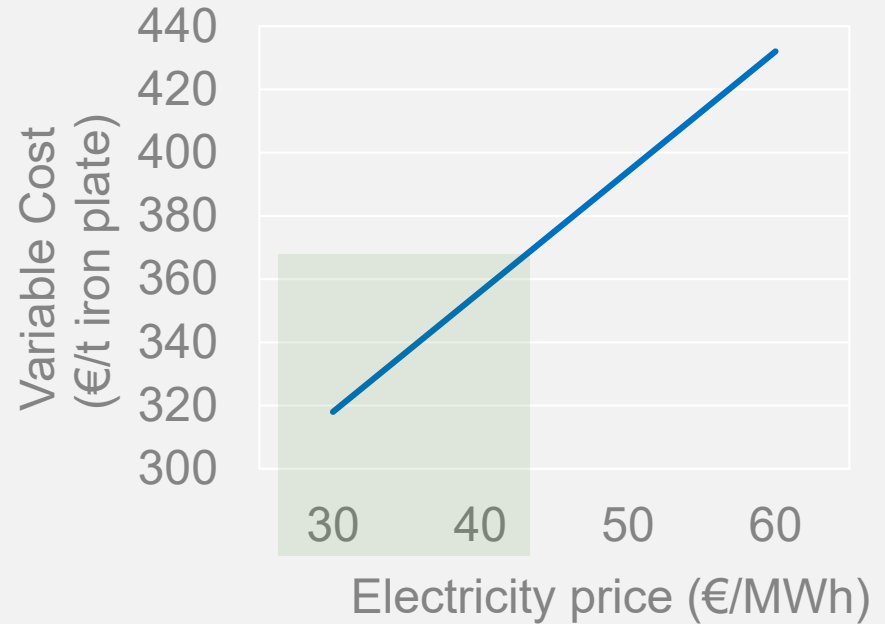
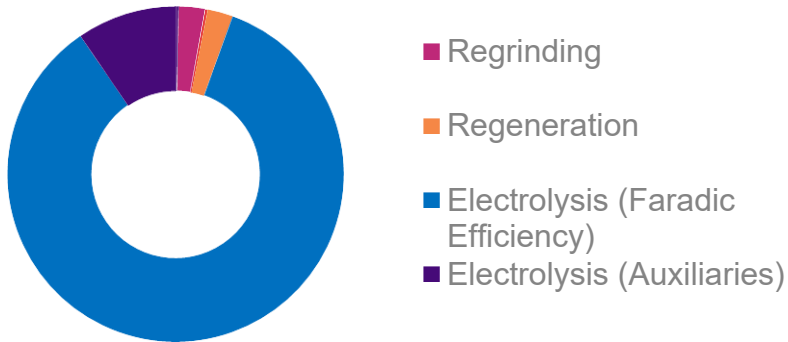
Key parameters	Process driver	Optimal value
<i>Caustic soda concentration</i>	Iron ore dissolution	50% NaOH
<i>Electrolyte Temp.</i>	Electrolysis driving force	110°C
<i>Iron concentration</i>	Electrolyte flow	10-20%
<i>Current density</i>	Faradic yield	Maximum 800 A/m ²
<i>Iron ore preparation</i>	Beneficiation quality (grinding, flotation)	PSD50 = 10-20 microns %SiO ₂ after flotation = 1%

Volteron™ OPEX is linked to electricity price

85% of the energy intensity linked to electrolysis

Energy intensity (kWh/t – iron plate)

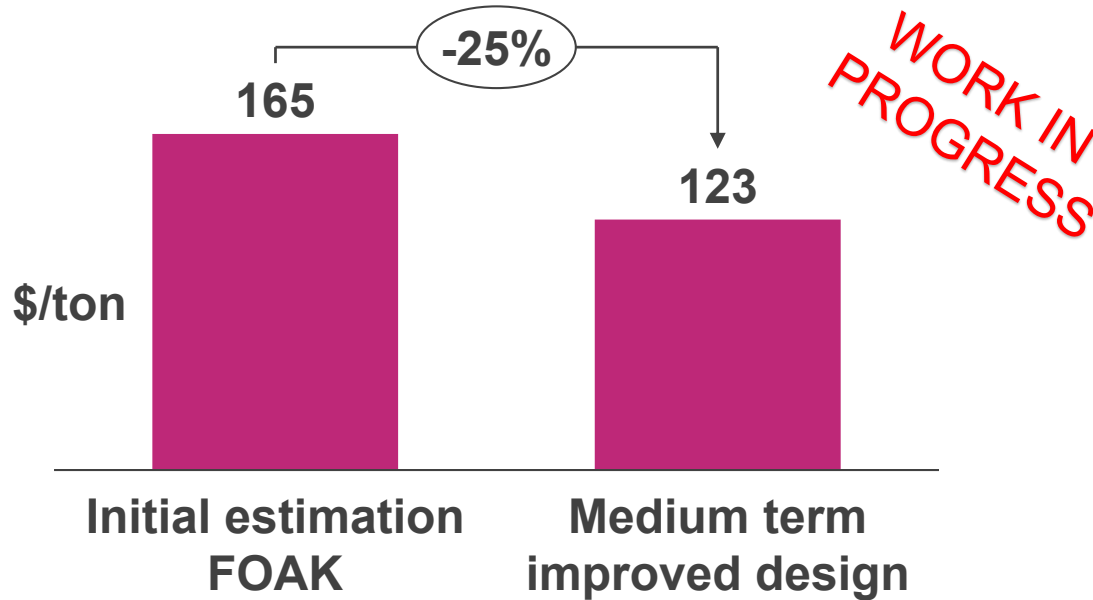
Extra Flotation	10
Regrinding	96
Dewatering	10
Regeneration	94
Electrolysis (Faradic Efficiency)	3220
Electrolysis (Auxiliaries)	309
Total energy	3739



Volteron™ commodities and utilities

	For 800 kt/y
Land (m ²)	275.000
Fresh Water (m ³ /t)	< 2
Fresh Caustic Soda (Kg/T)	92
Power (MW) – Plant	437

CAPEX charge expectations (\$/t iron plate for 800KT/y +)



Electrical
Power
generation not
included.

No other
infraestructure,
like CCS or
H2, is required

Volteron™ is a very promising innovative technology



Near zero direct CO₂ emissions

It is one of the lowest CO₂ emitting technologies.



Strong scalability and modularity

Scale-up can be managed with limited complexity.



High energy efficiency

It is more energy efficient and competitive than other low-carbon steel manufacturing technologies.



Streamlined operations

Unlike its green alternatives, Volteron™ does not require large infrastructure for H₂ distribution, storage or CO₂ capture.

Beside its low temperature, the process is suitable for start and stop utilisation matching the specificities of renewables.

Conclusions

- Volteron is consolidating TRL7. Roadmap for industrialization depends strongly on regulatory framework and on the results of the R&D 1m² pilot.
- It is based on proven technology, broadly applied in Cu and Zn industries.
- Its OPEX makes is feasible for cheap electricity, as far as there is a CO2 cost or a market premium (> 120\$/Ton).
- Major CHALLENGES we see are the CAPEX and Scale-up confirmation, so we are working hard on it.