



Helios

Beyond Scrap: Sodium-Based Ironmaking as a New Source of Clean Metallic Iron

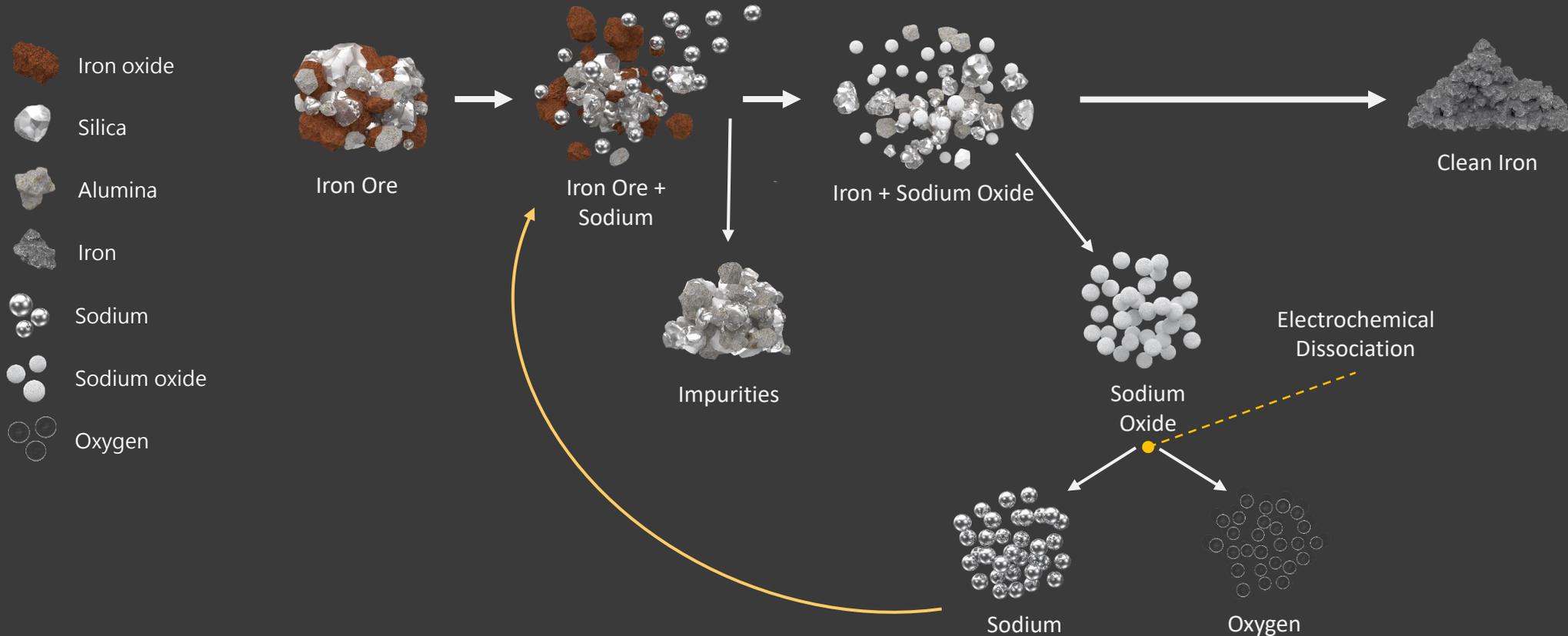
Scrap Supplements and Alternative Ironmaking 10
2026

Hani Farran, PhD.
VP R&D at Helios

The Helios Cycle™

A closed sodium loop

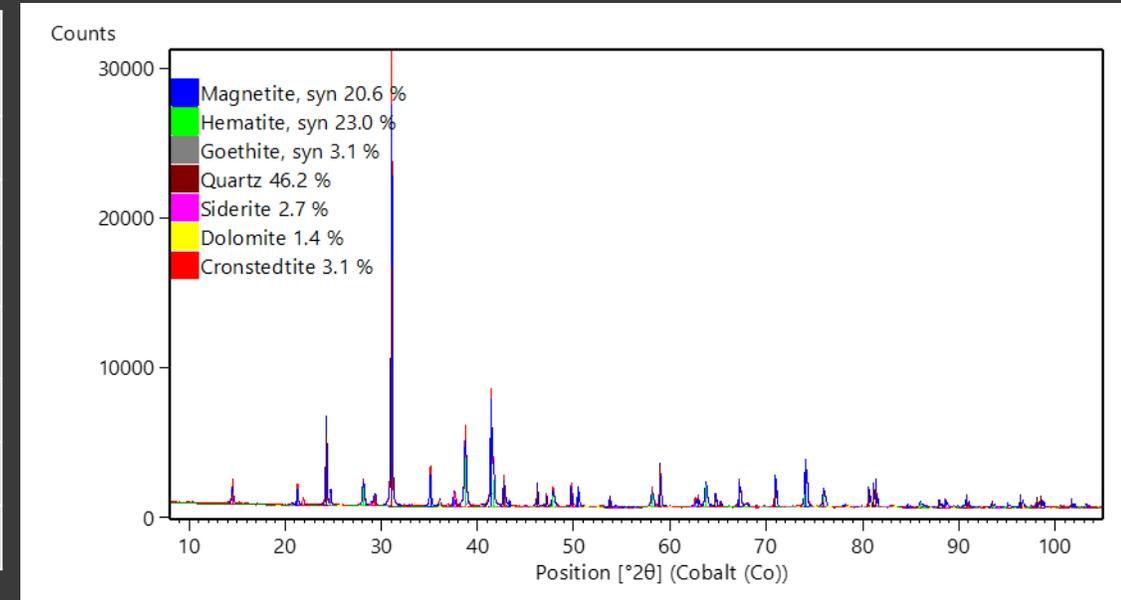
- Using sodium, replacing coal or hydrogen
- Indifferent to feedstock grade
- 3.0MWh-4.0MWh per ton (at 250°C to 350°C)



Reduction Results For Various Ores

Hematite & Magnetite (USA – Run of mine) Low grade ore, Fe total **37.3%wt**

Compound Name	Formula	%wt
Hematite	Fe ₂ O ₃	23
Magnetite	Fe ₃ O ₄	20.6
Goethite	FeO(OH)	3.1
Silicon Oxide	SiO ₂	46.2
Cronstedtite	Fe ₄ SiO ₅ (OH) ₄	3.1
Dolomite	Fe ₄ SiO ₅ (OH) ₄	1.4
Siderite	FeCO ₃	2.7



Calculated results after reduction, before separation:

Experiment ID	Fe	Na ₂ O	SiO ₂	Na ₄ (SiO ₄)	Sodium
B02-40	19.5	52.2	25.2	2.4	0.7

Calculating Iron Metallization

$$\% \text{ Metallization} = \frac{n(\text{Fe})_{\text{metal}}}{n(\text{Fe})_{\text{total}}} \times 100$$

$$n(\text{Fe})_{\text{total}} = \sum \frac{\text{wt}(\text{Compound}_i)}{\text{Mw}(\text{Compound}_i)} \times \text{stoichiometric ratio of Fe in Compound}_i$$

$$\% \text{ Metallization} = \frac{0.349}{0.349} \times 100$$

$$n(\text{Fe})_{\text{total}} = \sum \frac{19.5}{55.845} \times 1$$

Iron metallization > 99%

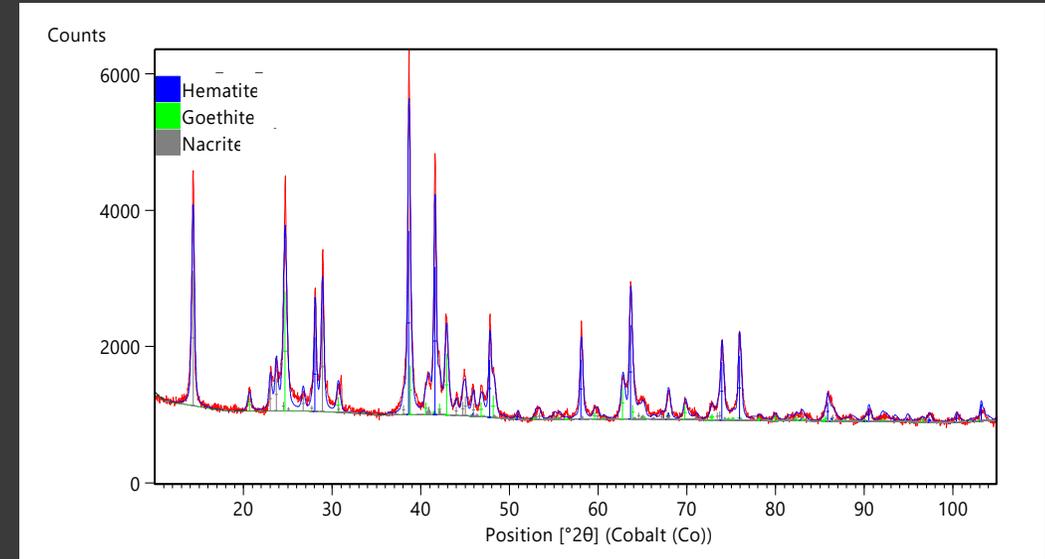
Experiment ID	Fe	Na ₂ O	SiO ₂	Na ₄ (SiO ₄)	Sodium
B02-40	19.5	52.2	25.2	2.4	0.7

Reduction Results for Various Ores

Tailings (Australia) - Fe total **41%wt**

XRD

Compound Name	Formula	%wt
Hematite	Fe_2O_3	37.5
Goethite	FeOOH	23.3
Nacrite	$\text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4$	39.1



XRF

Sample ID	Fe	SiO ₂	Al ₂ O ₃	P	S	Mn	CaO	MgO	TiO ₂	K ₂ O
Tailings	39.0	18.95	14.6	0.072	0.018	0.411	0.14	0.28	0.8	0.068

Reduction Results for Various Ores

Tailings (Australia) - Fe total **41%wt**

Calculated results after reduction, before separation:

Experiment ID	Fe	Na ₂ O	Na ₄ (SiO ₄)
B01-120	34.9	15.8	49.4

ICP

Sample ID	Fe	SiO ₂	Al ₂ O ₃	P	S	Mn	CaO	MgO	TiO ₂	K ₂ O
Tailings	52.54	4.14	24.19	0.0011	0.01	0.65	0.28	0.40	0.90	0.08

Iron metallization > 99%

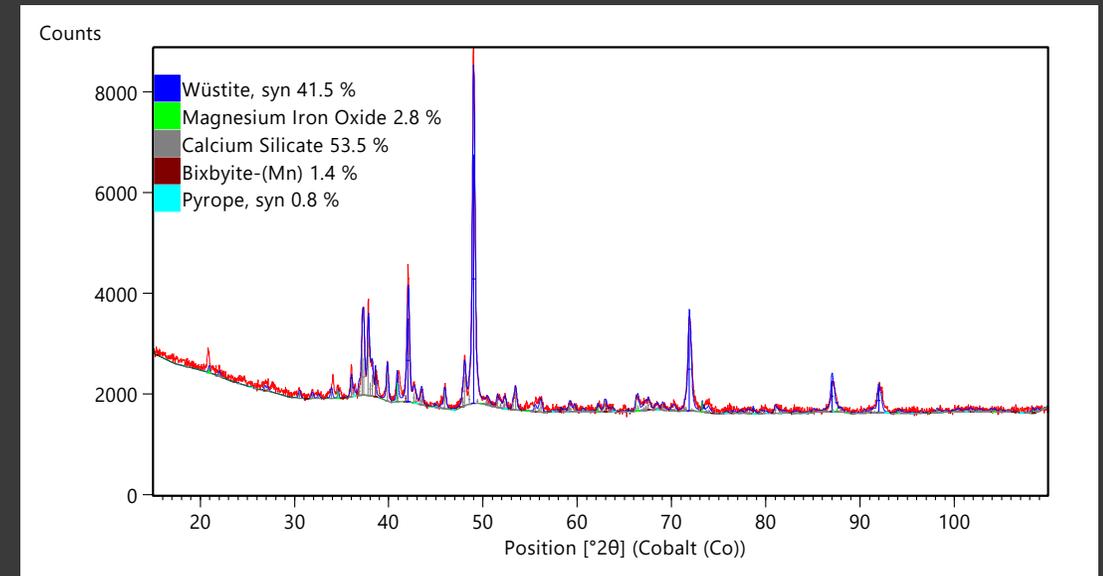
Yes,
we can extract iron
from slag



Reduction Results for Various Ores

EAF Slag (U.S.A) – Fe total **22.8%wt**

Compound Name	Formula	%wt
Wustite	FeO	41.5
Magnesioferrite	MgFe ₂ O ₄	2.8
Calcium Silicate	Ca ₂ (SiO ₄)	53.5
Bixbyite	MnFeO ₃	1.4
Pyrope	Mg ₃ Al ₂ (SiO ₄) ₃	0.8

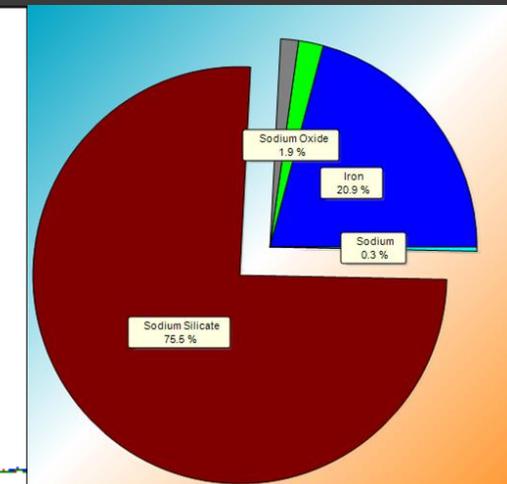
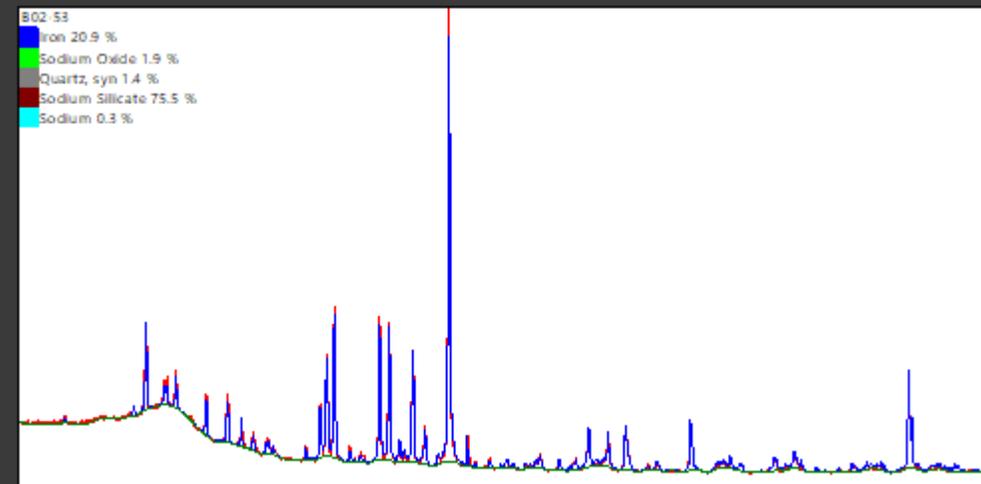
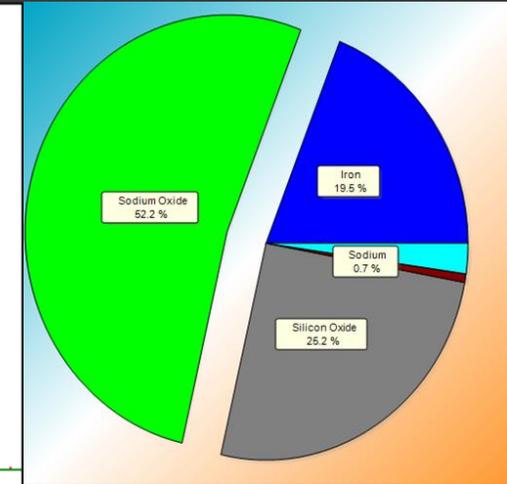
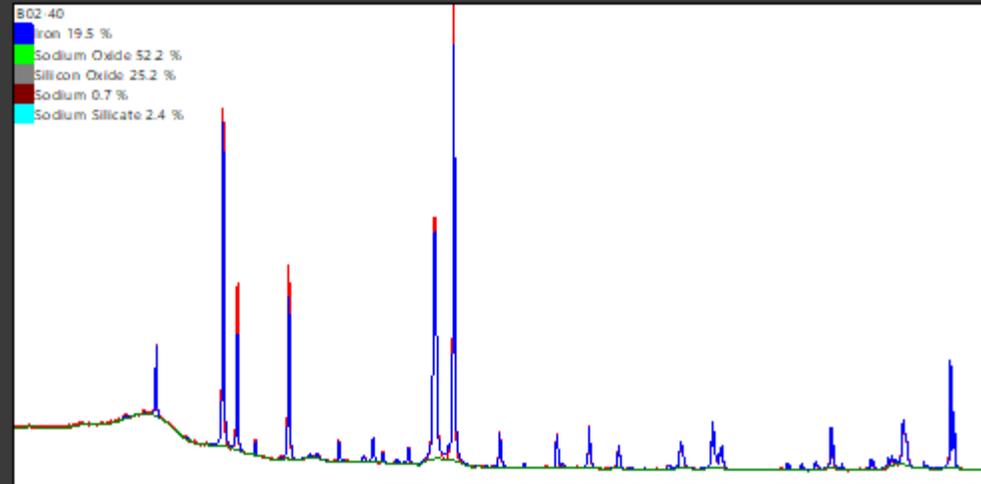
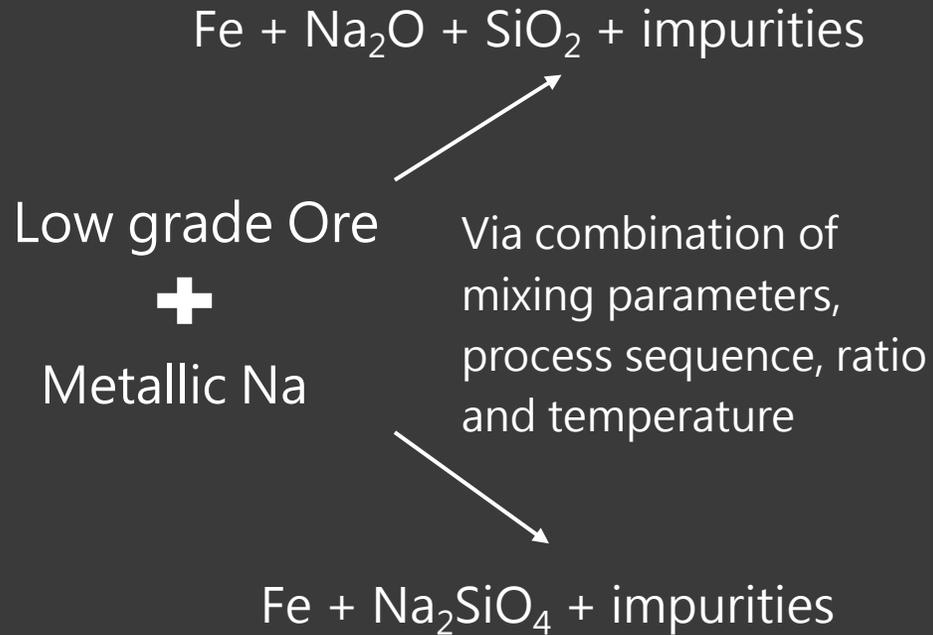


Calculated results before separation:

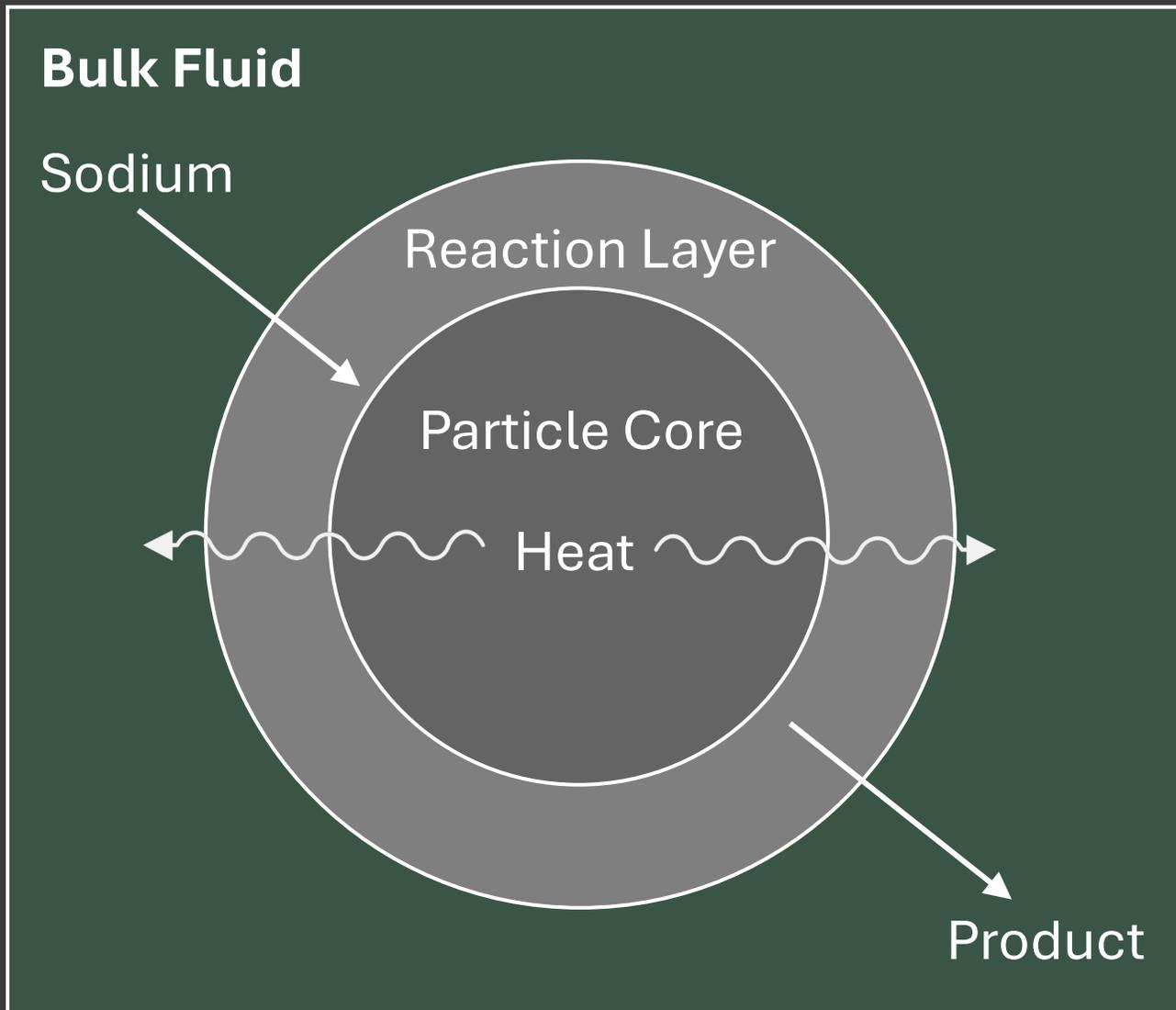
Experiment ID	Fe	Na ₂ O	FeO	Ca ₂ (SiO ₄)	CaO	Sodium
%wt	14.3	68.8	0.6	2.9	2.9	14.5

Iron metallization = **96.9%**

Byproduct Management



Particle size and the reaction kinetics

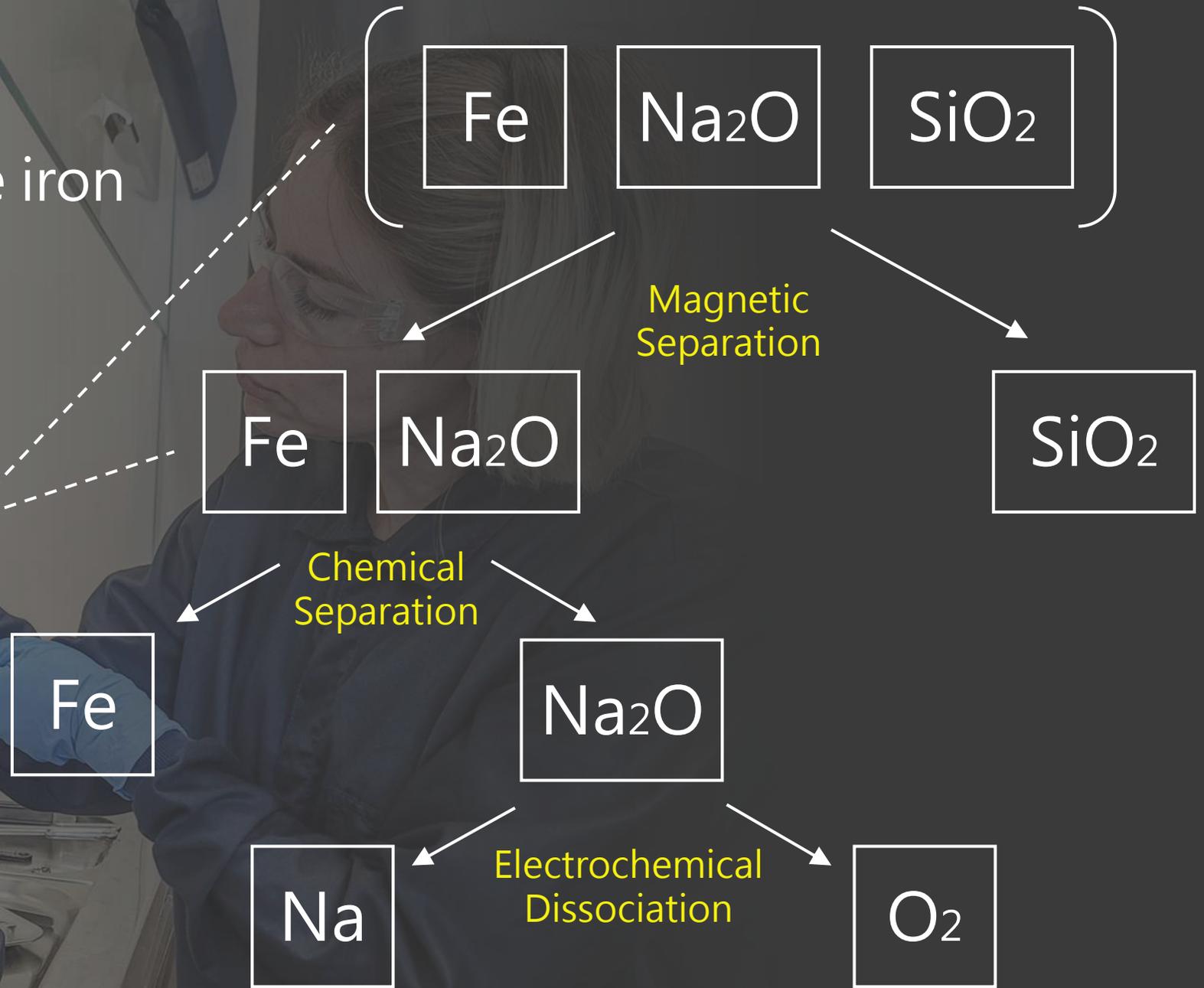
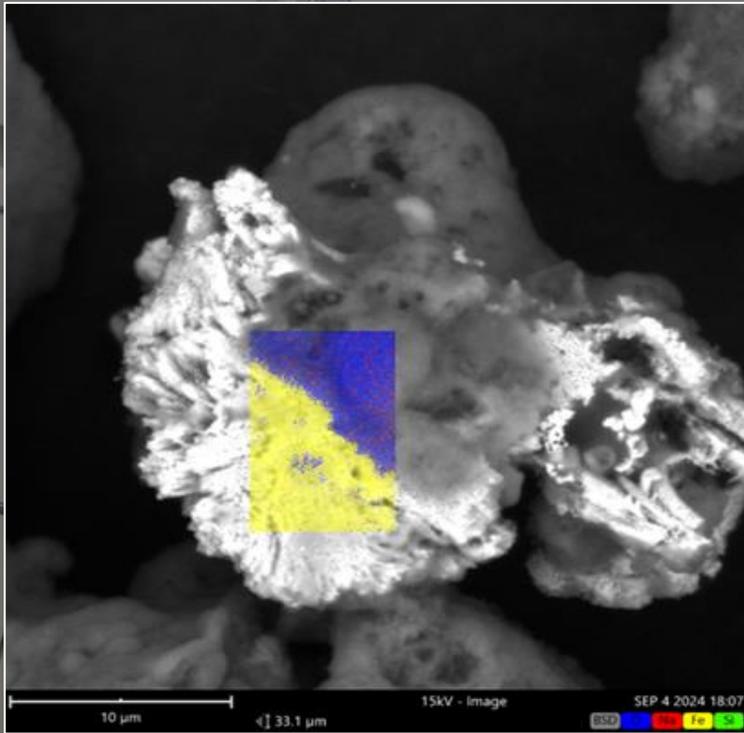


When particle size is lowered:

Phenomenon	How it is affected by particle size reduction
Reduction reaction rate	More available surface area -> Faster reaction
Reactor heat removal rate	Faster reaction leads to higher required heat removal rate
Fluidization of particles	Smaller particles have larger drag forces and are therefore easier to fluidize in mixed reactor vessel
Product separation	Smaller product grain size generally makes separation steps more challenging, including solid-bulk liquid separation and solid-solid separation steps

Separation Flow

From iron ore to pure iron



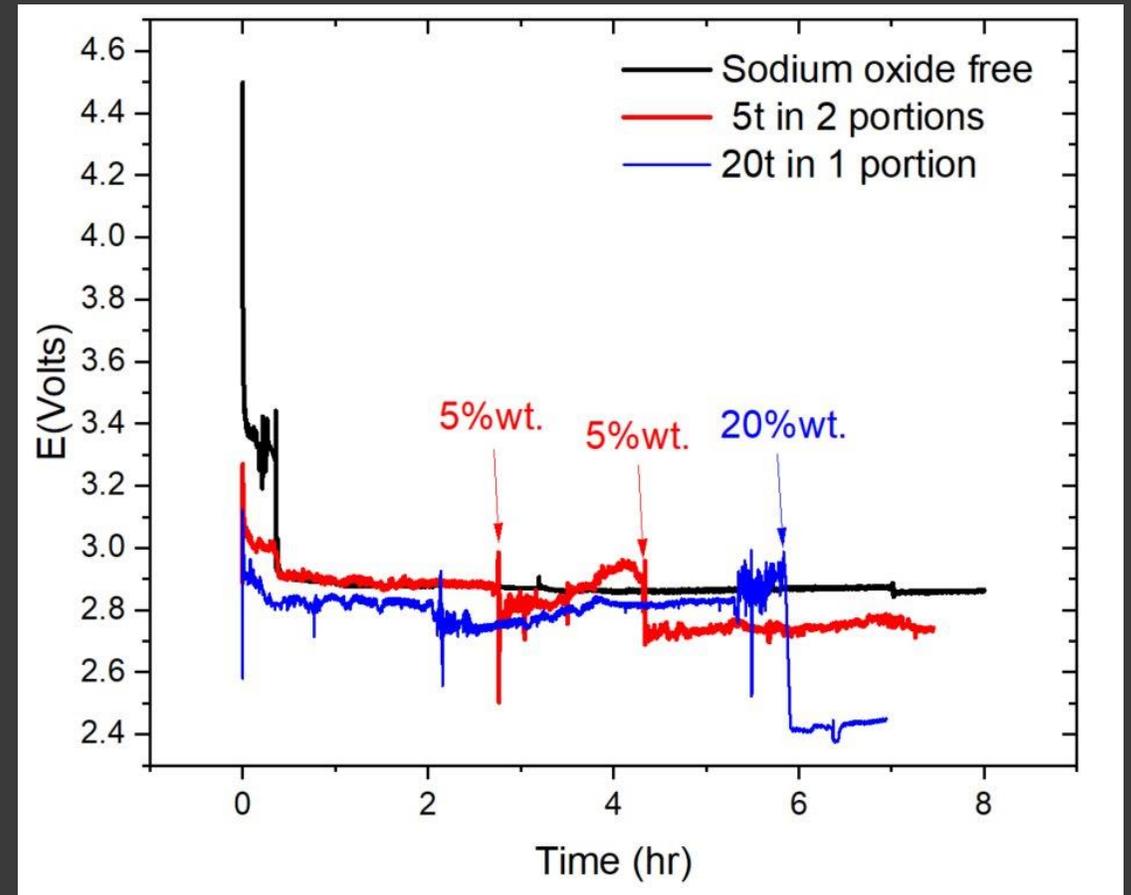
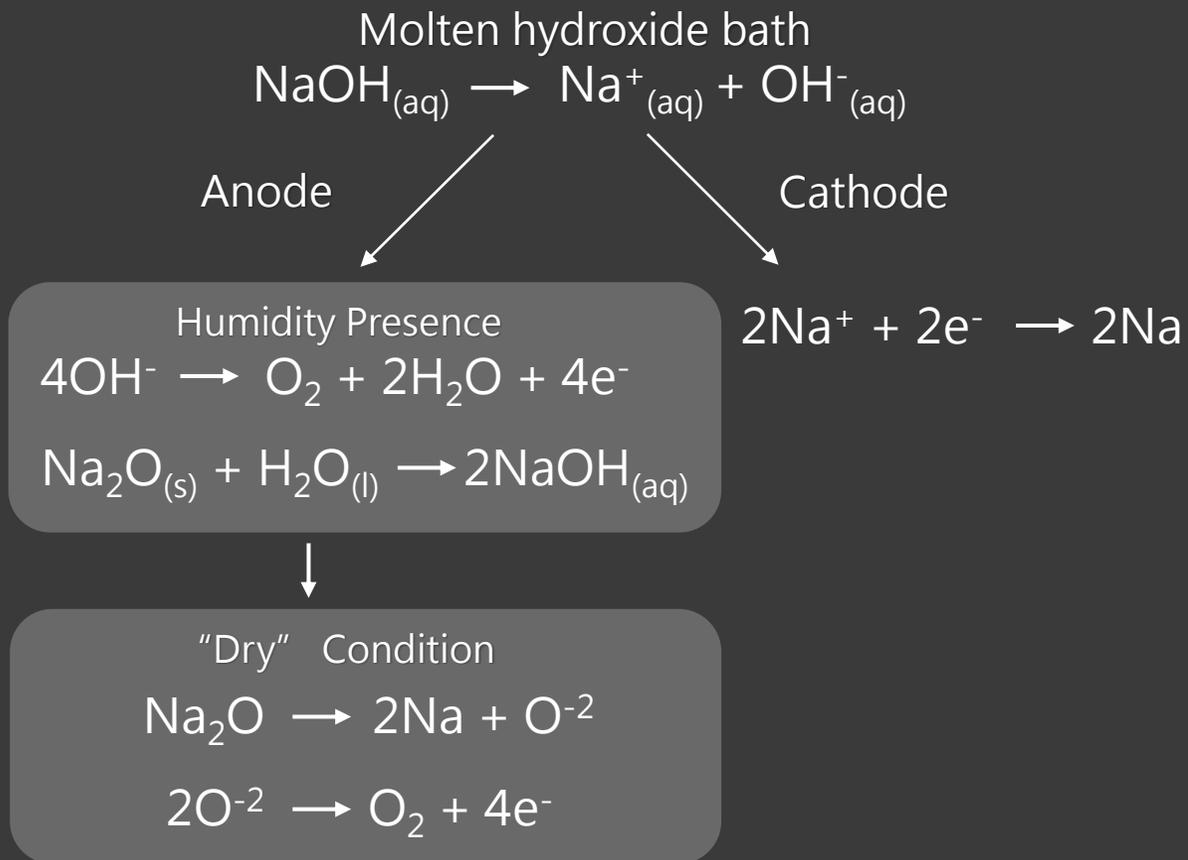
Sodium Looping



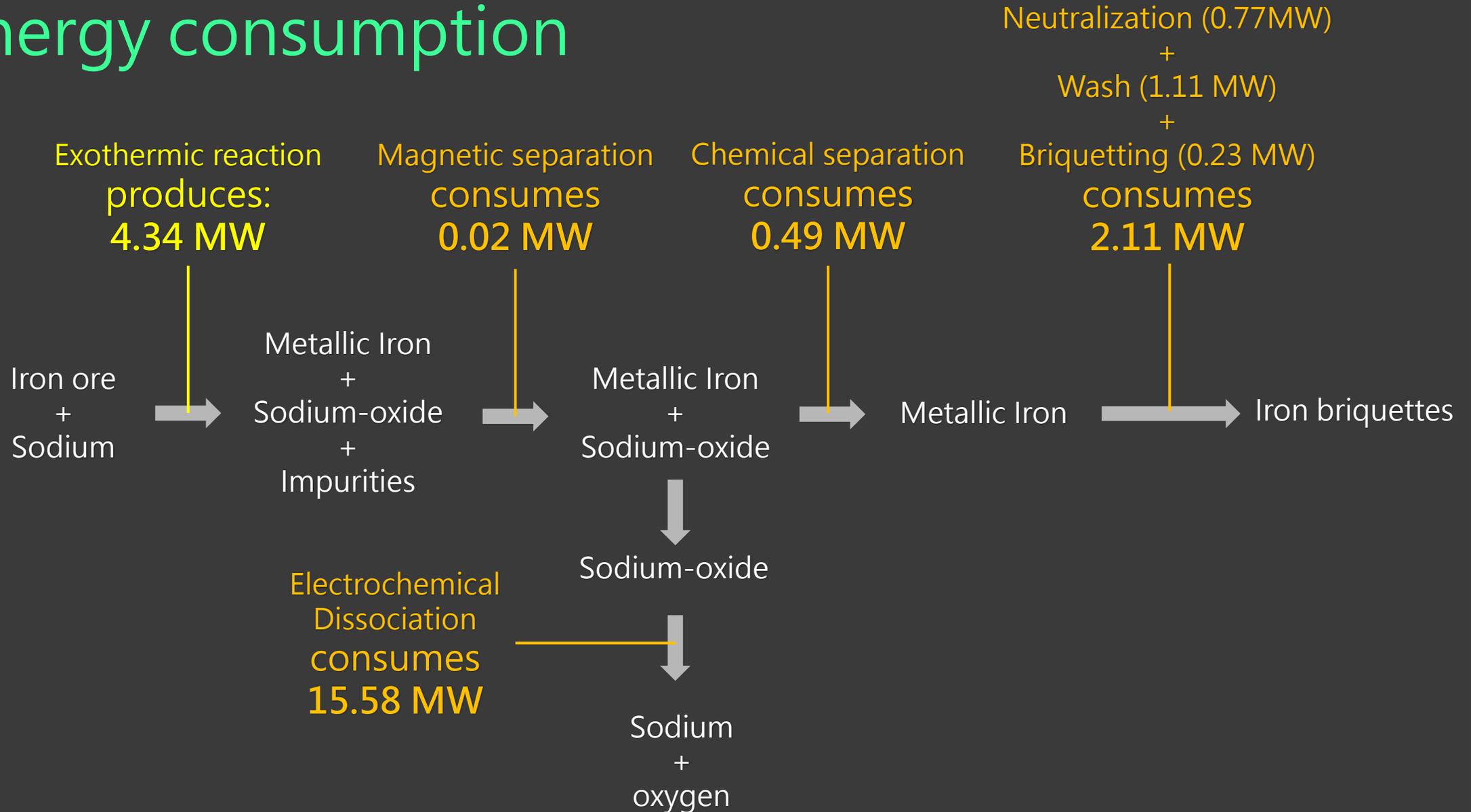
Sodium looping

Concept of Operation

The Helios concept of operation is relying on the Castner process of manufacturing sodium metal by electrolysis of molten sodium hydroxide at approximately 330 °C

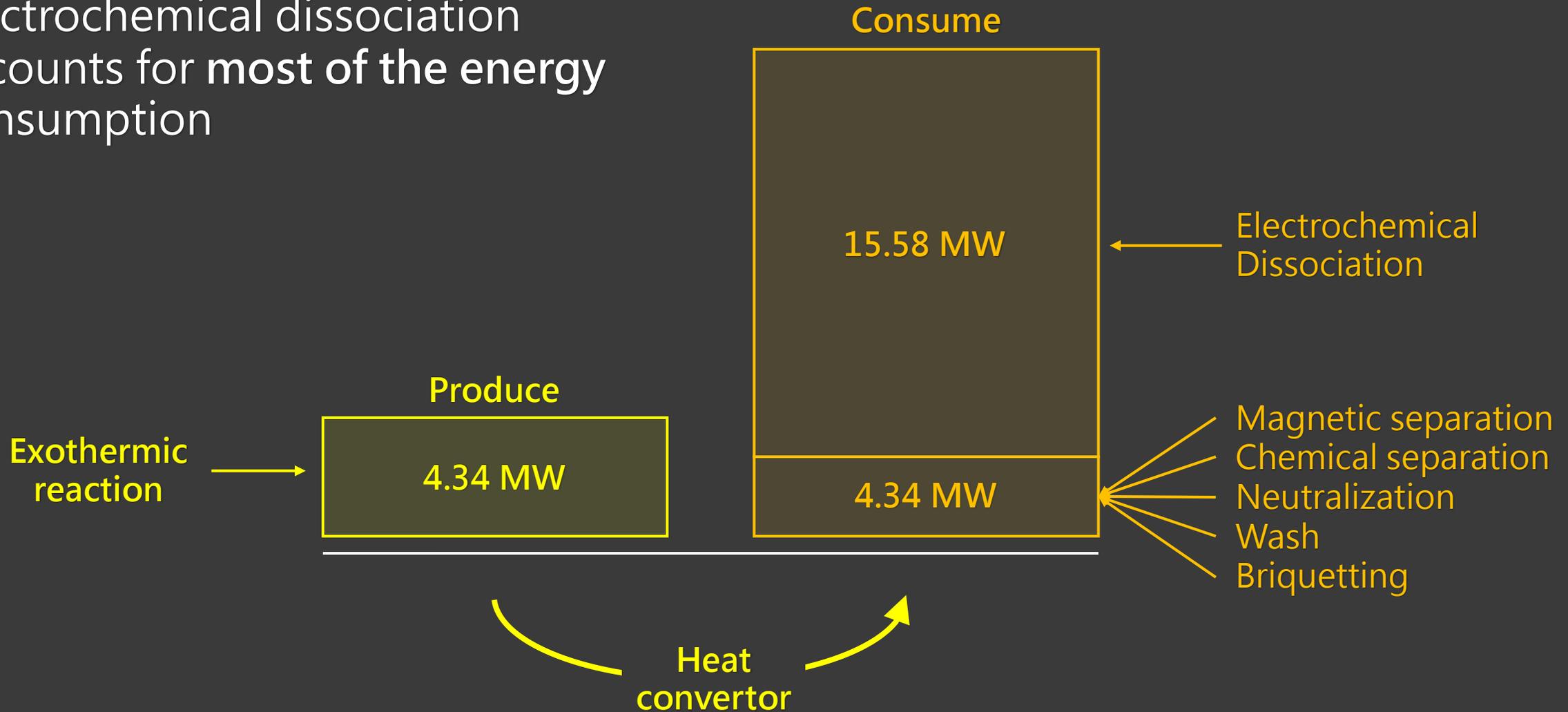


Energy consumption



Energy consumption

Electrochemical dissociation accounts for most of the energy consumption



The Final Product

Clean Iron

From iron powder to a uniform briquetted iron



Full control over
shape and size

Scale-Up

Helios is using scalable, readily available
"off the shelf" equipment

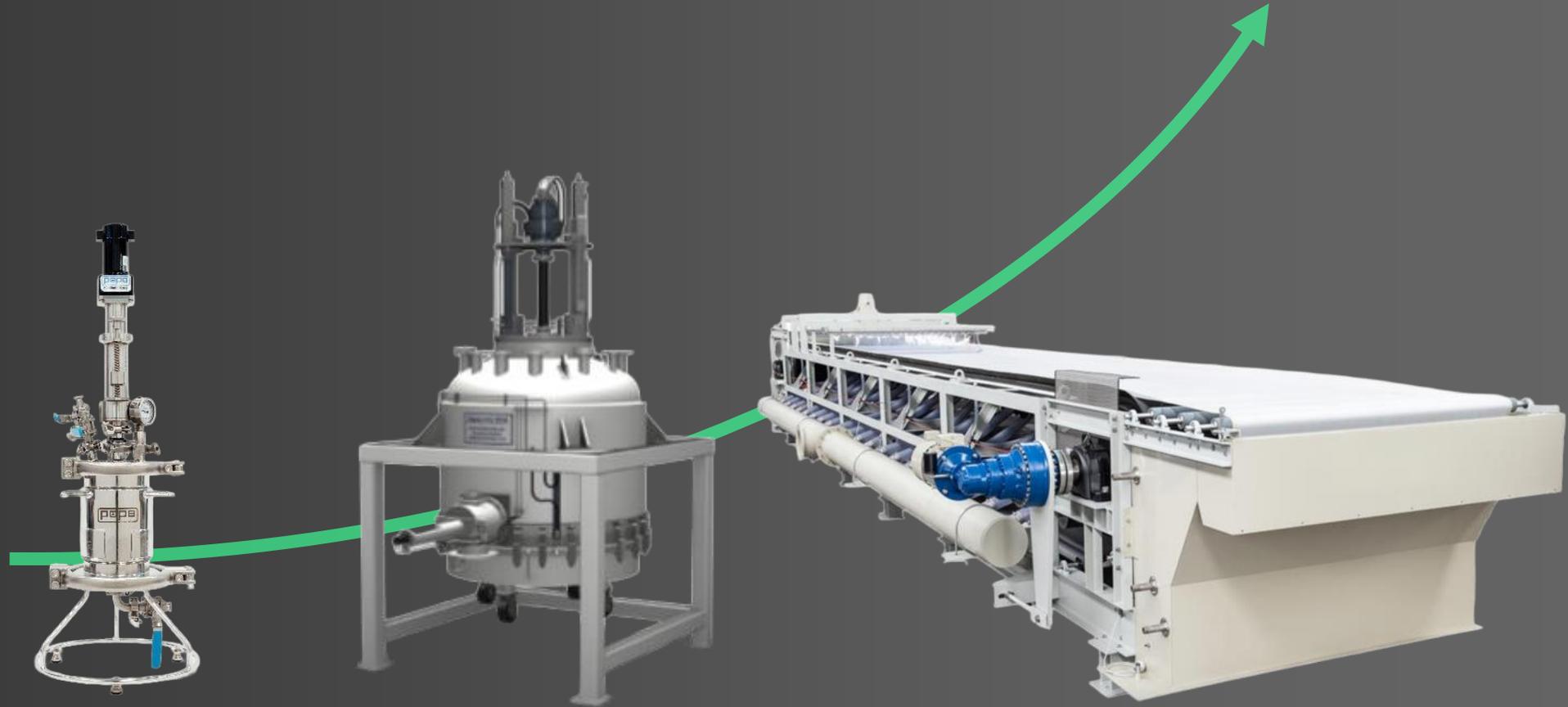
Chemical
reactors



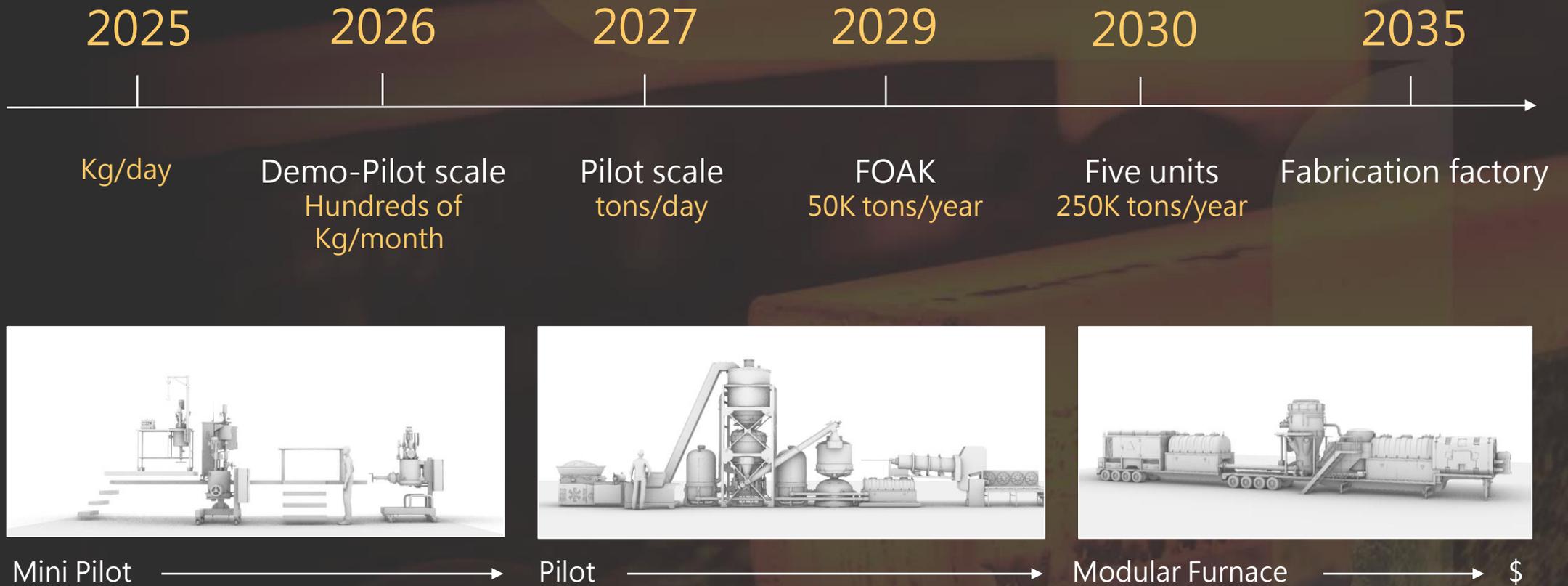
Scale-Up

Helios is using scalable, readily available
"off the shelf" equipment

Nutsche
filters



Roadmap



2029

FOAK 50K t/year



2031

5 units - 250K t/year



2035

Fabrication factory - 400 units/year
20,000,000 tons/year²



Key Takeaways:



Indifferent to feedstock



Ready for scaleup



Lower cost



SCRAP SUPPLEMENTS & ALTERNATIVE IRONMAKING 10



Q&A

Thank you, please connect with us for more information



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VP R&D



LinkedIn

HeliOS