Dii

MENA Energy Outlook 2025

Renewables, Hydrogen and Energy Storage Insights 2030

Contents

Executive Summary

Dii Desert Energy has been a driving force in the energy transition in the MENA region since its inception in 2009. This includes enabling physical clean energy infrastructures, emerging clean energy markets and fast and secure information systems to ensure integrity and efficiency of the energy transformation. For that purpose Dii has been maintaining a unique data base of all relevant physical assets along the clean energy value chain.

With the fast evolution the region is experiencing in the last years and targets set by countries, we want to provide a forward-looking picture on how the energy transition to 2030 could unfold. The work leverages the insights from the Renewable Projects database, the MENA H2 tracker and the newly added Energy Storage Projects database on one side, and the unique knowledge of the region that Dii Desert Energy has built over the years. Having most of the 'doers of projects' as partners, Dii has unique insights and is always close to the latest developments of projects and markets.

The MENA region is experiencing a growth of renewable energy investments in the last decade, in particular due to autonomous competitiveness of solar and wind technologies. Contrary to renewable based power, clean hydrogen and derivatives are, unfortunately, not (yet) able to compete with fossil energy (oil, natural gas or coal). Competitiveness of clean hydrogen and derivatives will be expected, though, as soon as the costs of greenhouse gas emissions will become significant in the region, thus, offering a level playing field to climate neutral energy.

The Emission Trade System (ETS) and Carbon Border Adjustment Mechanism (CBAM) in the EU are already paving the way for clean hydrogen to become competitive, but similar developments are not yet in place in the MENA region. The same observation can be made for the absence of workable trade arrangements for green certificates.
Looking at historical data, project pipelines and numerous (often highly optimistic) announcements of future plans and targets, large differences among countries are observed, indicating that the energy transition is progressing at different paces within the MENA region.

The Kingdom of Saudi Arabia (KSA) is fast catching up with early pioneers of the energy transition, such as Morocco, the UAE, Jordan, Oman and Egypt. In this context, KSA is nowadays taking a leading role in the renewables space with a fast deployment of giga-projects. Should the same commitment be realized for hydrogen, it would certainly contribute to reducing emissions, cost and accelerate the transition, while adding to energy security in the region and globally. Mauritania stands out for having announced projects with the highest electrolyzer capacities. However, due to a rudimentary energy system infrastructure and limited institutional support, the country had limited opportunity to exploit its renewable potential (especially its outstanding wind resources). Green hydrogen (read: hydrogen plus an ever more valuable green certificate), possibly combined with local green steel production with abundant local iron ore, presents an opportunity to reverse that trend.

Hydrogen development is at an inflection point globally. Due to the absence of proper greenhouse emission costs or a market for green certificates, many promising announcements were not followed by enough concrete actions and were subjected to an evolving regulatory framework. This has resulted in a lower speed of execution than expected, probably also due to unrealistic expectations. Subsidies and government support alone are no powerful drivers. Market pull mechanisms, such as eventual

autonomous competitiveness of hydrogen are imperative for a sustainable market. This emerging insight will hopefully result in a more realistic view on the need of meaningful greenhouse gas and green certificate pricing.

We are aware that changes in the global political landscape may have a strong influence on the energy transition in the MENA region as international relations and energy policies adapt to the new course. On the one hand the USA seems to be pulling out of the Paris Agreement, but true leaders such as the EU and China are expected to stay strong in the energy transformation. We believe that leadership in the MENA region will as well ensure increased business cases for clean energy investors and operators in the coming period. As such, the next months will be crucial to determine these new dynamics and set the direction for the MENA region.

Renewable Energy

The deployment of renewable energy in the MENA region is accelerating, thanks to a record decline costs over the past decade (among the lowest at global level), particularly in photovoltaic (PV) technology.

Some countries in the region enjoy also among the world's best wind conditions and again lowest prices

Gigawatt-scale projects are the new standard, sometimes with several developments proposed at the same time, thanks to improved efficiency and lower costs of solar PV and wind technologies. This is reflected in projects announced with significantly larger capacities compared to the past (*Figure 1*).

The demand for renewables from sectors such as data centers (e.g., the Khazna center in UAE) is increasing and competing with other industries.

Localization is an ever-increasing focus in the region, with strategic decisions aiming to bring manufacturing and assembly of components in-country.

PIF in KSA recently signed several agreements for localizing wind and solar components[1] as part of a broader strategy to enhance local capabilities, create jobs and ensure a stable supply chain for renewable energy projects.

Existing and planned installations are not sufficient to meet 2030 renewable energy targets. Additional 40 GW of Solar PV and 23 GW of wind developments would need to be planned and executed in the next 5 years to achieve the ambitions.

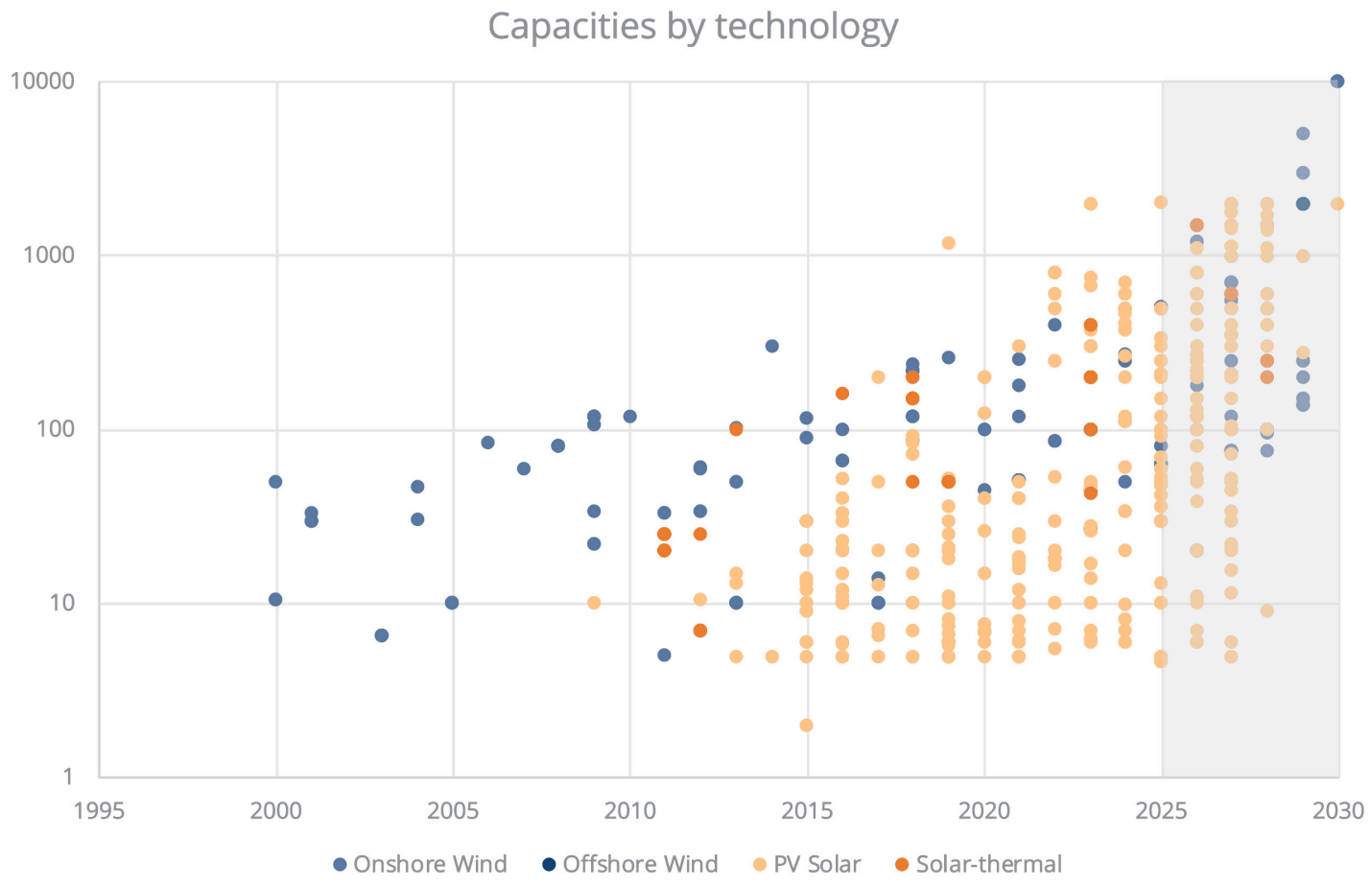


Figure 1: Scatter plot illustrating operational and future projects capacities (post-2024, in the grey area). A trend towards larger capacities is particularly evident for wind projects. Solar PV projects are also increasing in size, although smaller solar projects will continue to be prevalent in regions with limited land availability (e.g., Bahrain) or in private developments such as mines and real estate properties.

Hydrogen

After an initial surge of interest and announcements, the hydrogen movement is currently facing a slowdown due to a variety of factors, causing a delay of many projects to move closer to Final Investment Decision (FID). There is a critical need for clarity, speed and stability from policymakers to maintain momentum and gain investors' trust. Infrastructure is crucial and must be ready and available, with shared infrastructure being a potential solution.

There has been a notable shift from focusing solely on export-oriented hydrogen projects to recognizing the value of local utilization. Added value products are also gaining traction as countries seek to diversify their economies and reduce reliance on traditional commodities.

Offtake agreements are crucial for developing hydrogen. Initiatives such as H2Global (which awarded its first pilot auction to Fertiglobe in Egypt[2]) help to reduce commercial risks by providing long-term price and demand certainty. More are expected to come in the next months.

Private auctions (e.g. by the top three German steel companies or Total Energies for refineries) provide first sizable demand in the 100,000s tons of H2/a but prove complex in execution.

Energy storage

Energy storage is becoming increasingly important globally. The MENA region is rapidly enhancing its storage capabilities, with several significant developments of battery energy storage systems (BESS) announced in recent months.

The energy storage market is fast progressing in the MENA region, with KSA, UAE and Egypt leading in terms of energy storage capacity additions.

All new mega-capacity additions are of electrochemical type i.e. battery energy storage systems (BESS). For example, the Red Sea Global project with a 1.3 GWh BESS[3].

Global positioning

The MENA region has the potential to become a global powerhouse.

The EU's ambition of 10 Mt of hydrogen produced within the EU and 10 Mt from imports by 2030 seems out of reach today. A more realistic target for the European Union is between 4 and 7 Mt by 2030. Moreover, navigating the constantly changing framework creates additional challenges.

The readiness of infrastructure and transport options[4] for developing MENA hydrogen is crucial to pave the way for a transformative phase in the global energy market. Cross-continent pipelines, repurposed or new, are of strategic importance to developing the hydrogen market.

Initiatives such as ZETA[5] can help MENA to develop a transparent market for liquid low-emission products in the region, while effectively interacting with the emerging net-zero world markets. This will foster sustainable growth, attract investment and position MENA as a leader in the global transition to clean energy.

Introduction

The Middle East and North Africa (MENA) region, with its abundant sunlight and wind, has immense potential for renewable energy. As the world transitions to cleaner energy sources, the MENA region is poised to play a significant role in this global shift, having the lowest cost renewable energy in the world, combined with almost unlimited space.

Dii Desert Energy, an international industry alliance, is at the forefront of this transformation. With its comprehensive Renewable Energy (RE) Database and the MENA Hydrogen Tracker, Dii Desert Energy monitors renewable projects greater than 5 MW and hydrogen projects across the region, providing valuable insights into the operational, under construction, and planned emission-free energy projects.

These databases serve as a critical tool for understanding the current landscape and future trajectory of renewable energy and hydrogen in the MENA region.

Additionally, with energy storage emerging as a crucial topic at a global level, we recently directed our efforts to set up the first database on Energy storage developments in MENA.

In this report, we delve into the data from Dii's RE Database, the MENA Hydrogen tracker and the Energy Storage database to provide an overview of the renewable energy, hydrogen and energy storage status in the MENA region at the end of 2024 By leveraging these databases to highlight the progress made and the challenges ahead, we propose scenarios to 2030 that illustrate potential pathways for the energy transition in the MENA region.

Renewable Energy

When the Desertec 1.0 vision started in 2009, renewable energy was still nascent, with less than 1 GW installed across the region. Most of the installations were onshore wind turbines and Solar PV was still at the beginning with only 34 MW installed. Most of the projects were in Egypt, Morocco and Tunisia. The Middle East was still out of the picture, with the UAE only just starting to commission its first 10 MW project in Masdar City. Today, the MENA region presents a diverse and dynamic landscape for renewable energy development. The pace of development varies greatly across the region, underscoring the unique challenges and opportunities that each country faces in pursuing the energy transition. On the one hand, there are countries like KSA making bold announcements and aiming for rapid execution, reflecting their ambitious renewable energy targets. On the other hand – especially in North Africa – other nations struggle more to execute projects. Analyzing the projects and their status is the first step to define the context of the energy transition in the MENA region.

Renewable projects in the MENA region

The RE database tracks utility-scale projects in the MENA region that are greater than 5 MW. At the end of 2024, the Dii RE Database has recorded more than 700 of those at various stages of development (*Table 1* and *Figure 2*). This figure includes renewable installations related to standalone photovoltaic (PV) solar, solar-thermal (CSP) and wind projects. Hydrogen-related installations are not included in this database. We recently included the operational projects in Israel as well as developments in Yemen and Iraq.

Of these 714 projects, 467 are operational, 47 are under construction, 89 projects are in the development phase and an additional 90 have been announced. Israel is the country with most operational projects (191), followed by Jordan (64) and Egypt (62) follow in the ranking of operational projects. Algeria recently saw a new wave of projects moving to construction phase (18 in total), while Morocco has the largest pipeline of projects in current development (26).

	Total	Operational	Construction	Development	MoU/ Announced	On hold/Cancelled
Algeria	47	23	18	2	4	
Bahrain	11	2		5	4	
Egypt	81	62	3	7	9	
Israel	191	191				
Iraq	4		1	3		
Jordan	67	64	1		2	
KSA	54	20	11	9	14	
Kuwait	16	4	1		11	
Lybia	5			3	1	1
Mauritania	13	7			5	1
Morocco	78	33	1	26	10	8
Oman	29	8	2	9	10	
Qatar	4	1	2		1	
Sudan	12	3		9		
Tunisia	55	14	3	11	16	11
UAE	45	34	3	5	3	
Yemen	2	1	1			
Total	**714**	**467**	**47**	**89**	**90**	**21**

Table 1: Overview of renewable energy projects by status in the MENA region.

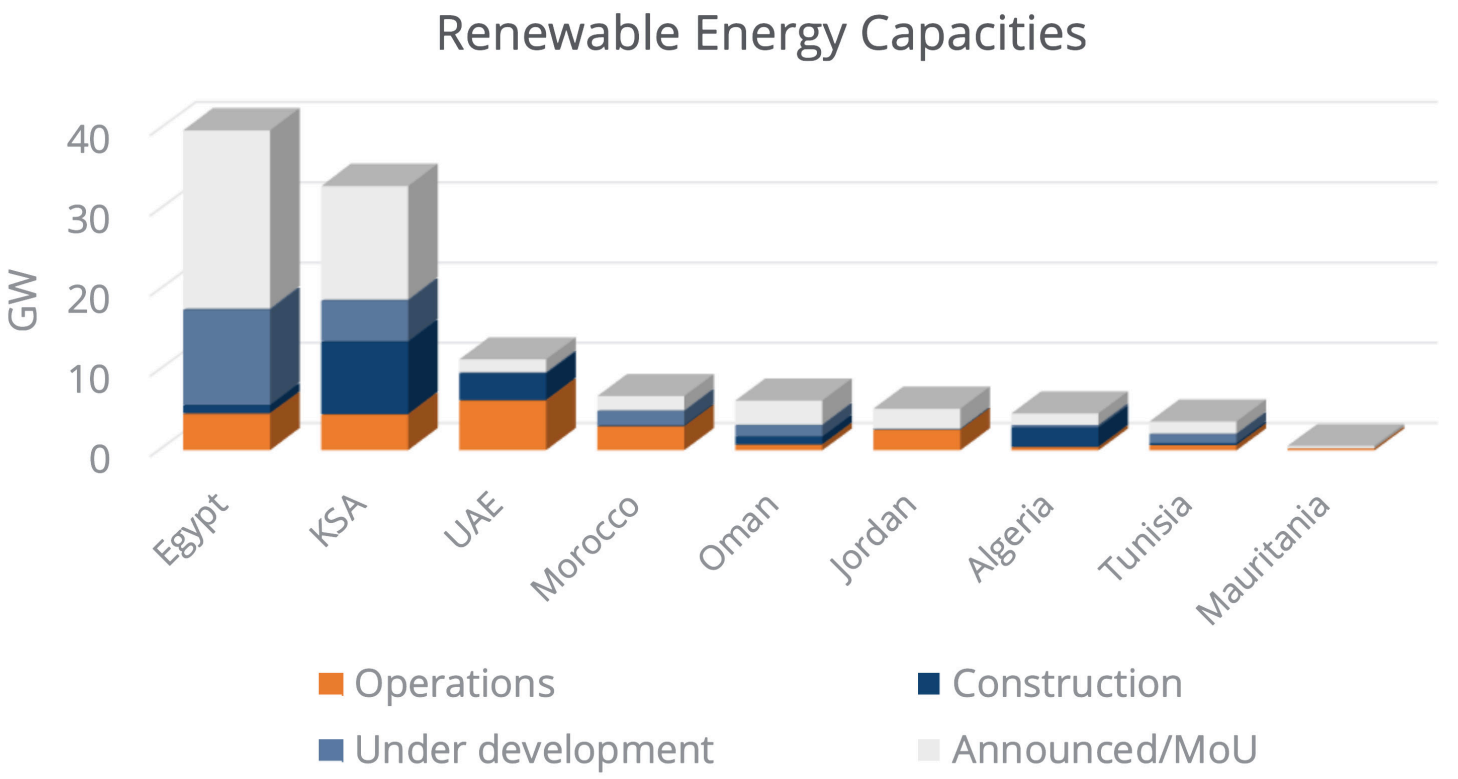


Figure 2: Renewable energy capacity by development phase for selected countries tracked in the RE database.

In 2024 several projects started commercial operations. For example, Ar Rass and Al Shauibah 1 in KSA, which added 700 MW and 600 MW respectively to the capacity of the country. In Egypt, the Abydos Kom Ombo (AMEA Power) and the Kom Ombo (ACWA Power) contributed an additional 500 MW and 200 MW respectively, while the Guelf of Suez 1 wind development increased the installed capacity of the country by 250 MW. Morocco continues to enhance its wind capacity thanks to the Jbel Lahdid installation (270 MW).

Numerous projects are in construction across the region (*Table 2*). In Egypt, wind developments are progressing with Amunet (500 MW) and RSWE Wind (500 MW). Oman inaugurated the Manah 1 and 2 PV projects, each contributing 500 MW, in January 2025. KSA is building Al Shuaiba 2 Solar PV project that will add respectively 2030 MW to the country's capacity. In UAE, the Mohammed bin Rashid Al Maktoum Solar Park (MBR) started building its 6th phase increasing its capacity by 1800 MW, while the Al Ajban PV projects will contribute an additional 1500 MW.

Among recent announcements (*Table 3*), Egypt has unveiled two projects incorporating Battery Energy Storage Systems (BESS): the Benban Solar PV and a project developed by Scatec. Morocco remains focused on developing wind energy with the Dar Chaoui project (250 MW).

Qatar is planning to build its second major renewable energy project, the Dukhan solar Park (2,000 MW). In the past few years, KSA has seen a surge in projects announcements, driven by its increased renewable energy target of 100 to 130 GW by 2030 translating into an additional 20 GW per year. In January 2025, Masdar announced the launch of the world's first large-scale 'round the clock' gigascale project: a 5.2GW solar PV plant, coupled with a 19 GWh BESS.

Country	Project	Capacity (MW)
Algeria	Hassi Delaa Laghouat PV	300
Egypt	Amunet Wind	500
Egypt	Red Sea Wind Energy	500
KSA	Al Shuaiba 2 PV	2,030
KSA	Haden PV	2,000
Oman	Manah 1 PV	500
Oman	Manah 2 PV	500
Qatar	Ras Laffan Industrial City PV	470
Qatar	Mesaieed Industrial City PV	410
Tunisia	Kairouan PV	100
UAE	MBR Phase 6 PV	1,800
UAE	Al Ajban PV	1,500

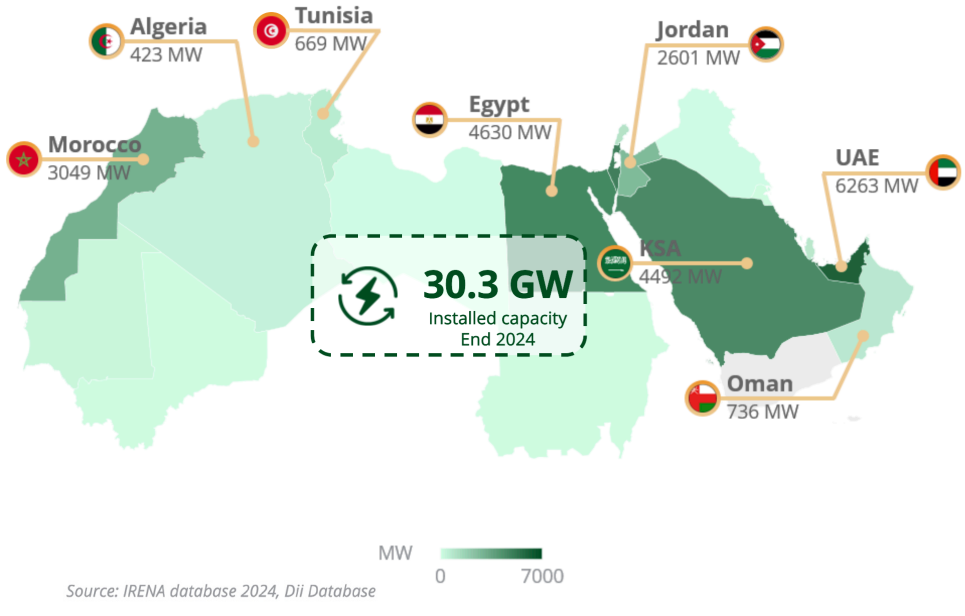
Table 2: Summary table of selected major projects in Construction in the MENA region.

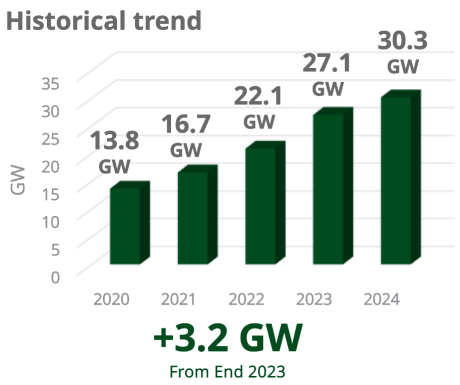
Country	Project	Capacity (MW)
Egypt	Benban PV + BESS	1,000
Egypt	Scatec PV + BESS	1,000
Iraq	Basra Solar Park	1,000
KSA	Dawadmi Wind	1,500
KSA	Najran PV	1,400
KSA	Samtah PV	600
KSA	Ad Darb PV	600
Kuwait	Shagaya Phase 3 & 4	3,200
Morocco	Dar Chaoui Wind	250
Oman	Ibri 3	500
Qatar	Dukhan Solar Park	2,000
UAE	Khazna PV	1,500

Table 3: Summary table of selected major projects announced in the MENA region.

Renewable installed energy capacity

The MENA region has a current renewable energy installed capacity of 30.3 GW at the end of 2024 (*Figure 3*), a number that has more than doubled in the last five years from 13.8 GW in 2020. Looking at the regional distribution, UAE emerges as a leader with 6.3 GW installed capacity, followed by Egypt (4.6 GW) and KSA (4.5 GW). It is worth noting that the UAE has achieved more installed capacity than Egypt with fewer than half the projects. This is largely due to the impact of the giga-project Mohammed bin Rashid Al Maktoum Solar Park (MBR Solar Park), which significantly contributes to the UAE's renewable energy capacity.





+3.2 GW
From End 2023

RE Energy installed capacity has **more than doubled** in the last 5 years

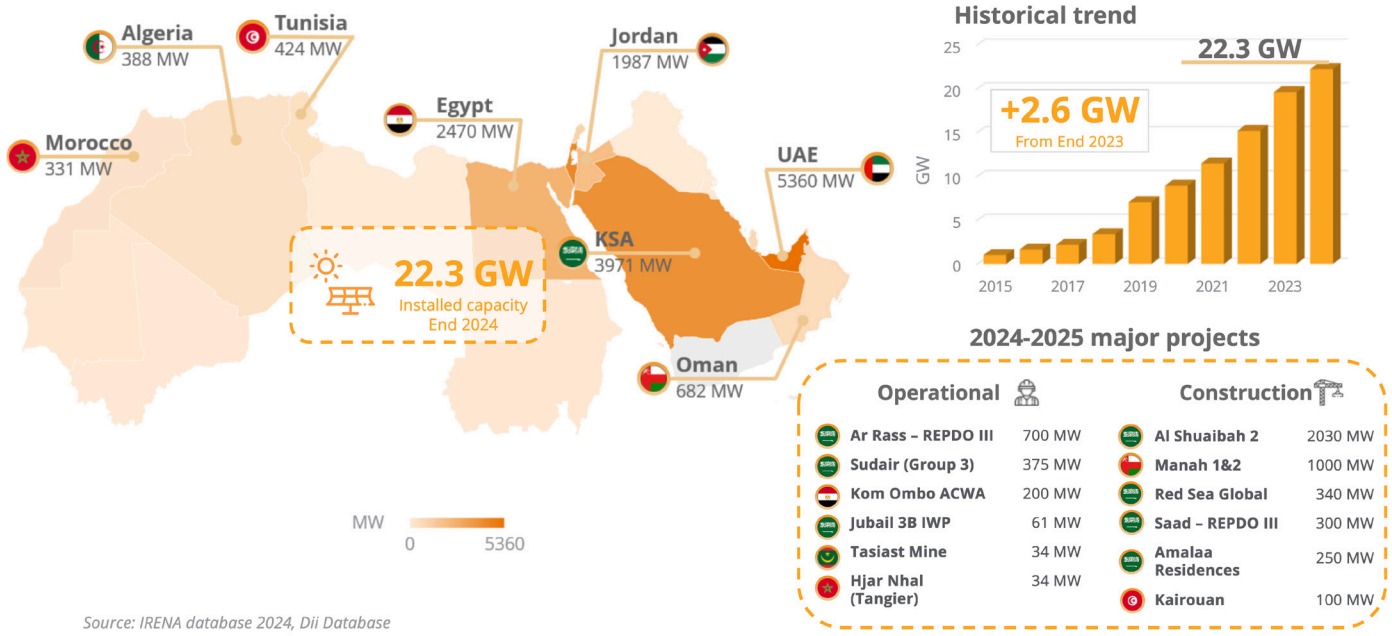
Source: IRENA database 2024, Dii Database

Figure 3: Overview of the Renewable Energy installed Capacity in the region as of December 2024.

Solar PV

The current installed solar PV capacity amounts to 22.3 GW in the MENA region (*Figure 4*). The UAE are leading the way with more than 5 GW installed. The Mohammed bin Rashid Al Maktoum Solar Park that alone accounts for more than 1.5 GW, while the Al Dhafra project in Abu Dhabi with 2 GW installed capacity is one of the world's largest single-site solar plants.

Apart from utility scale projects, the UAE can also count on a sizable additional market segment: under the Shams Dubai program, introduced in March 2015, more than 600 MW of mainly industrial/commercial solar rooftops were installed at the end of 2024. On the construction phase, KSA is leading the way with a series of giga-scale projects, including Al Shuaiba 2, the largest project to date with 2,030 MW. Oman is also set to significantly increase its capacity in 2025 with the Manah 1 and 2 projects, each having a capacity of 500 MW.



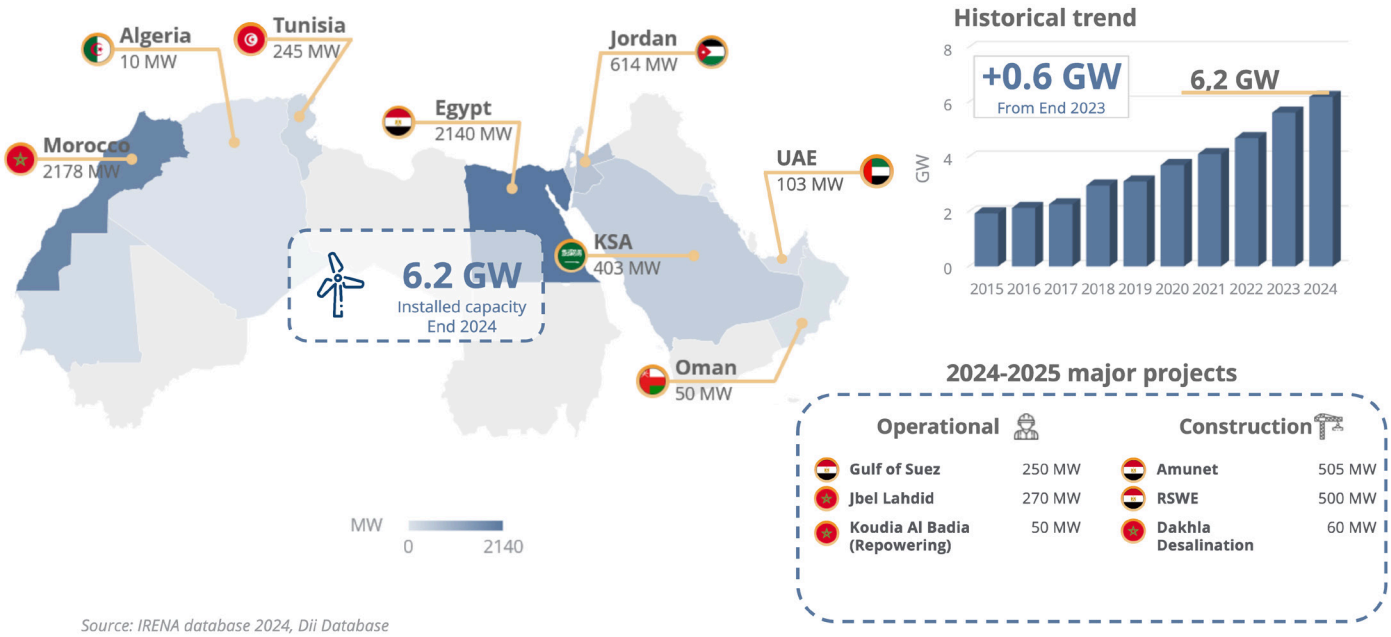
Source: IRENA database 2024, Dii Database

Figure 4: Overview of the Solar PV (on-grid) energy installed Capacity in the region as of December 2024.

Wind

The total installed wind energy capacity is currently 6.2 GW (*Figure 5*). Egypt and Morocco are leading the way, with each country having more than 2 GW installed. In 2023, the United Arab Emirates made a first step into wind energy with over 100 MW installed under the UAE Wind Program in four different sites. This program uses low wind speed turbines to best harness the reduced wind speed in the country and a tender to expand the Sila site next to the KSA border has been launched recently.

The outlook for wind energy in the MENA region is promising, with more than 15 GW in the development phase. A recent development is Masdar signing a Land Access Agreement for a 10 GW project in Egypt, which is a significant step forward in the region's renewable energy journey.



Source: IRENA database 2024, Dii Database

Figure 5: Overview of the Wind energy installed Capacity in the region as of December 2024.

Renewables forecast to 2030

The transition towards a sustainable energy future can materialize in different ways for the MENA region. With varying degrees of progress and readiness, countries within MENA are navigating their unique paths towards extensive renewable energy deployment, setting the stage for a transformative decade ahead. Leveraging on the insights from the Dii Desert Energy databases and combining those with the ambitious targets but also challenges faced by individual countries, we propose three different pathways to 2030.

Current pipeline of projects

As a starting point, it is useful to analyse the current pipeline of projects in the region (*Figure 6*). If all projects under construction, under development and announced will be successfully realized, the total renewable capacity installed in 2030 would reach 131 GW. Of this, 50 GW would come from onshore wind, 75 GW from Solar PV, 4 GW from CSP and 2 GW from offshore wind.

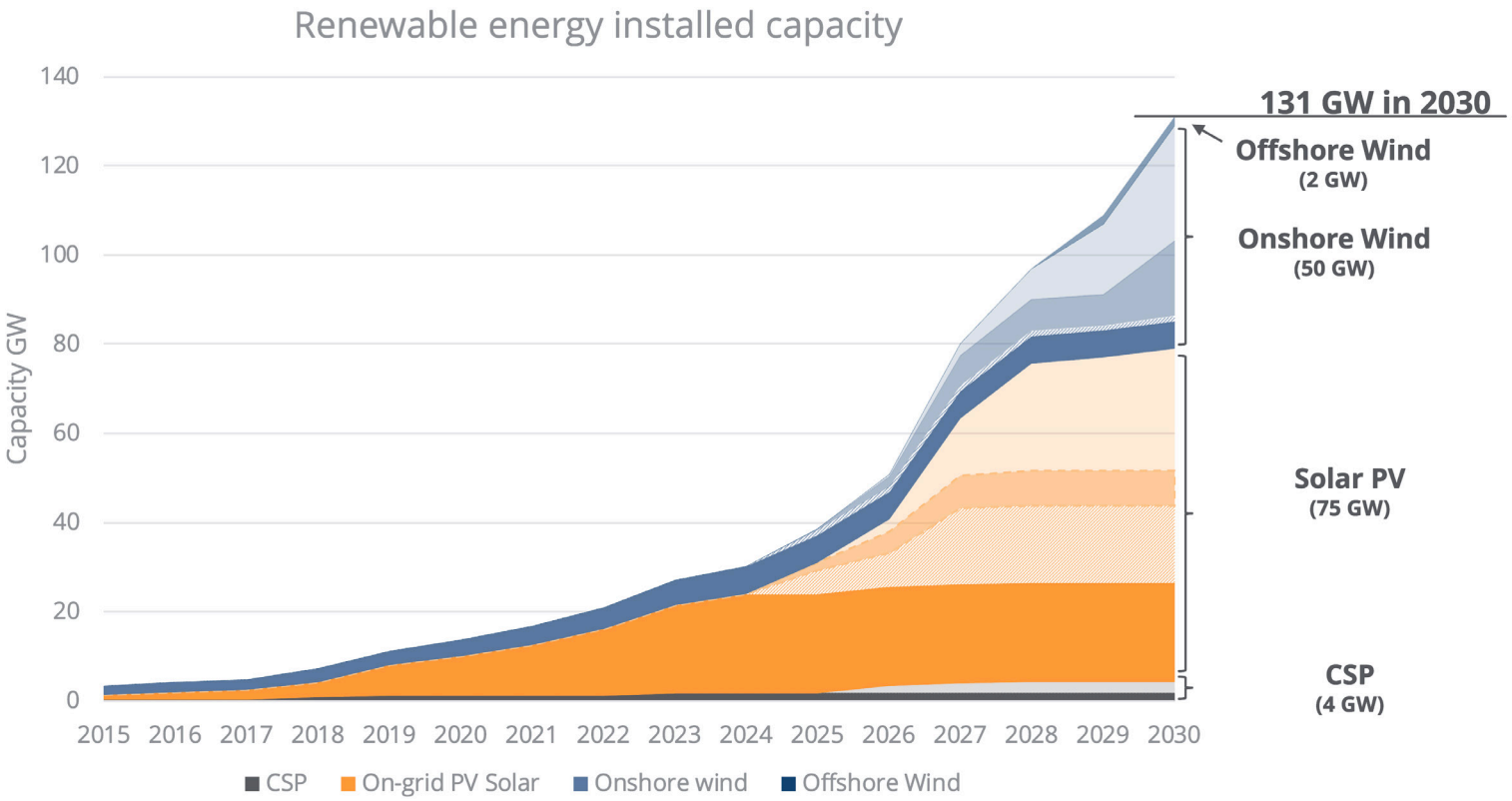


Figure 6: Overview of the current pipeline of renewable projects in the MENA region up to 2030. Dark colours indicate operational projects, dashed colours represent projects under construction, light colours represent announced projects.

Targets and ambitions

The 2030 ambitions for renewable energy – and in particular solar and wind – amount to 236 GW (*Figure 7*). Existing and planned installations would not be sufficient to meet the target, additional efforts need to be made to accelerate the deployment of renewables.

Solar PV is set to reach 115 GW in 2030, if all ambitions are met. The current project pipeline – including existing installations - tops to 75 GW (if all projects materialize), meaning that there are still 40 GW needed to be planned and executed in the next 5 years to reach the target.

Onshore wind should reach 75 GW in 2030, if all ambitions are met. The current projects pipeline accounts for 50 GW, should all projects materialize. Notably, 20GW of announced projects come from two huge projects in Egypt (10 GW each). To bridge the remaining 23 GW gap, similar giga-scale additional projects will be required to achieve the 2030 target.

There is no specific target set for CSP or offshore wind (a novelty for the region), however taking into account operational and planned project it is expected that CSP will reach 5 GW in 2030 and Offshore wind 2 GW.

Moreover, current ambitions include 39 GW for which a preferred technology has not been specified at this stage, nevertheless they would need to be planned and developed to meet the 2030 MENA target.

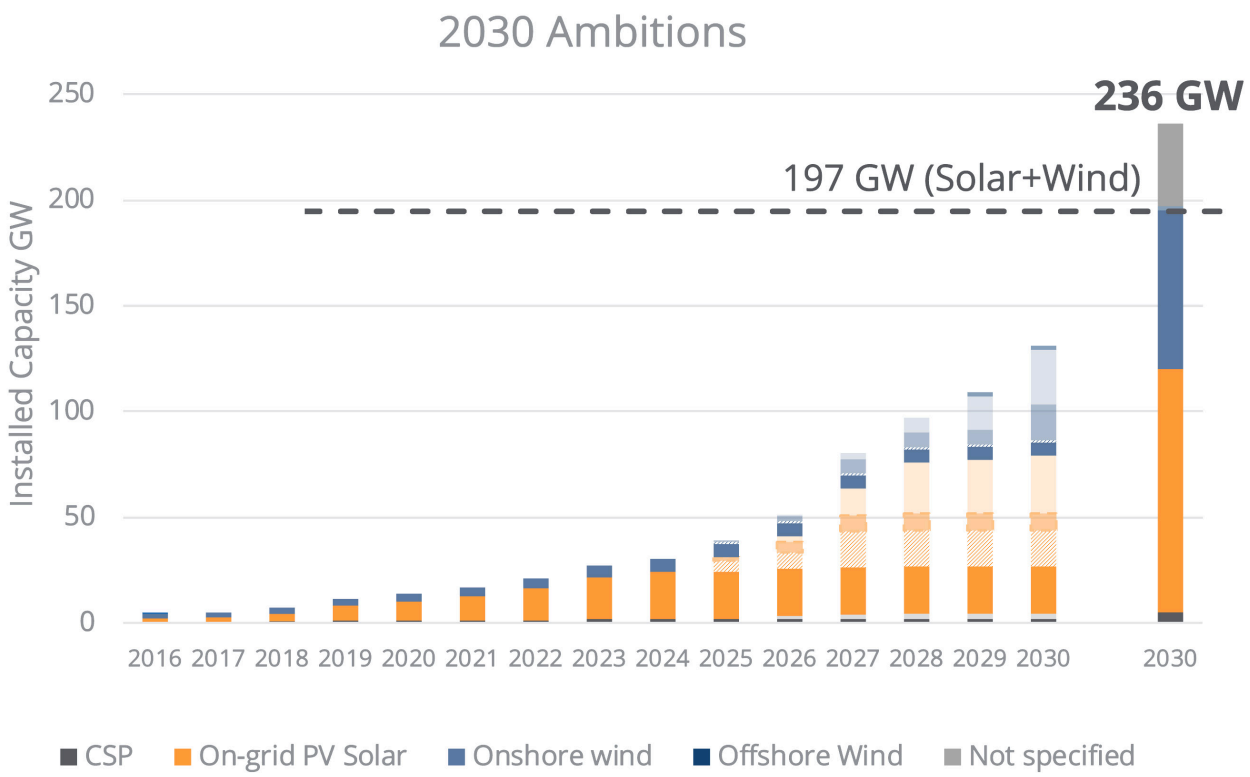


Figure 7: Current pipeline of projects vs 2030 ambitions. Dark colours indicate operational projects, dashed colours represent projects under construction, light colours represent announced projects.

Countries in the MENA region have set targets in terms of renewable energy deployment to 2030 (Figure 8). The range of ambitions varies greatly among nations, reflecting the diversity of approaches withing the region. Some countries prefer to lay out conservative plans while others produce bold statements.

KSA leads the region in terms of ambitions, accounting for nearly half of the MENA target with an aim to reach 100-130 GW of renewables by 2030 and a share of 45-50% in the energy mix. Jordan has the narrowest gap to fill to meet its 2030 ambition. Oman expects to reach its target of 30% generation capacity ahead of schedule, with 3.8 GW installed by 2028. Egypt aims to install 45 GW of renewable energy, with 28 GW coming from wind by 2030, although this might be reviewed downwards following latest targets announcements (more on the Country Focus section).

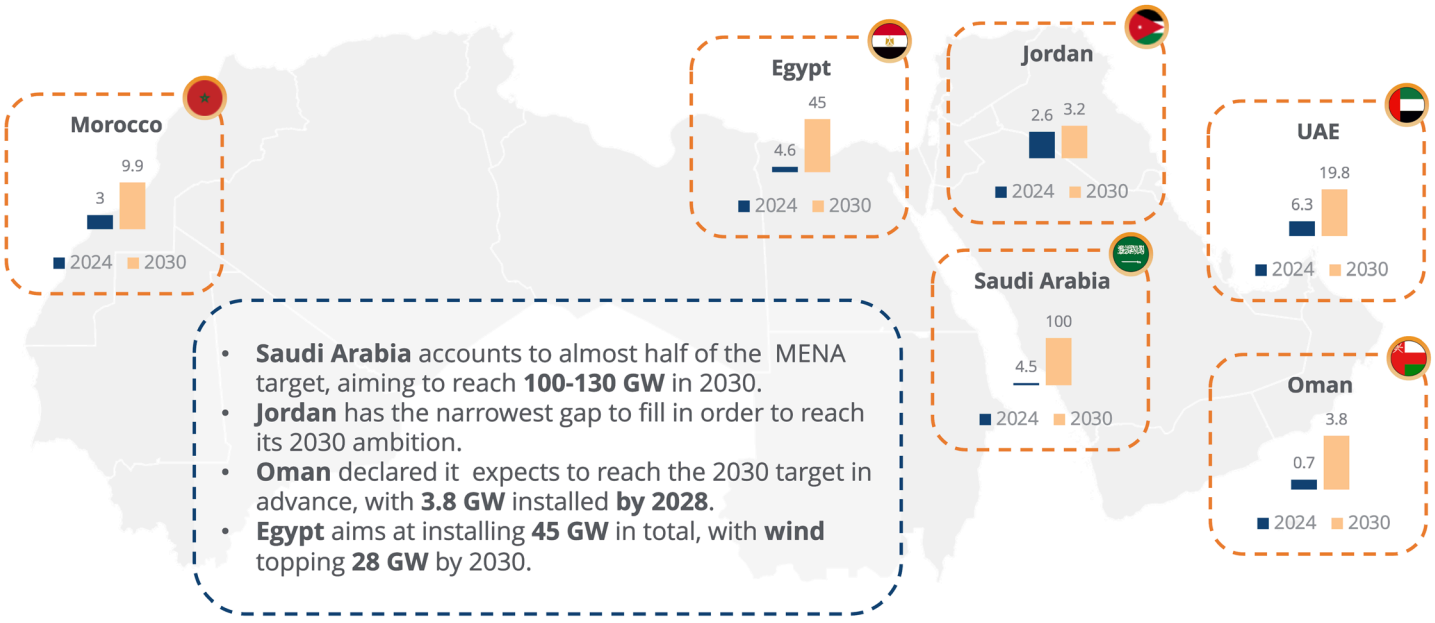


Figure 8: Targets for individual countries in the MENA region.

Data centers competing for demand

The MENA region is witnessing a rapid expansion of plans for data centers, following a fast rise in digitalization activities and technological advancements across the countries. The region has several factors that make it the right place to turn into a technology hub: a young demographic, a rapid growth in digital services that increase the need for data storage and cybersecurity, government initiatives (e.g., the Emirates Blockchain Strategy[6]) and improved regulations for international firms to invest.

The shift toward sustainability practices is expected to lead to new data centers being run using renewable energy. The Khazna Data Centers Facility in Masdar City is one example, using a 7 MW PV installation to power its activities.

At the end of 2023, the total live IT capacity in the MENA region was approximately 530 MW[7], mostly powered by non-renewable sources. The outlook to 2030 suggests a significant growth in data centers and consequently in renewable energy demand. Dii Desert Energy is currently working on a new study focusing on data centers, featuring case studies from the MENA region.

Scenarios to 2030

Three different trajectories are proposed for renewables deployment in the MENA region up to 2030 (*Figure 9*).

As a starting point, we assume that in addition to existing installations (about 30 GW), all projects currently in construction (18 GW) and under development (25 GW) will realize, for a total of 73 GW. Starting from here, the evolution of the renewable energy landscape could unfold in three different ways:

Conservative transition: this scenario anticipates that only the projects currently in the pipeline materialize, including those in pre-development and for which MoU have been signed (an additional 58 GW). The assumption is that future announcements will balance out cancelled projects, resulting in no substantial increase of current planned capacities. In this scenario, 131 GW of renewable capacity will be installed in the MENA region by 2030.

Balanced transition: in this scenario, new projects are expected to be announced, with the first ones becoming operational by 2026. The additional capacity will gradually reach 60% of current planned capacities by 2030 for total of 92 GW. However, this increase will still fall short of the 2030 ambitions, mainly due to the highly ambitious targets set by as KSA. By 2030, this scenario foresees the installation of 165 GW of renewable capacity in the MENA region.

Green revolution: this optimistic scenario envisages that the announced projects (today 58 GW) will be more than tripled to achieve the 236 GW needed to meet the ambitions. In this case, all ambitions will be met and even surpassed, ensuring a significant boost in renewable energy deployment and the realization of a true green revolution in the MENA region. This scenario projects the installation of 290 GW of renewable capacity in the MENA region by 2030.

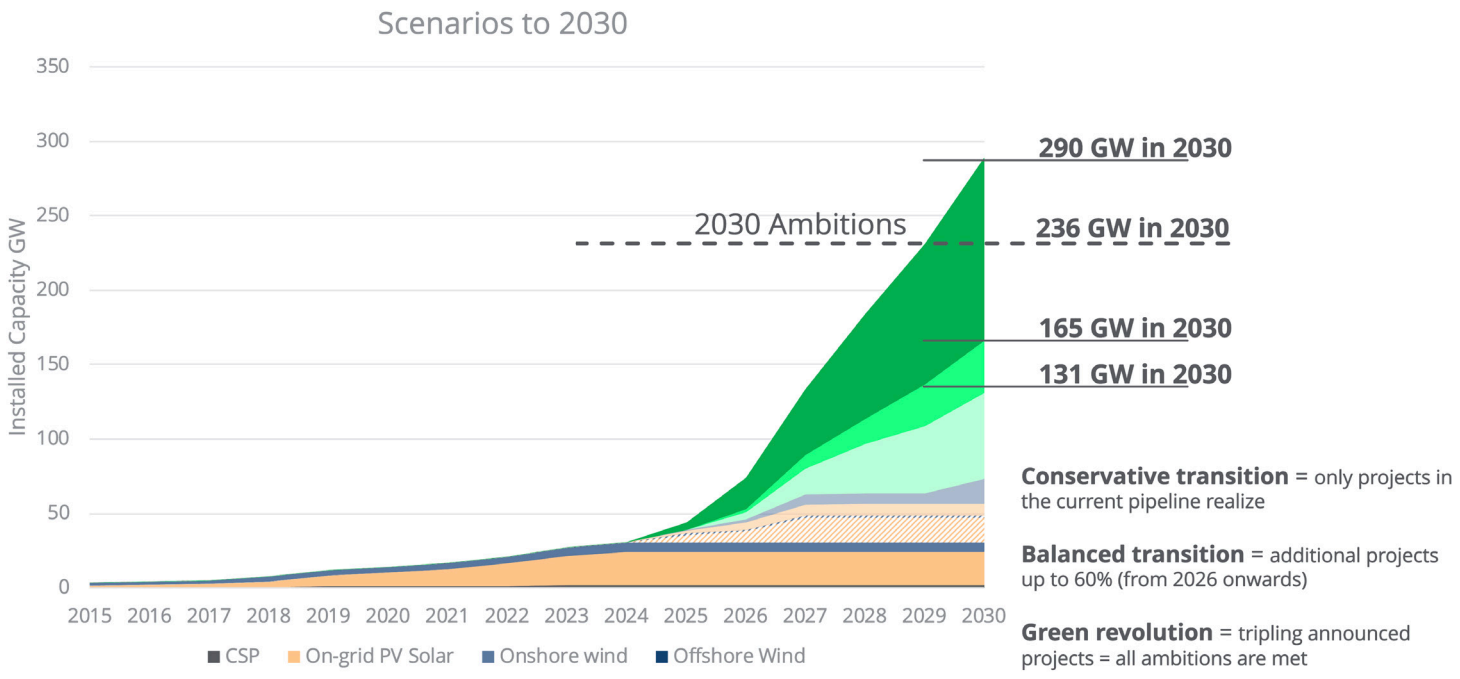


Figure 9: Proposed scenarios for renewable energy deployments in MENA region to 2030.

Hydrogen developments in the MENA region

The first hydrogen project announcements in 2018 marked a significant turning point for the energy sector of the MENA region. The momentum accelerated quickly with a flow of announcements in the region, and it is lately facing challenges that induced some delays and stalled projects progress. The slow-down of hydrogen deployment can be attributed to several factors, with the lack of demand – and consequently of committed off-takers – being certainly a crucial reason. Moreover, the absence of a CO2 price does not incentivise the transition to low-carbon alternatives. Regulatory uncertainties, macroeconomic considerations and the rise of interest rates since 2021 also contributed to the delays in execution.

Nevertheless, the MENA region continues to show a strong commitment towards the development of hydrogen projects with a pipeline accounting for 117 projects at the end of 2024 (*Figure 10*), increasing from the 75 projects registered at the end of 2023. Notably, over 90% of the projects are focused on green hydrogen, while the remaining 10% are categorized as 'blue' hydrogen, involving fossil-based production methods with Carbon Capture Utilization and Storage (CCUS), or "yellow" hydrogen where waste is used as feedstock. The limited amount of data publicly available prevents us from providing a refined estimate of production capacities and timeline. However, the order of magnitude of the expected hydrogen-equivalent production capacity is between 30-40 million tonnes per annum (Mtpa) on the long term.

Egypt is currently leading the way with 29 announced hydrogen projects, largely driven by a series of Memoranda of Understanding (MoUs) signed during COP27 in Sharm El Sheikh in 2022. At the same time, looking at concrete progress since then, Egypt might have the biggest gap between announced projects and concrete progress.

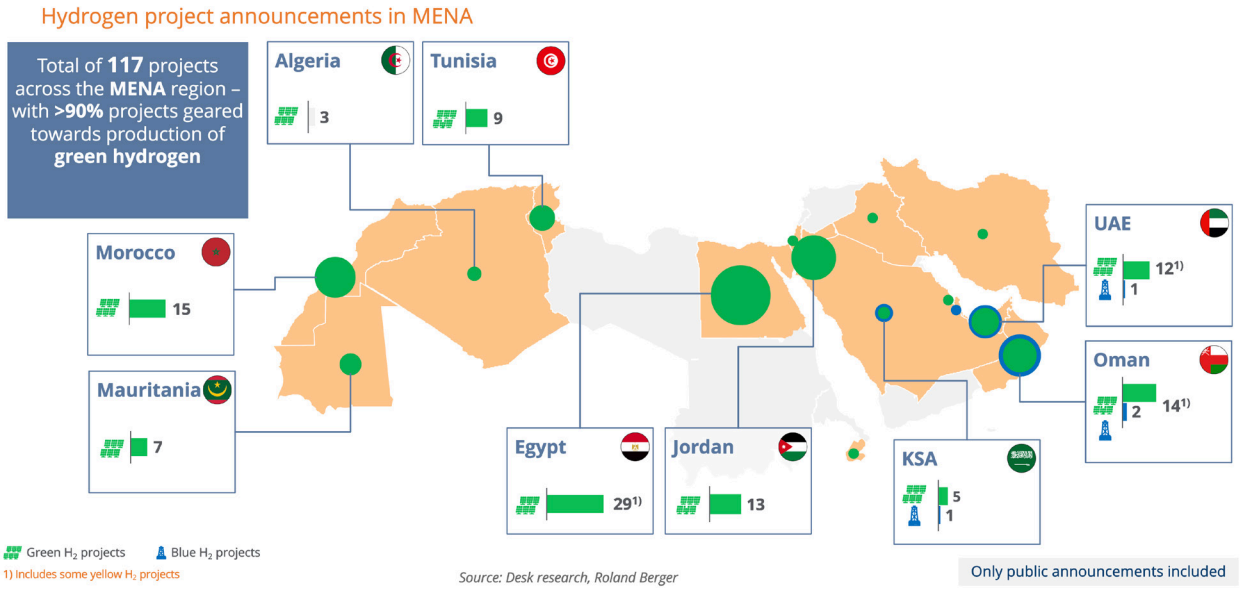


Figure 10: Overview of hydrogen projects announcements in the MENA region. Countries with only one project announced are represented by a single dot on the map. This includes Israel, Djibouti, Iran, Iraq, Qatar, and Bahrain.

Currently, in the MENA region only a few pilot projects are operational:

- DEWA Green Hydrogen Pilot 1 Plant in UAE that utilizes 1.25 PEM electrolyser[8]
- Egypt Green (Phase 1) project in Egypt developed by Fertiglobe and Scatec[9]
- Masdar-Emirates Steel pilot project in UAE that produces green steel using green hydrogen[10]

At the end of 2024, only six projects reached financial close and are either under construction or set to start soon.

- DEWA Green Hydrogen Pilot 2 Plant in UAE that will utilize a 2.5 Alkaline electrolyser
- NEOM Green Hydrogen project in KSA: it achieved financial close at the end of December 2022[11] and it is currently under construction with estimated commissioning by the end of 2026. A 4GW of dedicated renewable energy (solar and wind) will power the hydrogen-ammonia plant, set to produce 1.2 mtpa of green ammonia using 2.2 GW overall capacity of electrolyzers.
- ENOWA's Hydrogen Innovation and Development Center (HIDC) demonstration plant in KSA: it will produce green methanol (0.045 mtpa) and gasoline by end of 2025 for mobility and off-grid energy[12].
- ACME Green Project in Oman: it reached final investment decision (FID) in 2023[13] and secured a loan for the first phase of a Green Hydrogen and Ammonia Project. It is expected to produce 100 ktpa of ammonia, eventually expanding to 1.2 mtpa. However, there are varying perspectives on the project's market credibility and financial viability, which will require close monitoring going forward
- Ammonia-7 in Qatar: developed by QatarEnergy Renewable Solutions and QAFCO[14], it reached FID in 2022. The facility is set to produce 1.2 mtpa of blue ammonia and started the construction phase in November 2024[15].
- TA'ZIZ Blue Ammonia Plant in UAE: it is part of the TA'ZIZ industrial chemical complex development in Ruwais Industrial City. The blue ammonia plant is developed by a consortium comprising ADNOC, ADQ, Fertiglobe, Abu Dhabi Ports, GS Energy and Mitsui, it started construction in 2024[16]. It will have an ammonia production capacity of 1 mtpa.

Electrolyzer capacity planned

The hydrogen market in MENA is still at early stage of development and largest projects are expected to be operational after 2030. Project data on renewable energy use, electrolyzers and annual production can be inconsistent or incomplete. Based on public announcements and disclosed data, the Electrolyzer capacity planned in the region is between 200 and 230 GW, with timelines that extend beyond 2030. The wide range of announced electrolyzer capacities, ranging from a few hundred megawatts to an impressive 35 gigawatts in Mauritania, reflects both the ambition and the uncertainty in the region. The country has struggled so far to exploit its renewable potential, and hydrogen presents an opportunity to reverse that trend.

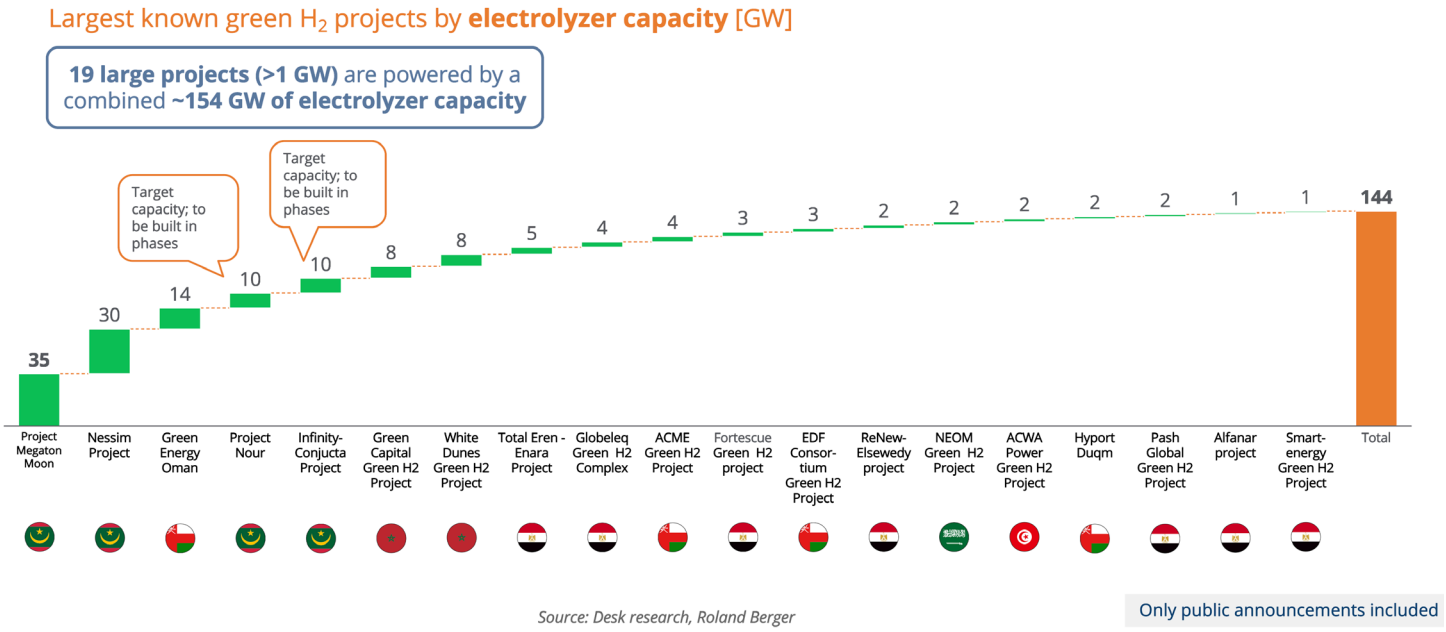


Figure 11: Electrolyzers capacities for hydrogen projects planned in the MENA region.

Green hydrogen ambitions to 2030

The early maturity of hydrogen in the region makes it difficult constructing scenarios to 2030, however initial insights can be drawn by the ambitions set by each country (*Figure 12*). Several countries in the MENA region have indeed declared official hydrogen targets by 2030 in their national strategies or roadmaps. This said, the MENA region aims to produce a total of 10 Mtpa in 2030, the majority of which will be green hydrogen. KSA has the highest target, including different hydrogen colours.

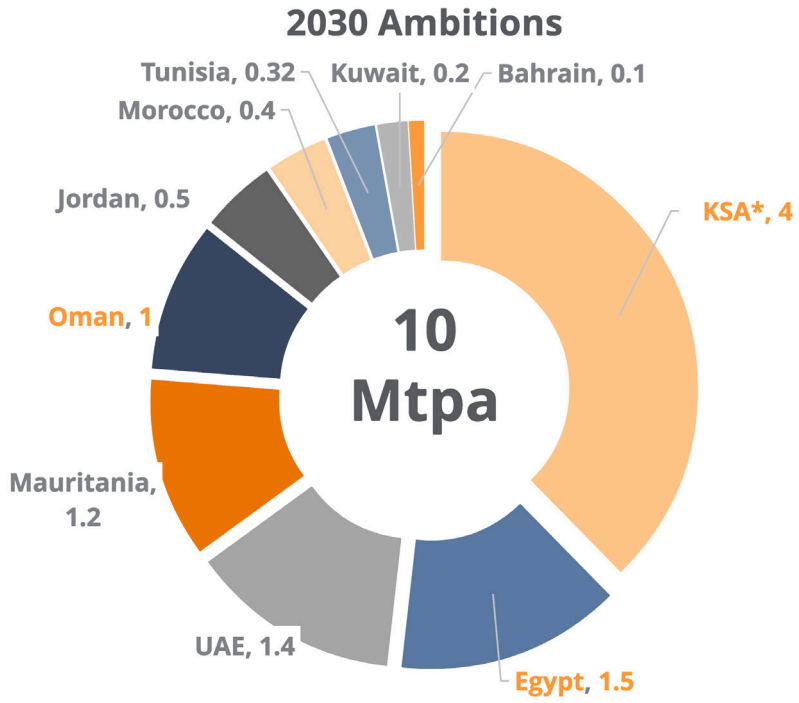


Figure 12: Declared ambitions for hydrogen production in the MENA region by 2030. Data labels for unofficial targets i.e. not part of an official strategy, are reported in orange.

**KSA declares ambitions for all colours of hydrogen, without specifying which portion is green.*

Renewable Energy requirements for green hydrogen

The MENA region aims at producing a total of approx. 10 million tonnes per annum (Mtpa) of hydrogen in 2030, the majority of which will be green hydrogen. Achieving this ambitious target will require approximately ~128 GW of additional renewable capacity (Figure 13), calculated using a PtX to H2 factor of 0.0045 MW/nm3 H2/hr and a capacity factor of 45% are used. The full set of assumptions and conversion factors is provided at the end of the study.

Currently, more than 110 hydrogen projects have been announced in MENA, with combined renewable energy requirements totalling over 450 GW. However, the timeline for the completion of these projects extends beyond 2030.

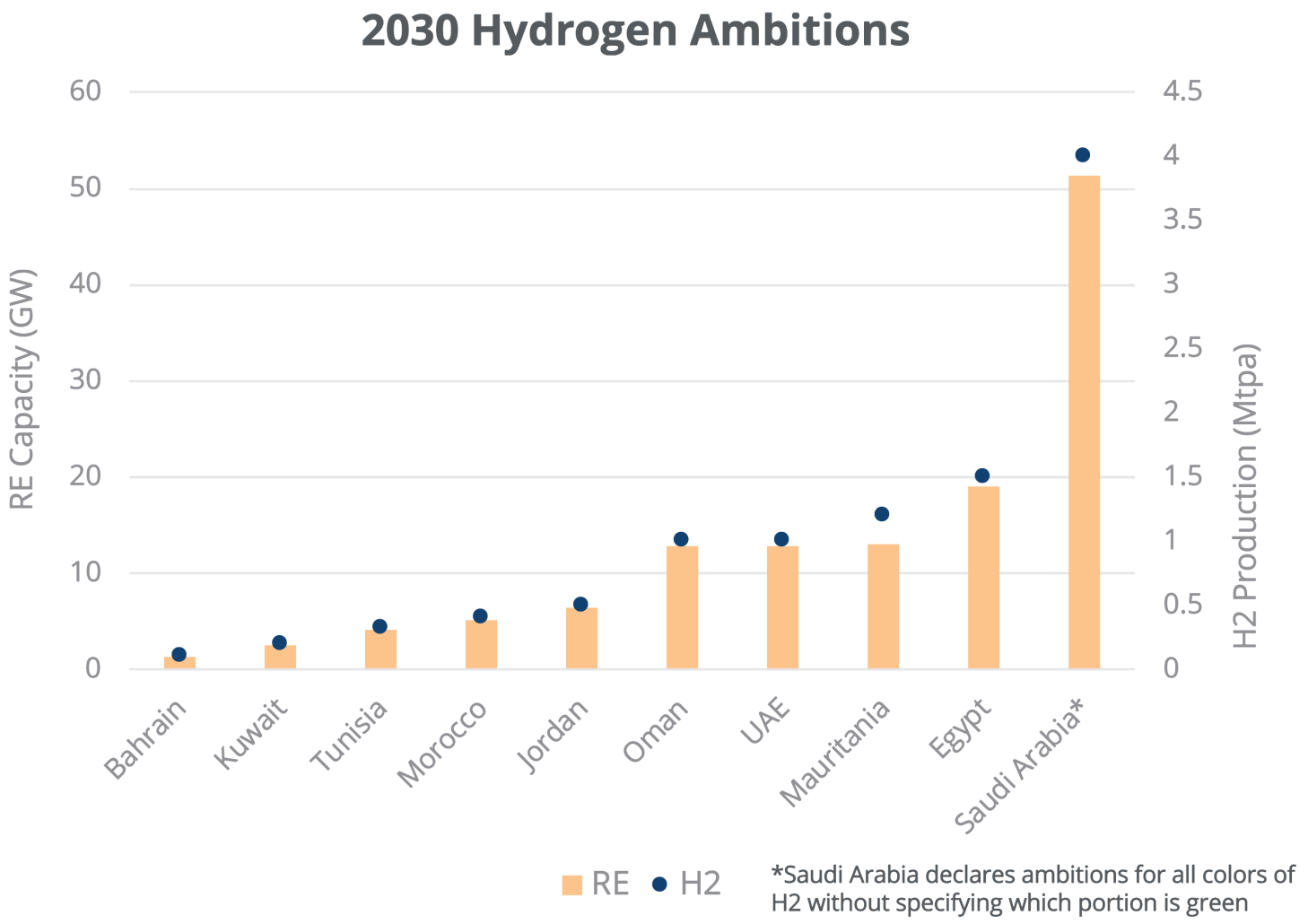


Figure 13: Renewable capacity requirements for meeting the declared hydrogen production targets in the MENA region. Assumptions: RE Capacity requirements are calculated using a PtX to H2 factor of 0.0045 MW/nm3 H2/hr and a capacity factor of 45%, aligned with the assumptions used in the IEA Global Hydrogen Review 2024[17].

Energy storage in the MENA region

The Energy storage projects database is the latest addition to the Dii database collection (*Table 4* and *Figure 14*), introduced following the rapid surge in projects announced in the MENA region in the past months. Energy storage is of growing importance to manage the variability of renewable energy, thus enhancing grid stability and ensuring the resilience of power systems.

	Total	Operational	Construction	Development
KSA	16		7	9
UAE	7	4	1	2
Egypt	3		3	
Jordan	3	3		
Morocco	3	1	1	1
Kuwait	1	1		
Total	**33**	**9**	**12**	**12**

Table 4: Overview of energy storage projects by status in the MENA region.

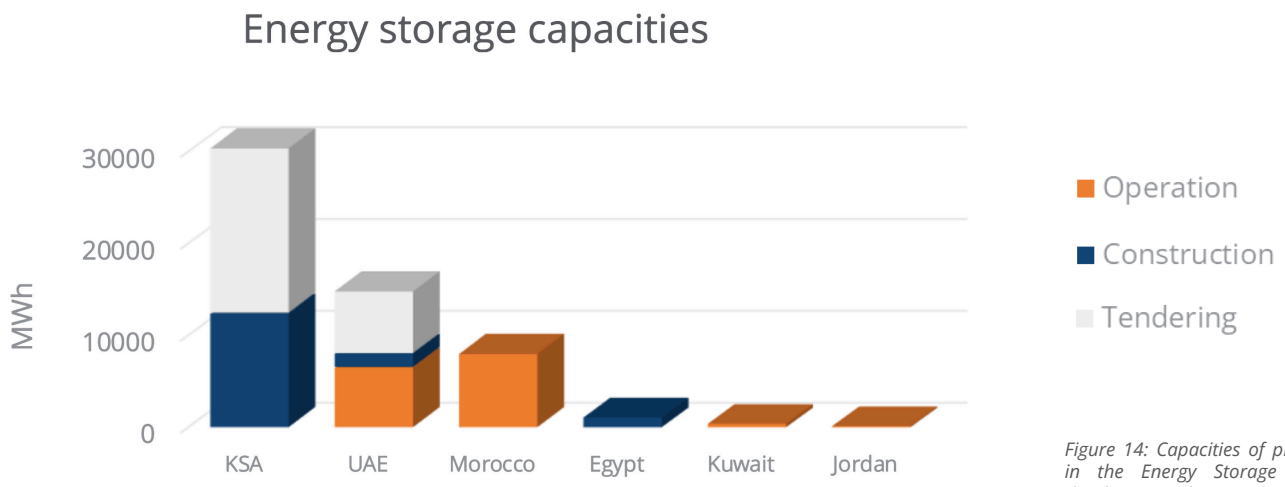


Figure 14: Capacities of projects tracked in the Energy Storage database by development phase.

The MENA region has currently 9 operational energy storage projects that have a total storage capacity of about 13,000 MWh. Most of these are battery energy storage systems (BESS), while two are thermal energy storage systems (TESS). The first project to become operational in 2015 was developed by EWEC in the UAE, with a capacity of 648 MWh. The Noor Energy 1 TESS, also this one in UAE and part of the 4th phase of the Mohammed Bin Rashid Al Maktoum Solar Park, with a capacity of 5,907 MWh is the largest thermal energy storage plant in the world[18].

Eleven projects are currently under construction, the majority BESS-based and only two pumped hydro storage (*Table 5*). Those new additions will increase the storage capacity by 16,750 MWh. KSA can count for the largest number of projects under construction, for example the NEOM project, a cornerstone of Saudi Vision 2030, that features a 600 MWh BESS to support its 4 GW of solar and wind energy. The Bisha BESS project (500 MW/2,000 MWh) in Saudi Arabia is finalizing construction and expected to be commissioned in January 2025.

Moreover, more than 25,000 MWh are currently undergoing a tendering process in KSA (the majority), UAE and Morocco. Notably, in the MENA region, all newly announced projects are BESS-based.

Country	Project	Capacity (MW/MWh)
Egypt	AMEA Benban PV + BESS	300/600
Morocco	Abdelmoumen Pumped Hydro	350 MW
KSA	Najran BESS	625/2,600
KSA	Madaya BESS	625/2,600
KSA	NEOM Green Hydrogen BESS	536/600
UAE	DEWA Hatta Pumped Hydro	250/1,000

Table 5: Summary table of selected Energy Storage projects in Construction in the MENA region.

Country focus

Egypt

The current total installed RE capacity in Egypt is about 4.6 GW at the end of 2024, and 1 GW is under construction *(Table 6)*.

The country has made significant progress in renewable energy deployment and has made announcements for increasing substantially the country's capacity in the next years with almost 12 GW under development and an additional 22 GW that have been announced. However, it is important to remark that renewable energy targets have experienced several changes in recent months that might affect the execution of renewable energy projects. Several GW scale MoUs/PPAs have been signed, nevertheless with recent changes in some key ministries, it remains to be seen whether and at which timelines these projects will be able to be realized.

Prior to hosting the COP27 climate summit in 2022, Egypt committed to generating 42% of its energy from renewable sources by 2035, later accelerating this target to 2030. In June 2024, then-Electricity Minister Mohamed Shaker set an ambitious goal of achieving 58% renewable energy by 2040.

However, in October 2024 the new minister revised down the renewable energy target for 2040 to 40%, indicating a strategic shift[19]. In fact, the decision was driven by Egypt's historical dependance on gas production and aims to attract a larger number of investments in gas exploration.

Technology	Operational (MW)	Construction (MW)	Under Development (MW)	Announced (MW)
Solar PV	2,470	13	170	2,130
CSP	20			250
Onshore Wind	2,140	1,005	11,800	20,000
Total	**4,630**	**1,018**	**11,970**	**22,380**

Table 6: Overview of renewables capacity by status in Egypt.

On the hydrogen space, Egypt is willing to position itself as a leader in green hydrogen production (*Table 7*). Most projects are strategically concentrated in Ain Sokhna, aiming at cost savings and efficiency gains through shared services like desalination facilities and transmission lines.

Green H2 projects announced	Projected Renewable Capacity (GW)	Projected Electrolyzer capacity (GW)	Projected H2 production (mtpa)	H2 Production target by 2030 (mtpa)
29	80-100	35-45	6-7.5	1.5-3.2

Table 7: Overview of Green H2 projects in Egypt, capacities are estimated based on public announcements and the execution timeline will likely extend beyond 2030.

Jordan

The country's total installed capacity amounts to 2.6 GW from PV and wind projects at the end of 2024, and 50 MW are under construction (*Table 8*).

Currently, 27% of the electricity in Jordan is sourced from renewable energy and it is aiming at reaching 50% by 2030 (up from 31% initially declared).

In 2019, the government issued a ban on new approvals for large-scale electric power projects exceeding 1 megawatt - thus halting new utility-scale renewable energy developments – due to grid limitations[20]. The ban has been finally lifted in September 2024[21], with the launch of the new system regulating the connection of renewable energy facilities to the national grid. As a result, it is expected that additional renewable energy installations will be announced, besides the 600 MW announced in Solar PV and 2 GW in wind energy.

Technology	Operational (MW)	Construction (MW)	Under Development (MW)	Announced (MW)
Solar PV	1,987	50		600
CSP				
Onshore Wind	614			2,000
Total	**2,601**	**50**		**2,600**

Table 8: Overview of renewables capacity by status in Jordan.

Jordan is seeking to become a regional and global centre for production and export of hydrogen (*Table 9*), leveraging its abundant renewable sources and its central position in the Middle East and Africa region. Green hydrogen is regarded as a key priority of the country's economic strategy outlined in the Economic Modernization Vision (2023-2033)[22].

As a result, the government has signed several agreements and it is investigating the possibility to implement a joint infrastructure for green hydrogen projects.

The proposal of a Green Hydrogen Industrial Complex (Green Hydrogen Hub) is currently under study by ILF, the World Bank and the European Bank for Reconstruction and Development (EBRD)[23].

Green H2 projects announced	Projected Renewable Capacity (GW)	Projected Electrolyzer capacity (GW)	Projected H2 production (mtpa)	H2 Production target by 2030 (mtpa)
13	7.5-11	3.5-5	0.65-0.85	0.5

Table 9: Overview of Green H2 projects in Jordan, capacities are estimated based on public announcements and the execution timeline will likely extend beyond 2030.

Morocco

The country's total installed capacity is 3 GW as of October 2024, and 60 MW are under construction (*Table 10*).

The renewable energy target for Morocco is set to 52% installed capacity by 2030. Future plans include about 1.8 GW under development projects, with an additional 950 MW announced for PV and 900 MW for wind energy.

Morocco is one of the leaders in North Africa, together with Egypt, in renewable energy, with a focus on wind energy. Historically, the country focused on developing concentrated solar power (CSP) systems, later shifting towards photovoltaic (PV).

Technology	Operational (MW)	Construction (MW)	Under Development (MW)	Announced (MW)
Solar PV	331		1,041	952
CSP	540			
Onshore Wind	2,178	60	818	900
Total	**3,049**	**60**	**1,859**	**1,852**

Table 10: Overview of renewables capacity by status in Morocco.

The Moroccan government published in March 2024 the "Morocco Offer"[24], a strategic initiative aiming to position the country as a competitive player in the emerging field of green hydrogen. This incentive-driven offer covers the entire value chain of the green hydrogen industry, whether for the domestic market, export, or both.

By providing a clear and transparent pathway for investors and developers, the Morocco Offer seeks to attract significant investments, drive economic development and create jobs. Masen has a strong mandate to manage this process as a one stop shop.

Green H2 projects announced	Projected Renewable Capacity (GW)	Projected Electrolyzer capacity (GW)	Projected H2 production (mtpa)	H2 Production target by 2030 (mtpa)
15	55-70	25-32	4-5.5	0.4

Table 11: Overview of Green H2 projects in Morocco, capacities are estimated based on public announcements and the execution timeline will likely extend beyond 2030.

Oman

The country's total installed capacity is more than 700 MW at the end of 2024, and 1 GW in under construction (*Table 12*).

The Vision 2040 Oman[25] was launched in Jan 2021 and sets the blueprint for sustainable growth in the country.

Under this plan, Oman aims to achieve an 11% share of renewables in its electrical mix by 2025, and then increase it to 30% by 2030. Future developments in Oman's renewable energy sector include about 1.5 GW under development in PV and wind projects. Additional projects have been announced, including 2.1 GW for PV, 400 MW for Wind, and 600 MW for CSP.

Technology	Operational (MW)	Construction (MW)	Under Development (MW)	Announced (MW)
Solar PV	682	1,000	531	2,081
CSP	7			600
Onshore Wind	50		920	400
Total	**739**	**1,000**	**1,451**	**3,001**

Table 12: Overview of renewables capacity by status in Oman.

Green hydrogen developments (*Table 13*) in Oman are being orchestrated by Hydrom, with an initial aim of meeting a production target of 1-1.25 Mtpa of green hydrogen by 2030[26].

Through two rounds of auctions, Hydrom has awarded eight projects: five in the Duqm area and three in Salalah. If all awarded projects realize on time, the production target for 2030 will likely be exceeded and reach 1.38 Mtpa. Oman has so far demonstrated a rapid progress in the green hydrogen sector, moving from land identification to international auctions and signing respective agreements in just two years. A sister company to Hydrom to manage the shared infrastructure has been established in mid 2024.

Green H2 projects announced	Projected Renewable Capacity (GW)	Projected Electrolyzer capacity (GW)	Projected H2 production (mtpa)	H2 Production target by 2030 (mtpa)
13	38-55	17-25	3-4	1-1.25

Table 13: Overview of Green H2 projects in Oman, capacities are estimated based on public announcements and the execution timeline will likely extend beyond 2030.

The Kingdom of Saudi Arabia

The country's total installed capacity is 4.5 GW at the end of 2024, and more than 9 GW under construction (*Table 14*).

KSA has escalated its renewable energy targets over recent years. The initial plan launched in 2012 aimed at producing 54 GW of electricity from renewables by 2030. This number was increased to 58.7 GW in 2019. In 2023, it was announced that KSA aims at adding 20 GW annually to reach a total output of 100-130 GW by 2030.

These ambitious increases are part of a broader strategy to produce 45-50% of the country's power from renewable sources by 2030[27], as outlined in the Saudi Green Initiative as part of the Saudi Vision 2030.

Future developments in KSA's renewable energy sector see more than 2.1 GW under development in PV and 3 GW in wind energy. An additional more than 14 GW has been announced, mainly in Solar PV projects.

Technology	Operational (MW)	Construction (MW)	Under Development (MW)	Announced (MW)
Solar PV	3,971	9,091	2,170	11,302
CSP	118			1,500
Onshore Wind	403		3,000	1,500
Total	**4,492**	**9,091**	**5,170**	**14,302**

Table 14: Overview of renewables capacity by status in KSA.

KSA is home of NEOM, a giga-project by the Public Investment Fund (PIF) that is leading the way in hydrogen innovation. Currently under construction, NEOM Green Hydrogen aims at producing 1.2 Mtpa of green hydrogen, powered by two dedicated 4GW solar and wind projects.

Besides NEOM, the country is fully committed to becoming a leader in clean hydrogen and several other projects have been announced.

Green H2 projects announced	Projected Renewable Capacity (GW)	Projected Electrolyzer capacity (GW)	Projected H2 production (mtpa)	H2 Production target by 2030 (mtpa)
4	13-26	6-12	1-2	4*

Table 15: Overview of Green H2 projects in KSA, capacities are estimated based on public announcements and the execution timeline will likely extend beyond 2030.
** the target includes also blue H2*

United Arab Emirates

The country's total installed capacity is more than 6.2 GW at the end of 2024, and more than 3.5 GW are under construction (*Table 16*).

The UAE was the first country in the region to sign the Paris Agreement and adopt a net zero target. Its target for renewables deployment is 30% installed capacity by 2030. Future developments in the UAE's renewable energy sector are expected to increase the PV installed capacity by an additional 1.5 GW. The UAE hosts the largest single-site solar park in the world, the Mohammed bin Rashid Al Maktoum Solar Park[28], projected to have a remarkable production capacity of 5,000 megawatts (MW) by 2025.

Recent technological advancements have made it possible for UAE to start developing wind projects, despite low wind speeds. The UAE Wind program launched in 2023 has successfully installed 103 MW across four sites in the country and set to be expanded further in the next years. On the private side, the D33 Solar PV Initiative by DEWA[29], in force since January 2024, overcomes the 1 MW cap introduced for Shams Dubai. The D33 initiative allows industrial sectors to install captive solar systems up to their total connected load, fostering energy independence and cost reduction while contributing to a cleaner energy mix.

Technology	Operational (MW)	Construction (MW)	Under Development (MW)	Announced (MW)
Solar PV	5,360	3,360	110	1,509
CSP	800	200		
Onshore Wind	103			140
Total	**6,263**	**3,560**	**110**	**1,649**

Table 16: Overview of renewables capacity by status in UAE.

The UAE wants to position itself as a major producer of low-emissions hydrogen by 2031 (Table 17), by developing supply chains, establishing hydrogen oases and creating research centres for hydrogen technologies. The National Hydrogen Strategy 2050 sets a target of 1.4 Mtpa by 2031, of which 1 Mtpa from green hydrogen and 0.4 Mtpa from blue hydrogen[30].

The UAE has made several agreements in the green hydrogen sector and several projects are currently under development. Two pilot projects are currently operational in the UAE.

The Green Hydrogen project launched in 2021 by DEWA in collaboration with Expo 2020 Dubai and Siemens Energy[8], was the first of a kind to use solar power for hydrogen production. In October 2024, Masdar and EMSTEEL announced the start of operations of a pilot project demonstrating the use of green hydrogen to extract iron from iron ore, which is then used in the production of green steel[10].

Green H2 projects announced	Projected Renewable Capacity (GW)	Projected Electrolyzer capacity (GW)	Projected H2 production (mtpa)	H2 Production target by 2030 (mtpa)
10	5-10	2.3-4.6	0.4-0.8	1*

Table 17: Overview of Green H2 projects in UAE, capacities are estimated based on public announcements and the execution timeline will likely extend beyond 2030.
** UAE has a 1.4 mtpa target by 2031, of which 1 mtpa from green H2 and 0.4 from blue H2.*

Emerging markets

Algeria

The country's total installed capacity is 423 MW at the end of 2024, and 2.4 GW are under construction (*Table 18*).

The National Renewable Energy program aims at installing 22 GW of renewable energy by 2030, of which 13.5 GW from solar photovoltaic (PV), 5 GW from wind energy, 2 GW from concentrated solar power (CSP) and 1 GW from biomass[31]. Future developments in Algeria's renewable energy sector see 280 MW under development in PV, although it has to be highlighted that many projects moved to construction phase in the last couple of years.

An additional more 500 MW has been announced, again in Solar PV projects. After a period of stagnation, the "Solar 1000 MW" was launched in 2021 and a 2 GW tender was announced in 2022, providing new momentum to solar installations in the country. On the wind energy side, an additional 1 GW has recently been considered for development.

Technology	Operational (MW)	Construction (MW)	Under Development (MW)	Announced (MW)
Solar PV	388	2,452	280	500
CSP	25			
Onshore Wind	10			1,000
Total	**423**	**2,452**	**280**	**1,500**

Table 18: Overview of renewables capacity by status in Algeria.

Algeria has launched a National Hydrogen Strategy in 2023, setting a target of 40 TWh (1.2 Mtpa) by 2040, of which 30 TWh are expected to be exported[32].

Concrete projects are anticipated to be announced in the next months, leveraging international partnerships to support the development of infrastructure and technologies.

Green H2 projects announced	Projected Renewable Capacity (GW)	Projected Electrolyzer capacity (GW)	Projected H2 production (mtpa)	H2 Production target by 2030 (mtpa)
3	65-200	30-85	0.005-0.015	n.a*

Table 19: Overview of Green H2 projects in Algeria, capacities are estimated based on public announcements and the execution timeline will likely extend beyond 2030.
** Algeria has an H2 target starting from 2040*

Iraq

Iraq's strategic role in regional energy stability was underscored by the agreement signed in October 2024 to connect the electricity grids of Iraq and the Gulf Cooperation Council (GCC)[35]. It is the first time that the Gulf Cooperation Council Interconnection Authority (GCCIA) extends its connection beyond the GCC six members states. There are also future connections plans between KSA and Jordan, and KSA and Egypt.

Scheduled to be operational next year, the new connection aims to help Iraq, particularly the southern part, reduce its dependency on more expensive imports from Iran, bolstering energy security and stability across the region.

Tunisia

The country's total installed capacity is 700 MW at the end of 2024, and 220 MW are under construction (*Table 20*).

Despite a target of 30% power production from renewable energy, Tunisia has historically struggled to execute projects, with large projects that remained unrealized in the last decade after promising announcements.

In 2024 a new impulse was observed with the announcement of the award of two Solar PV plants in the governorates of Gafsa and Tataouine, as well as the first round of the renewable energy program for the concession regime (1.7 GW in total). However, challenges remain, and the government will need to reduce administrative constraints to attract developers and move these projects forward.

Technology	Operational (MW)	Construction (MW)	Under Development (MW)	Announced (MW)
Solar PV	424*	220	750	850
CSP				
Onshore Wind	245		435	720
Total	**669**	**220**	**1,185**	**1,570**

Table 20: Overview of renewables capacity by status in Tunisia.
** Most of the PV capacity is derived from the Autoproduction program.*

Tunisia is also moving its first steps in the hydrogen space with the National Strategy launched in 2023[33]. According to the strategy, the country aims at producing 0.32 Mtpa by 2030.

Following the publication of the strategy, a number of projects have been announced, some of them fully dedicated to export such as H2 Notos (TotalEnergies, EREN Group, Verbund) that envisages transporting hydrogen through Europe via the SouthH2 Corridor[34].

Green H2 projects announced	Projected Renewable Capacity (GW)	Projected Electrolyzer capacity (GW)	Projected H2 production (mtpa)	H2 Production target by 2030 (mtpa)
13	7.5-11	3.5-5	0.65-0.85	0.5

Table 21: Overview of Green H2 projects in Tunisia, capacities are estimated based on public announcements and the execution timeline will likely extend beyond 2030.

Beyond MENA

Central Asia

Renewable energy deployment in Central Asia - particularly in Azerbaijan, Kazakhstan and Uzbekistan - is gaining momentum, thanks to strategic partnerships and international investments. Developers from the MENA region, such as ACWA Power and Masdar, are playing a pivotal role by bringing their expertise and financial resources to develop new projects.

Azerbaijan is making significant progress in renewable energy with an installed capacity of 4.5 MW (mostly from hydropower) and ambitious plans for expansion[36]. The country aims to achieve a 30% share of renewable energy in its total electricity production by 2030, leveraging solar, wind and hydropower sources. Masdar is emerging as a major player, with one project already operational, the Garadagh Solar PV (230 MW) inaugurated in 2023 and agreements to develop additional three projects with a combined capacity of 1 gigawatt (GW)[37]. These projects include the 445MW Bilasuvar Solar PV, the 315MW Neftchala Solar PV, and the 240MW Absheron-Garadagh onshore wind Project.

Uzbekistan has a current installed capacity of over 2.7 GW, mostly from hydropower, with solar and wind projects accounting only for 250 MW. The country aims develop 5 GW of solar and 3 GW of wind capacity by 2030, contributing to reach a target of 40% in terms of electricity production[38]. Uzbekistan is ACWA Power's second-largest market for ongoing investments, with a portfolio of more than 10 GW from renewable sources[39], including the Aral Wind IPP (5 GW) that will become Central Asia's largest wind farm. Additionally, ACWA Power is developing the first green hydrogen project in the country, which will produce 3,000 mtpa. AMEA Power is also investing in Uzbekistan, reaching an agreement to develop a 1 GW wind project[40].

Kazakhstan has an installed renewable energy capacity of 2.9 GW, with 1.41 GW from wind sources and 1.2 GW from solar power[41]. The target for 2035 is to reach a renewable energy contribution of 15% to energy mix, focusing on solar and wind projects. Several international companies - including ACWA Power, Masdar and TotalEnergies - are actively contributing to Kazakhstan's renewable energy landscape. These companies are developing wind projects (1 GW each) as well as battery energy storage systems[42,43,44].

Turkey

Turkey has almost 60 GW of installed renewable energy capacity[45], with a bit more than half (32 GW) coming from hydropower. Solar and wind account for 11.3 GW and 11.7 respectively. Notably, Turkey ranks 4th globally for installed geothermal energy with 1.7 GW as of end of 2023[46].

The country has announced an ambitious objective of adding an additional 60 GW of wind and solar capacity by 2035, in alignment with its pledge to become carbon neutral by 2053. Offshore wind will likely have a role with 5 GW set as part of the 2035 target, while the roadmap designed by the government and the World Bank[47] outlines a potential of 7 GW by 2040.

Authors & Acknowledgements

Authors

Chiara Aruffo
Director of Research, Dii Desert Energy
chiara@dii-desertenergy.org

Cornelius Matthes
CEO, Dii Desert Energy
cornelius@dii-desertenergy.org

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Assumptions

In the Country Focus, we present projected renewables capacities, electrolyzer capacities and hydrogen production capacities at country level. The information presented is drawn from public data available, complemented by the following assumptions to provide readers with an approximate understanding of what hydrogen developments might look like by 2030. In general, we have followed the same assumptions used by IEA in their Global Hydrogen Review analysis[17].

Conversion factors

	Factor	Unit	Note
Specific H2 requirement for NH3	0.180072	t/t	Conversion losses 2%
Specific H2 requirement for synthetic MeOH	0.191327	t/t	Conversion losses 2%
H2 density in standard conditions	0.089	Kg/m^3	
Electrolyzer capacity factor	45%		
*PtX to H2	0.0045	MW/nm^3/H2/hr	Equivalent to 50 kWh/kg H2
*H2 to PtX	222.22	nm^3 H2/MWh	

**H2 production capacity & Electrolyzer capacity: Where not disclosed, this is estimated using electrolyser power ratings.*
The assumed conversion factor is 0.0045 MW/nm^3 H_2/hour (equivalent to 50 kWh/kg H_2).
Similarly, the inverse function has been used to derive Electrolyzer capacity where only hydrogen production capacity was quoted.

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