

MARCO LAPASIN
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ARAB STEEL SUMMIT

OCTOBER 2023

ENERGIRON

DANIELI SOLUTIONS FOR TRANSITION TOWARDS GREEN STEEL

DANIELI / SINCE 1914
PASSION TO INNOVATE
AND PERFORM
IN THE METALS INDUSTRY



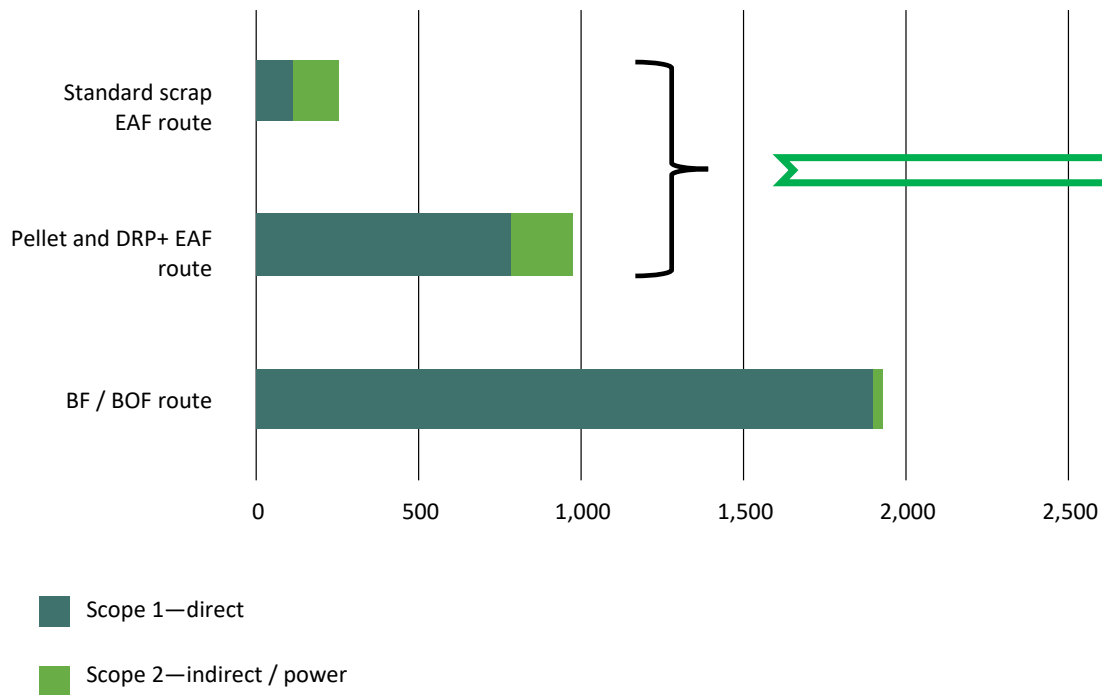
ENERGIRON HYL
DRI TECHNOLOGY BY TENOVA AND DANIELI



DANIELI TEAM
A CENTURY
OF PARTNERSHIP
EXPERIENCE

CURRENT SITUATION

Liquid steel production emission routes (kg/ton steel) – typical figures



Arab countries production route
32 Million Tons in 2021
(worldsteel figures)

Roughly 25% of gas DRI produced in the world is produced in Arab Countries

GasDRI production	2019	2020	2021
Arab Countries	18,3	17	19,4
Share of global	25%	24%	26%

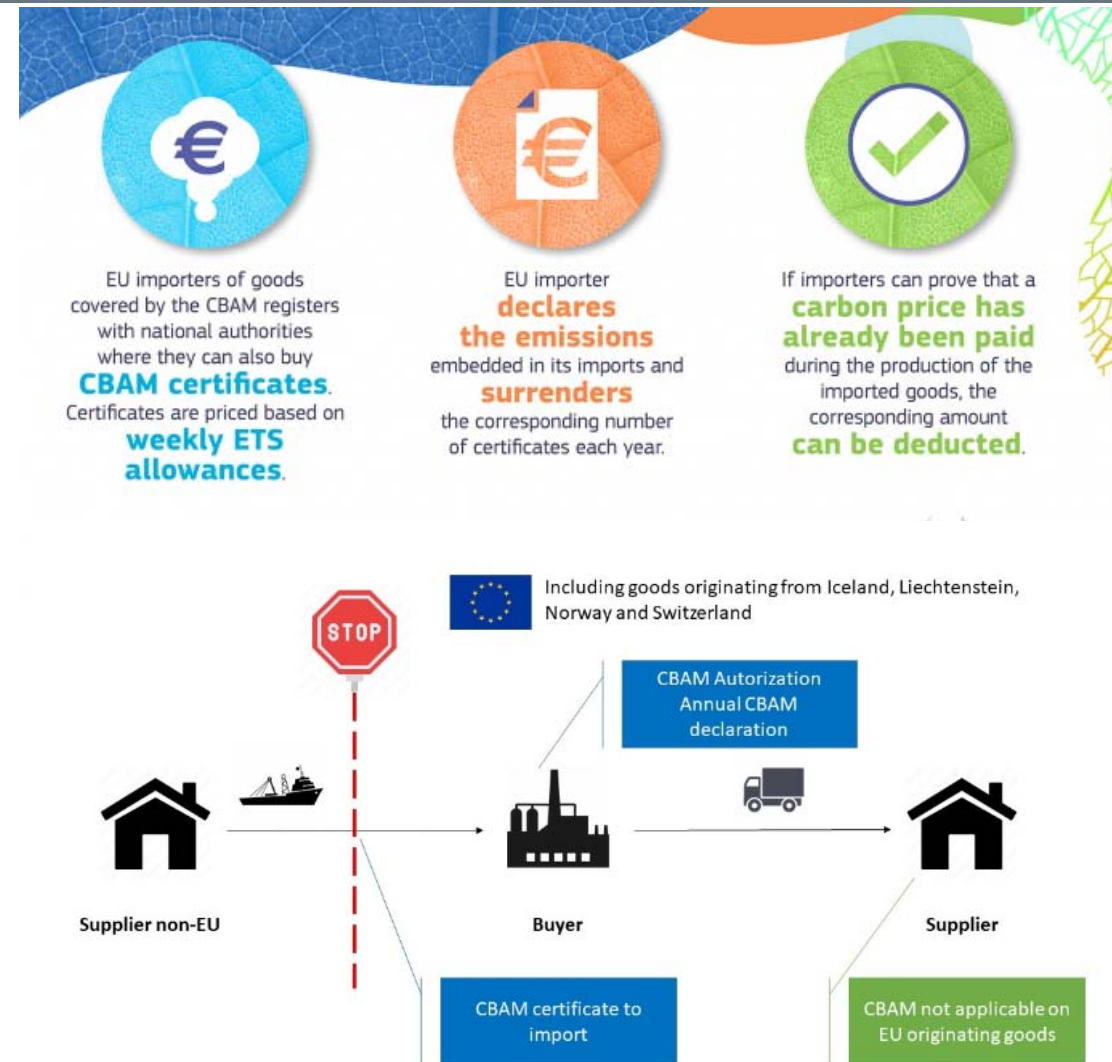
(worldsteel figures)

How will the CBAM work in practice?

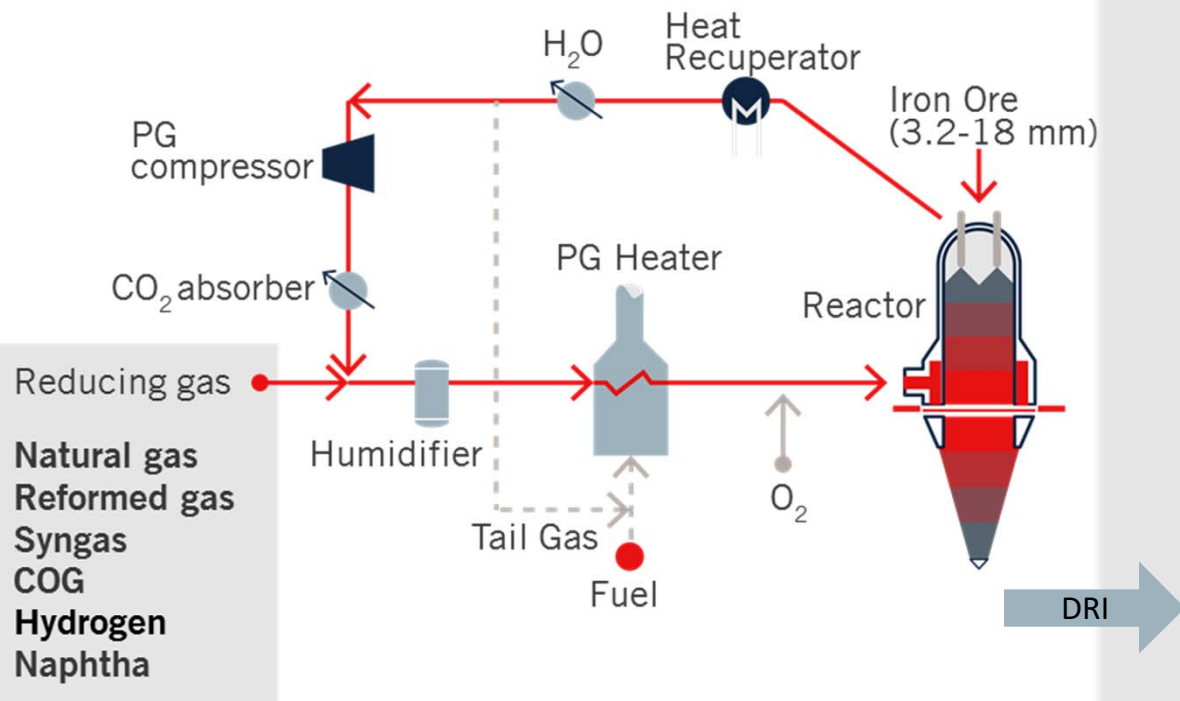
- > EU-Importers will have to purchase CBAM certificates. The **price of the CBAM** certificates is **linked** to the EU ETS price in € / ton of CO2 emitted.



- > **EU-Importers of the goods** will have to **register** with national authorities where they can also **buy CBAM certificates**.
- > **National authorities** will authorise registration of declarants in the CBAM system, as well as **reviewing and verifying declarations**.



IRON ORE ROUTE



From the smallest to the biggest DRP, processing lump ores and pellets, for any reducing gas source, complying to stringent environmental regulations

We produce at the lowest OPEX high quality DRI products

WITH THE SAME PLANT SCHEME



HIGH METALLIZATION
CONTROLLED CARBON CONTENT (1,0% - 5,0%)

EMIRATES STEEL



Two modules:

2.0 MTPY each
Carbon 1.5% - 2.5%
Met 94% - 96%
Hot DRI feed to EAF

Start-up
2009/2011

SUEZ STEEL



One module:

2.0 MTPY
Carbon 3.0% - 4.0%
Met 94% - 96%
Hot DRI feed to EAF

Start-up
2013

NUCOR



One module:

2.5 MTPY
Carbon 3.0% - 4.5%
Met 94% - 96.5%
Cold DRI

Start-up
2013

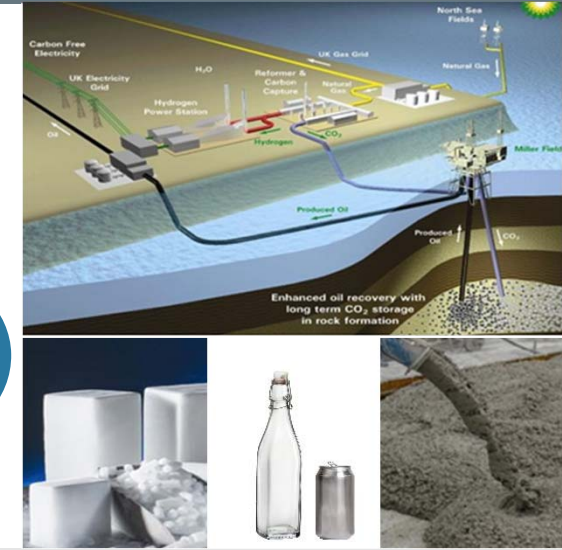
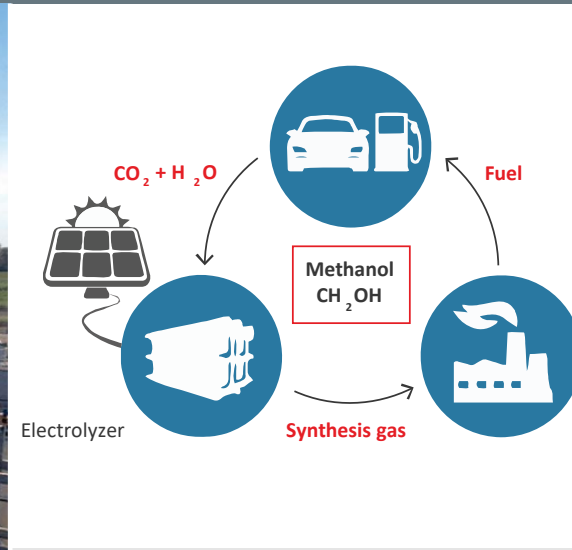
EZZ STEEL



One module:

1.95 MTPY
Carbon 1.5% - 2.5%
Met 94% - 96%
Cold DRI

Start-up
2015



FLEXIBILITY

- > Same scheme for ANY energy source
- > Minimum energy request
- > ZERO kWh / ZERO water make up scheme are a reality
- > No limitation in NG composition (HHC, S)
- > Wide range of IO input (dimension, shape, S content)

ENVIRONMENTAL

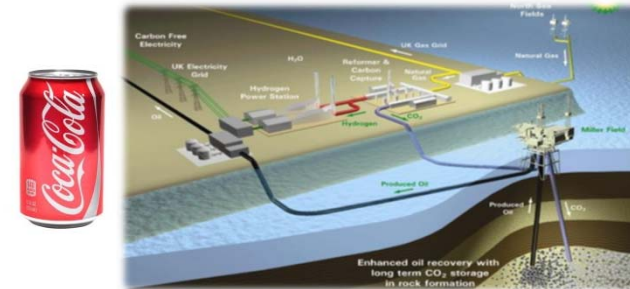
- > Lowest NO_x emissions: 0.030 kg_{NOX} / t_{DRI}
- > Lowest CO₂ emissions: 159-200 kg_{CO2} / t_{DRI}
- > Selective removal of reduction's by-products: H₂O & CO₂
 - > Beverages
 - > Dry ice
 - > EOR
 - > Construction aggregates
 - > Production of methanol (e-fuel) or urea (fertilizer)

➤ Since 1998, CO₂ gas, from the CO₂ absorption system of **ENERGIRON** plants has been used as by-products by different off-takers:

HYL/ENERGIRON DR Plant	Off-taking company	Use
Ternium; Monterrey, Mexico	Praxair	Food and beverages industries
Ternium; Puebla, Mexico	Infra	Beverages industries
PTKS; Indonesia	Janator	Food industry
PSSB; Malaysia	Air Liquid/MOQ	Food industry
JSW Salav; India	Air Liquid	Dry Ice
Emirates Steel; UAE ⁽¹⁾	Masdar/ADNOC	Enhanced Oil Recovery (EOR)
Nucor; USA ⁽²⁾	Denbury Resources Inc.	Nearby piping Network; EOR

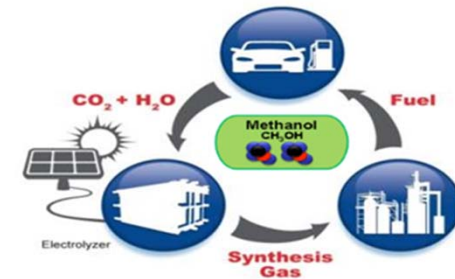
Note (1): On going project

Note (2): to be executed. Additionally NUCOR has a SULFEROX system that remove Sulfur from CO₂ stream



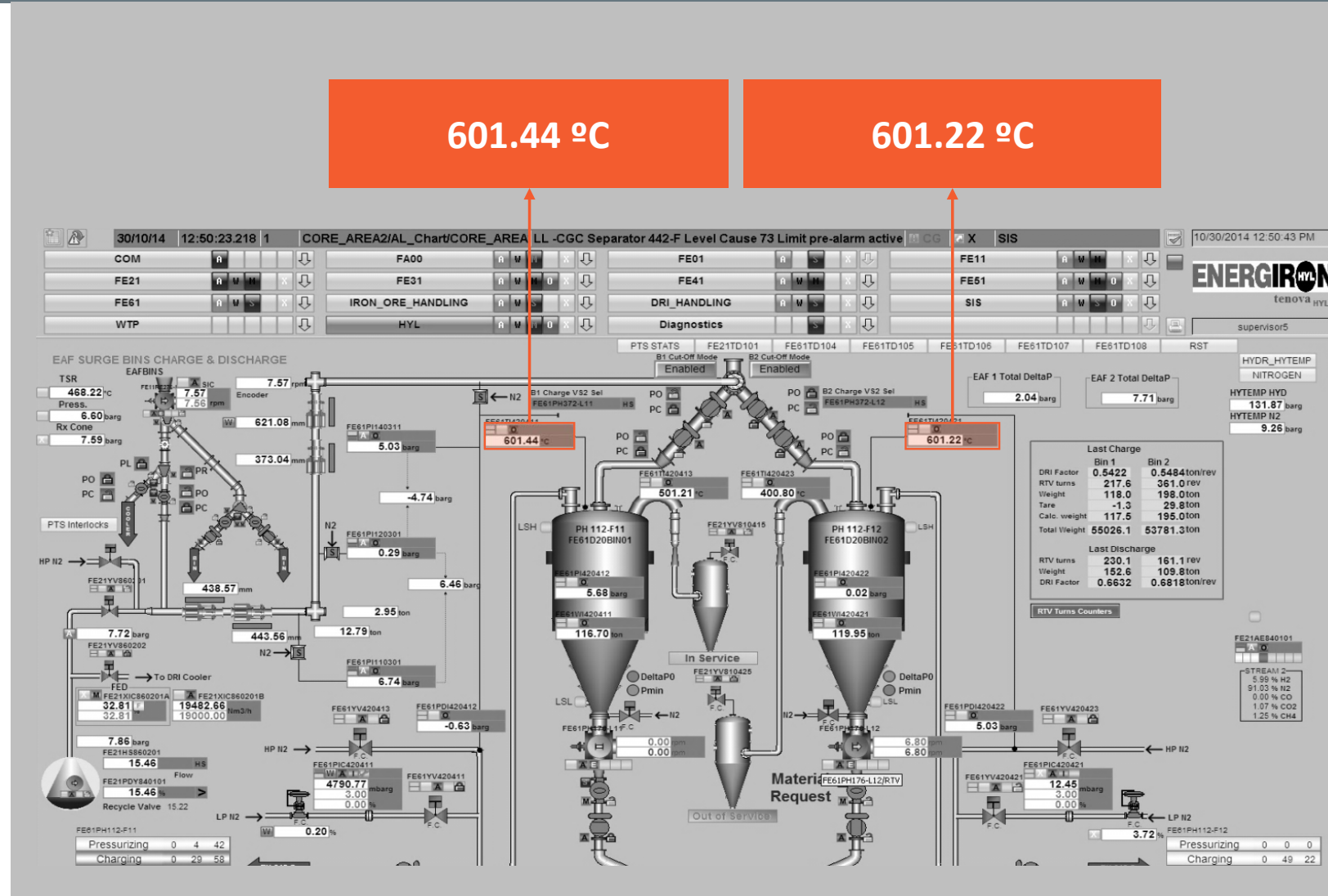
➤ **ENERGIRON** is also engaged in several R&D programs with associated companies looking for environmentally friendly capture and application of CO₂, such as:

- Biomimetic CO₂ capture and mineralization technology over a substrate to produce construction aggregates (with use of steelmaking dust/fines/sludge as seeding substrates)
- Use of CO₂ for production of methanol or urea (fertilizer), using green ammonia as feedstock.

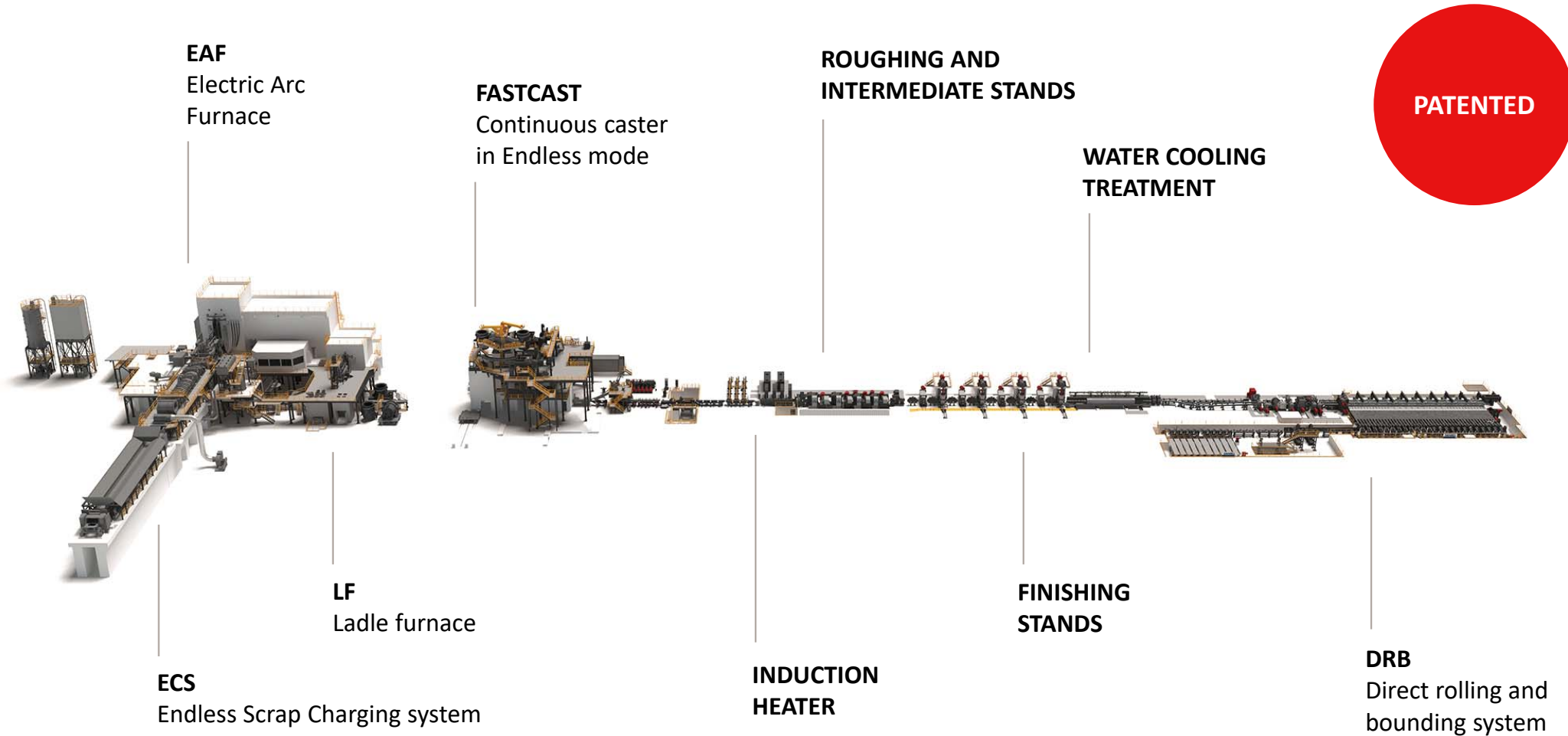


HOT DRI TEMPERATURE
FURTHER IMPROVED WITH THE
INSTALLATION OF THE
INNOVATIVE LINING
OF THE REACTOR CONE

HOT DRI T > 600°C



SCRAP ROUTE





Beni Suef



Ain Sukhna

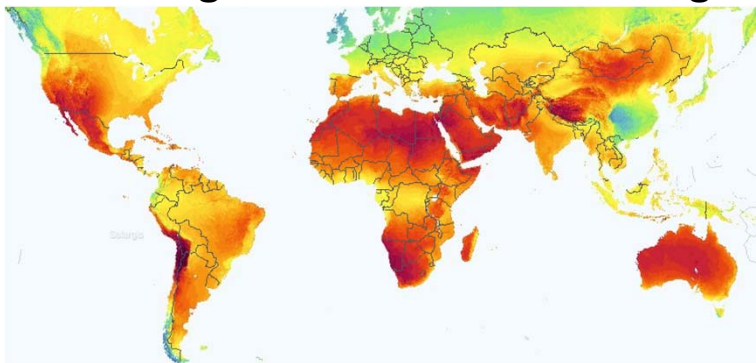


TRENDS & FORECAST

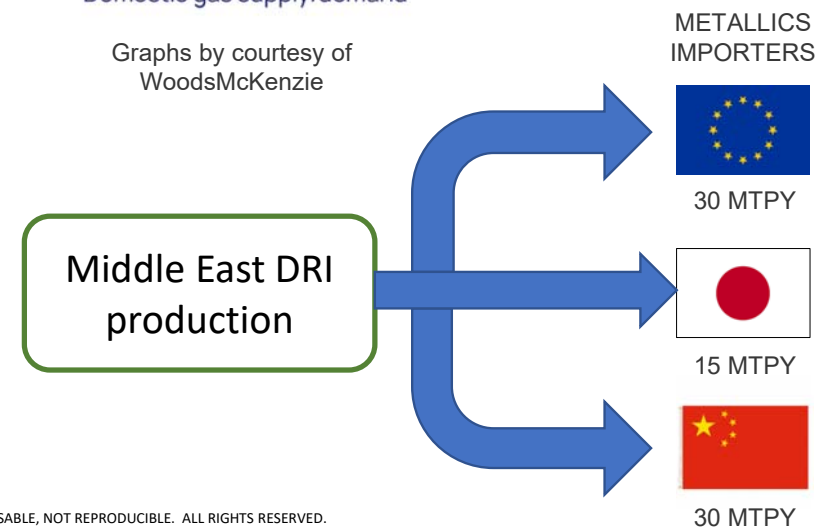
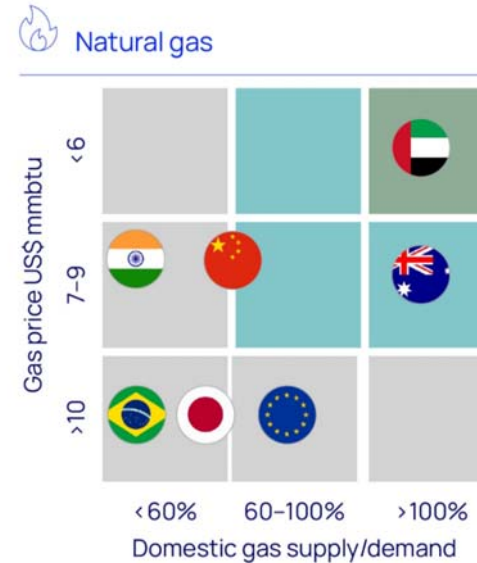
➤ **Natural Gas is already the cheapest in main Iron & Steel production areas**

➤ **The region is well positioned to ship HBI (or H-DRI) to other markets with steel production**

➤ **The potential for clean Hydrogen production is huge thanks to average sun radiation on the ground**



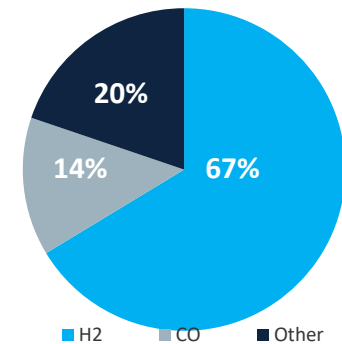
➤ **ENERGIRON** Technology takes also advantage of the extensive experience and operation with PG heaters design, specifically with high %H₂



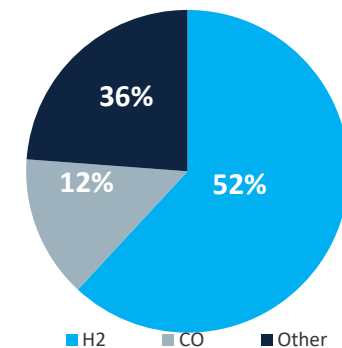
- **ENERGIRON** process Scheme is natively fitted for direct use of H₂
- **ENERGIRON** plants work, as per design concept, with high % of H₂. As a matter of fact, **ENERGIRON** technology runs with ratio H₂/CO up to 5, whilst other technologies average ratio is approx. 1,7.
- All the above is mainly due the Operating Pressure (6-8 bar(A) against approx. 2,5 bar(A) for other DR technologies). Being the H₂ the lightest and more diffusible compound in nature, having a higher operating pressure means:
 - Safer and reliable mechanical sealing for shaft charging and discharging systems
 - Enhanced and uniform gas distribution for proper gas-solid contact
- **ENERGIRON** Technology takes also advantage of the extensive experience and operation with PG heaters design, specifically with high %H₂

Average gas composition inside **ENERGIRON** DR plant

ENERGIRON HYL III



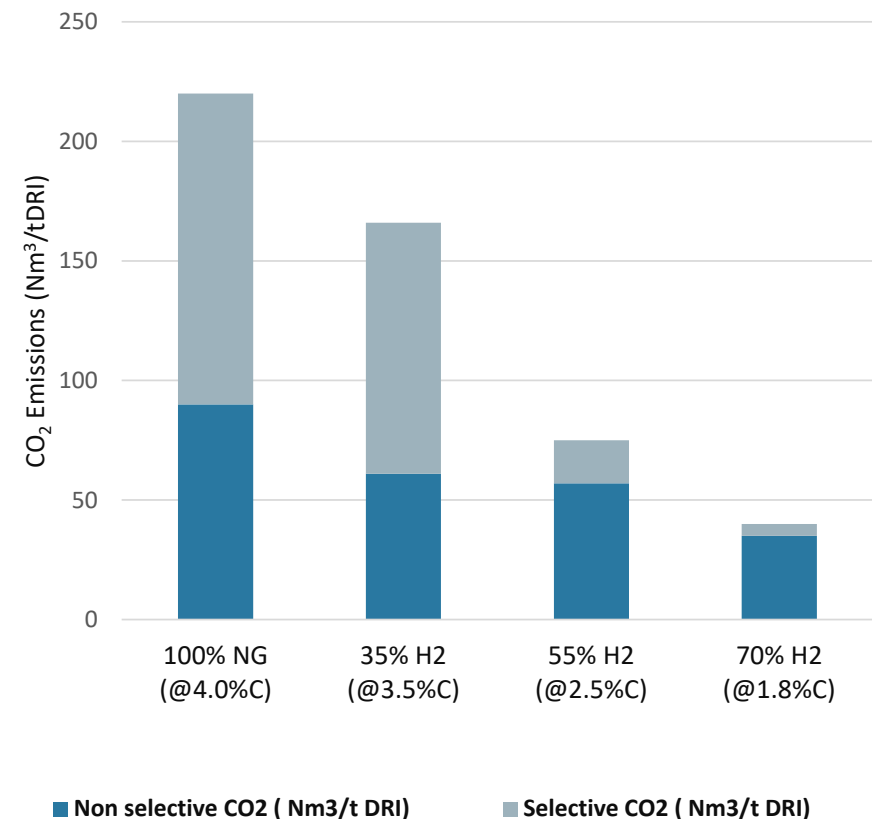
ENERGIRON HYL ZR



In addition to the vast industrial experience using H₂ in reformed gas, **ENERGIRON** Technology can take advantage of past, present and future R&D activities:

- Extensive tests carried at Proprietary Pilot Plant, since 1990's, with $\geq 90\%$ H₂. Testing activities provided capability results for all type of reducing gases. Low and high carbon condition (depending with downstream requirements) have been explored. CO₂ emissions with different % of H₂ have been defined.
- New pilot plants and testing campaigns are currently under development, jointly with partners and customers

CO₂ emissions with H₂ use in the **ENERGIRON** DR process



REFERENCES

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