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.

Intellectual leadership

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.

Independence

We are an independent non-profit think tank. Our analyses are thoroughly researched, fact-based, and data driven. Our work is free from political influence, corporate and sectoral interests.

Nimble

We act on signals across the energy and finance spectrums in South Asia and worldwide. Our analyses are timely and relevant. We can learn, adapt, and move quickly.

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IEEFA is a trusted voice on issues related to sustainable energy markets, trends, regulations, and policies.

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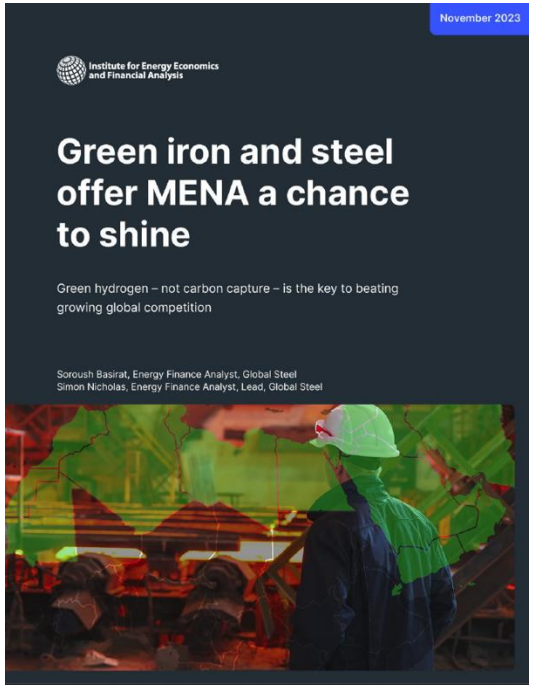
Our work makes a positive impact in the world. We aim to accelerate the energy transition to help achieve a cleaner future for humankind and the planet.

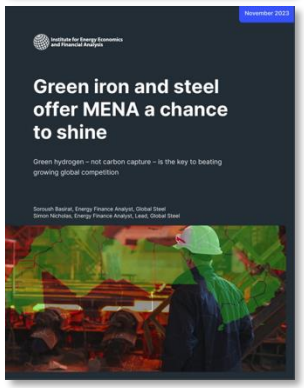
Accelerating the transition to a diverse, sustainable and profitable energy economy

Read our reports

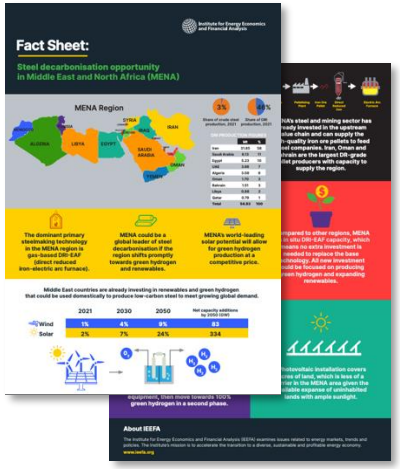


Read Our Reports on Decarbonising Iron and Steel in MENA

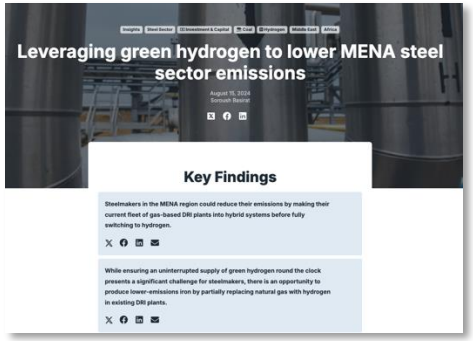
Reports

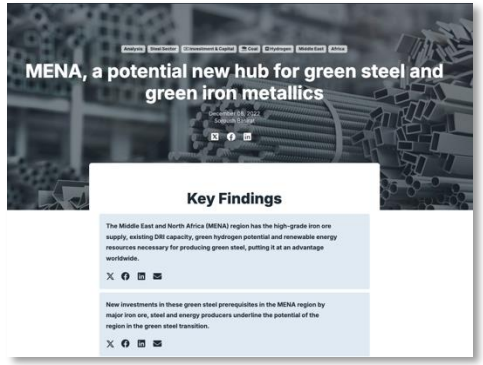


Fact Sheets



Commentaries and Briefing Notes





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.

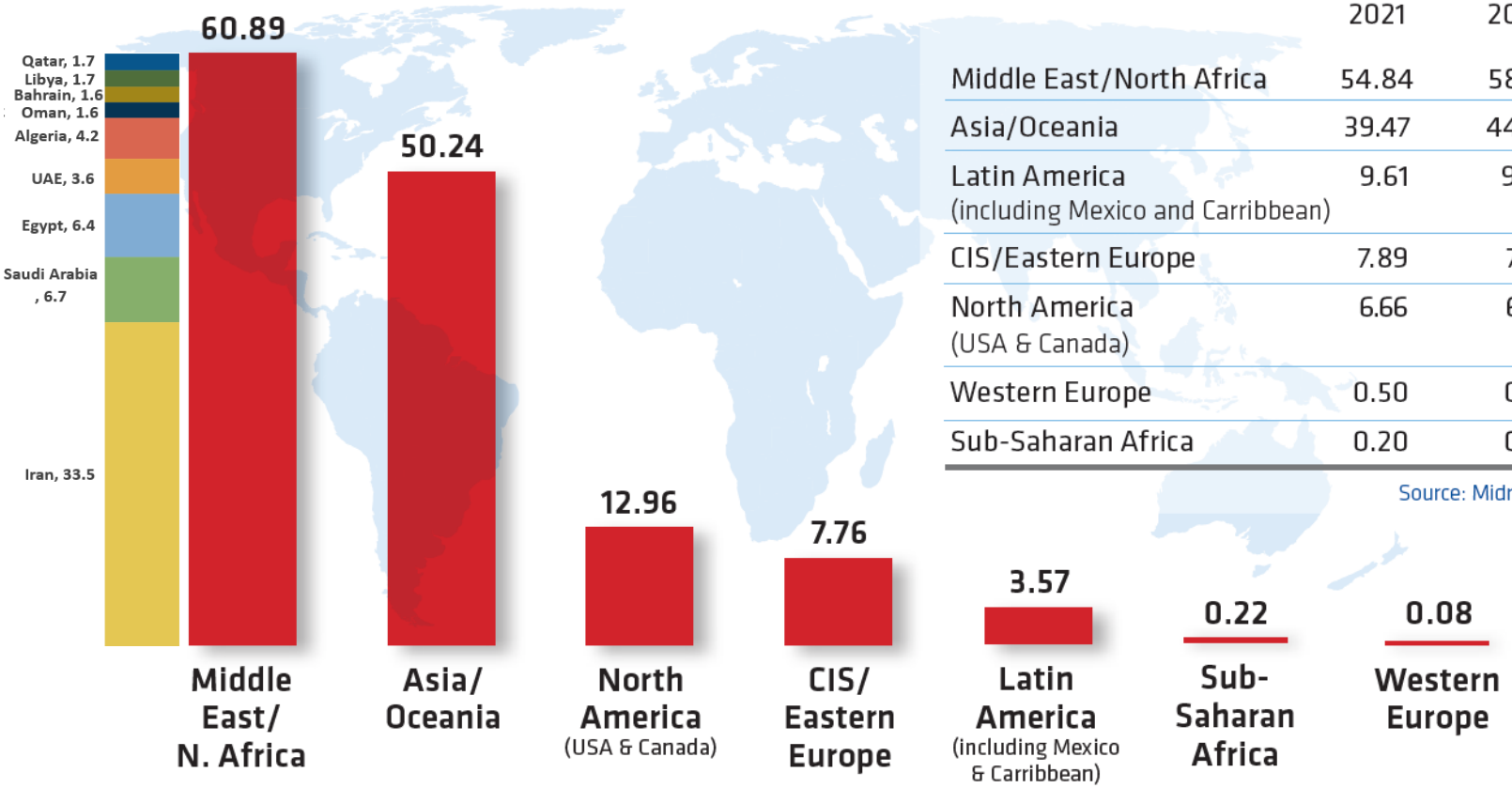
- MENA steelmakers must rapidly incorporate **renewables** into their energy mix to substantially lower indirect emissions. For direct emissions, they have an ideal opportunity to transition from gas to hydrogen gradually and transform their gas-based DRI plants into **hybrid systems**.

- 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)



	2021	2022	2023
Middle East/North Africa	54.84	58.48	60.89
Asia/Oceania	39.47	44.33	50.24
Latin America (including Mexico and Carribbean)	9.61	9.79	3.57
CIS/Eastern Europe	7.89	7.66	7.76
North America (USA & Canada)	6.66	6.76	12.96
Western Europe	0.50	0.15	0.08
Sub-Saharan Africa	0.20	0.19	0.22

Source: Midrex Technologies, Inc.

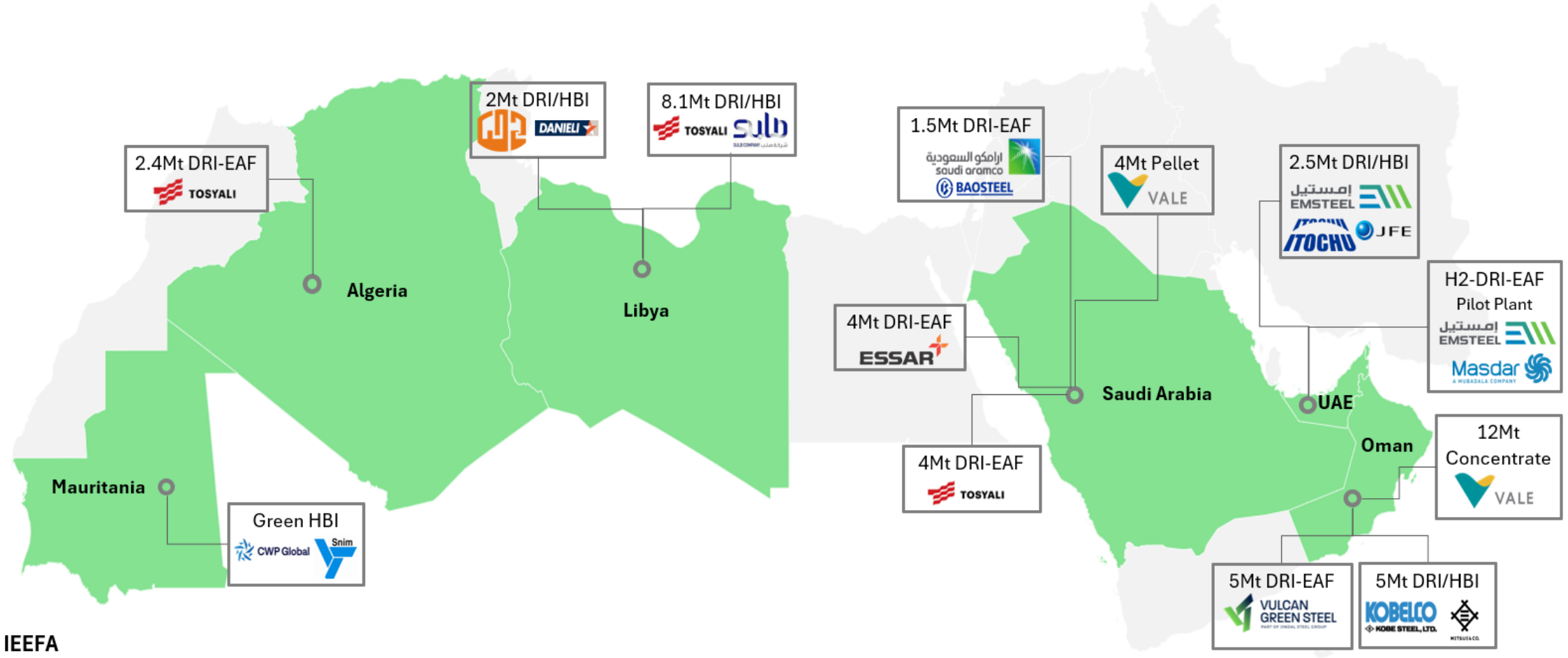
Key competitive advantages

- 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

Source: Midrex

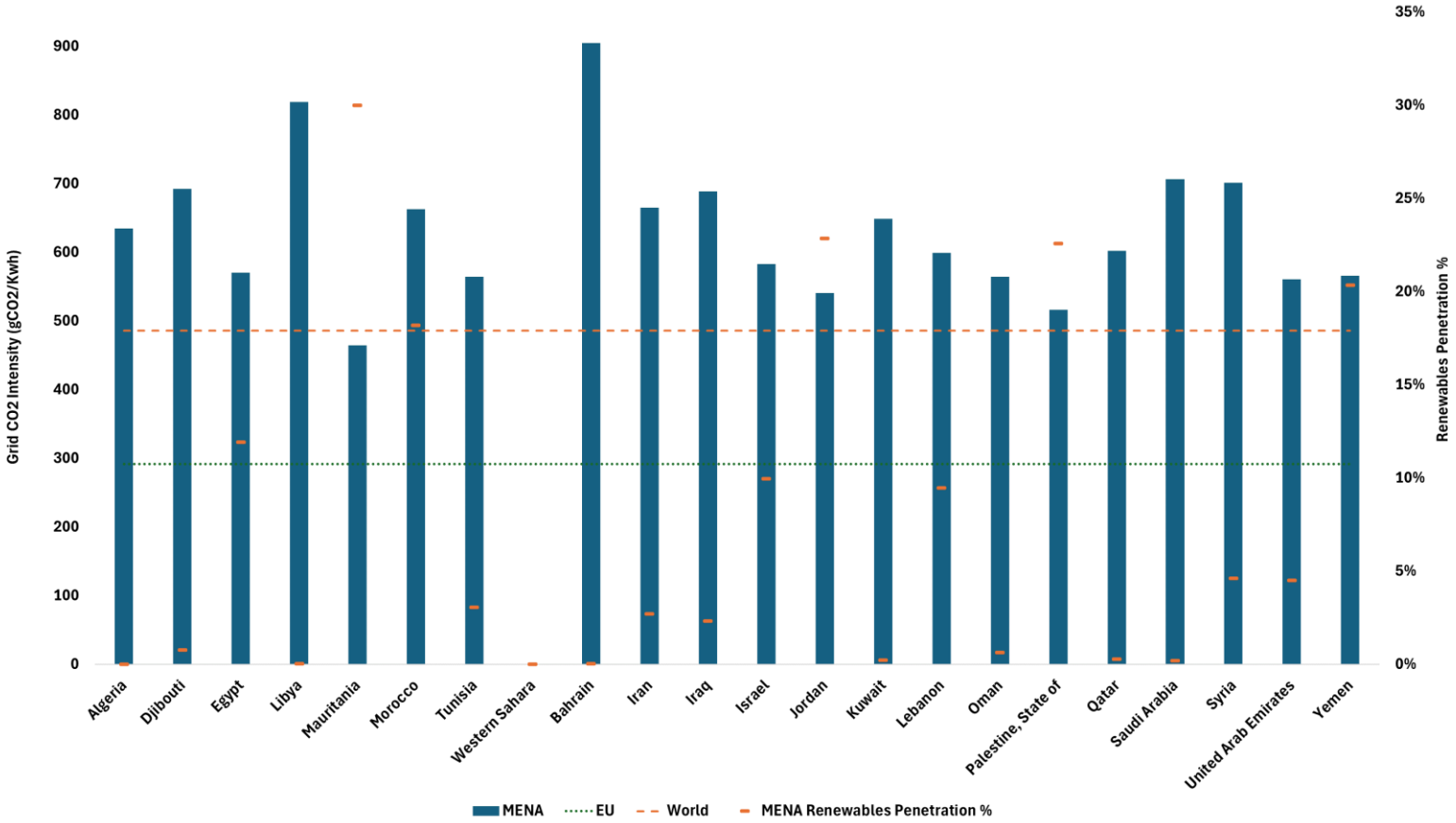
45% of the total DRI production and **65%** of the total gas-based DRI production

MENA Low-emissions Iron and Steel Initiatives



IEEFA

Grid Electricity Emissions in MENA Countries 2022



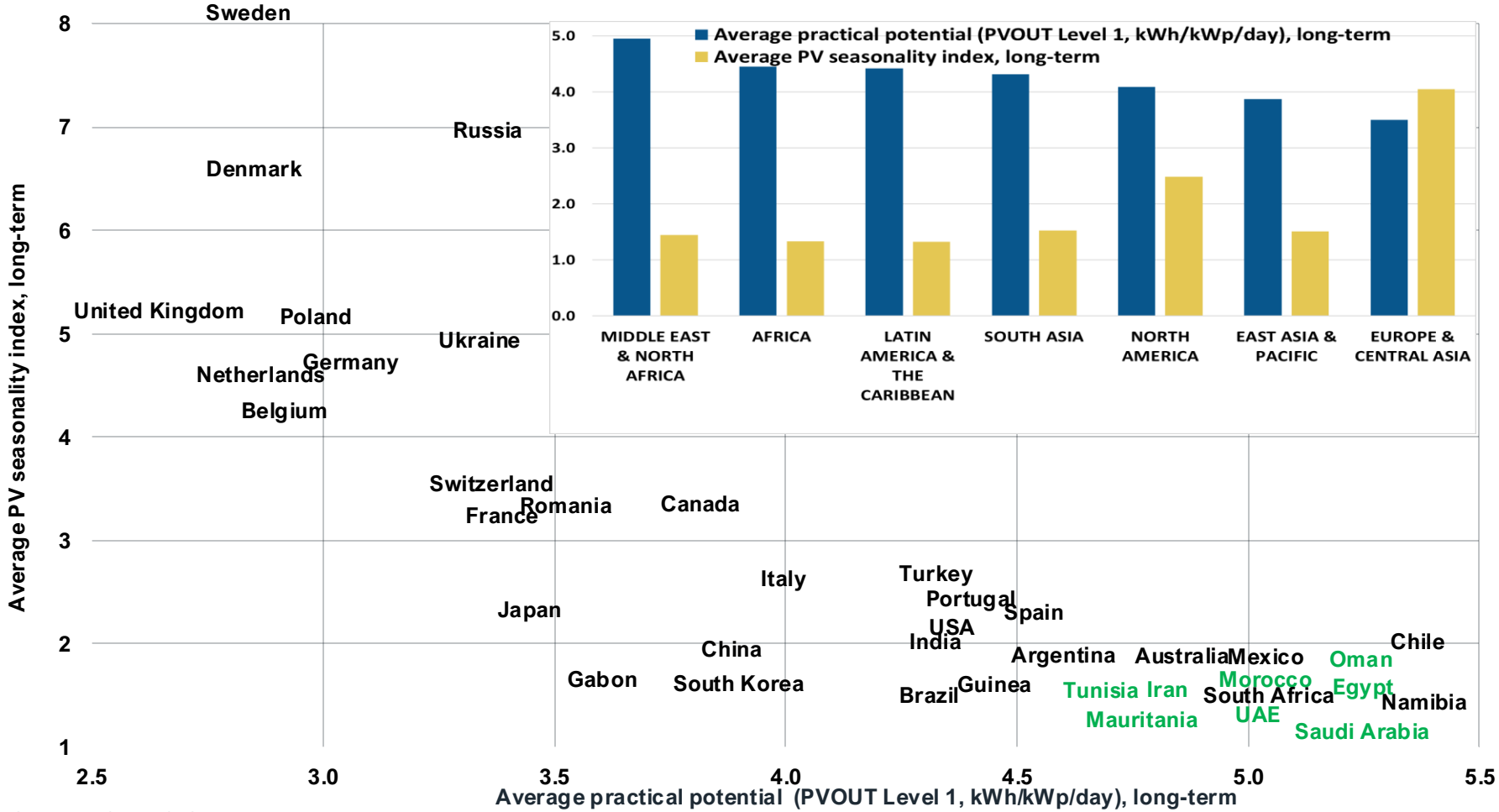
Source: Ember, IEEFA

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.

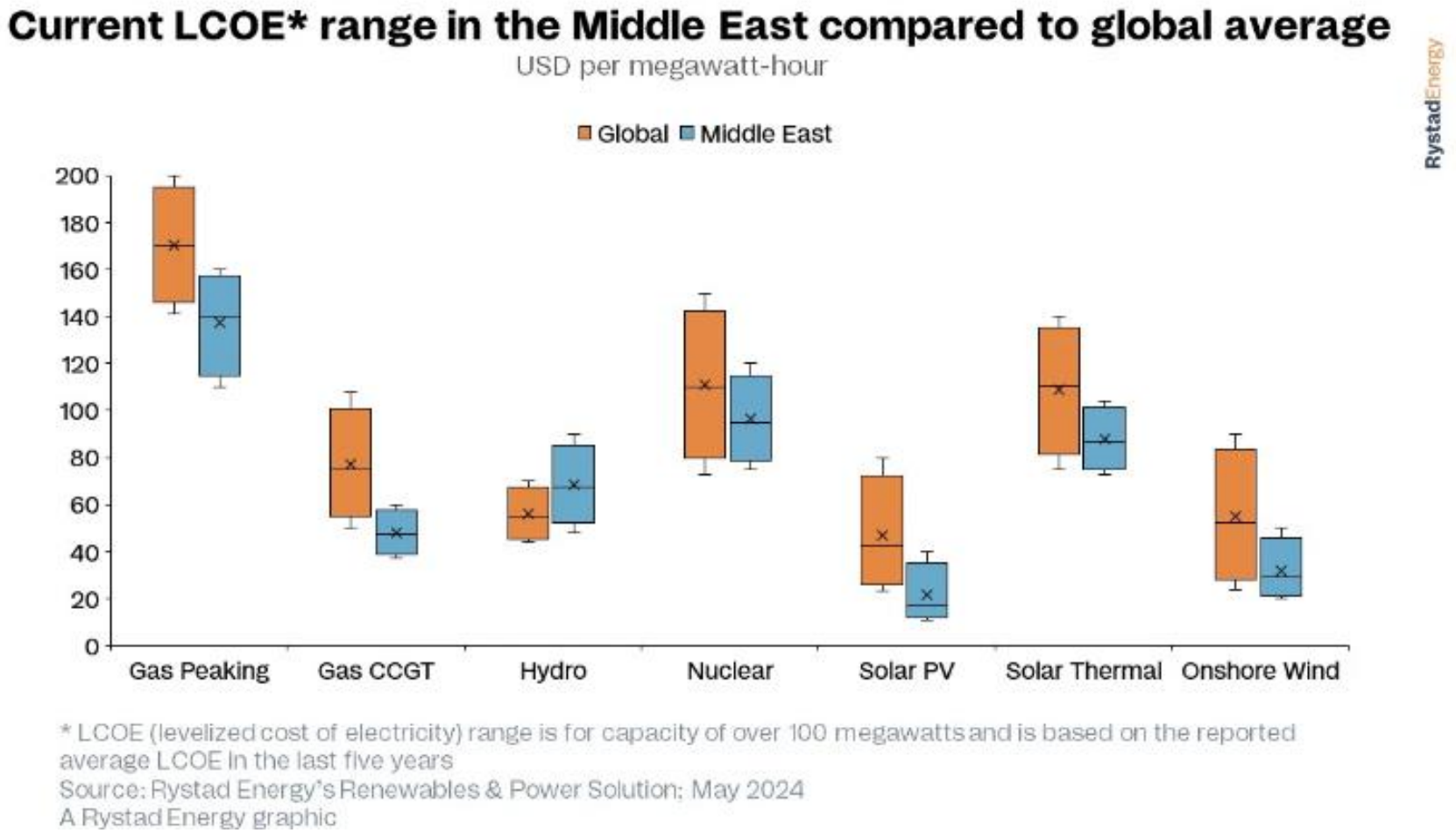
MENA Solar Opportunities



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.

Source: SolarGIS, IEEFA

MENA LCOE



Source: Rystadenergy

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.

Renewable Energy Deployment in Saudi Arabia by 2030 (Updated November 2023)

REPDO Projects:

1st Round
Tendered: 2017
Under Operation
Total = 700 MW

- Sakaka PV : 300 MW
- Dumat Al Jandal Wind : 400 MW

2nd Round
Tendered: 2019
Partially Under Operation
Total = 870 MW

- Rabigh PV : 300 MW
- Qurrayat PV : 200 MW
- Rafha PV : 20 MW
- Madinah Solar: 50 MW
- Jeddah PV : 300 MW

3rd Round
Tendered: 2020
Under Construction
Total = 1,211 MW

- Ar Rass PV : 700 MW
- Wadi Aldawaser PV : 120 MW
- Saad PV: 300 MW
- Layla PV : 91 MW

4th Round
Tendered: 2022
PPA Signed for PV
Total = 3,300 MW

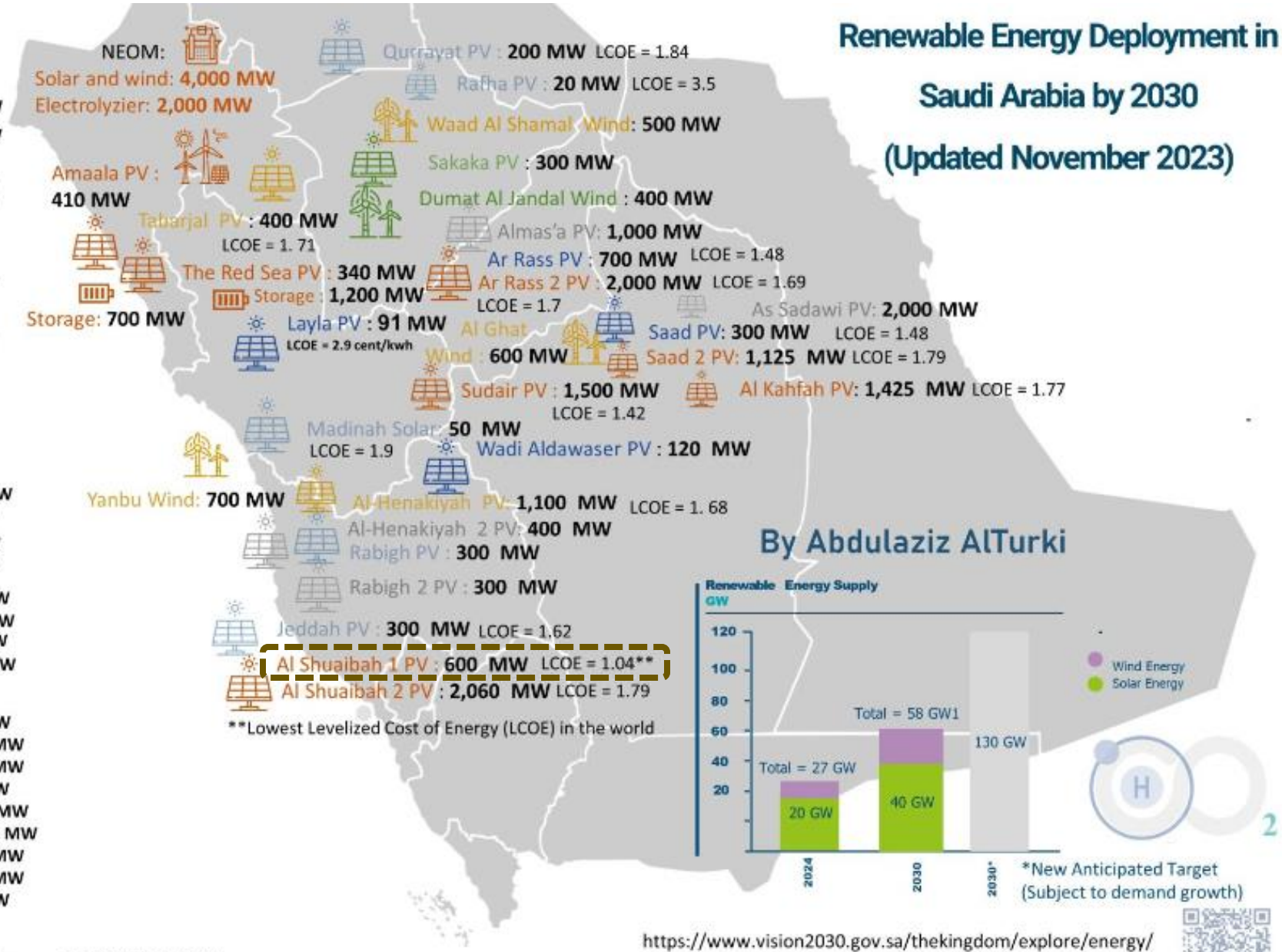
- Waad Al Shamal Wind: 500 MW
- Al-Henakiyah PV: 1,100 MW
- Al Ghat Wind : 600 MW
- Yanbu Wind: 700 MW
- Tabarjal PV : 400 MW

5th Round
Tendered: November 2023
RFQ Released
Total = 3,700 MW

- Al-Henakiyah 2 PV: 400 MW
- As Sadawi PV: 2,000 MW
- Rabigh 2 PV : 300 MW
- Almas'a PV: 1,000 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**	



Total Renewable Energy Capacity = 23,941 MW

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

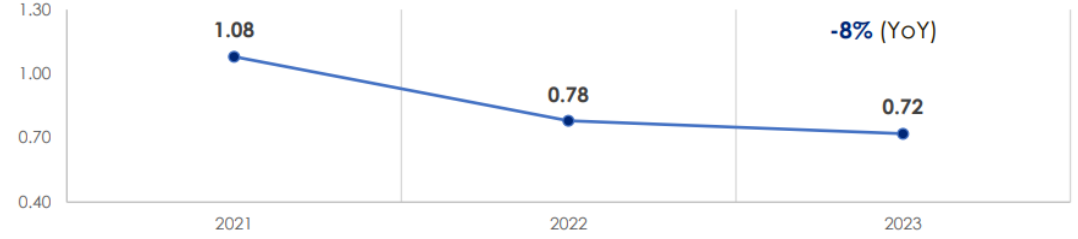
https://acwapower.com/en/projects/assets/

EMsteel Success Story

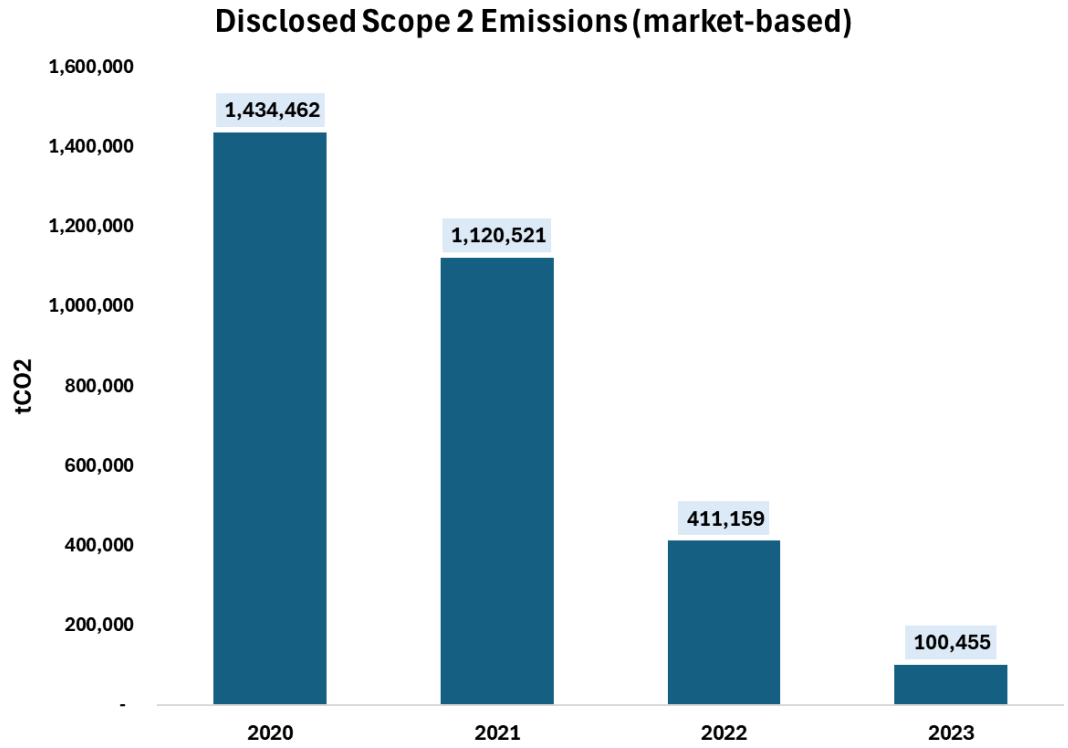
EMSTEEL is constantly working to deliver on its sustainability commitment. In 2022 we **reduced Scope 1&2 emissions from our steel business by 35% YoY.**

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

Nuclear Volume (MWh)	Solar Volume (MWh)
1,520,000	**500,000**



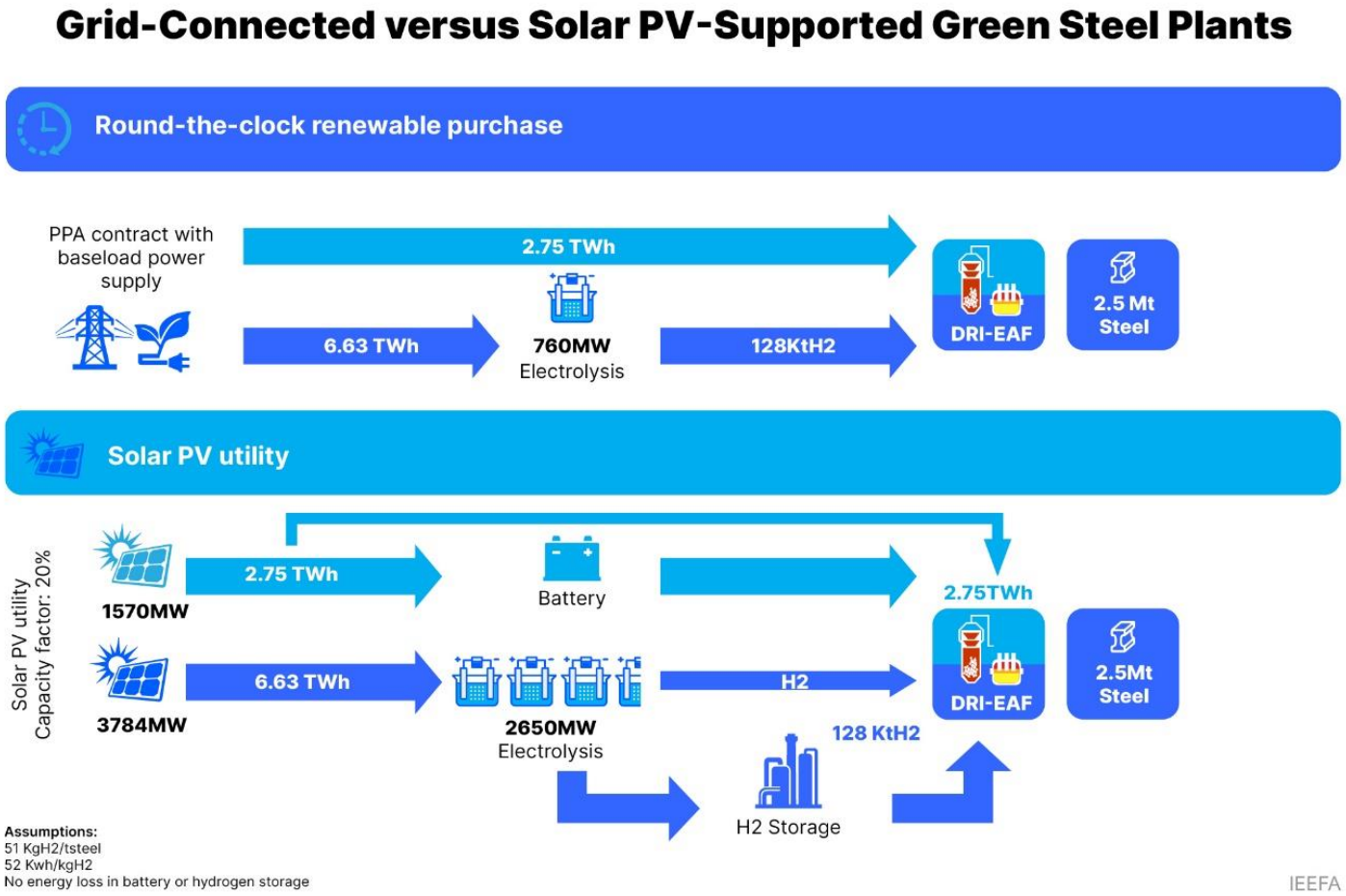
2 million MWH represent more than 80% of EMSTEEL's electricity consumption, contributing to the overall emissions reduction from our operations.



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



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.

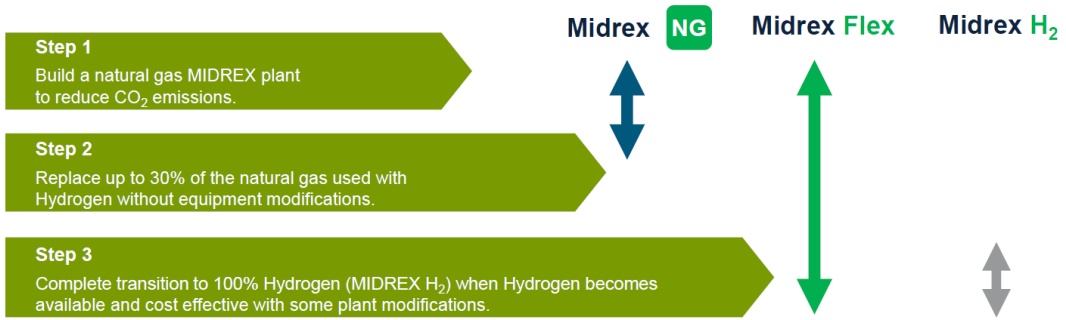
Gradual Transition

Midrex Flex

MIDREX PRIMETALS TECHNOLOGIES

A stepwise Approach to reduce CO_2 Emissions

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



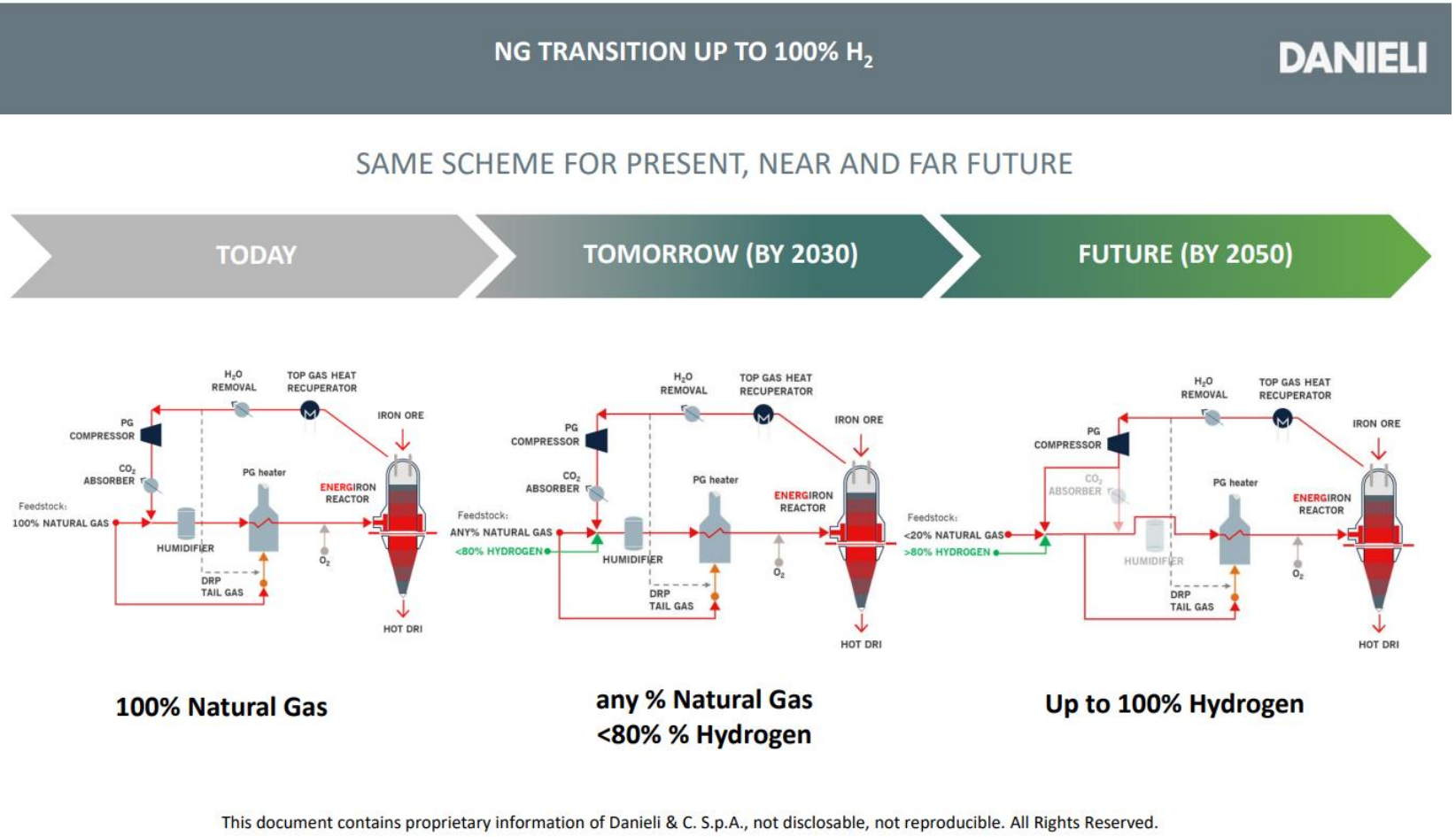
Source: Midrex

	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 ($kg\text{-}CO_2/t\text{-}DRI$)	500	350	250	100	From heater burners only (If fueled by C_nH_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



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

Same plant configuration from 0% to 100% hydrogen.

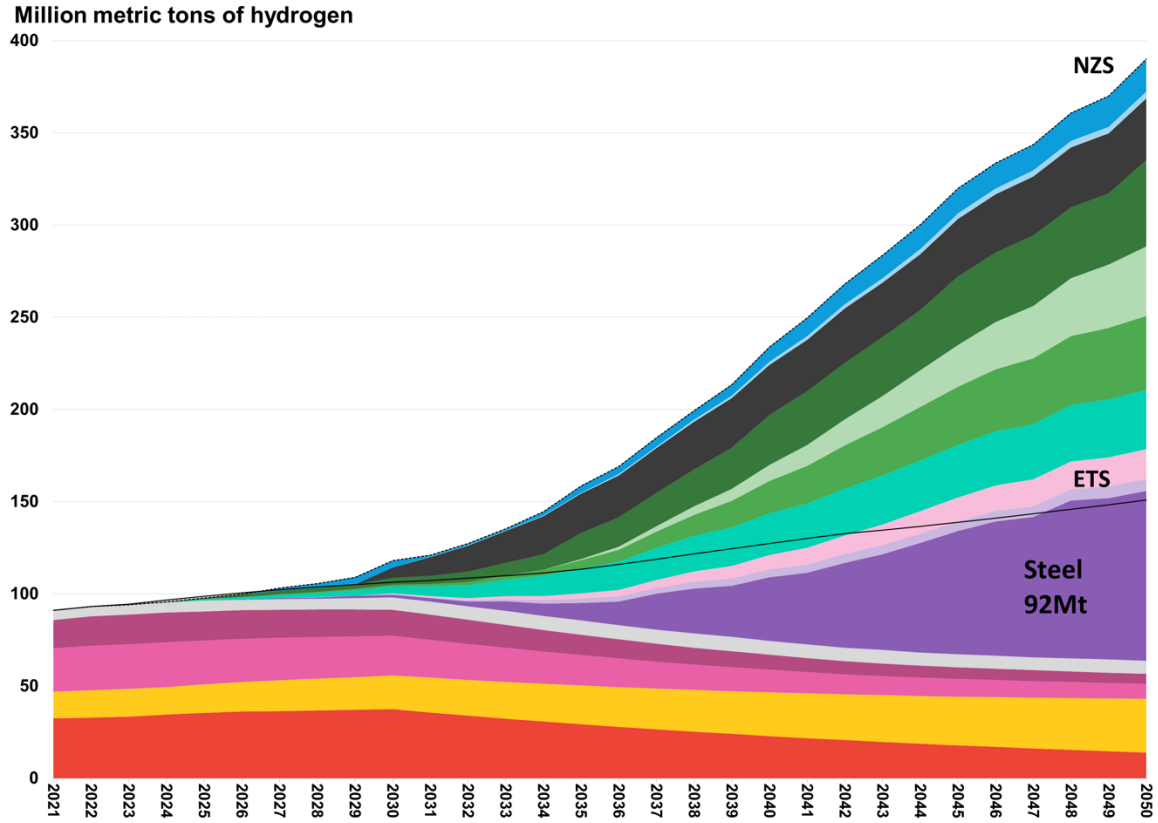
Without any changes, the plant can currently absorb up to **80%** hydrogen from external sources.

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.

Hydrogen and Steel: A Perfect Pairing

Hydrogen demand by sector and application in Net Zero Scenario



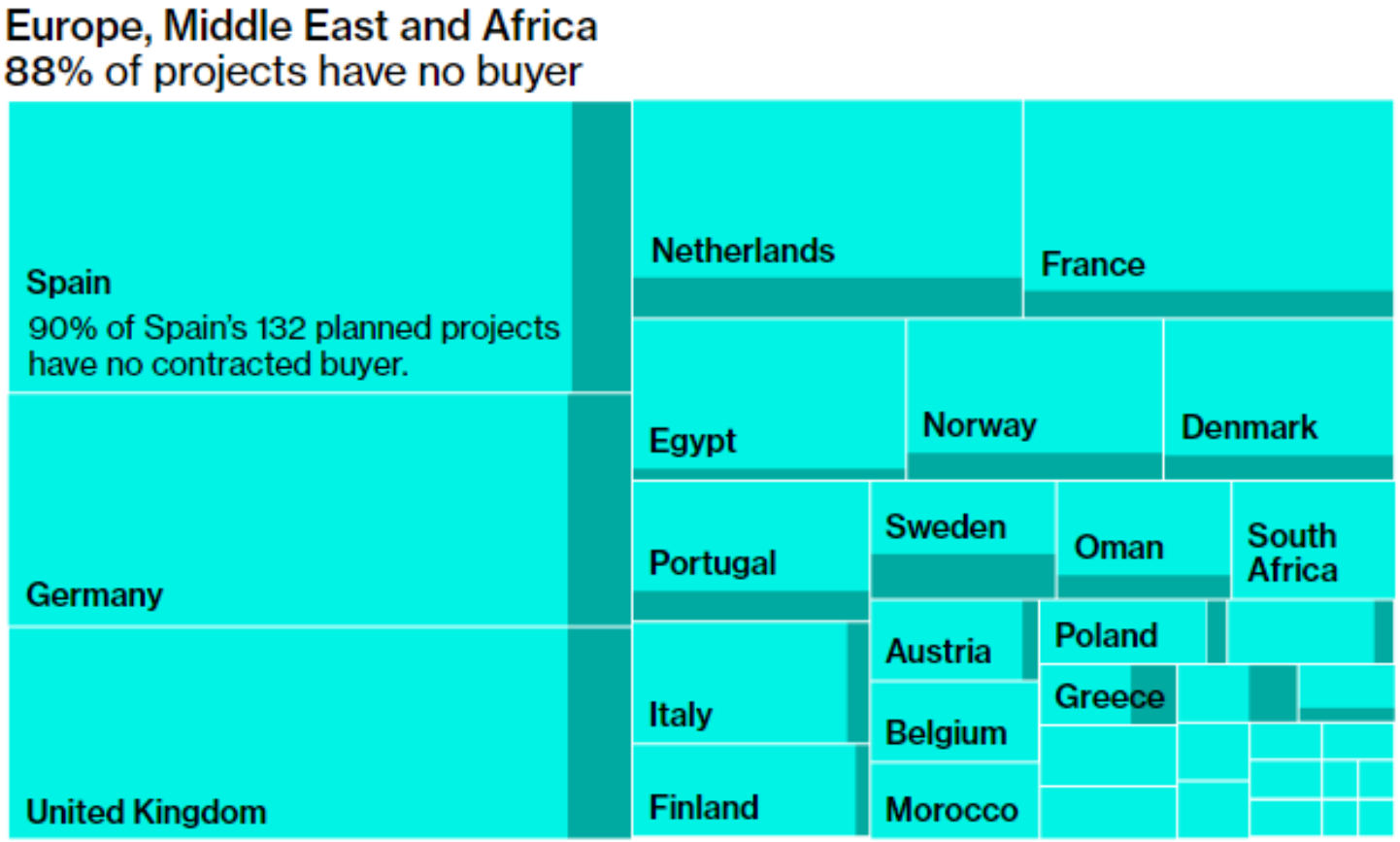
Source: BNEF New Energy Outlook 2024

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

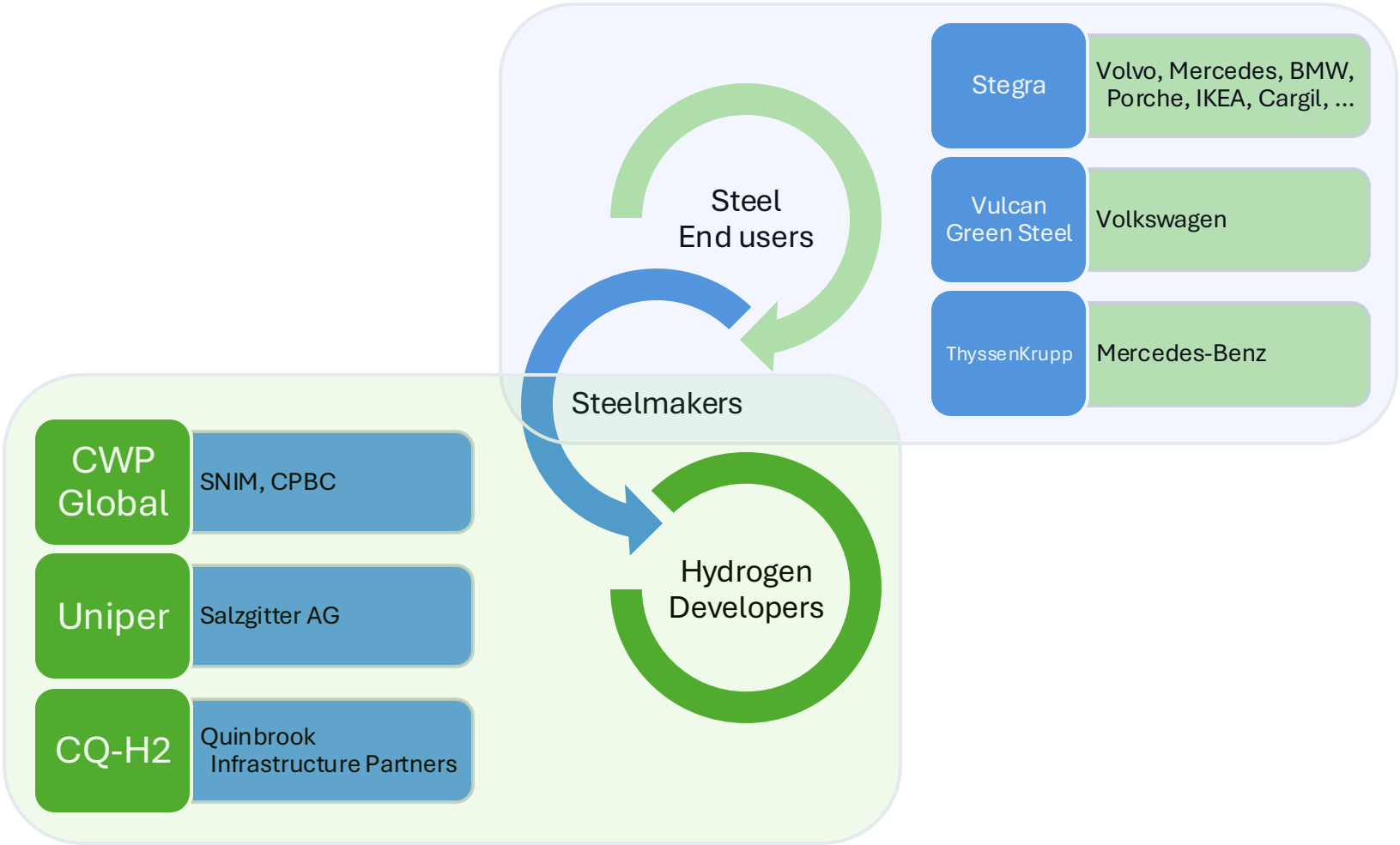


Source: BloombergNEF
Note: Data as of April 1. Excludes projects in which the country or name is unknown.

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.**

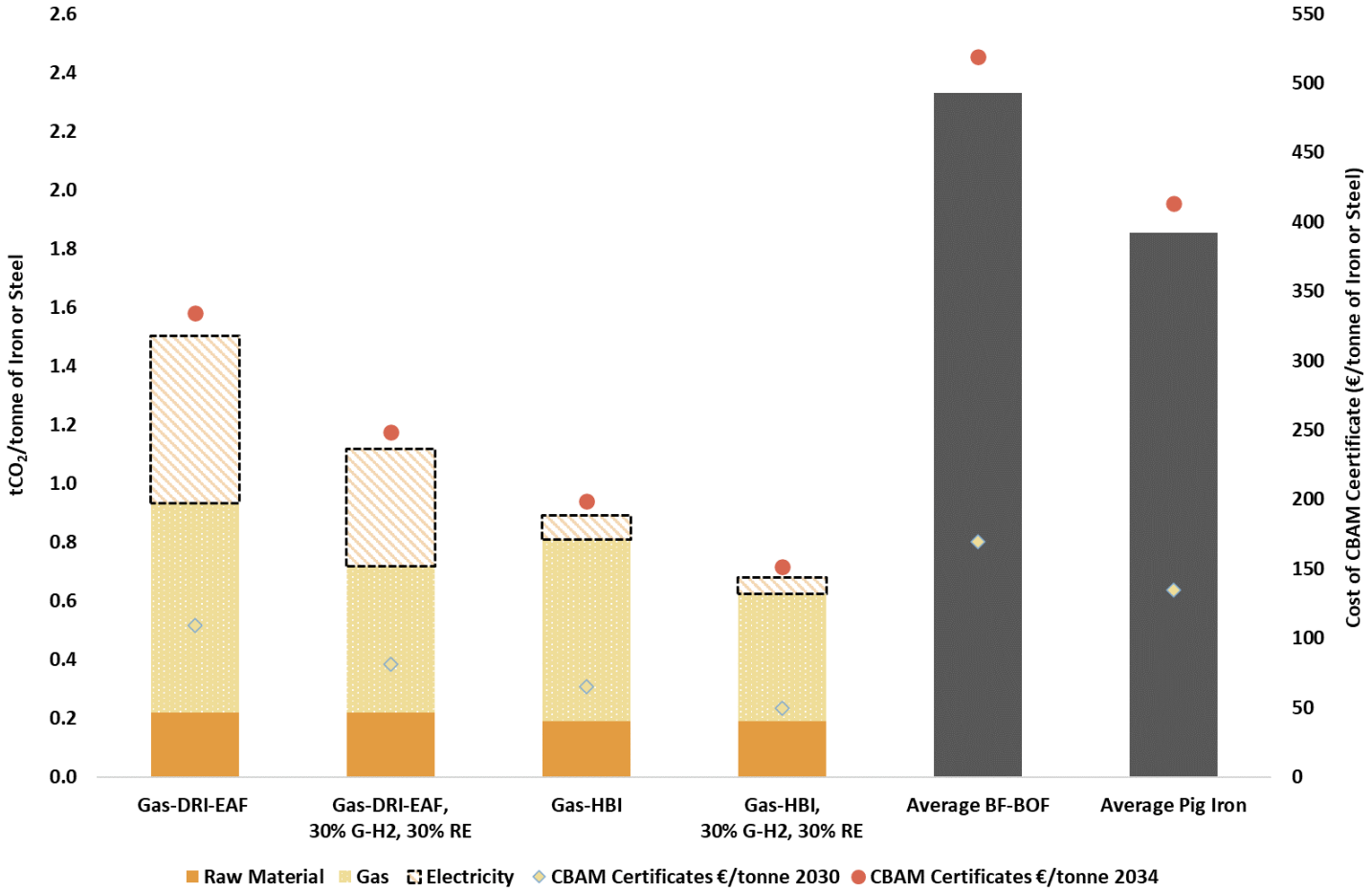
Close the loop: Steel as a key hydrogen offtaker



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



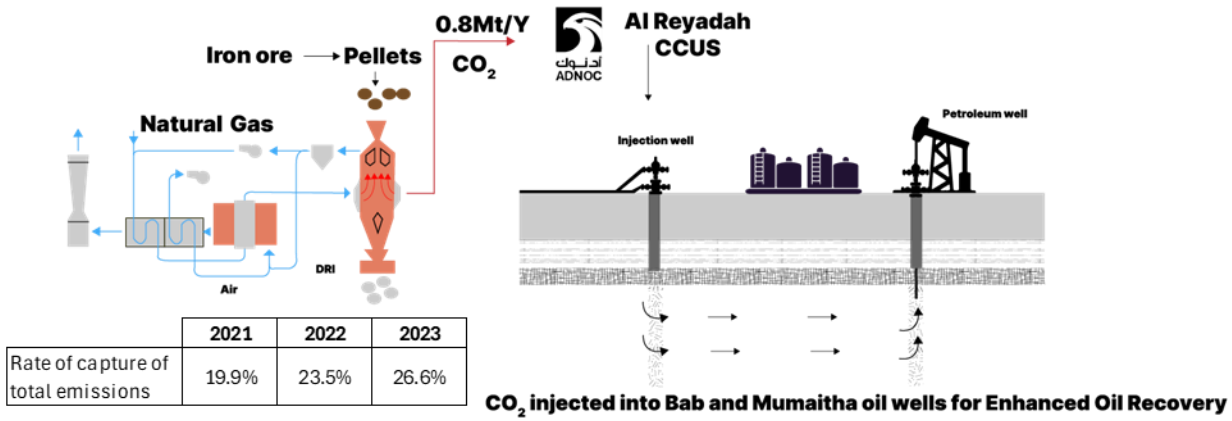
Source: IEEFA

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.

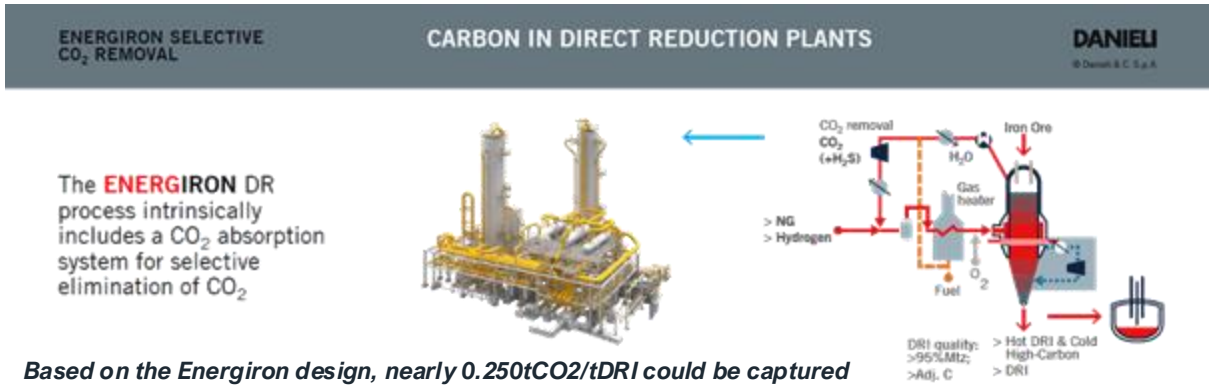
With comparatively lower emissions, MENA primary steelmakers may require fewer CBAM certificates than their competitors. This could potentially shift trade flows of iron and steel to the EU, even though MENA nations currently have low export volumes to the bloc.

CCUS in DRI-EAF Route



	2021	2022	2023
Rate of capture of total emissions	19.9%	23.5%	26.6%

CO_2 injected into Bab and Mumaitha oil wells for Enhanced Oil Recovery



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

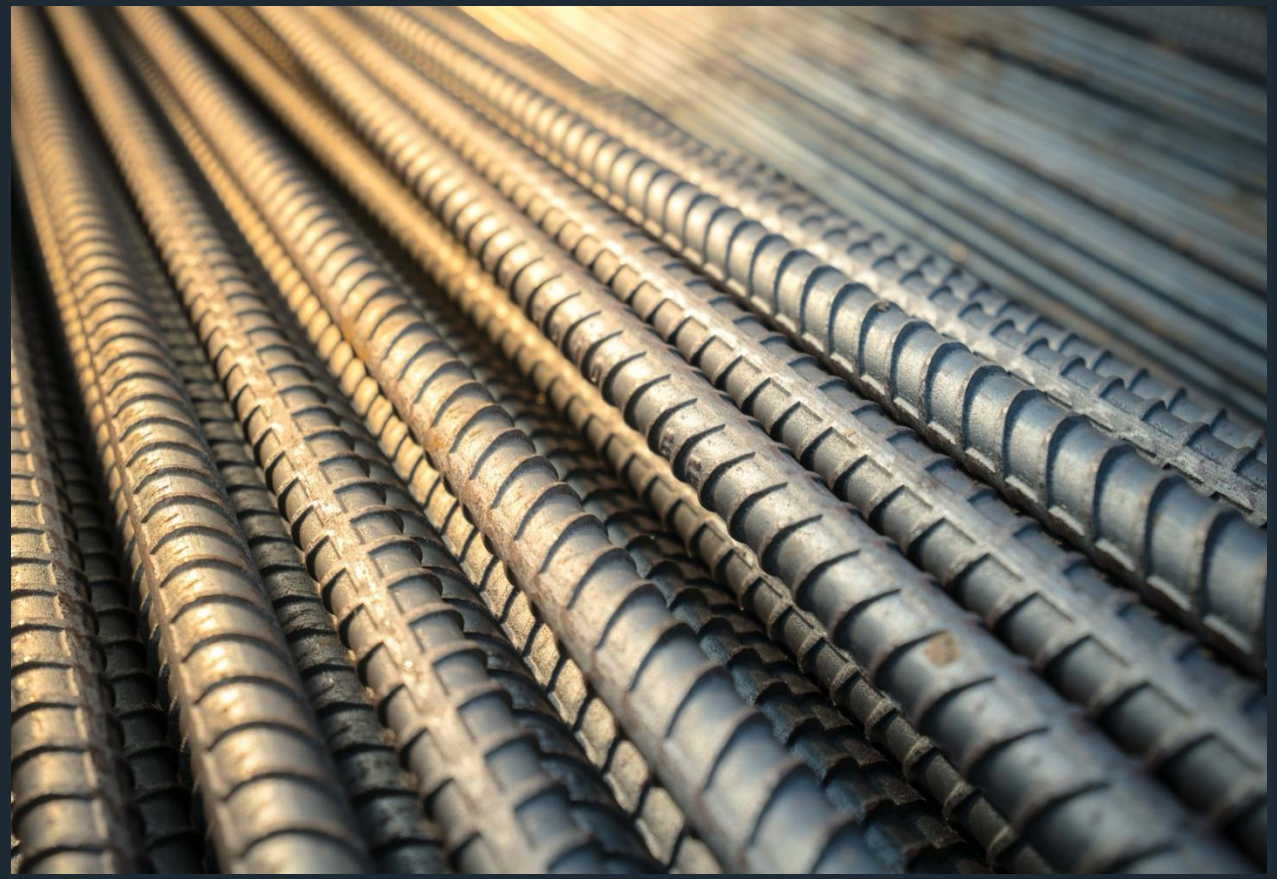
Al Reyadah is the world's only commercial-scale CCUS facility for steelmaking. Commissioned in 2016, its primary objective is to receive 0.8 $MtCO_2$/y from a steel facility operated by Emsteel and transport it for use in EOR operations.

EMsteel claimed that it can capture 45% of CO_2 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.

Read the report:
Carbon Capture For Steel



Thank You

Contact

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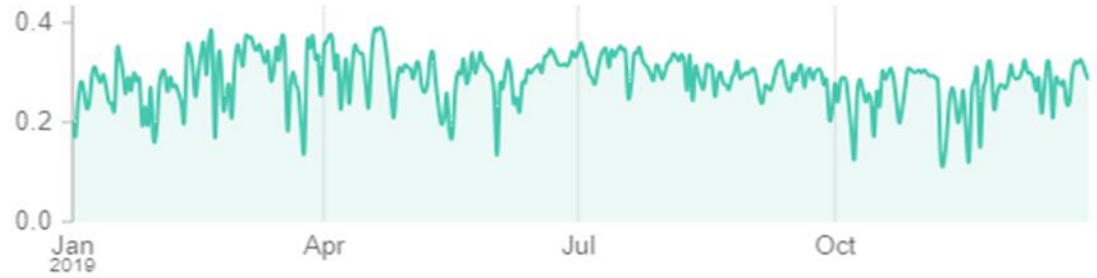
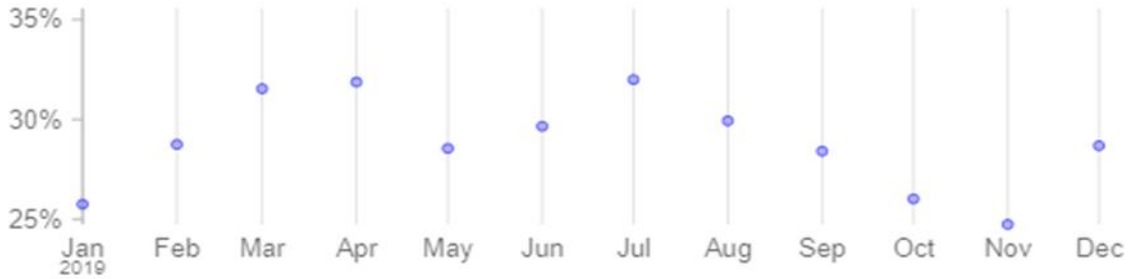
Results: Solar photovoltaic power (PV)

Daily mean



Monthly capacity factor

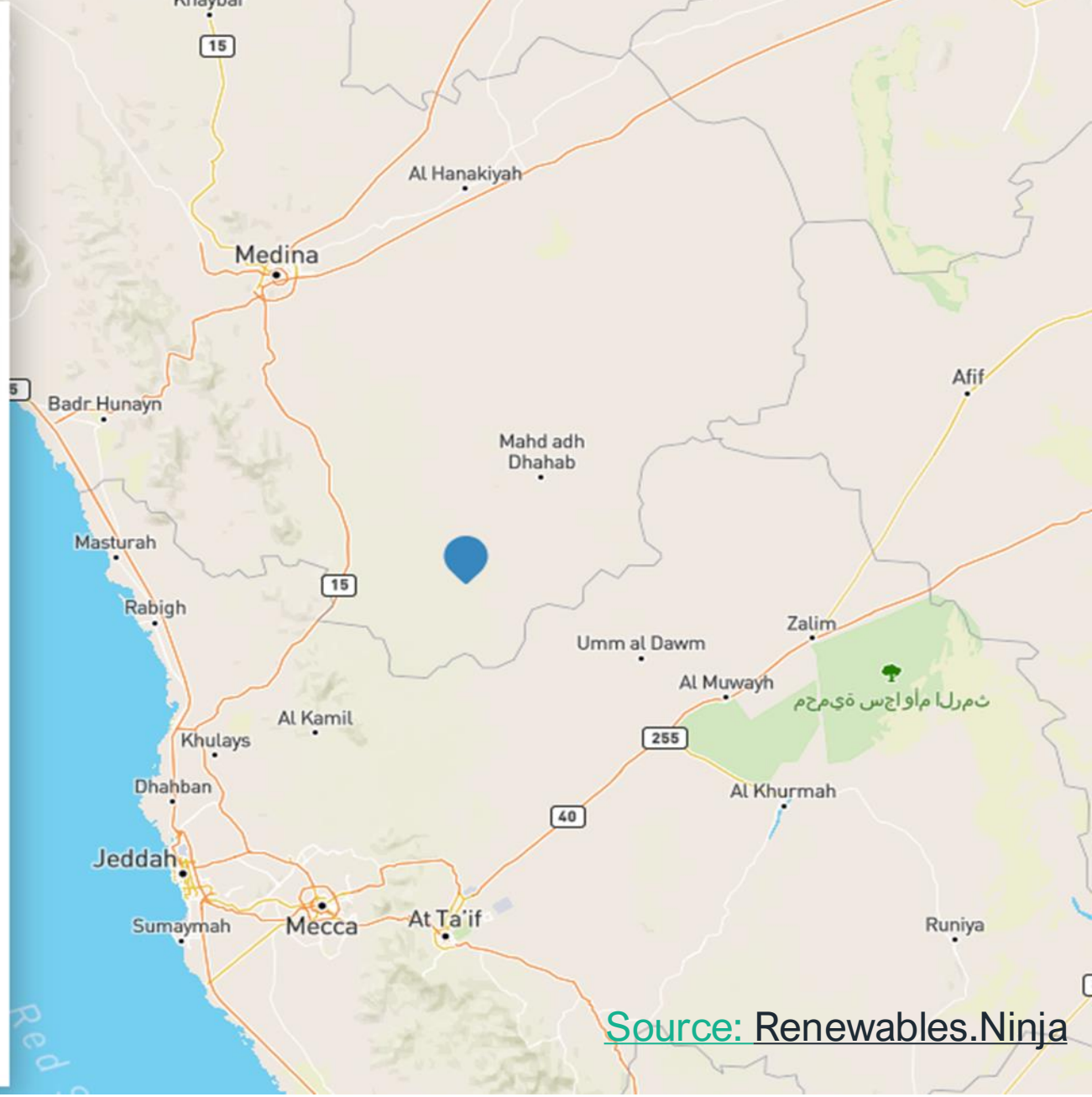


Total mean capacity factor: 28.8%

With 2-axis Tracking

Save hourly output as CSV

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

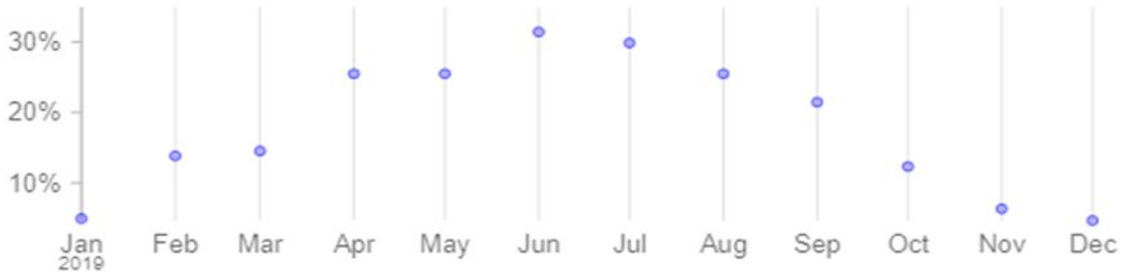


Source: Renewables.Ninja

Results: Solar photovoltaic power (PV)

Daily mean

Monthly capacity factor



With 2-axis Tracking

Total mean capacity factor: 18.0%

Save hourly output as CSV

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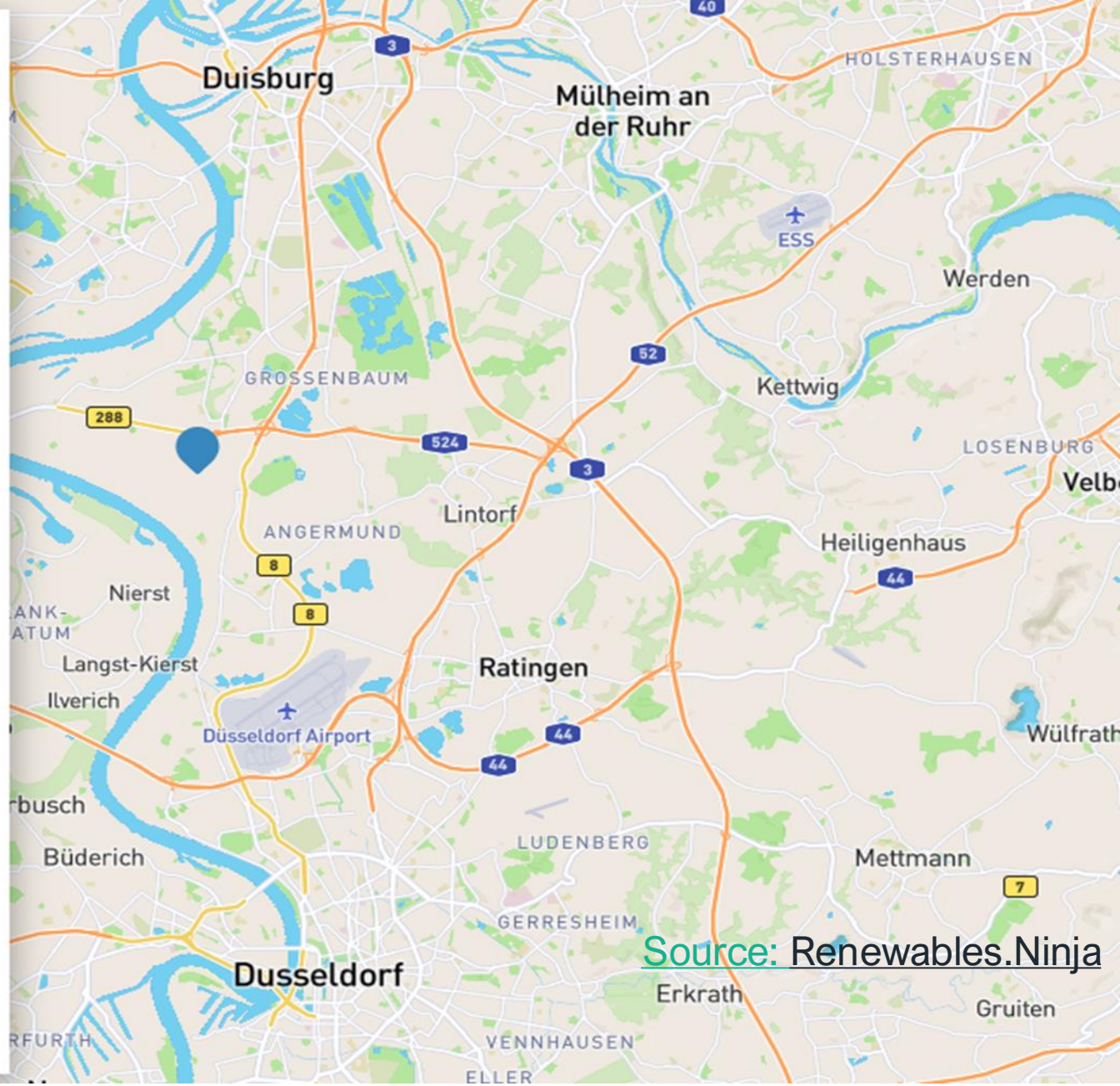
Citation: Pfenninger and Staffell (2016)



Source: Renewables.Ninja