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VICE PRESIDENT
DANIELI CENTRO METALLICS

17th Arab Steel Summit
14 – 15 October 2024

Renewable Energy For DRI Production With ENERGIRON[®] Technology

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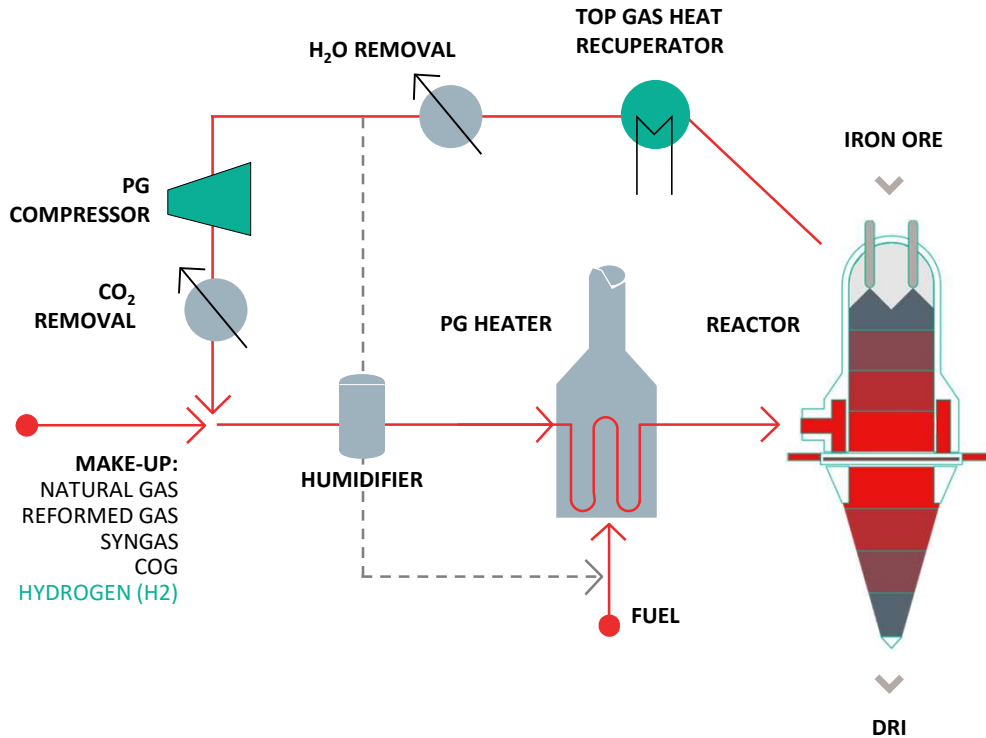
DANIELI / SINCE 1914
PASSION TO INNOVATE
AND PERFORM
IN THE METAL INDUSTRY

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ENERGIRON®
THE MOST FLEXIBLE &
SUSTAINIBLE DRI PROCESS

Energiron®
design concept

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PLANT SCHEME



**HIGH METALLIZATION
CONTROLLED CARBON CONTENT
(1,0% - 4,5%)**

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SUSTAINABLE DRI PROCESS

Energiron®
design concept

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ENERGIRON^{HYL}
THE INNOVATIVE DIRECT REDUCTION TECHNOLOGY

**SUSTAINABLE
TECHNOLOGY**

**FLEXIBLE
TECHNOLOGY**

ENERGIRON®
THE MOST FLEXIBLE &
SUSTAINABLE DRI PROCESS

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ENERGIRON FLEXIBILITY :

- Same Process Scheme for transition to Hydrogen
- No limitation on the Sulphur content in iron ore
- Capability to efficiently process different sources for reducing gas

ENERGIRON^{HYL}

THE INNOVATIVE DIRECT REDUCTION TECHNOLOGY

HIGH PRESSURE OPERATION



OPERATING AT SLIGHTLY HIGHER PRESSURE BRINGS GREAT BENEFITS

ELECTRICAL ENERGY SAVINGS

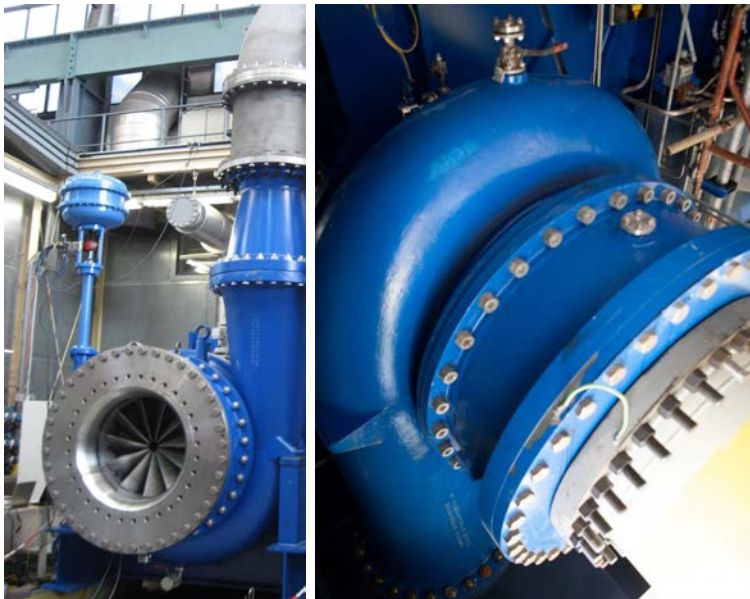
IRON ORE SAVINGS

EFFICIENT CO₂ REMOVAL

**OPERATING
PRESSURE**

6-10 barg

ELECTRICAL ENERGY SAVINGS



The largest electrical load is the process gas compressor

COMPRESSION $\propto (P_2/P_1)^k$

ELECTRICAL ENERGY CONSUMPTION FOR DR CORE AREA:

	P (barg)	kWh/tDRI
ENERGIRON	6-10	60-75
LOW P	1-2	100-120

OPERATING AT SLIGHTLY HIGHER PRESSURE BRINGS GREAT BENEFITS

ELECTRICAL ENERGY SAVINGS

IRON ORE SAVINGS

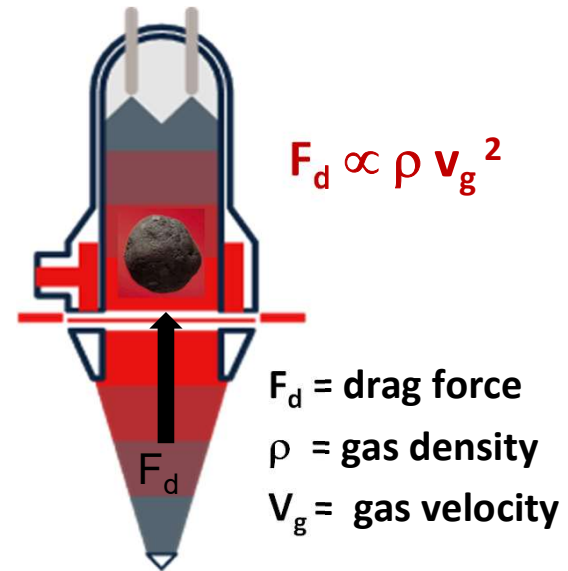
EFFICIENT CO₂ REMOVAL

IRON ORE SAVINGS

DURING HANDLING, IRON ORE IS REDUCED IN SIZE

THE CAPABILITY TO PROCESS SMALLER SIZE ORES
PROVIDES ADVANTAGES IN CONSUMPTION AND OPEX

LIMITATION IN USE OF SMALLER PARTICLE ORES IS THE
DRAGGING FORCE OF THE GAS FLOWING THROUGH
THE REACTOR, WHICH IS MAINLY A FUNCTION OF GAS
VELOCITY



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THE MOST FLEXIBLE &
SUSTAINIBLE DRI PROCESS

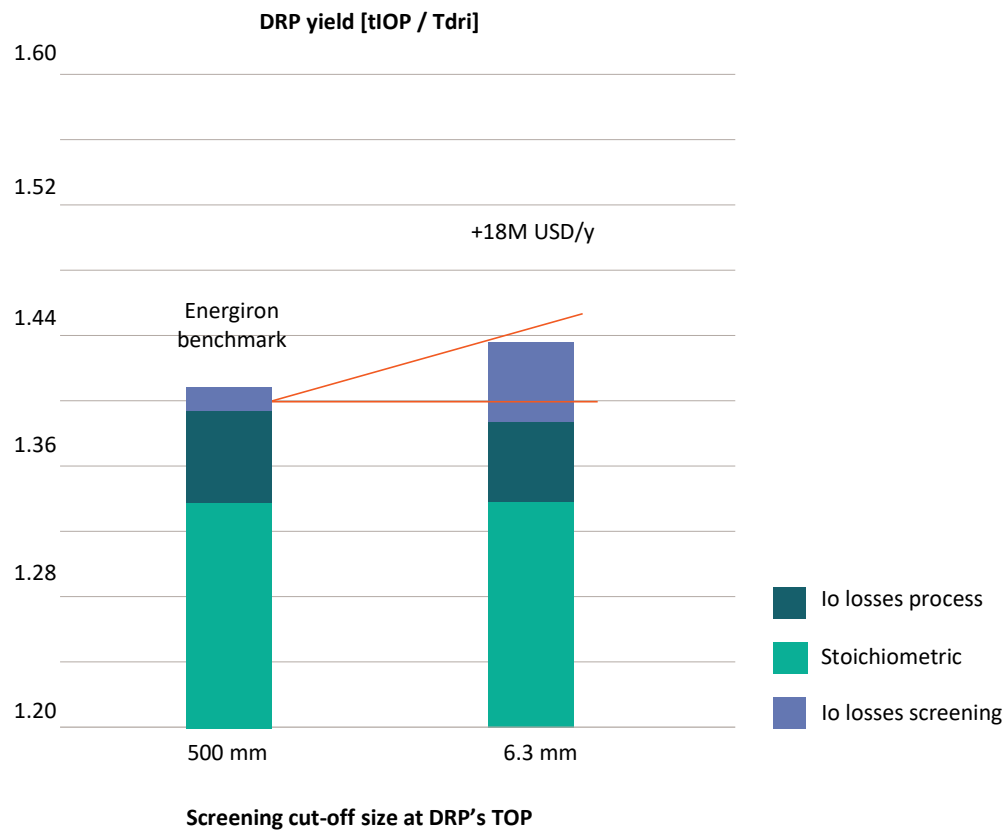
Technology characteristics

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IRON ORE SAVINGS

	P (barg)	Gas velocity (m/s)	Pellet size (mm)	Consumption (tIOP/tDRI)
ENERGIRON	6-10	2.4-1.9	5.0-42	1.40
LOW P	1-2	5.4-5.1	6.3-42	1.42



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SUSTANAIBLE TECHNOLOGY

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IS Reaching ZERO carbon emissions
With ENERGIRON Technology
possible?



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Low-carbon emission
footprint is possible

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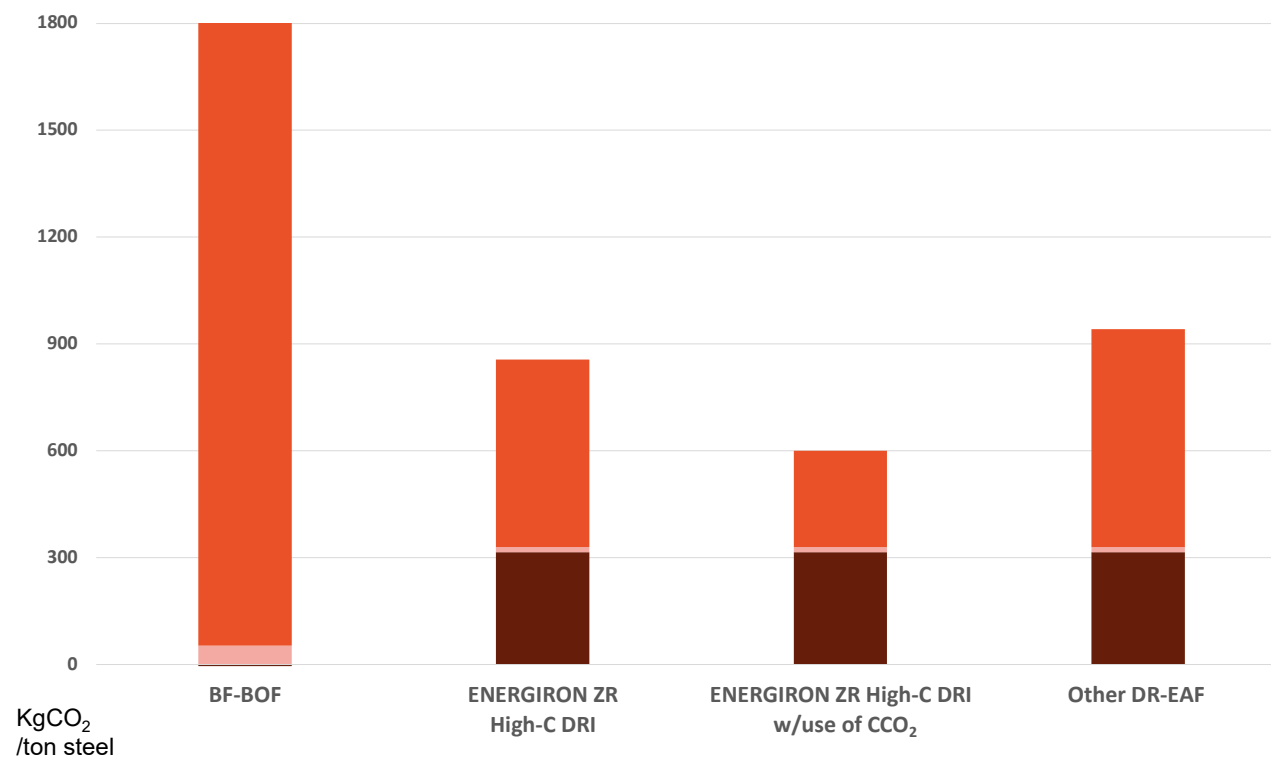
ENERGIRON DR

- 50%

OF BEST
AVAILABLE BF-
BOF ROUTE

- Coal / Natural Gas
- Others (Iron ore, fluxes, etc)
- Power

CO₂ EMISSIONS FROM STEELMAKING ROUTES (100% DRI-EAF)



ENERGIRON®
THE MOST FLEXIBLE &
SUSTAINIBLE DRI PROCESS

Reduction of
other pollutants

GREENSTEEL
ENERGIRON + DIGIMELTER Q-ONE

- > BAT
- > Up to - 50% PM
- > Drastic reduction of NOX SOX
and other pollutants

POLLUTANT	EMISSION
CO	-99%
NOx	-78%
VOC	-100%
BTX	-100%
PCDD/F	-100%
SOx	-91%
BAP	-100%
IPA	-100%

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SUSTAINABLE DRI PROCESS

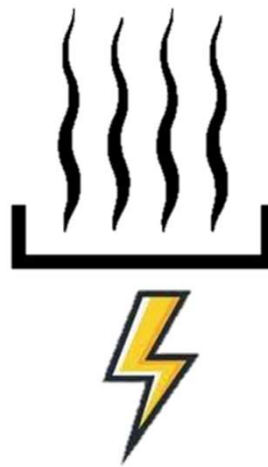
Road to Zero CO2 Emissions

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CO2 Removal System



Electrification Of Heating



Transition To H2



OPERATING AT SLIGHTLY HIGHER PRESSURE BRINGS GREAT BENEFITS

ELECTRICAL ENERGY SAVINGS

IRON ORE SAVINGS

EFFICIENT CO₂ REMOVAL

ENERGIRON®
THE MOST FLEXIBLE &
SUSTAINIBLE DRI PROCESS

1° move:
carbon capture
and reuse

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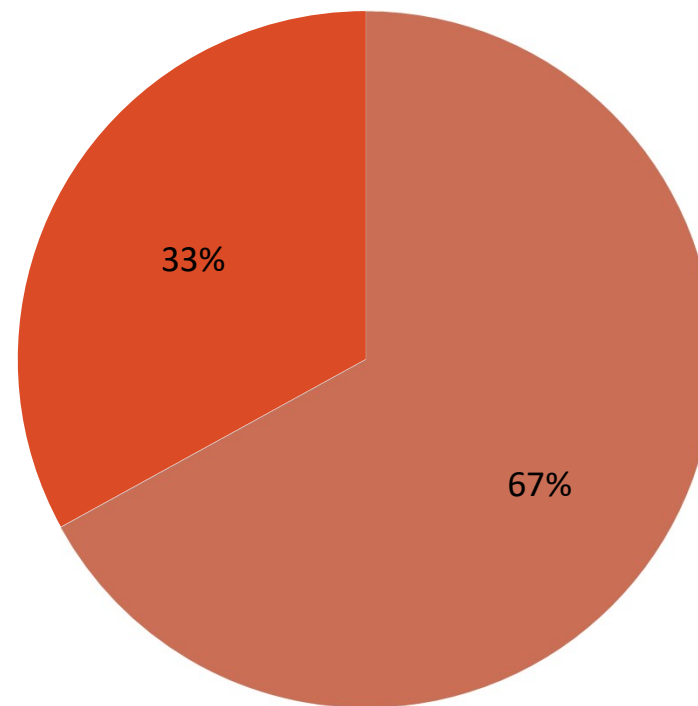
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ENERGIRON TECHNOLOGY FEATURES
CO₂ REMOVAL SYSTEM

COMMERCIALIZATION OF CO₂

- > Food and beverages industries
- > Enhanced oil recovery (EOR)
- > Conversion into chemicals

FROM TOTAL CO₂ GENERATED



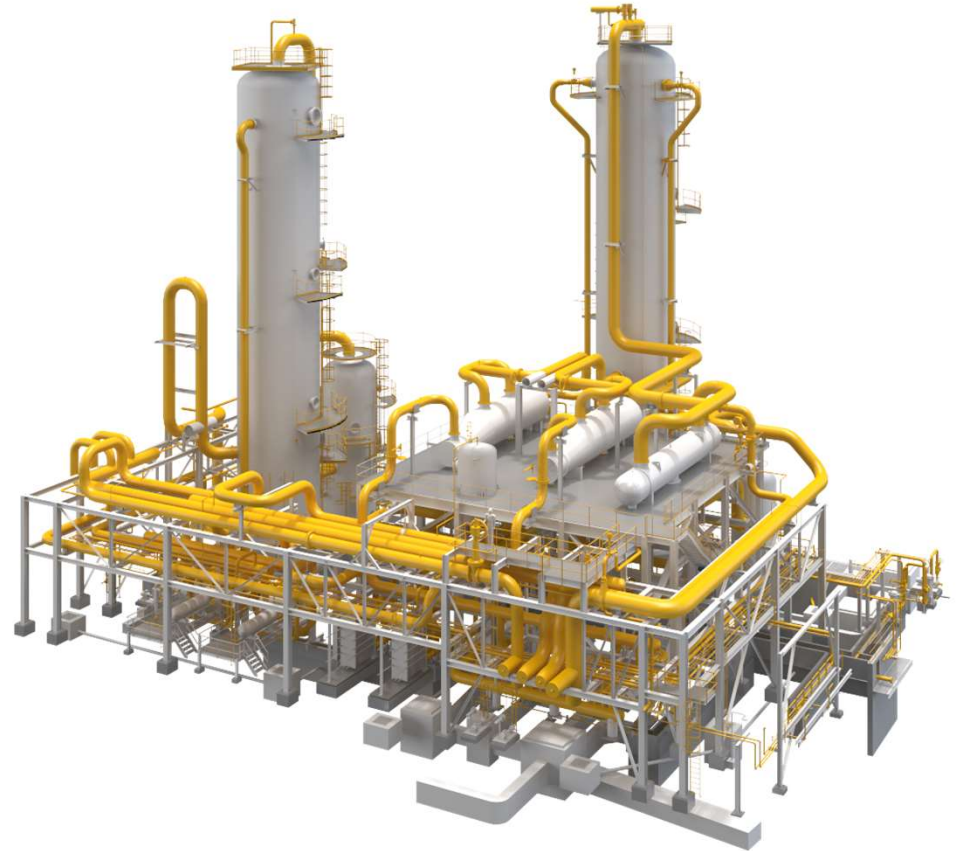
■ Selective CO₂
■ Emissions from stack

Approx. 256kg CO₂/t_{DRI}
can be stored and/or sold
as byproduct

EFFICIENT CO₂ REMOVAL

CO₂ removal is efficient because of:

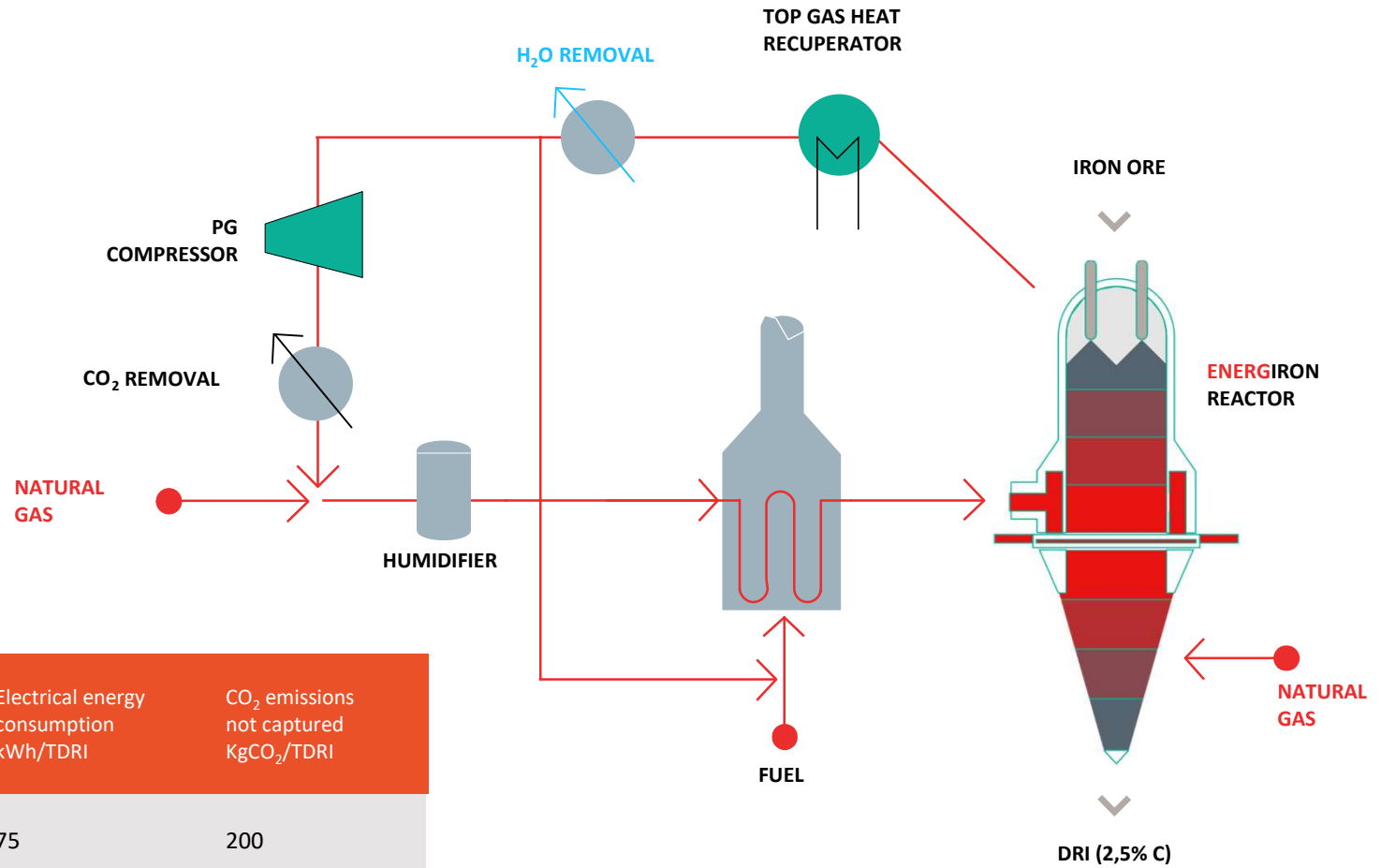
- > **High pressure that facilitates the transfer to liquid phase**
- > **Thermal integration with heat recovery inside project makes the separation efficient energy wise**



ENERGIRON®
THE MOST FLEXIBLE &
SUSTAINABLE DRI PROCESS

1st step of transition to green

ENERGIRON
DR plant
2.5 MTPY plant
(100 % NG gas feed
with fired PGH)



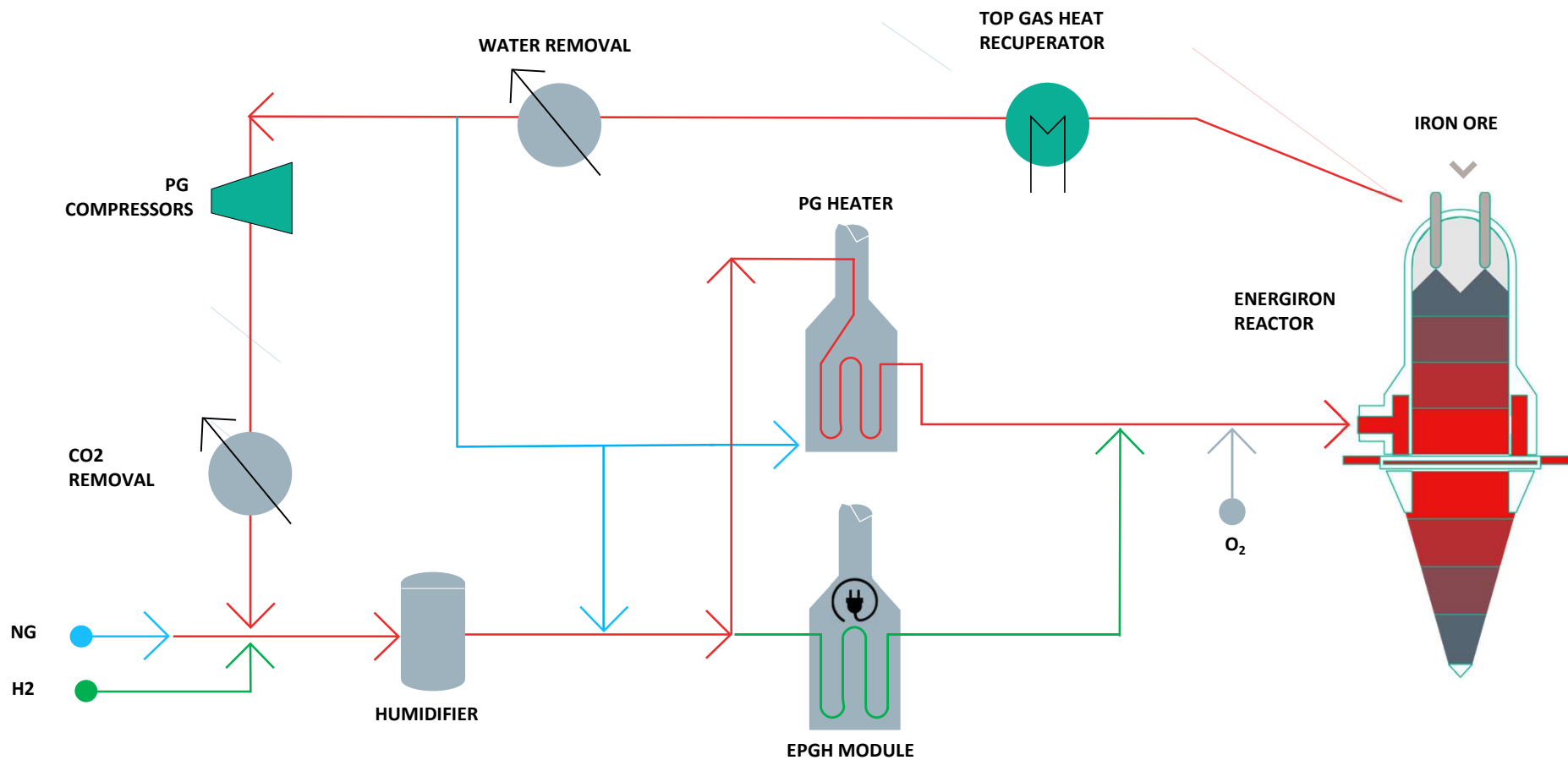
NG consumption kWh/TDRI	H ₂ consumption kWh/TDRI	Electrical energy consumption kWh/TDRI	CO ₂ emissions not captured KgCO ₂ /TDRI
3400	0	75	200

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2° move:
electrification of heating

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Electrical process gas heater

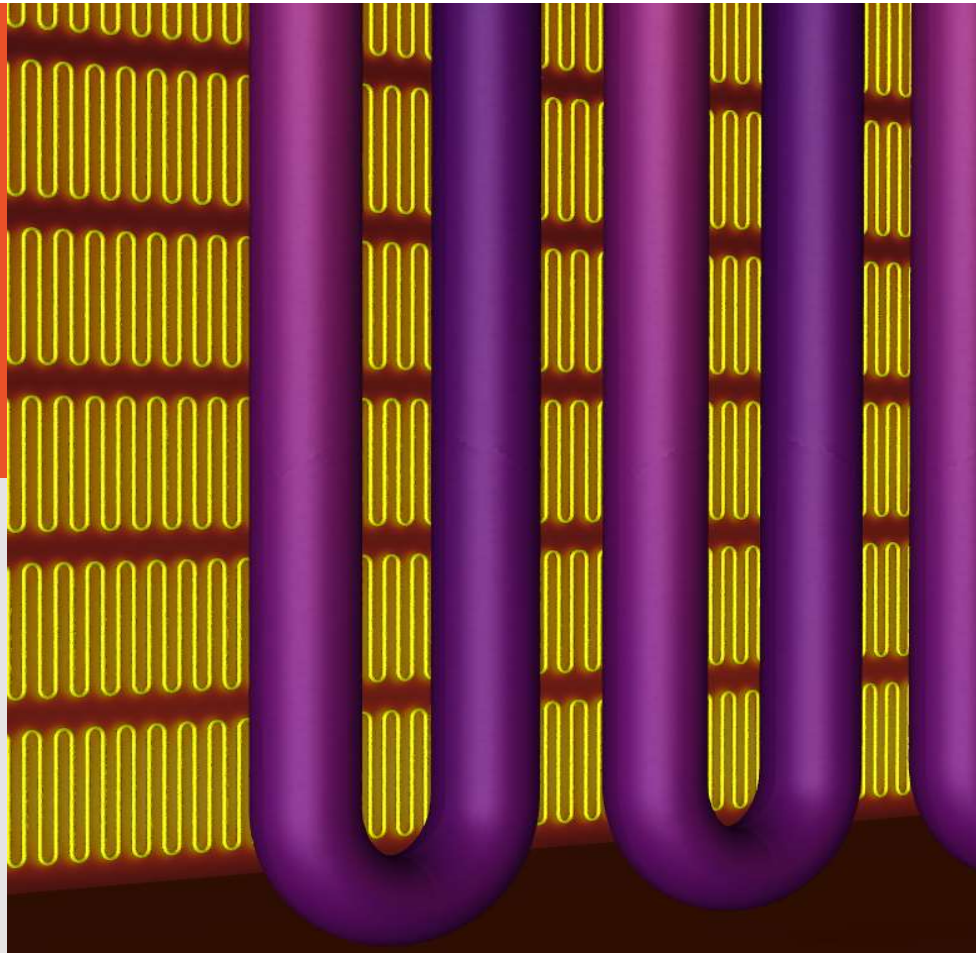
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E-PGH IS AN EFFECTIVE AND
EFFICIENT APPROACH TO
REDUCE CO₂ FOR DRPS

Available technologies to use
green EE:

- > Direct heating
- > Indirect heating



E-PGH 3D MODEL



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SUSTAINIBLE DRI PROCESS

E-PGH CONCEPT

for **2,5** MTPY
electrical heater
consumption

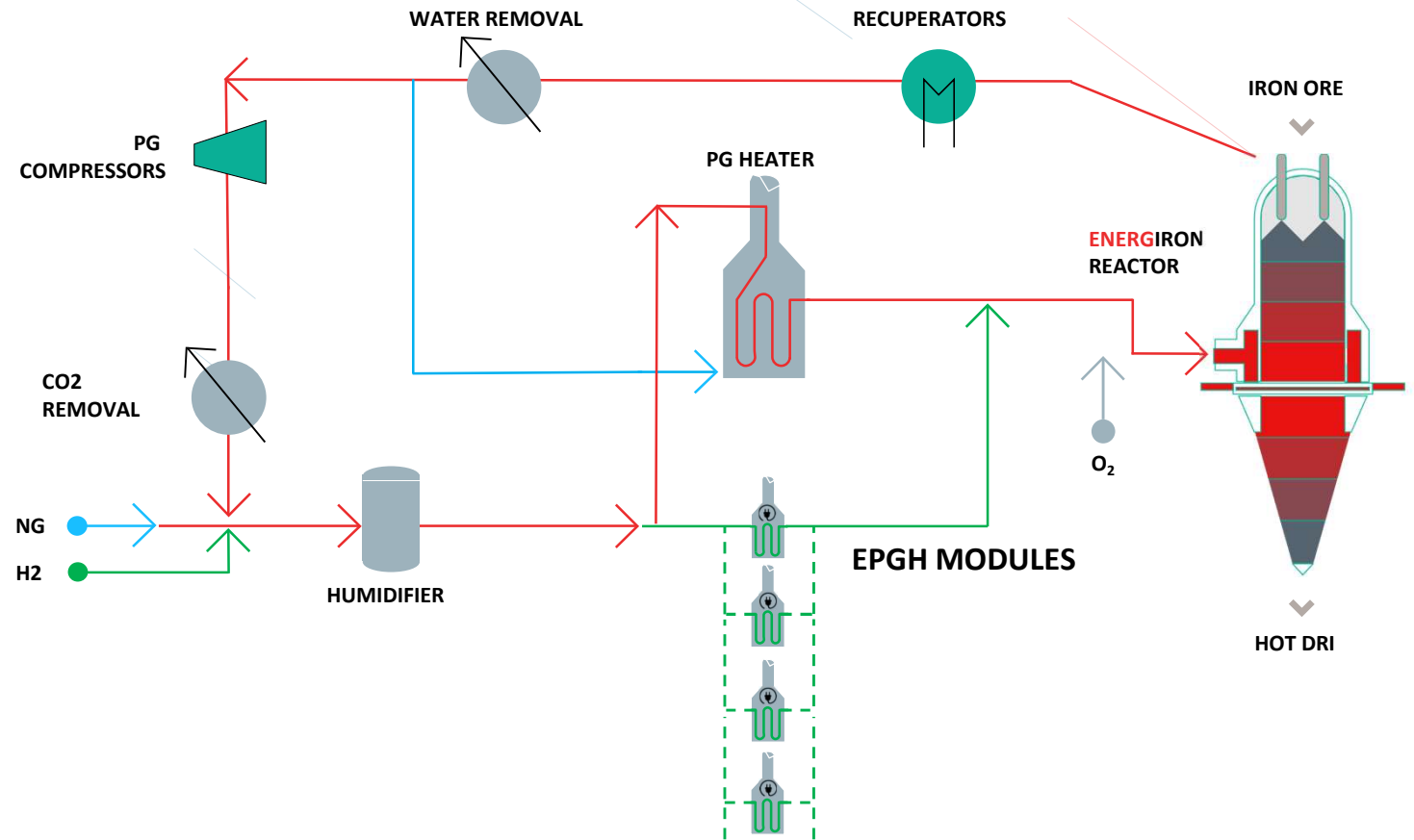
280 MW
with natural gas

200 MW
with hydrogen

Stepwise conversion
to electrification

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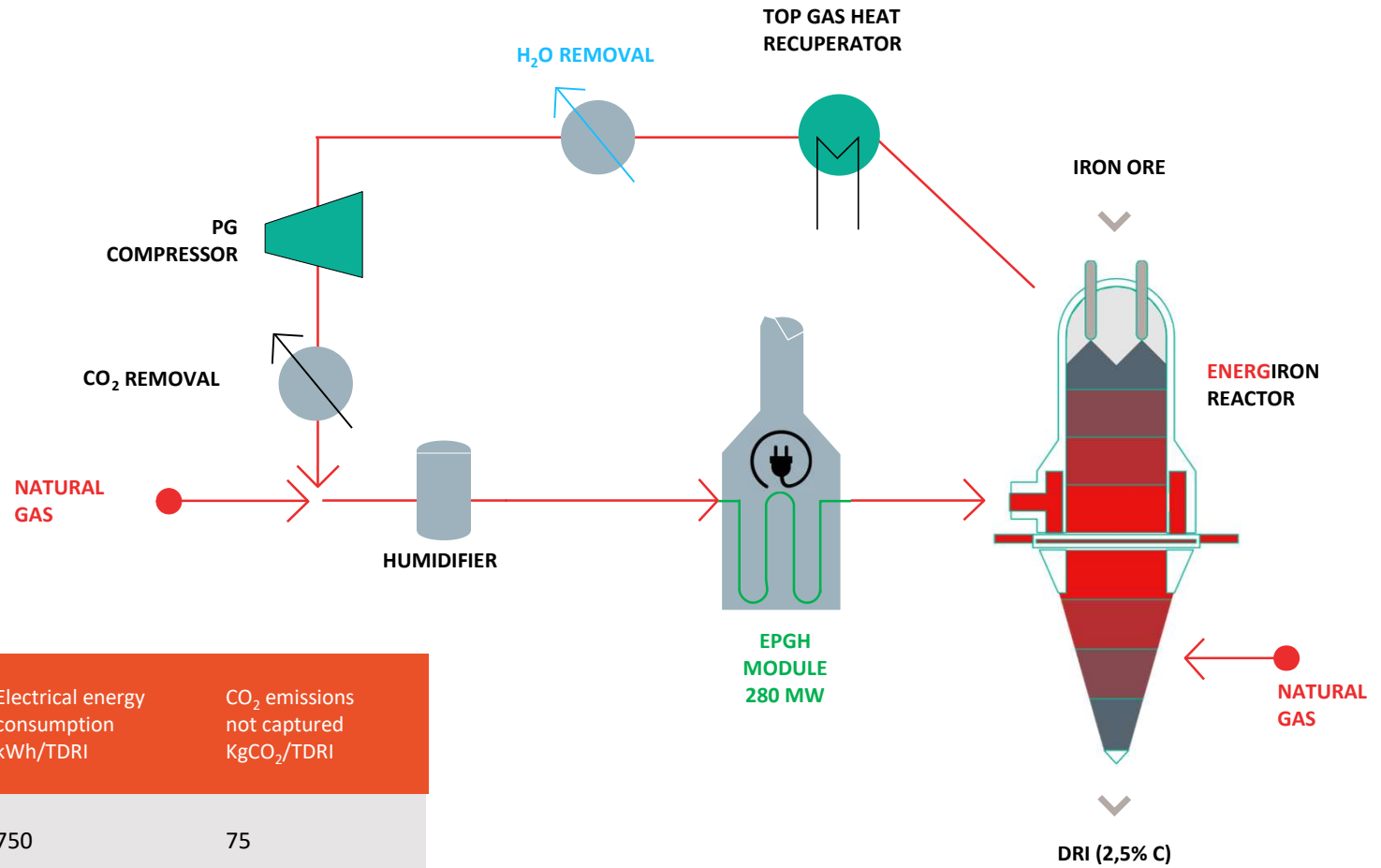
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 SUSTAINIBLE DRI PROCESS

2nd step of transition to H2

ENERGIRON
 DR plant
 2.5 MTPY plant
 (100 % NG gas feed
 with E-PGH)



NG consumption kWh/TDRI	H ₂ consumption kWh/TDRI	Electrical energy consumption kWh/TDRI	CO ₂ emissions not captured KgCO ₂ /TDRI
2750	0	750	75

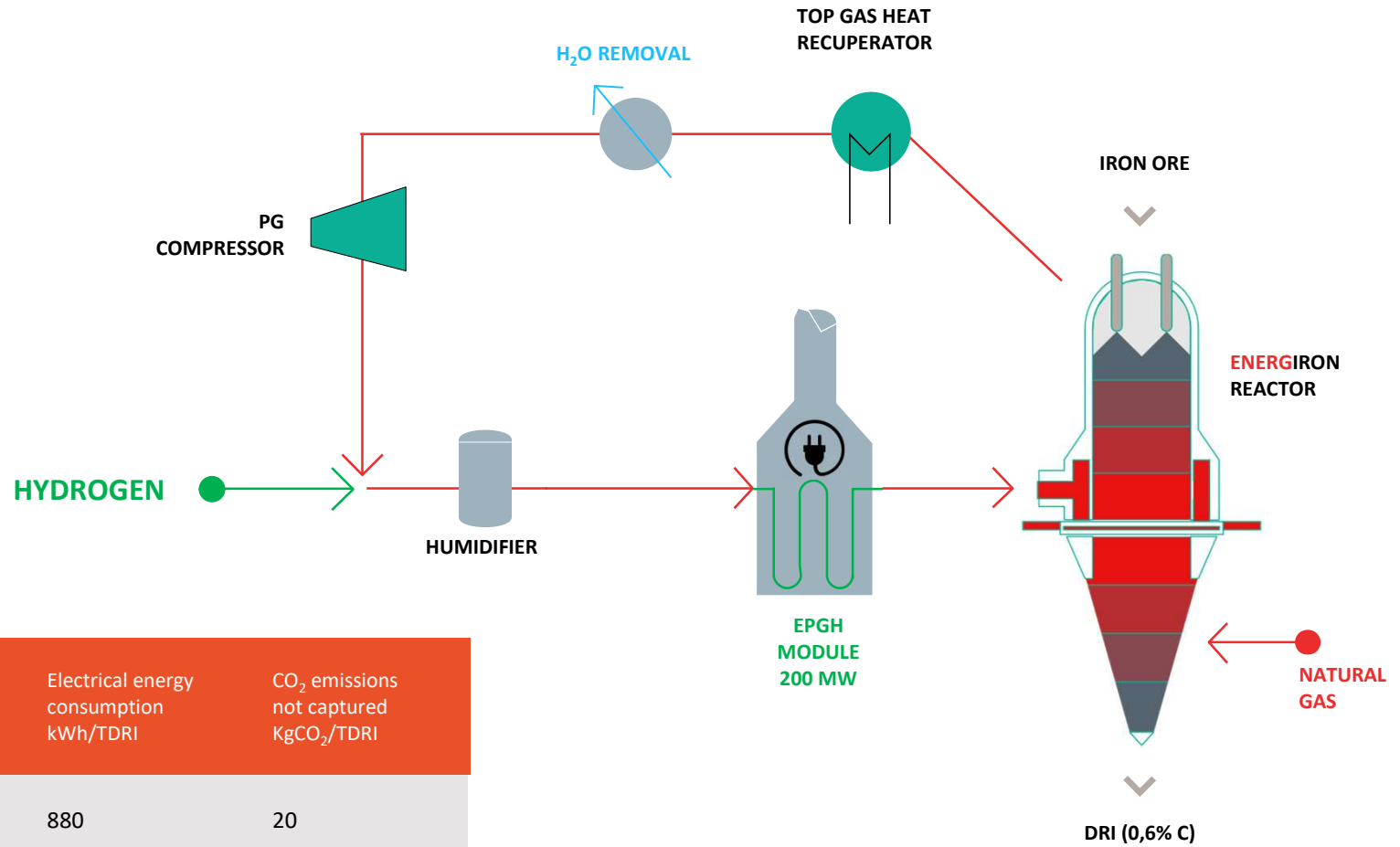
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3rd step of transition to H2

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ENERGIRON
DR plant
2.5 MTPY plant
(80 % H2 gas feed
with E-PGH)



NG consumption kWh/TDRI	H ₂ consumption kWh/TDRI	Electrical energy consumption kWh/TDRI	CO ₂ emissions not captured KgCO ₂ /TDRI
200	1400	880	20

ENERGIRON®
THE MOST FLEXIBLE &
SUSTAINABLE DRI PROCESS

NG transition
up to 100% H₂

FUTURE – by 2050

Up to 100% Hydrogen

Carbon – free
energy

Hydrogen +
Oxygen

Liquid
steel

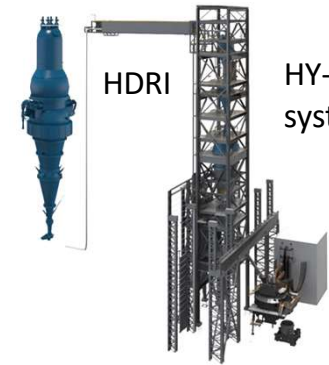


Renewable
energy sources



High-efficiency
electrolyser

ENERGIRON
DR plant



HY-TEMP®
system

EAF

FLEXIBLE PATH
TO LOWER IRON ORE
CONSUMPTION

CO₂ CAPTURE
AND UTILIZATION

FLEXIBLE TO LOWER
ELECTRICAL ENERGY
CONSUMPTION

E-PGH
MODULES

FLEXIBLE PATH TO
LOWER CO₂
EMISSIONS BY USING
CLEAN REDUCING
GASES

HIGH PERCENTAGES
OF HYDROGEN

14-15 October 2024

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Renewable Energy For DRI Production With ENERGIRON® Technology

MARCO LAPASIN
VICE PRESIDENT
DANIELI CENTRO METALLICS

Thank you



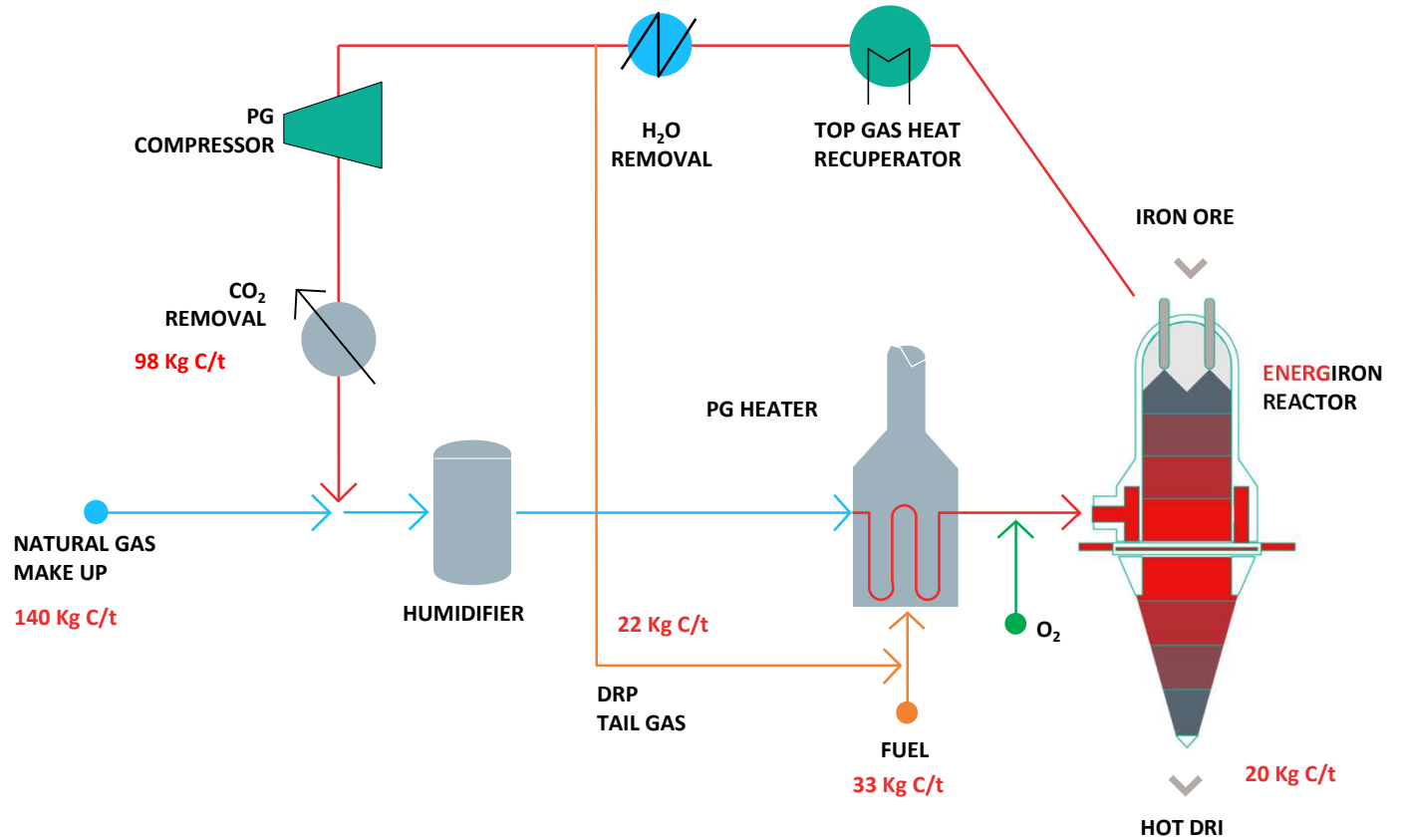
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Carbon balance and
 its removal system

The ENERGIRON
 → CCUS

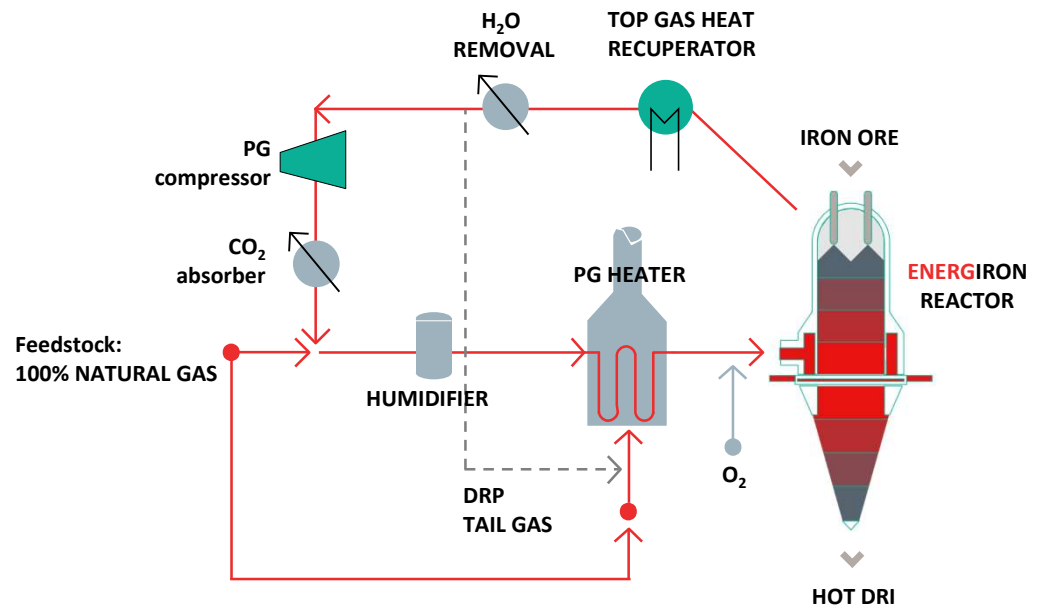


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SUSTAINABLE DRI PROCESS

NG transition
up to 100% H₂

TODAY

100% Natural Gas

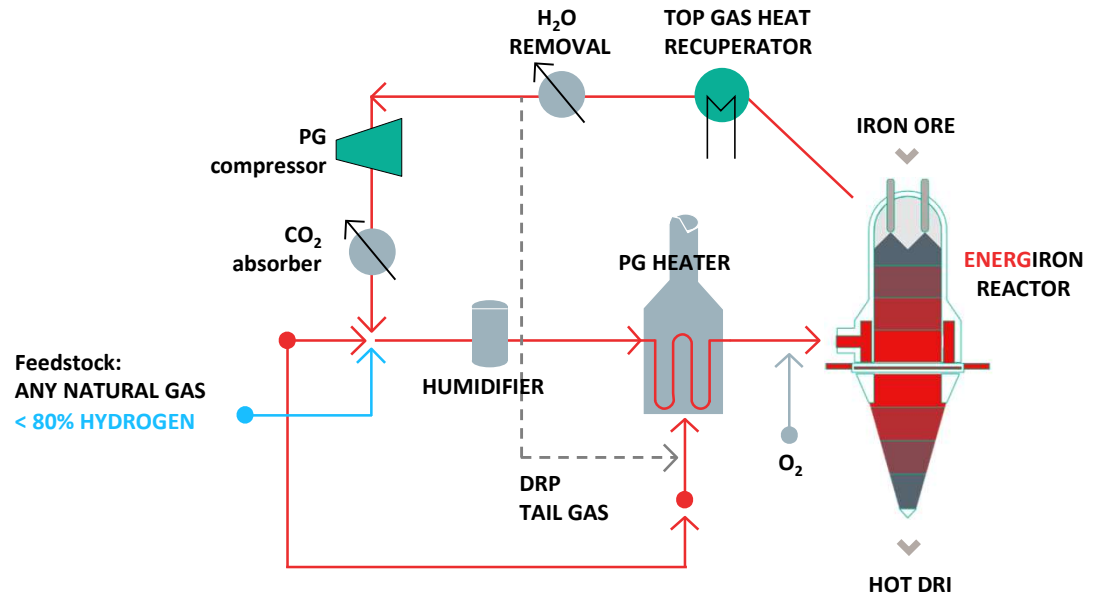


ENERGIRON®
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SUSTAINABLE DRI PROCESS

NG transition
up to 100% H₂

TOMORROW – by 2030

Any% Natural Gas
< 80% Hydrogen

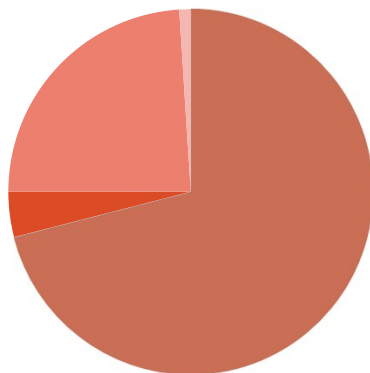


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Decreasing the CO2 emissions in
the iron/steel industry

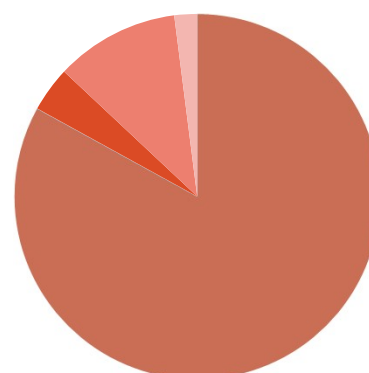
Current production
relies on blast
furnace route.

SHARE OF PRODUCTION



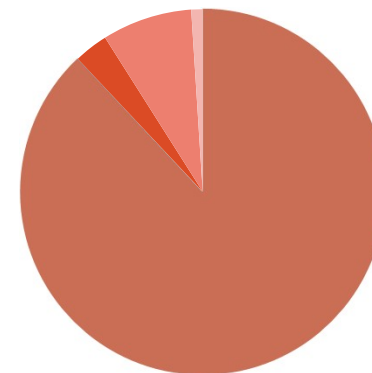
■ BF-BOF ■ Gas DRI EAF
■ Scrap EAF ■ Coal DRI EAF

ENERGY CONSUMPTION



■ BF-BOF ■ Gas DRI EAF
■ Scrap EAF ■ Coal DRI EAF

CO₂ EMISSION



■ BF-BOF ■ Gas DRI EAF
■ Scrap EAF ■ Coal DRI EAF