



**Institute for Energy Economics
and Financial Analysis**

Unlocking the Potential of Green Steel in MENA

How the MENA can reinvigorate, decarbonise
and futureproof the steel industry

Soroush Basirat, Energy Finance Analyst – Global Steel
MENA Green Steel Summit, 25 September 2024



Snapshot of IEEFA

The Institute for Energy Economics and Financial Analysis (IEEFA) is a non-profit global impact think tank that produces a significant volume of original independent public interest research and analyses on issues related to sustainable energy markets, trends, regulations, and policies.



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We produce cutting-edge, solutions-focused analyses. We don't just highlight the problems – we offer ways to resolve the issues and roadblocks that stand in the way of a zero-emissions future.



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September 2023

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Australia Faces Growing Green Iron Competition From Overseas

Research and development to enable the use of Pilbara iron ore in low-carbon steelmaking must be accelerated

Simon Nicholas, Energy Finance Analyst Lead
Soroush Basirat, Energy Finance Analyst, Steel Sector




November 2023

 Institute for Energy Economics and Financial Analysis


Green iron and steel offer MENA a chance to shine

Green hydrogen – not carbon capture – is the key to beating growing global competition

Soroush Basirat, Energy Finance Analyst, Global Steel
Simon Nicholas, Energy Finance Analyst, Lead, Global Steel




April 2024

 Institute for Energy Economics and Financial Analysis

Carbon Capture for Steel?

CCUS will not play a major role in steel decarbonisation

Simon Nicholas, Lead Analyst, Global Steel
Soroush Basirat, Energy Finance Analyst, Global Steel



Read Our Reports on Decarbonising Iron and Steel in MENA

Reports

Green Steel Opportunity in the Middle East and North Africa
Region Can Lead Green Hydrogen Use in Steel Sector

Executive Summary
The global steel industry is seeking a viable pathway to decarbonise iron (DRI) using green hydrogen to reduce emissions. Under the best scenario, green hydrogen (GH2) prices that are used to make iron, the direct reduced iron (DRI) process that uses coal as a reductant, are expected to be around \$100 per tonne by 2030. The direct reduction of iron ore in the presence of green hydrogen does not require additional energy, as the reduction of iron ore is exothermic. About 25% of the carbon reduction goes to the DRI process. The MENA region is potentially in a good position to begin producing carbon-neutral or green steel.



Green iron and steel offer MENA a chance to shine

Green hydrogen – not carbon capture – is the key to beating growing global competition



Fact Sheets

Fact Sheet: Steel decarbonisation opportunity in Middle East and North Africa (MENA)

MENA Region

Country	Area (km²)	Population (millions)	Steel production (million tonnes)
Algeria	2,381,470	44.5	0.1
Libya	1,759,540	7.0	0.0
Egypt	1,001,450	105.0	0.5
Saudi Arabia	2,150,000	35.0	0.0
UAE	83,600	10.0	0.0
Qatar	11,480	3.0	0.0
Yemen	527,970	30.0	0.0
Jordan	78,860	11.0	0.0
Lebanon	10,420	6.0	0.0
Syria	185,180	22.0	0.0
Israel	20,340	9.0	0.0
Palestine	58,780	5.0	0.0
Total	10,000,000	230.0	0.6

MENA's steel and mining sector has been slow to invest in the upstream value chain and one of the least decarbonised in the world. The region has a high potential to lead the world in green steel production with capacity to supply the region.

The MENA region is a global leader of steel decarbonisation of the region with a high potential to lead the world in green steel production with capacity to supply the region.

MENA's steel and mining sector has been slow to invest in the upstream value chain and one of the least decarbonised in the world. The region has a high potential to lead the world in green steel production with capacity to supply the region.



Commentaries and Briefing Notes

Leveraging green hydrogen to lower MENA steel sector emissions

August 18, 2023

Key Findings

Steelmakers in the MENA region could reduce their emissions by making their current fleet of gas-based DRI plants into hybrid systems before fully switching to hydrogen.

While ensuring an uninterrupted supply of green hydrogen round the clock presents a significant challenge for steelmakers, there is an opportunity to produce lower-emissions iron by partially replacing natural gas with hydrogen in existing DRI plants.



MENA, a potential new hub for green steel and green iron metallica

September 20, 2023

Key Findings

The Middle East and North Africa (MENA) region has the high-grade iron ore supply, existing DRI capacity, green hydrogen potential and renewable energy resources necessary for producing green steel, putting it at an advantage worldwide.

New investments in these green steel prerequisites in the MENA region by major iron ore, steel and energy producers underline the potential of the region in the green steel transition.

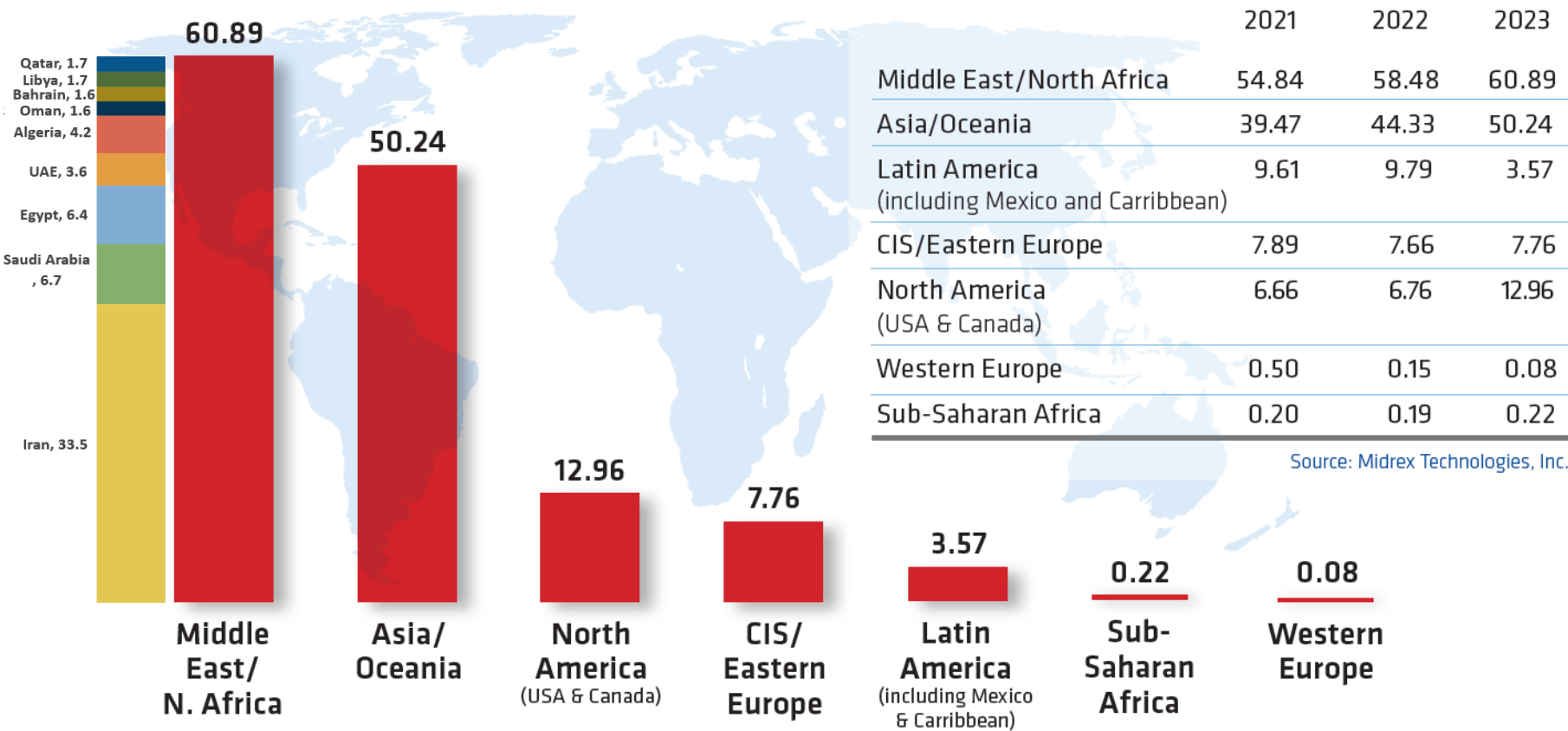


Summary and key messages

- Iron and steel decarbonisation has gained **momentum in MENA** countries. Recent announcements on developing low-emissions iron and steel capacities in the Middle East and North Africa (MENA) highlight the region's potential to become a global leader in steel decarbonisation.
- MENA steelmakers must rapidly incorporate **renewables** into their energy mix to substantially lower indirect emissions. For direct emissions, they have an ideal opportunity to transition from gas to hydrogen gradually and transform their gas-based DRI plants into **hybrid systems**.
- With carbon capture unable to make iron and steel truly low carbon, increasing the allocation of green hydrogen to steel production in the region is essential. MENA producers could become **key offtakers for green hydrogen** projects.
- Tighter international regulations on low-emissions steel production and trade present a valuable opportunity for MENA to become a **key supplier of green iron**.

MENA Steel Sector

2023 World DRI Production by Region (Mt)

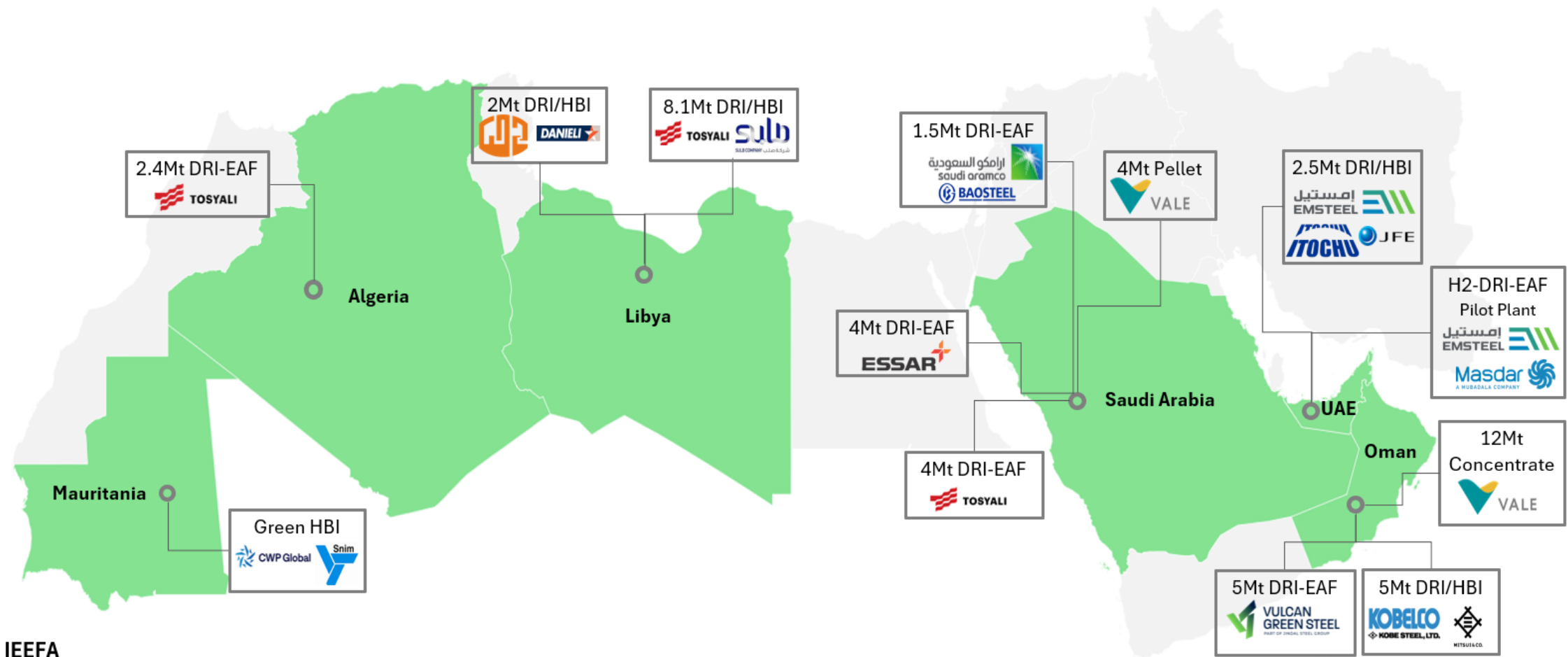


Key competitive advantages

- Global leader in DRI production
- Established supply of high-grade iron ore
- Abundant and cheap solar resources
- Large pipeline of hydrogen projects
- Close to key steel growth markets

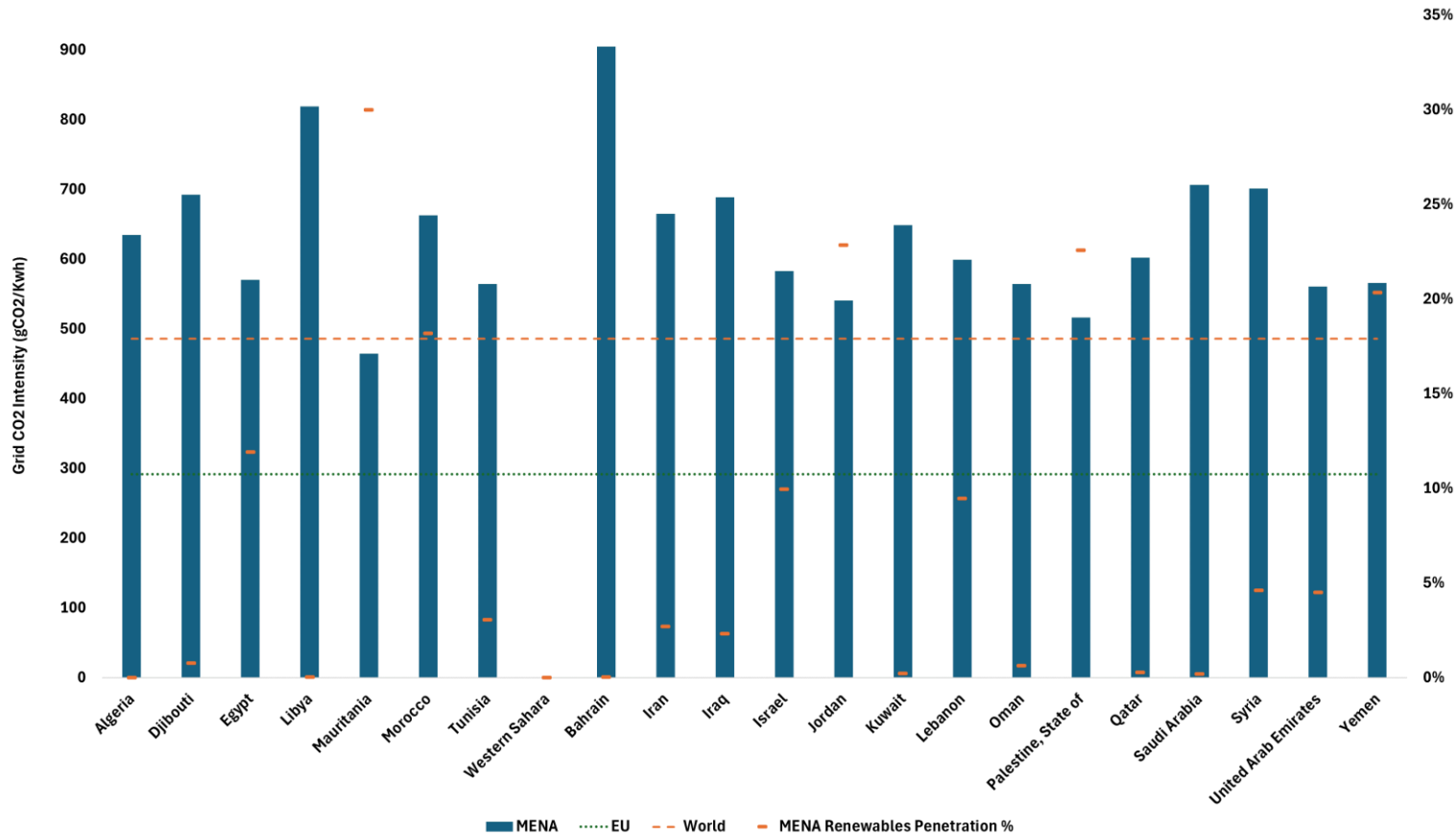
45% of the total DRI production and **65%** of the total gas-based DRI production

MENA Low-emissions Iron and Steel Initiatives



IEEFA

Grid Electricity Emissions in MENA Countries 2022



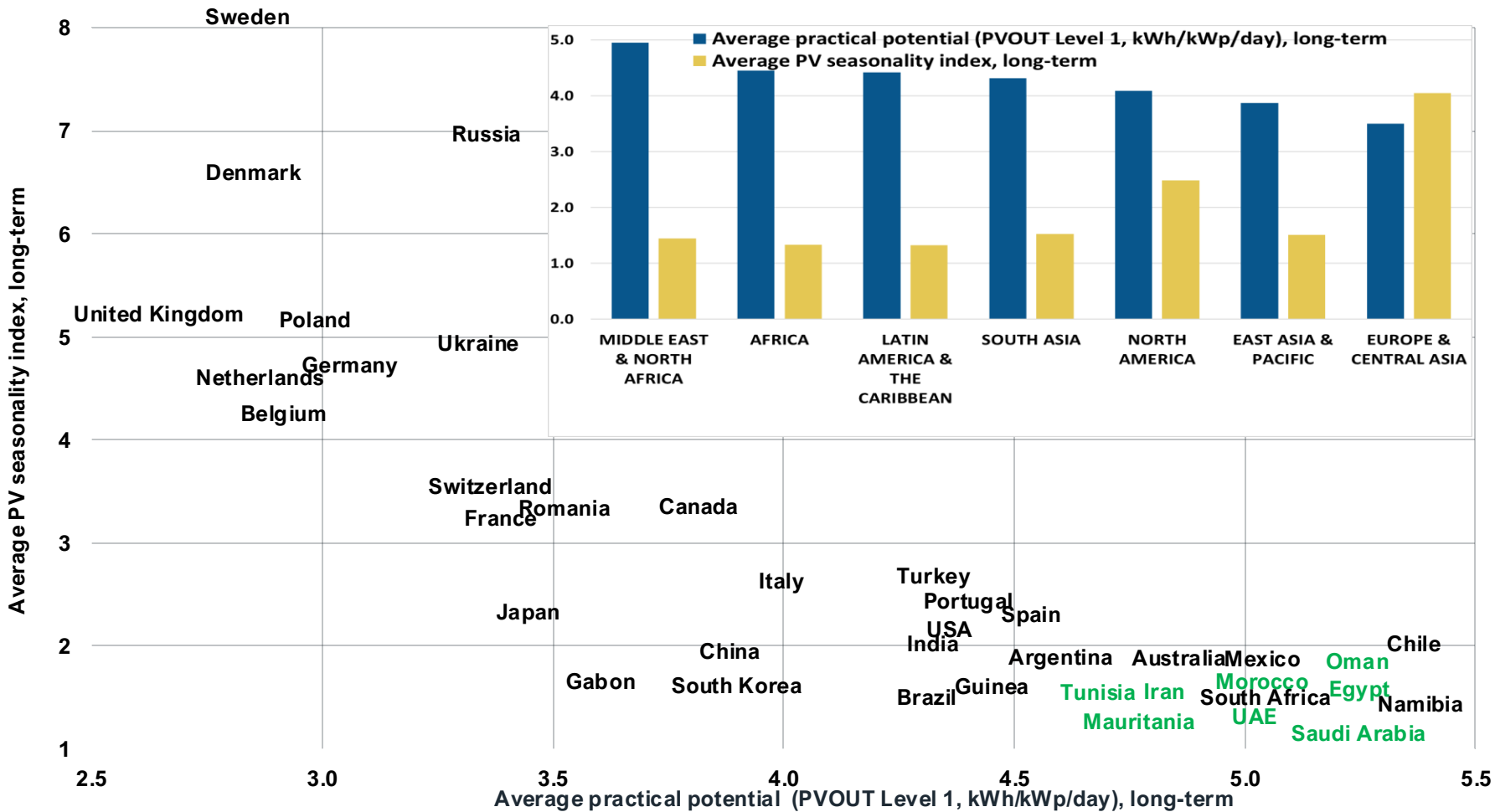
The average **grid carbon intensity** in MENA is 650g/kWh and the weighted average renewables **penetration** is only 3.9%.

Utilising grid electricity in steel mills or for electrolysers negates the MENA region’s advantages due to its higher carbon intensity compared with other regions.

MENA steelmakers must rapidly incorporate renewables into their energy mix to significantly reduce indirect Scope 2 emissions.

Source: Ember, IEEFA

MENA Solar Opportunities



Source: SolarGIS, IEEFA

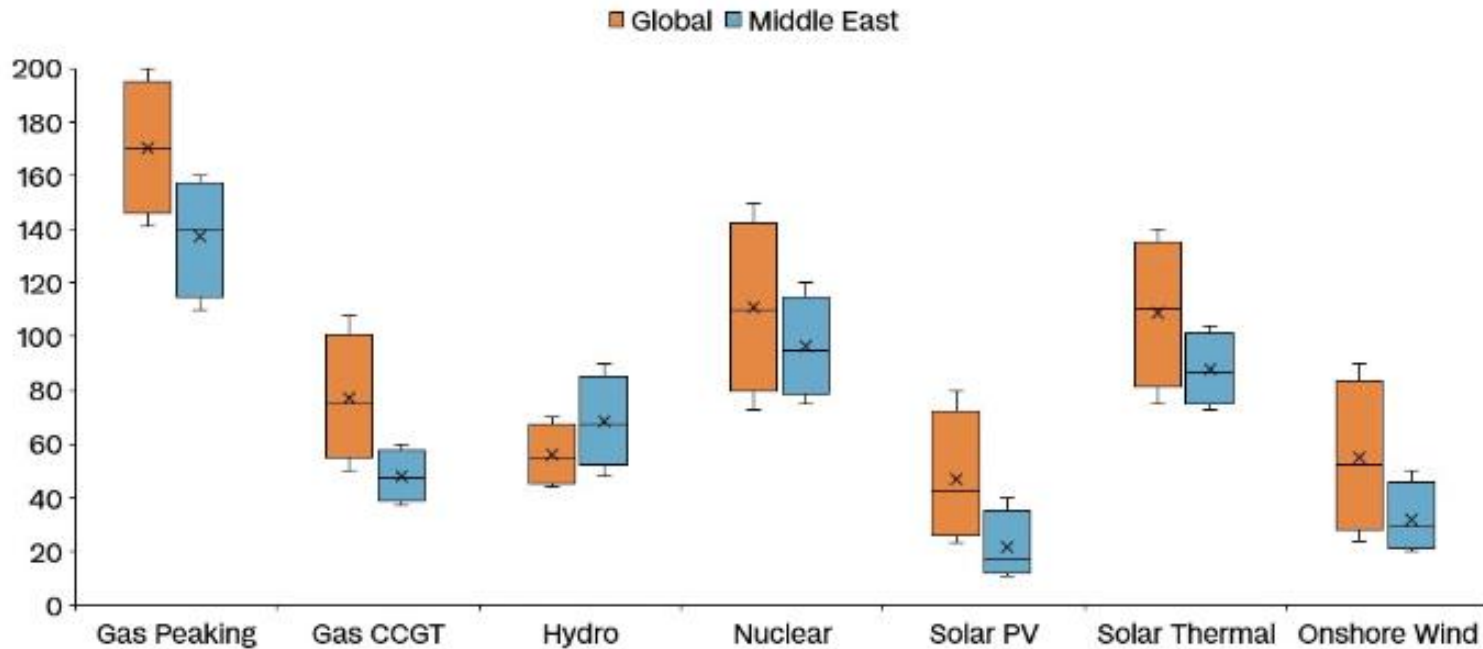
The MENA region is blessed with reliable solar radiation. MENA's photovoltaic potential is the highest globally, with minimal seasonal variability, offering a consistent and reliable energy supply.

MENA LCOE

Current LCOE* range in the Middle East compared to global average

USD per megawatt-hour

RystadEnergy



* LCOE (levelized cost of electricity) range is for capacity of over 100 megawatts and is based on the reported average LCOE in the last five years
 Source: Rystad Energy's Renewables & Power Solution; May 2024
 A RystadEnergy graphic

MENA possesses outstanding renewable energy potential. Solar PV and onshore wind have the lowest levelised cost of electricity (LCOE), making them the most cost-effective methods of generating electricity.

Saudi Arabia has the **world's lowest LCOE** from solar at just \$10.4/MWh.

Source: Rystadenergy

Renewable Energy Deployment in Saudi Arabia by 2030

(Updated November 2023)

REPDO Projects:

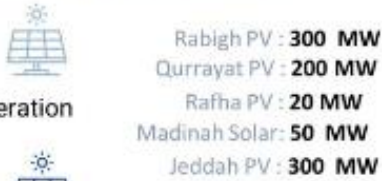
1st Round

Tendered: 2017
Under Operation
Total = 700 MW



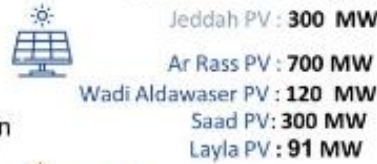
2nd Round

Tendered: 2019
Partially Under Operation
Total = 870 MW



3rd Round

Tendered: 2020
Under Construction
Total = 1,211 MW



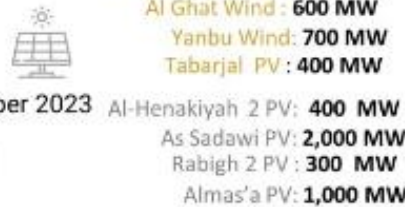
4th Round

Tendered: 2022
PPA Signed for PV
Total = 3,300 MW



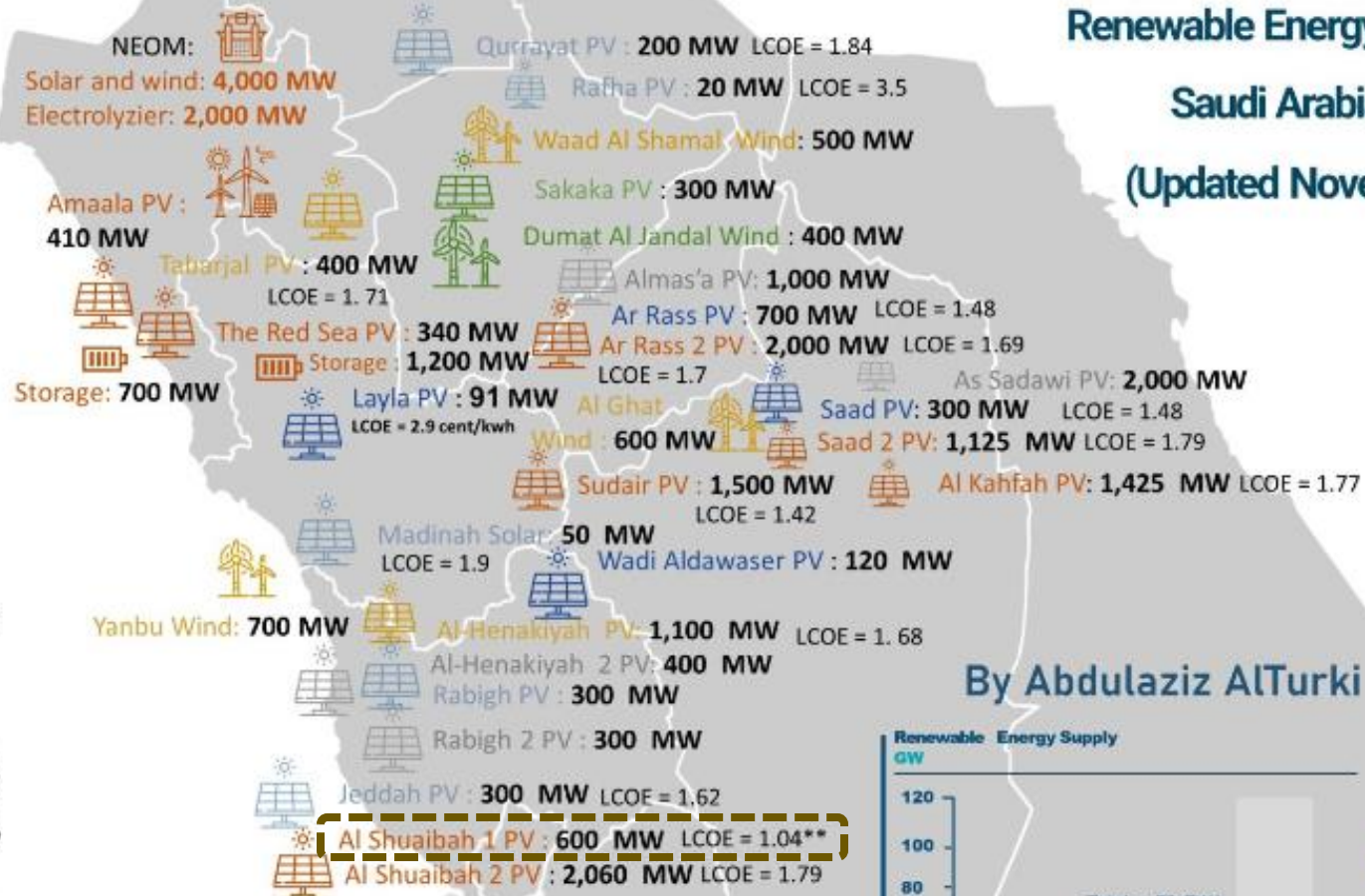
5th Round

Tendered: November 2023
RFQ Released
Total = 3,700 MW



ACWA Power & others besides NRE above:

Red Sea Project	340 MW
Shuaibah PV 1&2	2,660 MW
Sudair PV	1,500 MW
Ar Rass 1 PV	700 MW
Ar Rass 2 PV	2,000 MW
Saad 2 PV	1,125 MW
Al Kahfah PV	1,425 MW
NEOM PV & Wind	4,000 MW
Amaala PV	410 MW
Total	14,160 MW



By Abdulaziz AlTurki



<https://www.vision2030.gov.sa/thekingdom/explore/energy/>

<https://acwapower.com/en/projects/assets/>

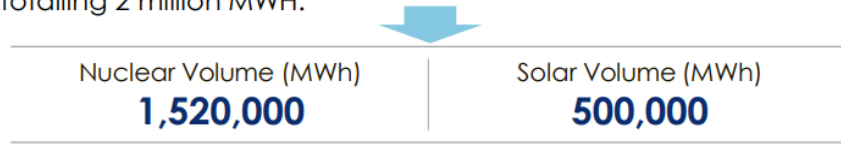


Total Renewable Energy Capacity = 23,941 MW

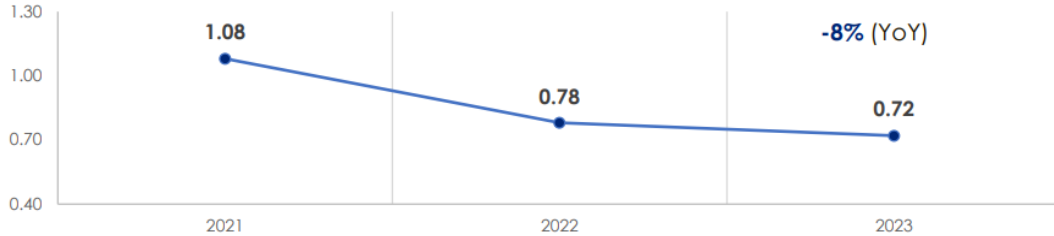
EMsteel Success Story

EMSTEEL is constantly working to deliver on its sustainability commitment. In 2022 we **reduced Scope 1&2 emissions from our steel business by 35% YoY**.

This was partially driven by **securing clean energy from solar and nuclear** sources totalling 2 million MWh.

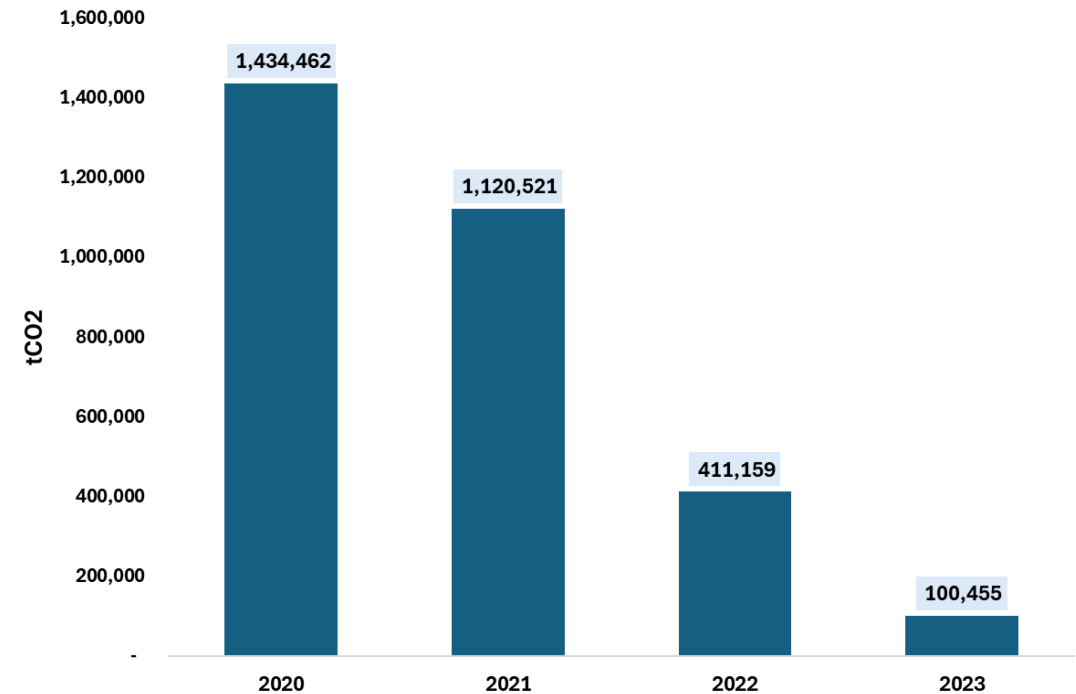


EMSTEEL // Sum of Scope 1&2 carbon emissions in steel business
tCO₂e/tonne of crude steel



2 million MWh represent more than 80% of EMSTEEL's electricity consumption, contributing to the overall emissions reduction from our operations.

Disclosed Scope 2 Emissions (market-based)

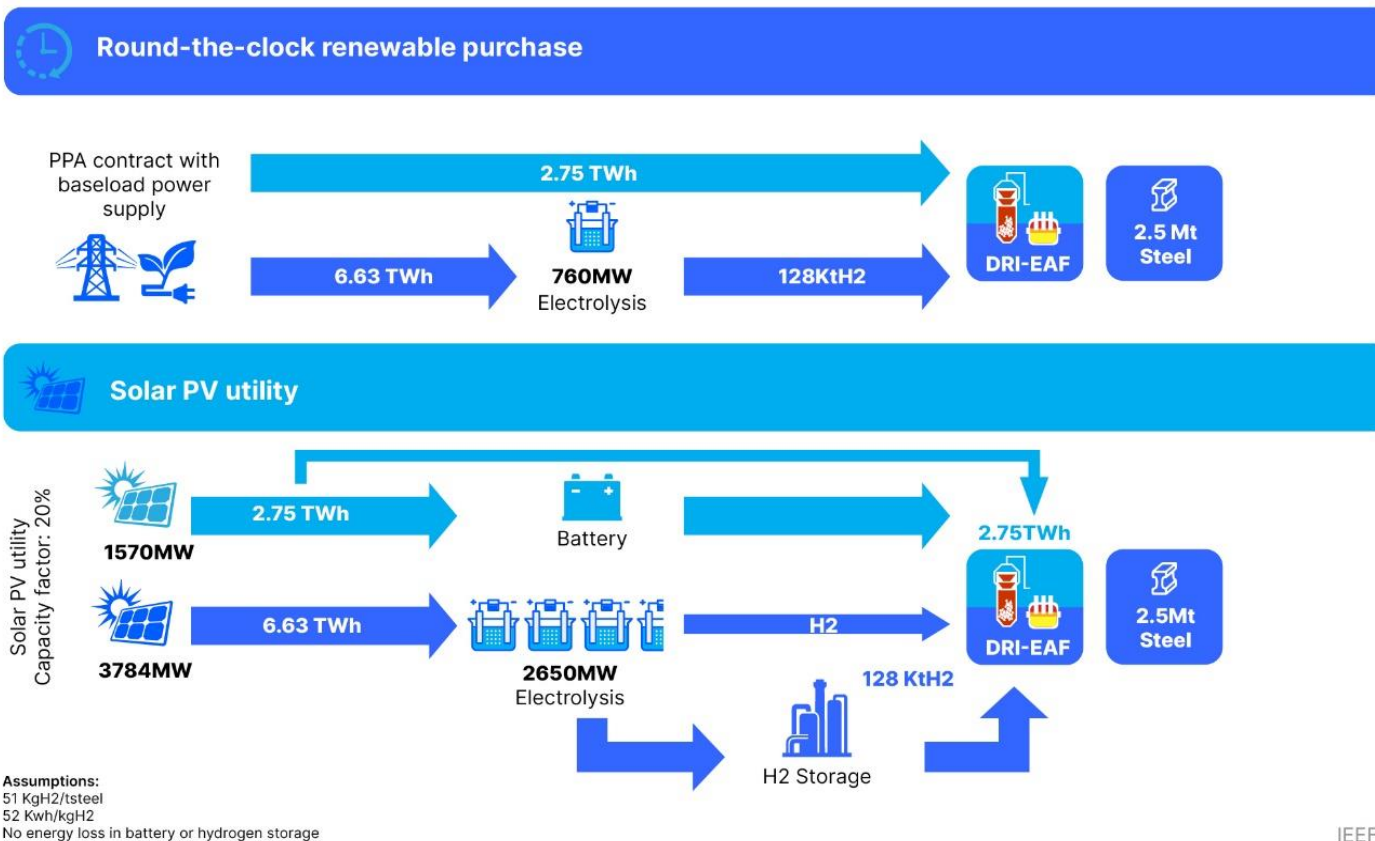


Source: EMSteel sustainability report 2023, IEEFA

In 2023, the company primarily sourced its electricity from nuclear (1.52 terawatt hours/TWh) and solar (0.53TWh) power, resulting in a reduction of Scope 1 and 2 emissions to 720kg of CO₂ equivalent (CO₂e) per tonne of steel – a 33% decrease on 2021.

Hydrogen Production Challenge

Grid-Connected versus Solar PV-Supported Green Steel Plants



For one tonne of steel produced via H2-DRI-EAF, nearly 3.6MWh of electricity is required.

To produce green steel of the same scale as the phase 1 Stegra (H2 Green Steel) using a solar PV utility with a 20% capacity factor – irrespective of the plant’s location, and without relying on battery storage for hydrogen production – the electrolyser’s size should be increased by a factor of 3.5, and this augmentation must be supported by solar utility oversized by a factor of 5.

This increases project capital expenditure (capex), making the transition to green steel more challenging.

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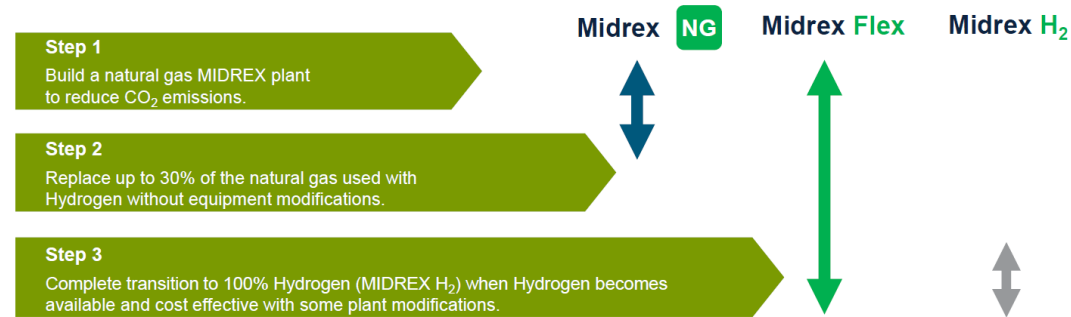
Gradual Transition

Midrex Flex



A stepwise Approach to reduce CO₂ Emissions

The MIDREX plant is extremely flexible and can accommodate the initial transitions from a Carbon to a Hydrogen economy.



Source: Midrex

	NG (No added H ₂)	NG replacement by H ₂ (Energy Basis)			
		30%	50%	80%	100%
Natural Gas Consumption (Nm ³ /t)	275-300	190-215	140-165	50-80	0*
H ₂ Consumption (Nm ³ /t)	0	250-300	450-500	700-750	850-900*
H ₂ / CO	1.6	2.8	4.5	10.5	N/A
CO ₂ Emissions from flue gas (kg-CO ₂ /t-DRI)	500	350	250	100	From heater burners only (If fuelled by C _n H _m) 0 if fuelled by 100% H ₂

30% replacement of gas with hydrogen without equipment modification is technically feasible in MIDREX plants.

Direct reduction facilities have already operated commercially with H₂/CO ratios of 3 or higher.

Gradual Transition

NG TRANSITION UP TO 100% H₂

DANIELI

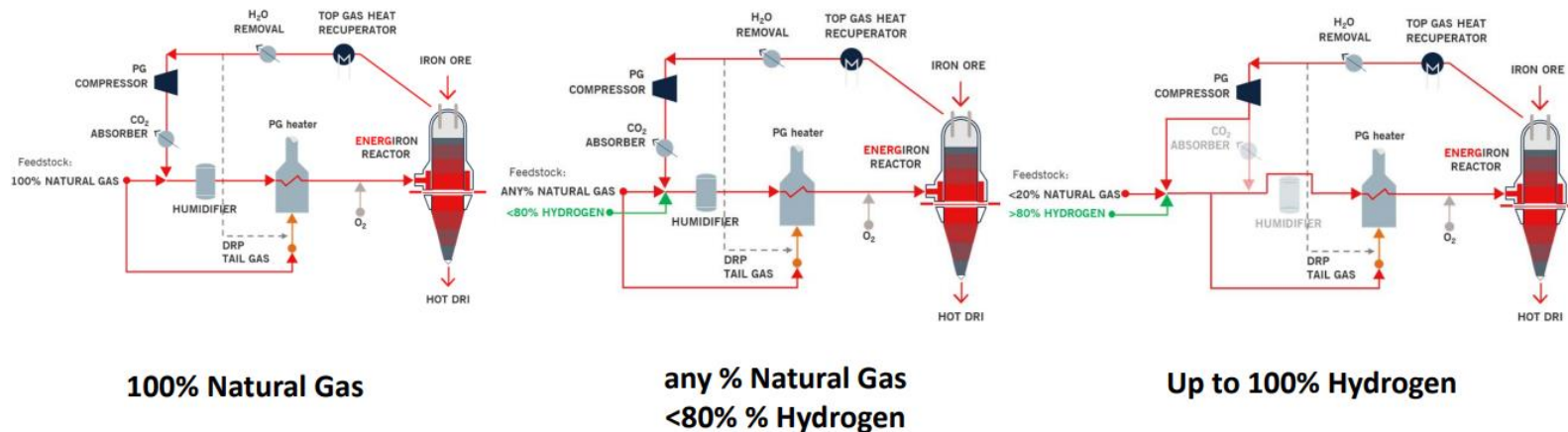
Same plant configuration from 0% to 100% hydrogen.

SAME SCHEME FOR PRESENT, NEAR AND FAR FUTURE

TODAY

TOMORROW (BY 2030)

FUTURE (BY 2050)



Without any changes, the plant can currently absorb up to **80%** hydrogen from external sources.

Steelmakers in the MENA region have a significant opportunity to cut emissions by transforming their current fleet of gas-based DRI plants into **hybrid systems**.

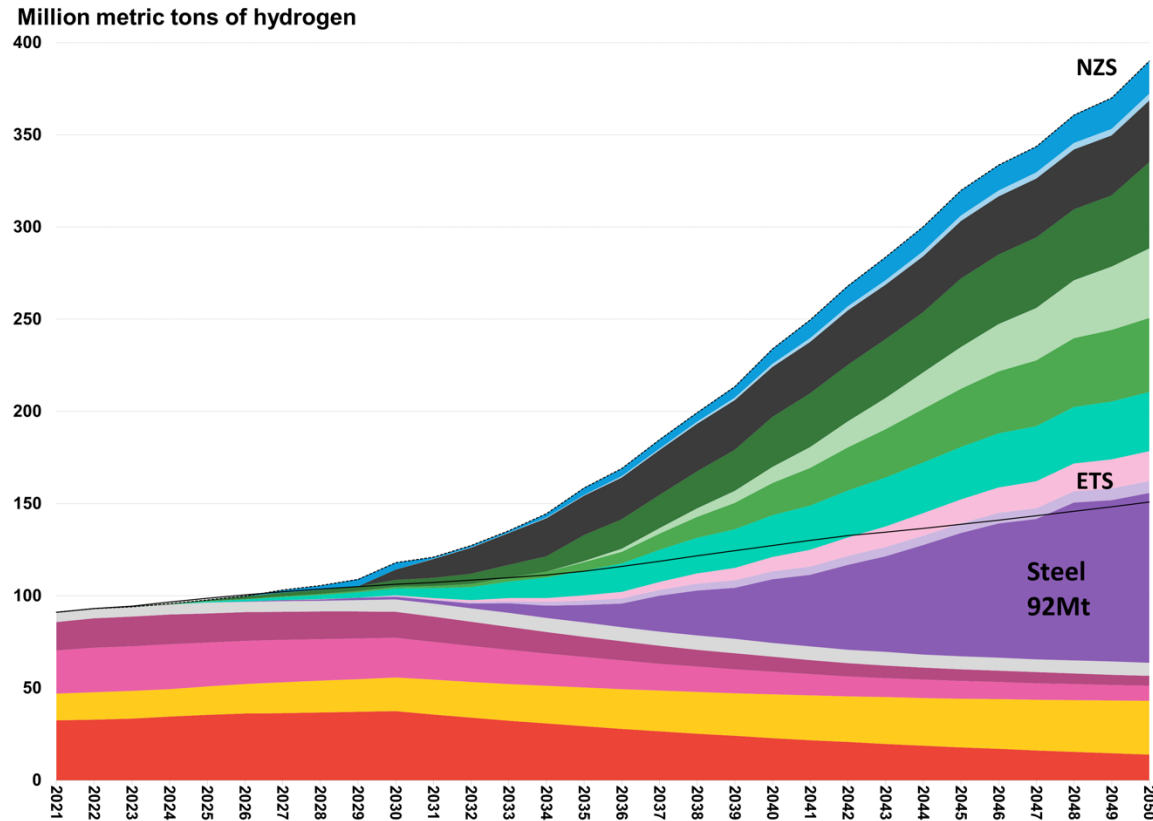
Emirates Steel is the first steelmaker in MENA to announce the partial replacement of gas with green hydrogen in its in-situ facilities. In collaboration with Masdar, the company has been working on a **pilot project** to utilise green hydrogen in its first direct reduction plant.

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Source: Danieli, 16th Arab Steel Summit Cairo October 2023

Hydrogen and Steel: A Perfect Pairing

Hydrogen demand by sector and application in Net Zero Scenario



Source: BNEF New Energy Outlook 2024

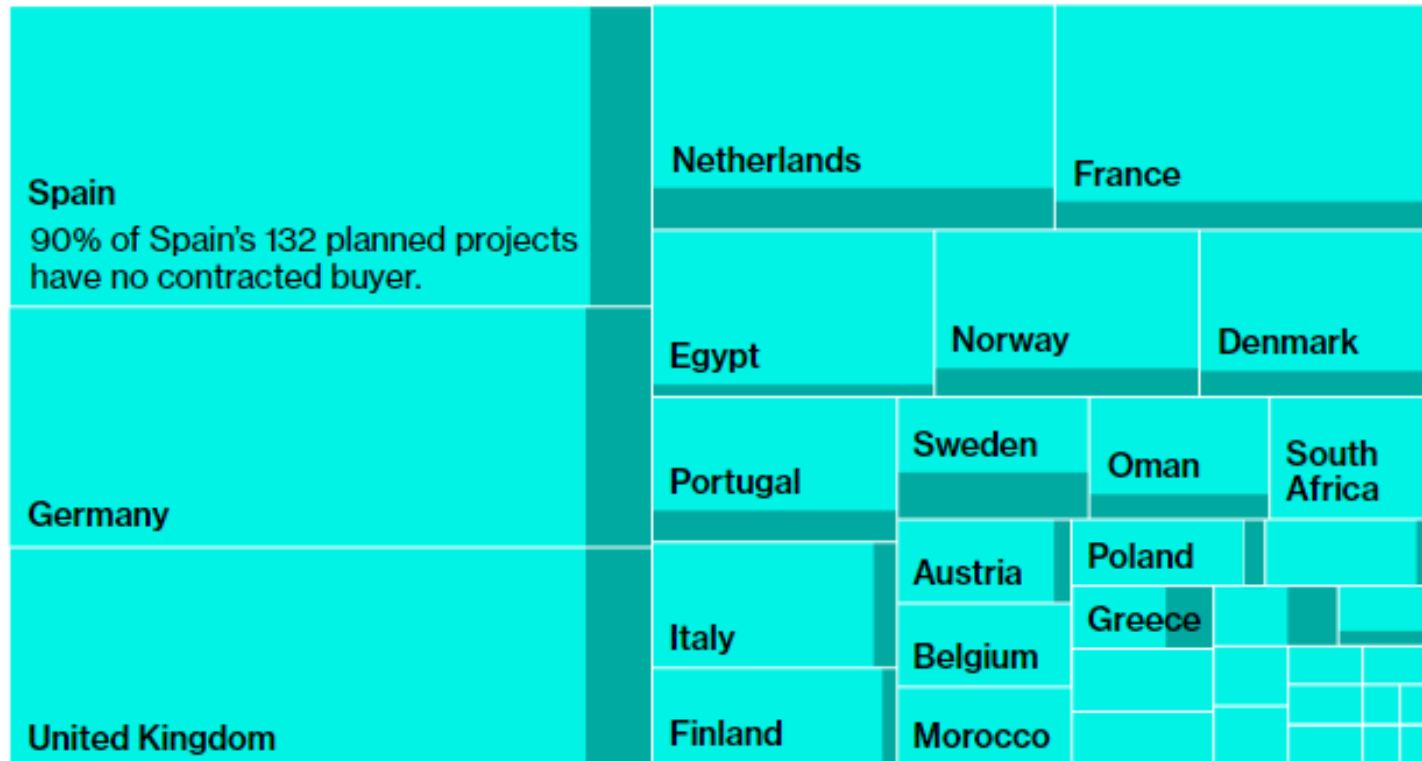
Primary steelmaking is a **no-regret, high-priority application** of hydrogen.

Currently, most green hydrogen projects under development in MENA are aimed at ammonia production for both domestic use and export purposes technologies.

Low-emissions hydrogen projects in a pipeline are estimated to reach 16.4mt by 2030. The steel sector's share currently is 275,000t, all of which is green hydrogen, with the largest capacities being developed in the Nordics for projects such as Stegra and SSAB HYBRIT.

Challenges in Hydrogen Offtake

Europe, Middle East and Africa
88% of projects have no buyer



Nearly 90% of all announced hydrogen projects do not have buyers with signed contracts.

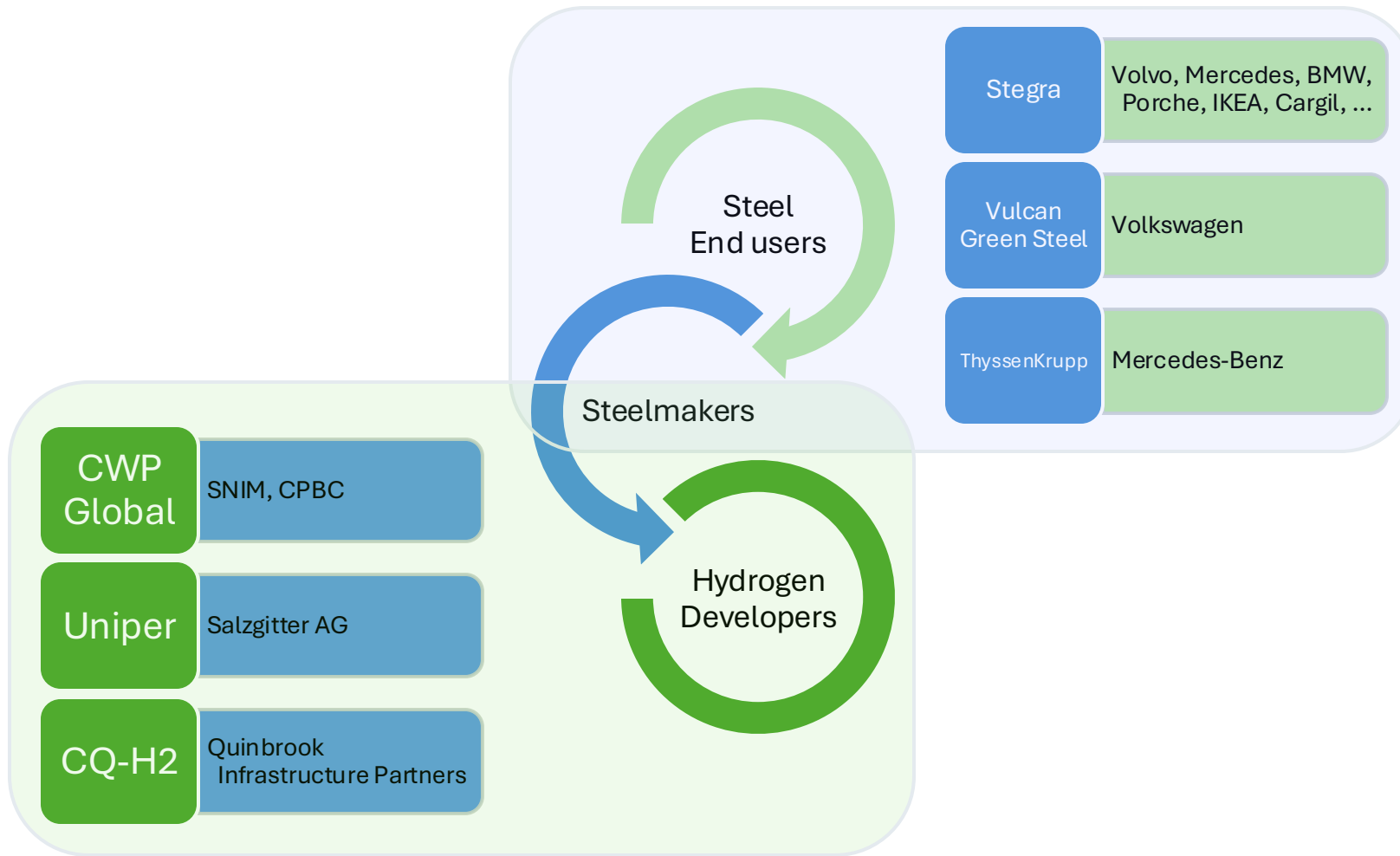


No sane project developer is going to start producing hydrogen without having a buyer for it, and no sane banker is going to lend money to a project developer without reasonable confidence that someone's going to buy the hydrogen, says BNEF analyst **Martin Tengler**.

Source: BloombergNEF

Note: Data as of April 1. Excludes projects in which the country or name is unknown.

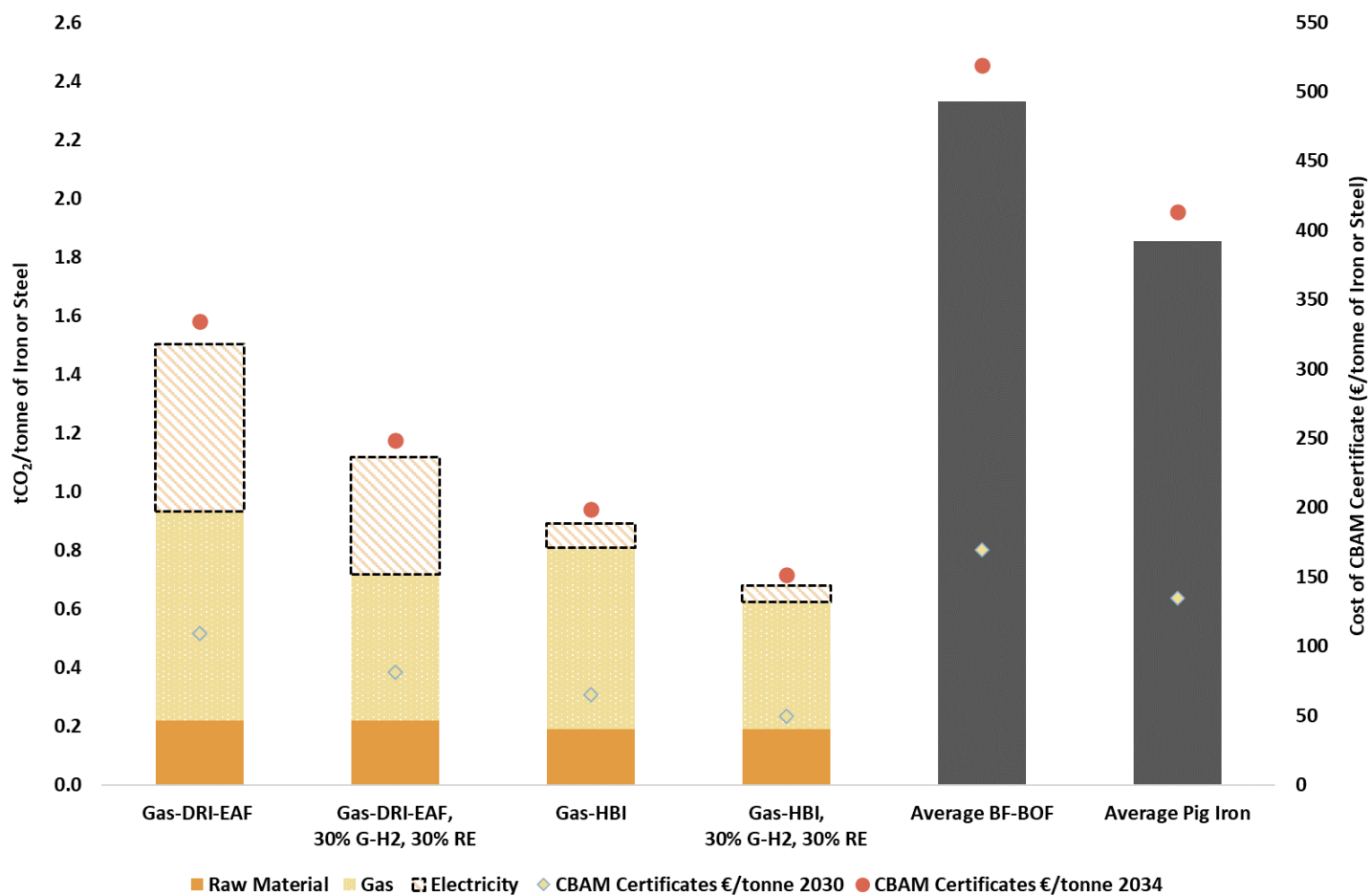
Close the loop: Steel as a key hydrogen oftaker



While demand for green steel appears promising from the end-user perspective, green hydrogen projects are facing challenges in reaching final investment decisions (FID).

To overcome this hurdle, collaboration between steelmakers and hydrogen developers is essential.

MENA iron and steel CO2 emissions and CBAM certificates required by 2030 and 2034



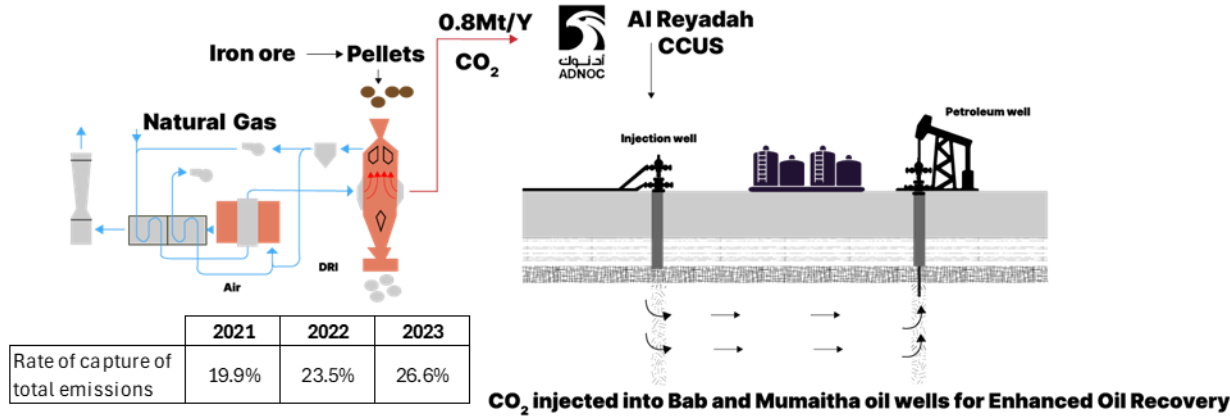
Although the EU is firmly committed to decarbonising its steel sector, some steelmakers remain reluctant to import green iron from regions with more favourable conditions.

EU steelmakers have received billions of euros in grants to accelerate the transition within the EU, rather than relocate ironmaking to other regions.

With comparatively lower emissions, MENA primary steelmakers may require fewer CBAM certificates than their competitors. This could potentially shift trade flows of iron and steel to the EU, even though MENA nations currently have low export volumes to the bloc.

Source: IEEFA

CCUS in DRI-EAF Route



Al Reyadah is the world's only commercial-scale CCUS facility for steelmaking. Commissioned in 2016, its primary objective is to receive 0.8 MtCO₂/y from a steel facility operated by Emsteel and transport it for use in EOR operations.

EMsteel claimed that it can capture 45% of CO₂ generated from direct reduction plants which is a part of the process. (Public data on the actual capture rate of the Al Reyadah facility is not available)

CCUS Challenges in the steel sector including partial carbon removal, limited proximity to storage sites, missing scope 3 emissions and higher costs due to the low CO₂ concentration.

In collaboration with Masdar which has already divested its shares in the Al Reyadah project to ADNOC, EMsteel is teaming up to establish the first pilot project for H₂-DRI-EAF in the MENA region.

ENERGIRON SELECTIVE CO₂ REMOVAL

The **ENERGIRON DR** process intrinsically includes a CO₂ absorption system for selective elimination of CO₂

CARBON IN DIRECT REDUCTION PLANTS

CO₂ removal (+H₂S)
 > NG
 > Hydrogen
 > Hot DRI & Cold High-Carbon
 > DRI
 DRI quality: >95%Adj. C

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Based on the Energiron design, nearly 0.250tCO₂/tDRI could be captured

Read the report:
[Carbon Capture For Steel](#)



Thank You

Contact

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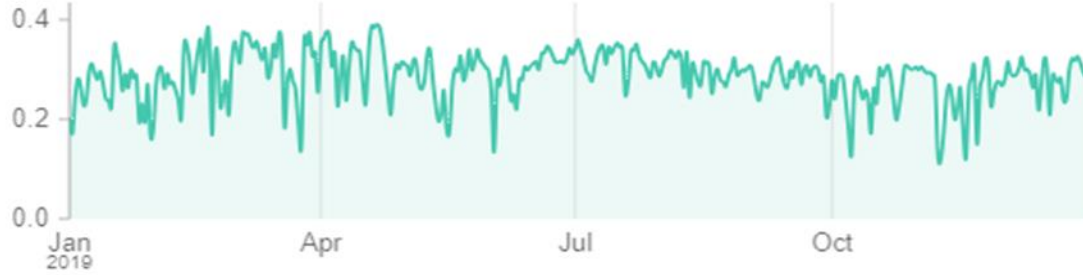
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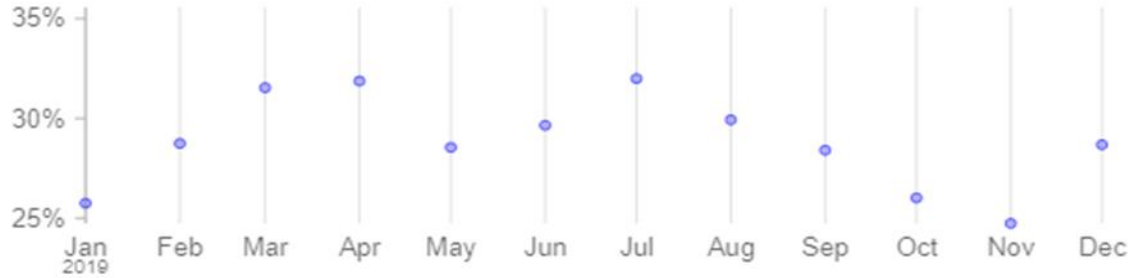
Results: Solar photovoltaic power (PV)



Daily mean



Monthly capacity factor

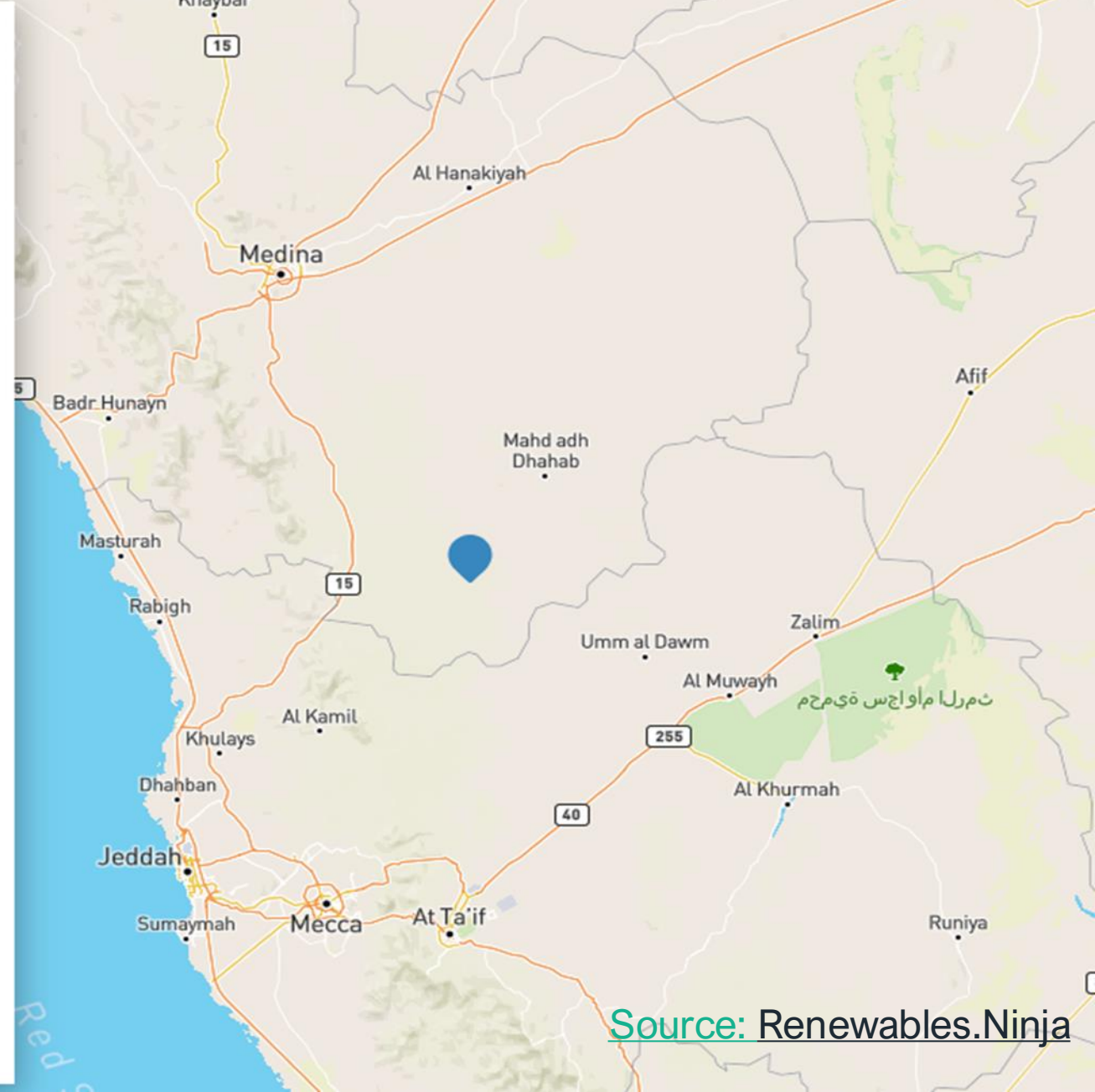


Total mean capacity factor: 28.8%

With 2-axis Tracking

Save hourly output as CSV

License: Creative Commons Attribution-NonCommercial
Citation: Pfenninger and Staffell (2016)



Source: Renewables.Ninja

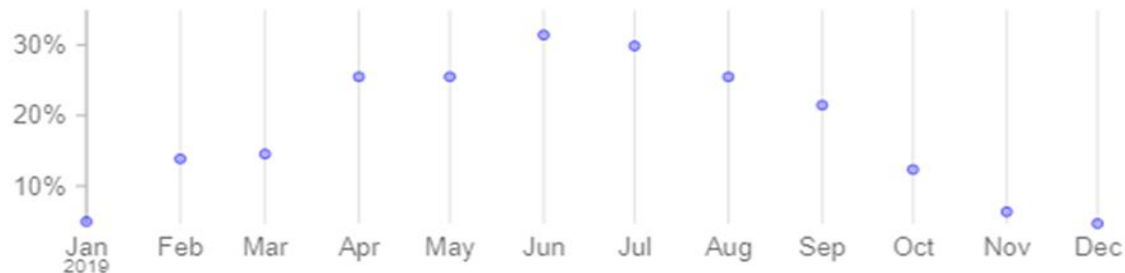


Results: Solar photovoltaic power (PV)

Daily mean



Monthly capacity factor

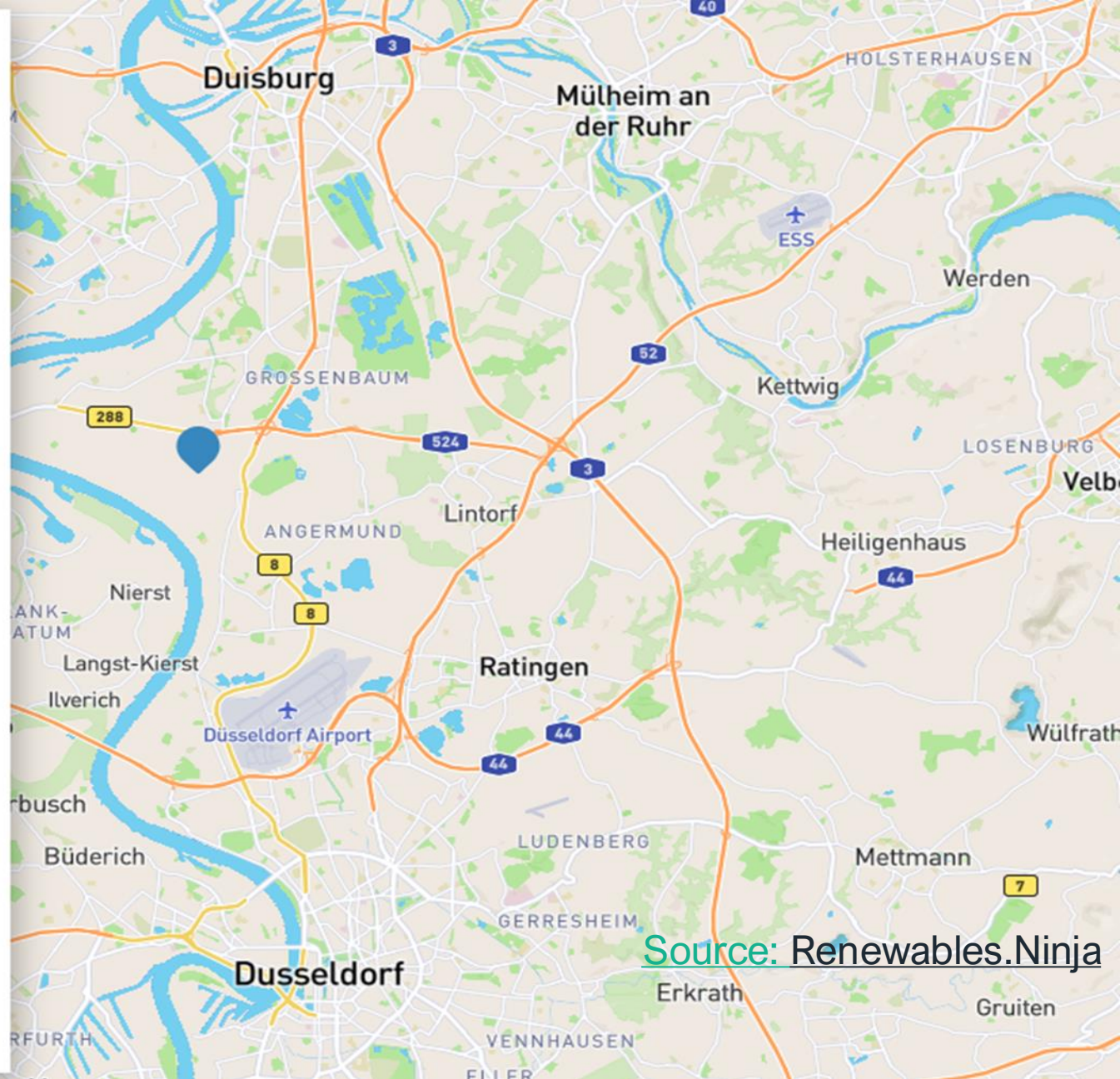


Total mean capacity factor: 18.0%

With 2-axis Tracking

Save hourly output as CSV

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Citation: [Pfenninger and Staffell \(2016\)](#)



Source: [Renewables.Ninja](#)