Energy
& Utilities

Middle East and Africa
Outlook Report 2023

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CHAPTER 1

The Middle East and North Africa Outlook

MENA gets a global stage

The 48th edition of Middle East Energy occurs at a remarkable moment, at the midpoint between two global climate change summits that straddle the Middle East and North Africa. The COP27 meeting in Sharm El Sheikh, Egypt in November 2022 and the COP28 summit to be held in Dubai in November this year, are focusing the world's attention on the region's real progress toward energy transitions.

The COP 27-28 conferences offer a prominent stage on which developers have not hesitated to unveil MENA's most innovative power sector projects.

Power generation across the Middle East and North Africa (Mena) has doubled in the past 15 years and it is rapidly changing in character. While oil and natural gas remain the dominant fuels for power plants across the region, the amount of electricity being generated from oil peaked ten years ago and, while the use of natural gas is still growing, it is doing so at a far slower pace than either solar or wind energy.

Governments are taking significant steps to reduce their reliance on fossil fuels and promote renewable energy. It will be some time before carbon-free power overtakes fossil fuel generation, but the momentum is clearly now with renewables and low-carbon sources.

Investment is pouring into the technologies and emerging alternative fuels that will be required for countries to meet their net zero carbon emission targets, including battery storage, carbon capture and storage (CCS) and hydrogen and hydrogen-based fuels such as ammonia.

This is particularly apparent in Egypt, which has seen a wave of green hydrogen projects emerge over the past year – part of Cairo's ambitions to transform the country into an energy exporter and regional power provider. An array of projects, appearing in announcement after announcement leading up to and during COP27, showed new systems of power production rising along the Gulf of Suez, the Mediterranean, near Aswan, and elsewhere.

Saudi Arabia is also developing its green hydrogen ambitions, with the futuristic city of NEOM the location for what is planned to be one of the world's largest hydrogen plants.

On the other side of the country, in the industrial east, Saudi Aramco has announced a number of large CCS projects as it develops its hydrogen and ammonia offerings.

These developments are seeing parallels in other countries, from Morocco in the west to Oman in the east, with important announcements in Algeria, Qatar, the UAE, and elsewhere.

In some of the more vulnerable countries that have struggled to meet local demand for power and water, innovative solutions are also being deployed. Power delivery projects are being put in place to help stabilise and enhance the capacities of utility networks in Lebanon and Iraq. A major new water desalination project, and a potential three-country energy-for-water project, promise to help Jordan meet the needs of its people.

Taken together, all this activity suggests the region is still in the early stages of what promises to be a period of dramatic change in its utilities and energy sectors.

The growing share of renewables in the regional energy mix

As of 2021, around 9% of the region's electricity generating capacity came from renewable sources, according to data from the Abu Dhabi-based International Renewable Energy Agency (IRENA).

The areas furthest ahead include the West Bank and Gaza, where 42% of electricity is based on renewables, followed by Morocco and Jordan, which are both near 30% (see table, p.19).

Gulf countries such as Bahrain, Qatar, Kuwait and Saudi Arabia, had less than 1% of capacity from renewables as of 2021. The UAE is near 10%, its leadership being due to the development of nuclear power and major solar power plants in Dubai and Abu Dhabi. In the case of Iran, its significant share of renewables is in large part because of its extensive network of hydropower plants.

Egypt rising

Hydrogen projects

In mid-November, during the COP27 climate change summit, Egyptian state bodies signed eight framework agreements for green hydrogen and ammonia projects, as part of a strategy to become a regional hub for hydrogen production. Cairo is hoping to secure 5% of the global market for the emerging fuel by 2040.

Producing green hydrogen is both energy-intensive and costly, with vast amounts of renewable energy required to power the electrolysers which take water and separate out its oxygen and hydrogen components. Given those challenges, it is not clear if all the proposed projects will go ahead or if some plans will have to be amended.

The agreements signed at COP27 included ones with developers AMEA Power, Alfanar, TotalEnergies, Globeleq, EDF, Fortescue Future Industries, ReNew and Scatec. These projects are all based around the Red Sea port of Ain Sokhna and the Suez Canal Economic Zone.

Since COP27 ended, further green hydrogen agreements have been announced. In December, for example, UK energy major BP signed a memorandum of understanding for another project with the country's key stakeholders in the hydrogen sector, including the New and Renewable Energy Authority, the Egyptian Electricity Transmission Company, the General Authority for Suez Canal Economic Zone (SCZone) and the Sovereign Fund of Egypt for Investment and Development.

In total, the hydrogen projects database maintained by the Paris-based International Energy Agency (IEA) lists 16 hydrogen projects in Egypt, 11 of which are still at the concept stage and five of which are at the feasibility study stage. That database, however, was last updated in October 2022 and the number now is thought to be closer to 20.

Among the hydrogen projects is one planned by Abu Dhabi-based renewable energy company Masdar and Cairo-based Hassan Allam Utilities, involving 4GW of renewable energy for plants in the SCZone and on the Mediterranean coast. The first phase is due to be operational by 2026, producing 100,000 t/y of e-methanol for bunkering in the Suez Canal.

Egypt's clean energy push into renewable wind power also continues. At COP27, Masdar announced plans for a 10GW onshore wind farm to be developed with Dutch firm Infinity Power and Hassan Allam Utilities. It will be among the world's largest wind farms once complete.

In addition, AMEA Power said in late November that it had reached financial close on 1GW of wind and solar energy projects in Egypt, worth $1.1bn in investment.

Nuclear power

Egypt is also developing nuclear power plants, with four 1.2GW Russian-designed reactors being built at El Dabaa on the Mediterranean coast, half-way between Alexandria and the Libyan border.

The project suffered some delays during the Covid-19 pandemic, but in June 2022 the Egyptian Nuclear Regulatory and Radiological Authority (ENRRA) approved the permit for the first unit. Construction work on the plant began the following month, although it is unclear when work might move ahead on the remaining three units.

Saudi Arabia evolving

Saudi Arabia remains the regional giant when it comes to oil resources, with production of well over 10 million b/d. It remains committed to making the most of its hydrocarbon resources, but it is also looking to prepare for the transition away from carbon-heavy fuels by developing its renewables sector.

As part of that there are the green and blue hydrogen projects underway. These are being developed in the futuristic city of NEOM, which is gradually taking shape in the remote northwest corner of Saudi Arabia, and in the heartlands of the oil industry in the east of the country.

NEOM: green hydrogen

The green hydrogen project at NEOM is being developed in a joint venture between NEOM, US-based Air Products and Riyadh-based Acwa Power. It will include around 3.9GW of power generated from onshore solar and wind power resources, backed up by storage facilities. Acwa has described the project as the world's largest utility-scale, commercially-based hydrogen facility powered entirely by renewable energy.

The plant is due to be commissioned in 2026 and will produce 600 t/day of clean hydrogen. It is estimated that the project will have production capacity of 1.2 million t/year of green ammonia.

Aramco: CCUS/blue hydrogen

On the other side of the country, energy giant Saudi Aramco is also developing carbon-free energy capacity. Among its key projects is a blue hydrogen scheme – the term for hydrogen produced from natural gas and supported by carbon capture, utilisation and storage (CCS). Currently, around half of the world's industrial hydrogen comes from natural gas (methane) which, when it burns, creates hydrogen and CO_2. However, for every tonne of hydrogen produced, there are about 10 tonnes of CO_2 emitted. That CO_2 can be captured and put to other uses – including injecting it into oil wells for enhanced oil recovery, or converting the CO_2 into methanol for industrial use. Alternatively, it can be captured and sequestered underground.

A further necessary element is converting the hydrogen into liquefied ammonia, which is easier to transport and which can be converted back into hydrogen later or used directly as a fuel in gas turbines.

In 2020, Amarco shipped 40t of blue ammonia to Japan, where it was used alongside coal and natural gas as feedstock for three power plants. By 2030, Aramco is aiming to produce 11 million t/y of blue ammonia.

Regional hydrogen projects

Several other countries around the MENA region have been developing hydrogen projects, or intend to do so. Among the most ambitious is Oman, but there are also notable efforts in the UAE, Morocco and Mauritania at various stages.

Oman

Oman has one of the largest low-emission hydrogen project pipelines in the Middle East, with a target of exporting 1 million t/y of green hydrogen by 2030, rising to as much as 8 million t/y by 2050. Abdullah Al Abri, Oman's representative at the IEA, said in a presentation to the Green Hydrogen Summit in Muscat in December that Oman could be responsible for 61% of the total hydrogen exports from the Middle East by 2030.

In October 2022, the government set up Hydrogen Oman (Hydrom), a subsidiary company of Energy Development Oman (EDO), with a remit to develop the green hydrogen sector. The following month, Hydrom launched a first licensing round for onshore green hydrogen concessions near Duqm port.

The bids had been due to be submitted by mid-February 2023, but in late January Hydrom announced the deadline had been pushed back by a month to 15 March.

Those who succeed will be expected to invest an estimated $4-5 billion in solar and wind facilities to power the electrolysers needed to produce the hydrogen. A further bid round is due to be launched in April for similar developments close to Salalah.

Other projects are more advanced. In May 2022, the state-owned OQ signed a joint development agreement with Acwa Power and Air Products to develop a green hydrogen-based ammonia production facility in the Salalah Free Zone.

UAE

In November, the Energy Industries Council (EIC) reported that the UAE had six hydrogen projects under development that could involve a combined capital expenditure of about $1.7 billion. The report suggested that the UAE could deliver 25% of global low-carbon hydrogen production by 2030.

To promote development of the sector, in January 2021, the Abu Dhabi Hydrogen Alliance was set up by national champions Mubadala Investment Company, ADQ, Abu Dhabi National Oil Company (Adnoc) and the Ministry of Energy and Infrastructure.

The UAE has been testing the potential for hydrogen exports. A first test-cargo of ammonia was sent from the UAE to Germany in October 2022, as part of a wider plan to develop a hydrogen supply chain between the two countries. In January this year, Masdar signed a memorandum of understanding (MoU) with the Port of Amsterdam, SkyNRG, Evos Amsterdam and Zenith Energy to explore possible green hydrogen exports from Abu Dhabi to Amsterdam.

The UAE is also investing in hydrogen production projects overseas. In May 2022, Adnoc, Masdar and UK energy major BP said they planned to develop two green hydrogen and technology hubs at Teesside in the northeast of the UK.

North Africa

While Egypt has the most fully-developed hydrogen production plans in North Africa, several other countries along the south coast of the Mediterranean have also been exploring the potential for developing their own facilities. Tunisia has the small Amun Vert pilot project, while in neighbouring Algeria state-owned energy giant Sonatrach has signed an MoU with Italian major Eni covering a hydrogen pilot project at Bir Rebaa North.

In Morocco, there are at least three schemes, including the $750 million Hevo Ammonia project, which involves 600MW of electrolyser capacity and the production of 31,000 t/y of hydrogen and 183,000 t/y of green ammonia.

The other schemes include a German-backed Power-to-X (PtX) project which involves 100MW of electrolyser capacity and the Total Eren green ammonia project in the southern region of Guelmim-Oued Nour. In late 2022, there were media reports that the Moroccan government had held initial talks with India's Adani Group for a potential 10GW wind and solar scheme that would be used to power a green hydrogen plant focused on exports to Europe. As yet, no further details have emerged about this project.

Slightly further south, there are three proposed schemes in Mauritania. In September 2022, a consortium of Chariot and Total Eren announced a feasibility study into the Nour project, which they said could be scaled up to 10GW of electrolyser capacity.

Earlier in the year, mining giant ArcelorMittal said it had signed an MoU with the local iron ore mining company SNIM to evaluate the potential to develop a direct reduced iron (DRI) production plant using green hydrogen. The largest potential scheme in Mauritania is the $40 billion AMAN project between the government and renewable energy developer CWP Global. This involves as much as 30GW of power – including 18GW of wind and 12GW of solar – to produce some 1.7 million t/y of green hydrogen or 10 million t/y of green ammonia.

New areas of investment

Alongside the development of renewable power plants, governments are also putting investment into energy storage systems (ESS) – a vital element if national grids are to remain stable even as they start to rely ever more heavily on intermittent solar and wind power.

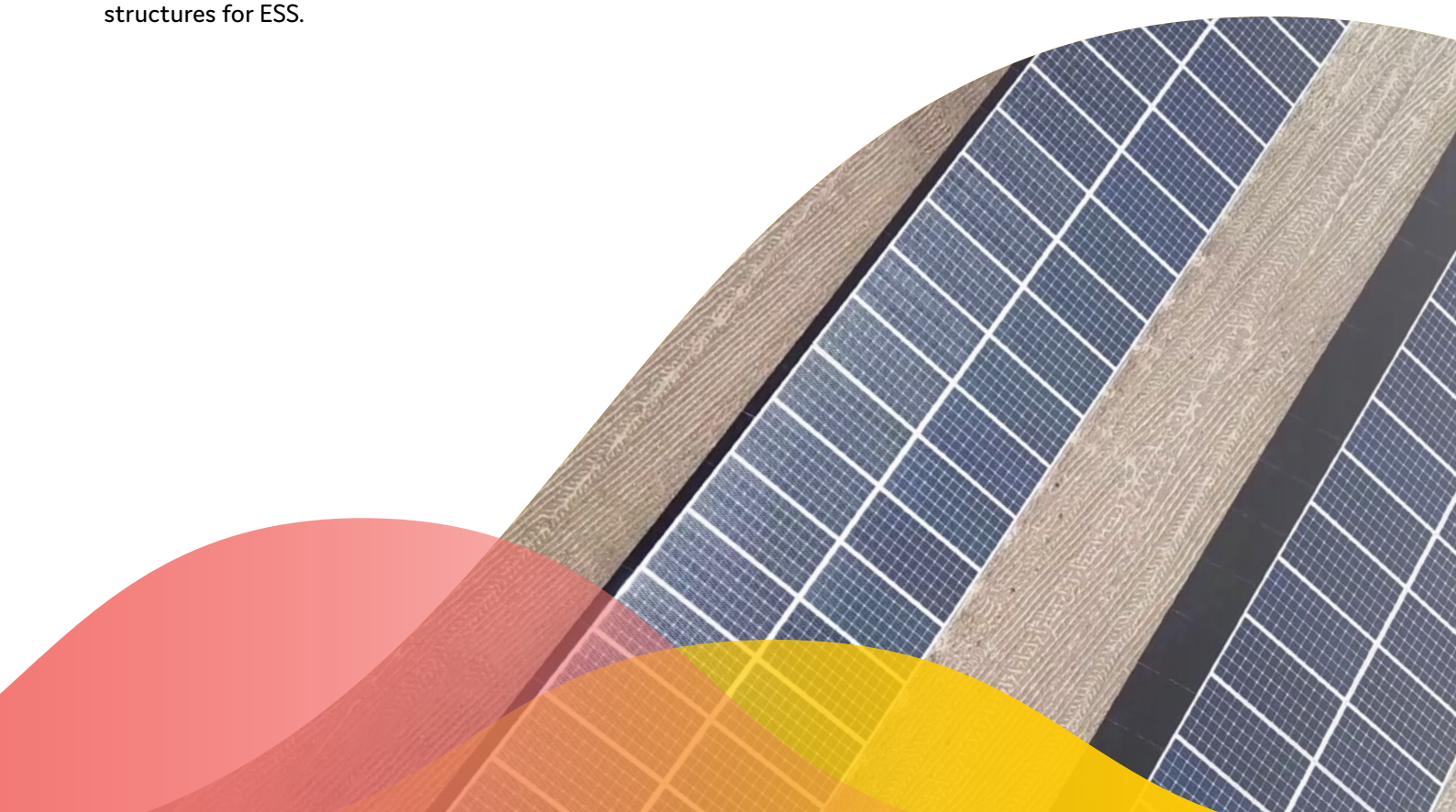
A report by Dammam-based Arab Petroleum Investments Corporation (Apicorp) – Leveraging Energy Storage Systems in MENA, published in December 2021 – estimated that the amount of on-grid energy storage solutions across the GCC countries at the time was 1.46GW.

Pumped hydro storage (PHS) has the largest share of installed capacity in MENA at 55%, with major facilities including the 350MW plant at Agadir and the 465MW plant at Afourer, both in Morocco, as well as the 250MW Hatta dam project in the UAE. Electrochemical energy storage, or batteries, account for a further 7% of the region's storage capacity, with most of it installed in the UAE.

The amount of energy storage will need to grow in the years ahead, although Apicorp said in its report that there were several issues that could hinder the development of this sector, including the high cost of financing, the lack of cost-reflective tariffs across most of the region and the need for clearer regulatory structures for ESS.

Electricity generating capacity (MW) Source: IRENA

	Off-grid	On-grid	Total
Algeria	433	25,729	26,162
Bahrain		8,775	8,775
Egypt	214	59,905	60,119
Iran	0	86,180	86,180
Iraq	38	30,101	30,138
Israel		20,009	20,009
Jordan	2	6,404	6,406
Kuwait	2	20,256	20,259
Lebanon	1,208	2,204	3,412
Libya	6	11,063	11,069
Mauritania	126	501	627
Morocco	28	10,634	10,662
Oman	0	12,057	12,057
Palestine	2	275	277
Qatar		10,622	10,622
Saudi Arabia	0	80,106	80,106
Syria	1	10,124	10,124
Tunisia	7	6,093	6,100
United Arab Emirates	6	36,747	36,752
Yemen	513	1,485	1,998
Total	**2,586**	**439,269**	**441,855**



High-capacity power lines

A further element that may need to be developed over the longer-term is greater cross-border electricity networks and the use of high-capacity power lines. Such systems allow intermittent renewable energy resources to be exploited wherever they are available and for that power to be delivered more easily to where the demand is.

Some schemes have already been developed and more ambitious ones have been proposed. The six GCC countries are connected via a 400kV regional grid using high-voltage direct current (HVDC), managed by the GCC Interconnection Authority (GCCIA).

Saudi Arabia and Egypt are pushing ahead with a plan to develop a 3GW interconnection, at an estimated cost of $1.8bn. Contracts were signed by the two sides in October 2021, with Japan's Hitachi Energy leading the consortiums building the HVDC converter stations. There will be two in Egypt, at Badr in north-east Cairo and Taba on the Sinai Peninsula, and a further two in Saudi Arabia, at Tabuk and Medina.

An even more ambitious project involves a proposed 3,800km cable linking 10.5GW of solar and wind energy power plants in the Guelmim Oued Noun region of Morocco to the UK. The scheme is being led by UK-based XLinks and is estimated to cost around $20 billion. If it goes ahead, it would be the world's longest undersea power cable. It also involves a 5GW battery component.

Thermal power

Even as the MENA region continues to invest heavily in renewable energy, the thermal power sector continues to expand, with many of the largest schemes in the Gulf.

The Kuwait Authority for Partnership Projects (KAPP) has plans for several independent water and power plants (IWPP), including the Al Khiran scheme, with electricity generating capacity of 1.5GW and desalinated water capacity of 125 million g/d. It's multi-phase Az Zour North IWPP includes 1.5GW and 102 million g/d in phase one, followed by a combined second and third phases totalling 2.7GW and 120 million g/d of water.

The Saudi Power Procurement Company has plans for 3.6GW gas-fired plants at Al-Qassim and Taiba. In Bahrain there are plans to expand power generating at Addur. In nearby Qatar, state-owned utility Kahramaa is pushing forward with the 2.6GW Facility E IWPP. The UAE is also developing several new thermal power plants including the 1.8GW Hamriyah IPP in Sharjah and the 2.4GW Fujairah F3 IPP, which is due to be completed in 2023.

Iraq, which regularly endures power cuts during the summer months, has plans to add some 11GW of gas-fired power plants, although like other major projects in the country these ambitions may prove difficult to execute.

Data tables

The eight tables are provided courtesy of business intelligence partner ABiQ.

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Top 40 MEA | Utility-scale Wind Projects: proposed and awarded

Source: ABiQ 2023

Project	Region	Country	Status	Stage	Value million USD
AFRICA					
Aysha II Wind Power Plant	East Africa	Ethiopia	Ongoing	Construction	257
Bubisa Wind 300 MW	East Africa	Kenya	Upcoming	Plan	550
Namaacha Wind 120 MW	East Africa	Mozambique	Ongoing	Construction	280
Singida Wind Plant	East Africa	Tanzania	Ongoing	Awarded	1,500
Serenje Wind 200 MW	East Africa	Zambia	Upcoming	Plan	350
South Africa Renewable Energy Project 6.8 GW Window 6	Southern Africa	South Africa	Ongoing	Awarded	7,000
South Africa Renewable Energy Project 6.8 GW Window 5	Southern Africa	South Africa	Ongoing	Awarded	3,500
South Africa REIPPP 1 Mainstream Wind 824 MW	Southern Africa	South Africa	Ongoing	Awarded	1,500
Enel-H1-Pele 700 MW Wind Farms in South Africa	Southern Africa	South Africa	Upcoming	Plan	1,200
Magnora South Africa Wind and Solar 775 MW	Southern Africa	South Africa	Upcoming	Plan	950
Mpumalanga Wind Plant 450 MW	Southern Africa	South Africa	Upcoming	Plan	730
South Africa REIPPP 1 EDF Wind 420 MW	Southern Africa	South Africa	Ongoing	Awarded	700
Red Rocket Wind 364 MW	Southern Africa	South Africa	Ongoing	Awarded	663
Sibanye-Stillwater Mines Wind Power Plants	Southern Africa	South Africa	Upcoming	Study	400
Autonomous Port of Cotonou Wind Farm	West Africa	Benin	Upcoming	Study	500
Ayitepa Wind Power	West Africa	Ghana	Ongoing	Awarded	400
Togbloku Wind 200 MW	West Africa	Ghana	Upcoming	Study	340
Madavunu Wind 200 MW	West Africa	Ghana	Upcoming	Study	340
Amlakpo Wind 200 MW	West Africa	Ghana	Upcoming	Study	340
Konikablo Wind 250 MW	West Africa	Ghana	Upcoming	Study	340
Koluedor Wind 160 MW	West Africa	Ghana	Upcoming	Plan	270
Tarka Wind Farm	West Africa	Niger	Upcoming	Study	270
NEK Gambia Wind 250 MW	West Africa	The Gambia	Upcoming	Plan	430

Top 40 MEA | Utility-scale Wind Projects: proposed and awarded (contd.)

Source: ABiQ 2023

Project	Region	Country	Status	Stage	Value million USD
MENA					
Oman Wind IPPs	Middle East	Oman	Upcoming	Design	2,400
Dhofar III Wind IPP 200 MW	Middle East	Oman	Upcoming	Design	300
Duqm Wind IPP 200 MW	Middle East	Oman	Upcoming	Design	300
NEOM Hydrogen Power Wind	Middle East	Saudi	Ongoing	Awarded	2,000
Saudi NREP Round 4 Yanbu	Middle East	Saudi	Upcoming	Pre-qualification	1,000
Saudi NREP Round 4 Waad Al Shamal	Middle East	Saudi	Upcoming	Pre-qualification	700
Masdar Wind Project in Egypt 10 GW	North Africa	Egypt	Upcoming	Study	15,000
Engie Wind Project in Egypt 3 GW	North Africa	Egypt	Upcoming	Study	4,500
ACWA Power Wind IPP in Egypt 1.1 GW	North Africa	Egypt	Upcoming	Plan	1,500
Ras Ghareb Wind 500 MW RSWE	North Africa	Egypt	Ongoing	Construction	800
Ras Ghareb Wind 500 MW AMEA Power	North Africa	Egypt	Ongoing	Awarded	650
Harmattan Wind Project	North Africa	Morocco	Upcoming	Plan	3,000
Boujdour Wind Farm	North Africa	Morocco	Ongoing	Construction	450
Koudia Al Baida Wind Expansion	North Africa	Morocco	Ongoing	Awarded	350
Jebel Lahdid Wind 270 MW	North Africa	Morocco	Ongoing	Construction	314
Sudan Wind Projects	North Africa	Sudan	Upcoming	Study	1,800
Tunisia Wind IPPs 600 MW	North Africa	Tunisia	Upcoming	Bidding	900

Top 15 in Africa | Geothermal power plants: proposed and awarded

Source: ABiQ 2023

Project	Region	Country	Status	Stage	Value million USD
Baringo-Silali Geothermal Project	East Africa	Kenya	Ongoing	Construction	5,000
Lake Ngozi Geothermal Plant	East Africa	Tanzania	Upcoming	Bidding	821
Tulu Moye Geothermal Plant	East Africa	Ethiopia	Ongoing	Construction	780
Longonot Geothermal Project	East Africa	Kenya	Upcoming	Study	560
Corbetti Geothermal 300 MW	East Africa	Ethiopia	Ongoing	Construction	500
Boseti Geothermal Plant	East Africa	Ethiopia	Upcoming	Study	400
Akiira I Geothermal Plant	East Africa	Kenya	Ongoing	Construction	356
Olkaria II Geothermal Plant Expansion	East Africa	Kenya	Upcoming	Study	350
Olkaria VII Geothermal Plant	East Africa	Kenya	Upcoming	Study	350
Olkaria VI Geothermal Plant	East Africa	Kenya	Upcoming	Study	350
Katwe-Kikorongo Geothermal Plant	East Africa	Uganda	Upcoming	Study	300
Suswa Geothermal Plant	East Africa	Kenya	Upcoming	Plan	300
Aluto-Langano Geothermal 70 MW	East Africa	Ethiopia	Ongoing	Construction	218
Gale Le koma Geothermal Plant	East Africa	Djibouti	Ongoing	Construction	174
Abaya Geothermal Plant	East Africa	Ethiopia	Ongoing	Awarded	150

Top 20 MEA | Transmission projects: proposed and awarded

Source: ABiQ 2023

Project	Region	Country	Status	Stage	Value million USD
AFRICA					
Caculo Cabaça Power Transmission Project	Central Africa	Angola	Ongoing	Awarded	1,400
Dundo Camanongue Power Transmission Line	Central Africa	Angola	Ongoing	Awarded	790
Cameroon Chad Power Interconnection Cameroon Section	Central Africa	Cameroon	Upcoming	Plan	550
Songo Matambo Transmission Line	East Africa	Mozambique	Upcoming	Design	1,000
Chimuara Nacala Power Transmission	East Africa	Mozambique	Ongoing	Construction	600
Kisongo Segera Power Transmission Line	East Africa	Tanzania	Upcoming	Study	700
ZTK Regional Power Interconnector Tanzania Section	East Africa	Tanzania	Upcoming	Bid Evaluation	595
Electricity Access Scale-up Project	East Africa	Uganda	Upcoming	Study	638
Mozambique Tanzania Interconnector Project	East Africa		Upcoming	Plan	2,000
Nigeria Chad Power Interconnection	West Africa	Nigeria	Upcoming	Plan	700
North Core Project	West Africa		Ongoing	Construction	550
MENA					
Saudi Iraq Power Interconnection	Middle East	Iraq	Upcoming	Study	600
Saudi Kuwait Power Interconnection	Middle East	Kuwait	Ongoing	Awarded	800
North South Interconnection Project	Middle East	Oman	Ongoing	Construction	1,040
Saudi Egypt Power Interconnection	Middle East	Saudi	Ongoing	Awarded	1,600
Saudi Jordan Power Interconnection	Middle East	Saudi	Upcoming	Bidding	700
Adoc Subsea Power Transmission Network	Middle East	UAE	Ongoing	Awarded	3,800
EuroAfrica Interconnector	North Africa	Egypt	Ongoing	Construction	2,750
Morocco-UK Power Project	North Africa	Morocco	Upcoming	Design	22,000
Tunisia Italy Power Interconnection	North Africa	Tunisia	Upcoming	Study	680

Top 20 in Africa | Africa hydropower projects: planning and construction

Source: ABiQ 2023

Project	Region	Country	Status	Stage	Value million USD
Caculo Cabaca Hydroelectric Plant	Central Africa	Angola	Ongoing	Construction	4,500
Lauca Hydroelectric Dam	Central Africa	Angola	Ongoing	Construction	4,300
Grand Eweng Hydropower Plant	Central Africa	Cameroon	Upcoming	Study	5,500
Inga 3 Hydroelectric Dam	Central Africa	Congo-Kinshasa	Upcoming	Study	18,000
Grand Ethiopian Renaissance Dam	East Africa	Ethiopia	Ongoing	Construction	4,800
Koysha Hydropower	East Africa	Ethiopia	Ongoing	Construction	2,800
High Grand Falls Dam	East Africa	Kenya	Ongoing	Awarded	3,493
Mphanda Nkuwa Hydroelectric Dam	East Africa	Mozambique	Upcoming	Bidding	4,200
Chemba Hydropower Project 1,000 MW	East Africa	Mozambique	Upcoming	Study	2,550
Julius Nyerere Power Plant	East Africa	Tanzania	Ongoing	Construction	2,900
Ayago Hydroelectric Power Plant	East Africa	Uganda	Ongoing	Awarded	1,970
Karuma Hydropower Plant	East Africa	Uganda	Ongoing	Construction	1,700
Luapula Hydropower Plant	East Africa	Zambia	Upcoming	Study	4,300
Kafue Gorge Hydroelectric Dam	East Africa	Zambia	Ongoing	Construction	2,000
Batoka Gorge Hydroelectric Dam	East Africa	Zimbabwe	Ongoing	Construction	5,200
Devil Gorge Hydroelectric Project	East Africa	Zimbabwe	Upcoming	Plan	4,000
Attaqa Mountain Pumped Storage Hydroelectric Pant	North Africa	Egypt	Ongoing	Construction	2,600
Mambilla Hydropower Project	West Africa	Nigeria	Ongoing	Awarded	5,800
Makurdi Hydropower Plant	West Africa	Nigeria	Upcoming	Study	3,500
Zungeru Hydropower Plant	West Africa	Nigeria	Ongoing	Construction	1,500
Gale Le koma Geothermal Plant	East Africa	Djibouti	Ongoing	Construction	174
Abaya Geothermal Plant	East Africa	Ethiopia	Ongoing	Awarded	150

Top 38 MEA | Hydrogen projects: proposed and awarded

Source: ABiQ 2023

Project	Region	Country	Status	Stage	Value million USD
AFRICA (8 PROJS)					
Project Aman	West Africa	Mauritania	Upcoming	Study	40,000
Project Nour	West Africa	Mauritania	Upcoming	Study	17,000
Namibia Hydrogen and Ammonia Project	Southern Africa	Namibia	Upcoming	Study	10,000
Namibia Hydrogen and Ammonia Project 2	Southern Africa	Namibia	Upcoming	Study	9,400
HDF Hydrogen Plant in Namibia	Southern Africa	Namibia	Upcoming	Study	513
Coega Green Ammonia Plant	Southern Africa	South Africa	Upcoming	Study	5,920
Boegoebaai Hydrogen Project	Southern Africa	South Africa	Upcoming	Study	4,000
HDF Hydrogen Plant in Uganda	East Africa	Uganda	Upcoming	Study	200

Top 38 MEA | Hydrogen projects: proposed and awarded (contd.)

Source: ABiQ 2023

Project	Region	Country	Status	Stage	Value million USD
MENA					
ACME Hydrogen Plant in Sokhna	North Africa	Egypt	Upcoming	Plan	13,000
Globeleq Hydrogen Plant in Sokhna	North Africa	Egypt	Upcoming	Study	11,000
Masdar Green Ammonia Project in Egypt	North Africa	Egypt	Upcoming	Plan	9,000
ReNew Hydrogen Plant	North Africa	Egypt	Upcoming	Study	8,000
Alfanar Hydrogen Plant in Sokhna	North Africa	Egypt	Upcoming	Plan	4,000
AMEA Green Ammonia Project in Egypt	North Africa	Egypt	Upcoming	Study	4,000
Hydrogen Project in Egypt	North Africa	Egypt	Upcoming	Study	4,000
Green Fuel Alliance Ammonia in Ain Sokhna	North Africa	Egypt	Upcoming	Study	3,000
Total Green Ammonia in Ain Sokhna	North Africa	Egypt	Upcoming	Study	3,000
Waste to Hydrogen Plant in Port Said	North Africa	Egypt	Upcoming	Study	3,000
Alcazar Hydrogen Plant in Sokhna	North Africa	Egypt	Upcoming	Plan	2,000
K&K Hydrogen Plant in Sokhna	North Africa	Egypt	Upcoming	Plan	2,000
Actis Green Ammonia Plant in Sokhna	North Africa	Egypt	Upcoming	Plan	1,500
Scatec Green Ammonia in Ain Sokhna	North Africa	Egypt	Ongoing	Awarded	450
MEP Green Ammonia in Sokhna	North Africa	Egypt	Upcoming	Plan	250
Hydrogen and Ammonia in Guelmim-Oued Noun	North Africa	Morocco	Upcoming	Study	10,611
HEVO Ammonia Morocco	North Africa	Morocco	Upcoming	Study	800
Hydrogen Ammonia Plant in Oman	Middle East	Oman	Upcoming	Study	30,000
Hydrogen Ammonia Plant in Salalah	Middle East	Oman	Upcoming	Study	7,000
ACME Scatec Green Ammonia in Oman	Middle East	Oman	Upcoming	FEED	5,000
Hyport Duqm	Middle East	Oman	Upcoming	Design	3,000
Waste to Hydrogen Plant in Oman	Middle East	Oman	Upcoming	Plan	1,400
NEOM Hydrogen Plant	Middle East	Saudi	Ongoing	Construction	900
Ruwais Hydrogen Ammonia	Middle East	UAE	Upcoming	Study	5,000
Taqa Hydrogen Ammonia in KIZAD	Middle East	UAE	Upcoming	Study	2,500
Brooge Green Hydrgen and Ammonia Plant	Middle East	UAE	Upcoming	Study	1,500
Helios Hydrogen Ammonia in Abu Dhabi	Middle East	UAE	Upcoming	Study	1,000
Petrolyn Chemie Green Ammonia in KIZAD	Middle East	UAE	Ongoing	Awarded	1,000
Emirates Steel Hydrogen Plant	Middle East	UAE	Upcoming	Study	250
Sharjah Waste to Hydrogen Plant	Middle East	UAE	Upcoming	Study	180

Top 30 MEA | Gas-fired power plants: proposed and awarded

Project	Region	Country	Status	Stage	Value million USD
AFRICA					
Maputo Floating Power Plant	East Africa	Mozambique	Upcoming	Study	5,000
Beluluane Power Plant	East Africa	Mozambique	Upcoming	Pre-qualification	2,000
Zambezi Thermal Power Plant	East Africa	Zimbabwe	Ongoing	Construction	1,700
Nseleni Floating IPP	Southern Africa	South Africa	On Hold	Study	20,000
Karpowership Port of Coega	Southern Africa	South Africa	Ongoing	Awarded	5,540
Karpowership Richards Bay	Southern Africa	South Africa	Ongoing	Awarded	5,540
Richards Bay Power Plant	Southern Africa	South Africa	Upcoming	Study	4,000
Karpowership Saldanha	Southern Africa	South Africa	Ongoing	Awarded	3,940
Egbin Phase 2	West Africa	Nigeria	Upcoming	Plan	2,000
MENA					
Riyadh Power Plant 15	Middle East	Saudi	On Hold	Design	6,000
Al Khairat Thermal Power Plant	Middle East	Iraq	Ongoing	Construction	5,600
Zour North IWPP	Middle East	Kuwait	Upcoming	Pre-qualification	4,000
Facility E IWPP	Middle East	Qatar	Upcoming	Bid Evaluation	3,500
Riyadh Power Plant PP16	Middle East	Saudi	On Hold	Study	3,500
Nuwaiseeb Phase 1 Power and Desalination Plant	Middle East	Kuwait	Upcoming	Study	3,500
Hassyan IPP	Middle East	UAE	Ongoing	Construction	3,237
Riyadh Power Plant 13	Middle East	Saudi	Ongoing	Construction	2,500
Jeddah South Power Plant Expansion Phase 2	Middle East	Saudi	On Hold		2,400
Khiran 1 IWPP	Middle East	Kuwait	Upcoming	Pre-qualification	2,300
Shuqaiq Power Plant Extension Phase 1	Middle East	Saudi	On Hold		2,300
Al Rais IPP 2	Middle East	Saudi	On Hold	Study	2,100
South Madinah Power Plant 2	Middle East	Saudi	On Hold	Study	2,100
Taiba 1 IPP	Middle East	Saudi	Upcoming	Pre-qualification	2,000
Taiba 2 IPP	Middle East	Saudi	Upcoming	Pre-qualification	2,000
Qassim 2 IPP	Middle East	Saudi	Upcoming	Pre-qualification	2,000
Al Dur Phase 3 IWPP	Middle East	Bahrain	Upcoming	Plan	2,000
Qassim 1 IPP	Middle East	Saudi	Upcoming	Pre-qualification	2,000
Marjan Field Expansion - Tanajib ISWPP	Middle East	Saudi	Ongoing	Construction	2,000
Jorf Lasfar Gas to Power Project	North Africa	Morocco	Upcoming	Pre-qualification	4,600
i-kWh IPP in Libya	North Africa	Libya	Ongoing	Awarded	2,000

Source: ABiQ 2023

Top 40 MEA | Utility-scale Solar Projects: proposed and awarded

Source: ABiQ 2023

Project	Region	Country	Status	Stage	Value million USD
AFRICA					
Masdar 2 GW Solar Projects in Angola	Central Africa	Angola	Upcoming	Study	2,000
MCA Solar Project 950 MW	Central Africa	Angola	Ongoing	Construction	2,000
Burundi Solar Plant	East Africa	Burundi	Upcoming	Study	4,500
Masdar 2 GW Solar Projects in Tanzania	East Africa	Tanzania	Upcoming	Study	2,000
Masdar 1GW Solar Projects in Uganda	East Africa	Uganda	Upcoming	Study	1,000
Masdar 2 GW Solar Projects in Zambia	East Africa	Zambia	Upcoming	Study	2,000
Namibia-Botswana Solar 5,000 MW Botswana	Southern Africa	Botswana	Upcoming	Plan	2,000
Namibia-Botswana Solar 5,000 MW Namibia	Southern Africa	Namibia	Upcoming	Plan	2,000
AngloAmerican Renewable Energy Project in South Africa	Southern Africa	South Africa	Ongoing	Awarded	7,000
Embedded Generation Investment Program	Southern Africa	South Africa	Upcoming	Study	1,800
Musina Makhado Solar Plant	Southern Africa	South Africa	Upcoming	Study	1,500
Kenhardt Solar 540 MW	Southern Africa	South Africa	Ongoing	Construction	962
Redstone Solar CSP 100 MW	Southern Africa	South Africa	Ongoing	Construction	828
Meinergy Solar 1 GW	West Africa	Ghana	Ongoing	Construction	1,500
Kebbi Solar IPP	West Africa	Nigeria	Upcoming	Plan	6,000
Five Solar Plant in Nigeria 961 MW	West Africa	Nigeria	Ongoing	Awarded	1,500
G5 Sahel Desert to Power	West Africa		Upcoming	Study	10,000

Top 40 MEA | Utility-scale Solar Projects: proposed and awarded (contd.)

Source: ABiQ 2023

Project	Region	Country	Status	Stage	Value million USD
MENA					
Iraq SolarChina 2 GW	Middle East	Iraq	Upcoming	Plan	2,000
Iraq Solar Masdar 2 GW	Middle East	Iraq	Upcoming	Study	2,000
Iraq Solar TotalEnergies 1 GW	Middle East	Iraq	Upcoming	Plan	1,000
Shagaya Renewable Energy Park Phase 3	Middle East	Kuwait	Upcoming	Plan	3,200
Al Dibdibah Solar IPP	Middle East	Kuwait	Upcoming	Plan	1,500
Manah Solar IPPs	Middle East	Oman	Upcoming	Bidding	1,000
Saudi National Renewable Energy Program	Middle East	Saudi	Ongoing	Construction	60,000
Ma'aden Solar I	Middle East	Saudi	Upcoming	Study	4,000
NEOM Hydrogen Power Solar	Middle East	Saudi	Ongoing	Awarded	2,700
Shuaibah 2 PV	Middle East	Saudi	Ongoing	Awarded	2,000
The Red Sea Project Power	Middle East	Saudi	Ongoing	Construction	1,400
Saudi NREP Round 4 Al Hanakia	Middle East	Saudi	Upcoming	Pre-qualification	1,000
Sudair Solar PV	Middle East	Saudi	Ongoing	Construction	906
SaudiNREP Round 3 Ar Rass PV	Middle East	Saudi	Ongoing	Awarded	900
Mohammed bin Rashid Al Maktoum Solar Park	Middle East	UAE	Ongoing	Construction	13,000
Ajban Solar IPP	Middle East	UAE	Upcoming	Bidding	1,500
Mohammed bin Rashid Al Maktoum Solar Park Phase 6	Middle East	UAE	Upcoming	Study	900
Al Dhafra Solar PV 2 GW	Middle East	UAE	Ongoing	Construction	900
Algeria Renewable Energy Development and Energy Efficiency Program	North Africa	Algeria	Ongoing	Construction	34,000
Tafouk 1 Solar PV	North Africa	Algeria	Upcoming	Bidding	3,600
Libya Solar 2 GW W Solar	North Africa	Libya	Upcoming	Study	2,000
Gabes and Kebili Solar Plants	North Africa	Tunisia	Upcoming	Study	1,500
Tunisia Solar IPPs 800 MW	North Africa	Tunisia	Upcoming	Bidding	800

MEA | Renewable power capacity and generation

Source: IRENA | Courtesy of ABiQ

Country	Renewable Capacity MW 2021	Renewable Capacity Share % 2021	Renewable Generation GWh 2020
AFRICA			
Angola	3,793.66	63.97	14,019.94
Benin	3.44	1.13	5.41
Botswana	5.94	0.64	5.98
Burkina Faso	97.79	22.38	214.55
Burundi	57.39	53.19	285.06
Cabo Verde	35.38	20.06	70.52
Cameroon	826.74	53.93	5,109.57
Central African Republic	19.17	21.02	136.03
Chad	3.83	1.34	18.78
Comoros	1.45	6.28	-
Congo DR	2,741.49	98.95	11,918.90
Congo Rep	226.82	27.54	1,046.90
Cote d'Ivoire	892.14	39.97	3,393.60
Djibouti	20.36	14.20	0.60
Equatorial Guinea	127.22	31.71	127.00
Eritrea	25.28	10.98	44.49
Eswatini	179.03	94.76	420.47
Ethiopia	4,758.77	97.86	15,075.02
Gabon	332.89	54.36	985.53
Gambia	3.39	2.75	3.57
Ghana	1,700.29	31.69	7,419.88
Guinea	831.58	73.04	1,514.03
Guinea Bissau	1.17	4.01	1.89
Kenya	2,384.34	76.04	9,563.36
Lesotho	75.11	99.84	417.49
Liberia	94.58	49.11	127.62
Madagascar	197.21	24.07	868.09
Malawi	527.40	78.93	1,863.04
Mali	454.84	49.76	1,733.87
Mauritania	121.91	19.46	271.21
Mauritius	245.51	28.69	688.70
Mayotte	18.00	15.38	16.86
Mozambique	2,272.59	79.05	4,201.00
Namibia	501.44	73.23	1,666.78
Niger	27.04	7.12	46.09
Nigeria	2,153.80	16.36	8,292.23
Reunion	454.44	49.75	932.80
Rwanda	158.74	58.17	577.42

MEA | Renewable power capacity and generation (contd.)

Source: IRENA | Courtesy of ABiQ

Country	Renewable Capacity MW 2021	Renewable Capacity Share % 2021	Renewable Generation GWh 2020
Senegal	421.20	30.30	400.95
Seychelles	19.40	15.46	64.61
Sierra Leone	99.10	41.67	248.29
Somalia	27.09	11.33	30.46
South Africa	10,192.93	17.58	9,551.29
South Sudan	1.28	0.43	1.25
Sudan	1,816.86	48.43	11,139.36
Tanzania	685.35	34.22	3,417.28
Togo	123.84	36.09	218.84
Uganda	1,198.53	92.11	4,417.98
Zambia	2,844.42	84.45	13,036.32
Zimbabwe	1,211.08	50.23	4,198.62
MENA			
Algeria	686.00	2.62	721.05
Bahrain	12.00	0.14	11.20
Egypt	6,226.50	10.56	24,064.23
Iran	11,929.32	13.82	23,200.04
Iraq	1,594.42	5.29	5,342.16
Israel	2,614.58	13.07	4,523.00
Jordan	2,171.29	33.89	3,046.77
Kuwait	105.74	0.52	60.29
Lebanon	370.66	8.05	1,168.40
Libya	6.33	0.06	7.79
Morocco	3,522.23	29.91	7,062.27
Oman	187.59	1.56	211.46
Palestine	178.17	52.69	178.71
Qatar	24.10	0.23	142.75
Saudi Arabia	442.64	0.55	266.95
Syrian	1,499.77	14.81	792.87
Tunisia	405.89	6.73	663.80
UAE	2,578.71	7.23	5,485.56
Yemen	252.81	11.20	489.67

CHAPTER 2

The Africa Outlook

Africa advances on many paths

With some 1.3 billion people, Sub-Saharan Africa is home to about a fifth of the world's population while it accounts for just 3% of electricity use. Yet entrepreneurial savvy and an increasing diversity of power sources are gradually overcoming the limitations of the continent's legacy infrastructure. A majority of new electricity connections in the coming years will come from off-grid solar.

The huge gap between electricity supply and demand in Africa is well known. Only a handful of countries on the continent can boast of 100% electricity access, including Egypt and Tunisia, while a few others get close, such as Mauritius, Cabo Verde and Gabon, according to data from the World Bank. Some of the larger economies, such as South Africa and Ghana, provide the vast majority of their people with power, but they are still not yet at 100% and power cuts remain a problem – particularly in South Africa where it is an increasingly important political issue.

Many other countries have much lower access, particularly in rural areas – electricity access in Mozambique, Malawi, Sierra Leone, Liberia and some other countries is well below 10% in rural areas. Across the continent as a whole, electricity access in rural areas is less than 27%, according to the African Development Bank (AfDB).

Yet the gap is gradually closing, helped by the increasing diversity of power sources. Renewable power projects are growing in size and reach and storage solutions are starting to address the intermittency of solar and wind power. New forms of financing are also being deployed to make the most of local capital.

There remain plenty of challenges. While the energy transition could allow African countries to create extensive, green energy networks, there remain numerous financial, regulatory and logistical problems that need to be overcome before the continent's full potential can be unleashed. In the meantime, governments insist on the need to continue expanding thermal power generation capacity.

Thermal power projects

Africa is home to some of the world's largest producers of hydrocarbons. Nigeria, Algeria, Angola and Libya are among the world's 20 biggest oil producers, while Algeria, Egypt and Nigeria are among the 20 largest natural gas producers. Several African countries also produce coal, most notably South Africa, but also some of its neighbours including Botswana, Mozambique and Zimbabwe.

Given that situation, it is perhaps unsurprising that coal and natural gas are the two largest sources of electricity generation across the continent, followed by hydropower and oil. The three carbon fuels in that list – gas, coal and oil – between them accounted for about 77% of Africa's total electricity generation in 2019, according to a 2022 report by the International Renewable Energy Agency (IRENA), in collaboration with the AfDB.

While much of the world's attention has been on the ramping up of renewable energy sources, including hydropower, wind, solar and geothermal power, there remains a strong appetite for conventional fuels, with natural gas in particular identified by many African governments as a vital 'transition fuel' in the continent's journey to reach its net zero carbon emission targets. This has been the cause of some friction with international partners and, as a result, sourcing finance for gas-fuelled plants has become more difficult in recent years as western backers have shied away from such projects.

Nonetheless, there are numerous thermal power plants under development, or at least under consideration, around the continent – both in terms of new plants being built and existing plants being expanded.

A key consideration is often the need for reliable baseload power – something that wind and solar power plants cannot provide due to intermittency of those sources and the under-developed nature of existing power storage technology.

Hydroelectric Power

According to the International Hydropower Association (IHA), there was some 33.4GW of installed hydroelectric power capacity across sub-Saharan Africa as of 2021. The most important country is Ethiopia, which has installed capacity of just over 4GW. It is followed by Angola (3.8GW), South Africa and Democratic Republic of the Congo (2.8GW).

On an electricity generation basis, the picture is slightly different, with Mozambique the leading actor with 15TWh in 2021, followed by Zambia (14.9TWh), Ethiopia (13.6TWh) and Angola (10.7TWh).

The Paris-based International Energy Agency (IEA) estimates that hydropower provided 16% of Africa's electricity output in 2020, with 90% of the generation capacity located in sub-Saharan Africa (SSA).

Even within SSA though, the industry is concentrated in a relatively small number of countries. Just 15 countries across SSA account for more than 90% of the installed hydropower capacity and generation.

That concentration is likely to increase in the years to come. The IEA says large hydropower projects are planned in 15 countries, including existing sector-leaders such as Angola, Ethiopia, DRC, Nigeria and Tanzania. Reservoir plants make up around 83% of this project pipeline – these are more flexible in producing power and better at managing water flow than run-of-river plants, which account for 6% of the planned schemes. Another 6% are pumped storage plants.

Selected major hydropower projects in SSA, planned or underway

Source: E&U

Country	Project	Capacity (MW)
Angola	Caculo Cabaça	2,172
Cameroon	Nachitgal	420
Democratic Republic of Congo	Grand Inga	40,000
Ethiopia	Grand Ethiopian Renaissance Dam (Gerd)	6,450
Nigeria	Mambilla	3,000
Nigeria	Zungeru	700
Tanzania	Julius Nyerere	2,115
Zambia / Zimbabwe	Batoka Gorge	2,400

Geothermal

Africa's geothermal power capacity is concentrated around the East African Rift System, and in Kenya in particular. According to IRENA, Kenya currently has some 863MW in installed capacity in 2021, putting it far ahead of the next nearest country Ethiopia, which has just 7MW. Indeed, for Kenya, geothermal power is the largest single element of its electricity supply.

Where Kenya has led, others are seeking to follow, with activity in a number of nearby countries. In December, the African Development Bank Group approved a $10m grant from the Sustainable Energy Fund for Africa (SEFA) for the Tulu Moye geothermal project – a drilling programme that will add 50MW to Ethiopia's power system, with a potential second phase adding a further 100MW.

In August 2022, the UK's Northern Powerhouse Investment Fund (NPIF) reported that Marriott Drilling Group had raised a "seven-figure loan" from NPIF - Mercia Debt Finance to help finance its work on the construction of two geothermal power stations in Ethiopia.

The Tanzania Geothermal Development Company (TGDC), a subsidiary of the state-owned Tanzania Electric Supply Company, issued tenders in November for drilling services and equipment to be used in its Ngozi geothermal drilling programme. That is one of several sites earmarked for development around the country, as part of wider ambitions by TGDC to develop up to 200MW of geothermal capacity in the coming years.

Off-grid, mini-grid and home systems

With large parts of Africa far from electricity transmission lines, the trend for off-grid and mini-grid networks continues to grow. These are generally powered by fossil fuels or solar photovoltaic plants, but there are also some schemes based on power from hydroelectric, wind and biofuel sources.

According to the World Bank's Off-grid Solar Market Trends Report 2022, some 586 million people in SSA are not connected to the grid – with the largest number being in West Africa, where 213 million are without a link. A further 182 million people around the continent have unreliable grid access.

Electricity grid access (millions of people)

Source: World Bank

Region	Unconnected	Unreliable grid
Central Africa	109	14
East Africa	161	41
West Africa	213	94
Southern Africa	103	33
Total	**586**	**182**

The World Bank estimates that the majority of new electricity connections in the period 2020-25 will come from off-grid solar, including 53% of new connections in Southern Africa, followed by 55% in West Africa, 64% in East Africa and 81% in Central Africa.

However, the rate of growth has shown sharply divergent trends in different regions in the past few years.

Sales of solar home systems (SHS) in the East Africa region fell from 737,000 in 2019 to 721,000 in 2020 and 569,000 in 2021. Lanterns and multi-light systems (MLS) have fared better, with sales of 3.4 million in 2019, dipping to just over 3 million in 2020 before rising to 3.5 million in 2021.

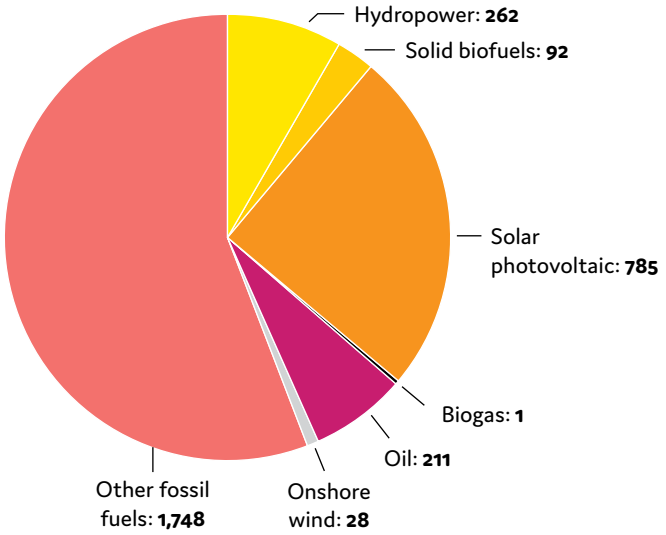
In West Africa the trend has been much more positive, with a steady increase in sales over the past three years in both categories, with lantern and MLS sales reaching 685,000 in 2021 and SHS sales reaching 377,000 that year.

In Central Africa, sales of lantern and MLS systems shot up to 348,000 in 2021, a rise of 140% on the year before. Sales of SHS were more modest but also more than doubled year-on-year to 64,000 in 2021.

Despite the growth seen in the sector to date, there is plenty of room for further development. Off-grid services provide just 2.5% of electricity access across SSA, according to data from IRENA for 2021. The off-grid total capacity of 3.1GW compares to 122.4GW for on-grid electricity.

Off-grid electricity generating capacity by fuel (MW)

Source: IRENA



Off-grid funding

Funding has been forthcoming for this sector. Globally, the off-grid solar sector attracted $2.3 billion of capital from 2012-2021, according to the database maintained by GOGLA, the global association for the off-grid solar energy industry.

That finance comprises a mixture of debt, equity and grants, but it has been heavily concentrated, both in geographic and commercial terms. Some 49% of funding was assigned to East Africa. In addition, seven large companies absorb the majority of investments, all of which are active in Africa. They are: Bboxx, d.light, Engie Energy Access, Sun King, Lumos, M-Kopa and Zola.

Investment trends

Between 2000 and 2019, $109 billion in public commitments were made to the energy sector across Africa, according to IRENA. More than half of the total – $64 billion – was directed towards renewable energy, of which $50 billion went towards hydropower projects from 2010 onwards. This is a reflection of the general trends for more finance to be directed into renewables – while the renewables sector attracted 14% of public investment in energy in 2000, by 2017 it had reached a record 79%.

A small number of investors accounted for the majority of those financial commitments, led by China (51% of the commitments), the International Bank for Reconstruction and Development (14%) and the Islamic Development Bank.

While investments in renewable energy have increased, they are unevenly distributed, with most going to the more developed economies. The top five recipients over the period were South Africa, Egypt, Nigeria, Morocco and Kenya – between them, they received more than half of all renewable investments. The 33 least-developed countries (LDCs) in Africa attracted just 37% of renewable energy commitments in Africa from 2010-19.

The discussion around financing of power projects in Africa has become inextricably linked with the global push to take action to minimise the damage from climate change. Many western financing institutions are now refusing to support oil and gas projects, or at least heavily prioritising renewable schemes. At the same time, most African governments insist that natural gas in particular must be allowed to play a role in their electricity supply industries in the short-to-medium term.

New financial frameworks continue to be drawn up, including South Africa's $8.5 billion Just Energy Transition Partnership (JETP), which was announced at COP26 and received initial funding at COP27 last year. This scheme involves a partnership between the governments of South Africa, France, Germany, the UK, US and the EU. It aims to accelerate the decarbonisation of South Africa's economy, helping the country transition its coal power plants to clean power. As such, the JETP offers a model which could be replicated in some other parts of the continent.

Governments are also increasingly keen to develop and tap local sources of finance, although this is not a realistic option in many parts of the continent.

The AfDB says it has a portfolio of energy projects worth more than $12 billion. Its key initiatives include the New Deal on Energy for Africa, which launched in 2016 and aims for universal energy access, with priority given to the use of low-carbon technologies. From 2016-20, the AfDB approved $7.2bn in funding under the New Deal and mobilised a further $850m in co-financing resources. Overall, this funding is expected to add 3GW of installed generation capacity, of which 2.2GW will come from renewable energy sources. The funding will also support the construction of more than 7,000km of transmission lines, including 3,000km of regional interconnections.

Other AfDB initiatives include the Desert-to-Power initiative (DtP) to accelerate economic development in the Sahel region through the deployment of solar technologies, the Sustainable Energy Fund for Africa (SEFA), and the Facility for Energy Inclusion investment platform.

CHAPTER 3

MEA new energy markets: insights from MESIA

MENA Challenges and Outlook

The MEA outlook is increasingly concerned with renewable energy and new fuels such as carbon-free hydrogen.

The Middle East Solar Industry Association (MESIA) provided insights on the current situation, challenges and outlook for fourteen countries in the Middle East and North Africa.

For a full discussion and project list, readers should consult MESIA's Solar Outlook Report 2023.

MESIA also has a forthcoming report on hydrogen in the Middle East and Africa, part of which appears below (p.36).

Get it here

Highlights in MENA's Leading Solar PV Markets

Algeria

Sofiane Boualchaoui, Research Associate CDER Energy Consultant, ESOLARTEK

RE Target by 2035	RE Target by 2035	RE capacity 2021
15,000 MW	35%	4,382 MW

Source: IRENA & CEREFE

Current situation

Algeria is moving steadily towards achieving its goal to increase the renewable energy share of the total energy mix to 35%, (around 15,000 MW) by 2035, from photovoltaic energy, solar thermal energy, and wind energy, in addition to cogeneration, biomass, and geothermal energy.

The country seeks to generate about 1,000 MW of solar energy annually, with the country having natural capabilities that qualify it to play a prominent role in the international renewable energy production market, in parallel with its essential role in the gas trade.

In 2021, the total capacity of renewable energy connected to the grid - without counting hydroelectric sources - was about 438.2 MW, which included 12 MW of new solar photovoltaic energy, in 2022, the government worked on adding about 59 MW of solar photovoltaic power plants. While the capacity of off-grid renewable energy reached 39 MW in 2022.

Challenges and Outlook

The availability of fossil fuels at reasonable prices is considered one of the major obstacles to the development of renewable energy in Algeria, especially due to the low LCOE of fossil fuels compared to renewable energy.

According to the announced energy transition roadmap, Algeria planned to increase the share of renewable energy in the total generation to 35% by 2035. Yet, due to the increase in energy demand, with the national energy supply growing from 7% to 10% annually, and the need to reduce carbon emissions, there is an urgent need for an alternative plan with a greater emphasis on renewables energies, especially CST Technology. However, the challenges discussed must be addressed and resolved in order to speed up the process and meet the targets set.

Bahrain

Ebrahim Ahmed Radhi, Co- Founder & Board Member, Green Innova

Total power capacity (2020)	RE target by 2025	RE target by 2035	RE installed capacity (2020)
8,781 MW	250MW	710MW	10 MW

Source: IRENA

Current situation

Bahrain started working early on developing the renewable energy sector, as it commissioned its first project in the country ten years ago, the pioneering 5MW Project by Bahrain Petroleum Company (Bapco). Bahrain initially set a goal to increase the renewable energy share of the total energy mix to 5%, (around 250 MW) by 2025, and to 10% by (around 710 MW) by 2035. In addition, during COP 26, Bahrain pledged to double its targets to reach 10% by 2025, and 20% by 2035.

Bahrain's proposed renewable energy pipeline consists of solar energy, wind energy, and waste-to-energy technologies, and it is expected that solar energy will constitute the largest part of this percentage due to the geographical location and the climatic conditions of Bahrain. The year 2023 shall reveal projects in shopping malls, hospitals, universities, factories, and others. This progress is attributed to the establishment of required legislation, and the local presence of regional developers, qualified local EPCs, and world-class manufacturers of solar system components.

Bahrain is working diligently to ensure sustainability conditions in all infrastructure updates and new buildings. Green buildings codes, waste management, conversion into energy, waste recycling, and the use of clean energy are being widely implemented especially in the commercial and industrial sectors.

Challenges and Outlook

Bahrain has set the goal of net zero carbon emissions by 2060. To achieve this target, massive deployment of solar systems in the governmental premises is needed including ministries and governmental companies, which started with the 72MW tender.

Adapting renewable energy in the residential sector requires further focus. This sector is subsidised by the government, and the tariffs are low; thus, the incentive for the end user to switch to renewable energy is insufficient. Innovative subsidisation is needed to unlock the potential for the broader deployment of solar energy in the residential sector.

For the industrial sector, which relies heavily on natural gas in electrical generation, the way forward for decarbonising needs cutting-edge technologies along with solar energy, which includes the implementation of Energy Efficiency initiatives, development of green hydrogen, and deployment of carbon capture technologies.

Egypt

Abdelhamid Sallam, Energy Expert, Infinity Solar

RE capacity by 2022	RE share in electricity generation by 2022	RE target by 2035
8,778 MW	14.4%	50%

Source: IRENA & ITA (US)

Current situation

At the beginning of 2022, Egypt announced plans to add about 10,000 MW to the national electricity mix by the end of 2023. This comes within the framework of Egypt's plans to increase the share of renewable energy in the electric energy mix to 50% by 2035.

The share of renewables in electricity generation in Egypt increased from 8.7 GWh in 2019-2020 to 10.2 GWh during 2020-2021, an increase of 17.2%. By 2022, the share of renewables in electricity generation, which includes solar energy, wind energy, and hydro-power, reached 20% of the total energy mix.

The majority of this renewable energy growth is expected to come through independent power producer (IPP) contracts. The net-metering scheme is also expected to support the expansion of distributed PV, particularly large utility-scale projects for onsite consumption in the agriculture, cement, and commercial sectors.(*)

Iran

Mohammad Parhamfar, Consultant in Power and Renewable Energy

Behrouz Adelshahian, Commercial Manager, Rahsun

RE installed capacity by 2022	RE share in electricity generation by 2022	RE target by 2026
1,000 MW	1.1%	2.5 GW by 2026

Source: Iranian Ministry of Energy

Current situation

By the end of 2022, the total renewable capacity installed in Iran will reach approximately 1 GW. However, the share of renewables in electricity generation is only 1.1%. In its 7th national development plan, Iran's thirteenth government aims to increase the renewable capacity to 10 GW or which 4 MW will come from solar power plants.
Currently, 974.1 MW of renewable energy is installed, and 519.12 MW of it is supplied by solar energy plants.

Qazvin, Fars, and Kerman are leading provinces in terms of renewable energy plants, with respective capacities of 169.6, 92.5, and 89.5 MW.

In 2022, a total of 95,969 rooftop solar projects were installed in offices, commercial and residential complexes, with a total capacity of 8.291 MW.

However, only 0.6% of the newly added electrical generation stations were from renewable energy.

Challenges and Outlook

The structure of the electricity network in Iran should be appropriately modified to facilitate the development of renewable energies. At the moment, there is significant potential for the development of solar power plants. According to the grid connection studies, suitable lands are selected and ready to be handed over to investors. No legal framework for energy storage and large-scale batteries exists yet, which requires further investigation.

Despite the presence of knowledgeable experts and enthusiastic investors in Iran, the biggest challenge in the development of renewable energy is the imposed sanctions and the inflation rate, which sometimes makes solar projects unattractive to investors, according to economic studies. Foreign companies are likely to invest due to suitable radiation and appropriate tariffs upon the resolution of the aforementioned market barriers.

There are two main barriers to speeding up the renewables in Iran. The first is the existence of generous subsidies to the energy and power sector. This means that the price of electricity is lower than its production cost, and this issue leads to low interest in investing in renewables. When the electricity prices increase more than the LCOE of renewables, the demand for renewable systems will naturally increase. The second are the sanctions against Iran causing inflation and price volatility, which in turn increases the capital cost of renewable power plants.

However, Iran has a very good solar radiation potential, and its climate conditions are better for solar than many countries, leading to better PV module performance. Moreover, a convenient grid structure is expanded all over the country that facilitates the grid connection of renewable power plants and exports electricity to neighbouring countries. The regulations and instructions have made the market ready for investors to enter and construct renewable power plants. Though considering a foreign investment, the government should issue payment guarantees to assure investors.

Iraq

Waleed K. AlHallaj, Head of Business Development, MENA - Amarenco Group

Total power capacity (2020)	RE installed capacity	RE target by 2030
31,278 MW	2,490 MW	33%

Source: IRENA

Current situation

Due to the continued absence of renewable energy legislation in Iraq, exact figures cannot be provided for the total capacity of installed renewable energy. Meanwhile, Iraq continues to suffer from the inability to meet the electricity demand and, consequently, an unstable electricity supply.

Iraq continues developing strategies to achieve energy security, reduce power production costs, and cut electricity imports, leading to the announcement of plans to develop utility-scale solar power plants with a total capacity of 12 GW to reach 33% of clean energy sources by 2030.

In general, the Iraqi market is promising and has enormous potential due to Iraq being blessed with ample solar radiation and the fact that Iraq is an industrialised country with high energy demand.

The announcement of the large utility projects by the Iraqi government is expected to drive growth, and it is on track to become one of the most important solar energy markets in MENA by 2030.

Challenges and Outlook

The solar energy market in Iraq faces a major bankability challenge, which affects the progress of large projects that were announced in previous years and the overall progression of the market. More work is required to remove these hurdles to growth.

The distributed generation market in Iraq depends almost entirely on diesel generators. Furthermore, there is an apparent price difference between the official subsidised diesel price of 450 Iraqi dinars per litter compared to the black market, which on occasion could be more than 200% higher. These factors are expected to drive growth in distributed solar (C&I and Residential) faster. It is expected to be one of the biggest drivers of the substantial expansion in distributed solar in the coming years.

Jordan

Abdalrhman Alqatawneh, General Manager, AQ Electric

RE share in electricity generation 2022	RE target by 2030	RE capacity (2022)
30%	50%	2,526 MW

Source: The Jordanian Ministry of Energy and Mineral Resources

Current situation

In 2022, Jordan made significant progress in increasing the share of renewables in its electricity generation, with a figure of 30% compared to 26% at the end of 2021. This was achieved through the installation of more than 52,000 renewable energy systems using wheeling and net-metering systems.

As a result of these efforts, Jordan currently ranks first in the Arab world in terms of the share of renewables (including solar and wind) in its electricity generation, with Morocco in second place and Egypt in third. The installed capacity is distributed among 1,498 MW from commercial projects under power purchase agreements (PPAs), which constitute 59% of the total installed capacity. 1,027 MW comes from renewable energy systems owned by subscribers to cover their consumption using net metering and wheeling systems, representing approximately 41% of the total installed capacity.

Jordan has ambitious plans to further increase the percentage of electricity generated from renewable energy sources, with a target of over 50% by 2030.

Challenges and Outlook

Jordan has made significant strides in the development of its renewable energy sector, with the agreement in place to establish projects with a capacity of more than 1 MW after the suspension decision in 2019. However, there are challenges in the implementation of this decision.

As previously mentionned, according to the Ministry of Energy, the requirements for investment in the sector include the establishment of a new industrial project or the expansion of an existing one, as well as the submission of an energy performance evaluation study prior to the commencement of the project. These conditions can be difficult to meet, which can act as a barrier to entry for new investors and prevent existing investments from expanding to meet higher demand.

In order to effectively incorporate renewable energy systems into the electrical grid, it is necessary to strengthen the capacity and stability of the grid. There has been discussion about the government's plan to add storage systems to the grid by 2027, although no official confirmation has been given. It is important to continue exploring and implementing strategies to improve the capacity and stability of the grid in order to support the integration of renewable energy systems.

Lebanon

Fadi Al-Makdessi, Technical Sales Manager, GoodWe Technologies Co. Ltd.

RE target by 2030	RE capacity target by 2030	RE capacity target by 2024
30%	3,000 MW	1,000 MW

Source: IRENA & The Lebanese Centre for Energy Conservation

Current situation

Since the beginning of the economic crisis in Lebanon in 2019, inflation has skyrocketed, and the value of the currency has deteriorated. This has made the central bank stop subsidies on fuel imports. In parallel and due to the political sensitivity and the government's inability to increase energy prices, persistent power cuts continue daily in certain regions.

Unwilling to rely entirely on private generators, residential and industrial owners have opted for solar energy, and therefore, 2022 saw exponential growth in the solar PV and BESS segments.

The shares of renewables in electricity generation are expected to increase to 1,000 MW by the end of 2024 and reach 3,000 MW by 2030*, which would be a good step toward solving the electricity problems of Lebanon.

According to the last announced statistics in 2020, Lebanon's cumulative PV installation reached 93 MW. Lebanon plans to reach 30% of the total electricity generated by RE by 2030 and to reach 500 MW rooftop solar capacity and 2500 MW utility-solar capacity by 2030.

Challenges

- Continuous deterioration of the Lebanese Lira makes it harder for people to import components and raw materials.
- Failing banking sector creates a challenging financial environment for developers and industrialists seeking to secure loans to invest in large solar projects.
- No accurate statistics or tracking of solar or renewable energy installations is available, which makes global suppliers, developers, and EPC companies reluctant to invest in the market.
- High CAPEX costs for residential owners due to the need for batteries to operate in off-grid mode.
- Low adoption of grid-feed as national grid energy is rarely provided.
- Lack of technical expertise and quality control causing many problems at installation levels.
- Extremely diversified and uncontrolled supply sources, causing the spread of fake brands with growing concerns about the inability to provide adequate after-sales services.

Outlook

- Solar PV sector to continue its growth, mainly driven by diesel-hybrid applications.
- The market will further mature with the consolidation of EPC companies and installers together with the reduced number of component suppliers.
- Government to employ further regulations to ensure safe installations and maintain grid quality.

Morocco

Sophia Hasnaoui, Business Development Manager, Yellow Door Energy

RE share in electricity generation by 2022 (excluding hydropower)	RE target by 2030	RE capacity by 2022
20%	52%	4,151 MW

Source: Moroccan Ministry of Energy

Current situation

The Moroccan government supports the country's strategy of transition to renewable and clean energy, by cancelling some subsidies directed at fossil fuels and taking necessary measures to reduce carbon emissions.

Morocco considers strengthening its energy sovereignty a national priority, seeking to enhance its progress in the development of renewable energy and working to support efforts to transition to a carbon-neutral economy to attract more domestic and foreign investments to the sector.

In 2022, Morocco managed to add 203 MW of renewable energy to the total electrical generation capacity. The share of renewables in the electricity generation capacity reached 20%, not including hydroelectric power. Electricity generation capacity from renewable sources reached 38% of total electricity generation capacity, amounting to 4,151 MW, with the distribution between the various renewable sources as follows;

- Hydroelectric power (1770 MW)
- Wind energy (1551 MW)
- Solar energy (830 MW)

Morocco is moving steadily toward reaching the share of renewables in electricity generation to 52% by 2030, and it's expected to add about 5,287 MW of renewable energy by 2026.

Challenges and Outlook

Morocco is expected to add 4.4 GW of renewable capacity between 2022 and 2027, with solar PV, wind, and hydropower leading the way. This growth will be driven by the government's competitive independent power producer (IPP) auction program, as well as corporate power purchase agreements (PPAs) supporting onshore wind development and state-owned projects and installations for the production of renewable hydrogen contributing to solar PV expansion.

This year's forecast for onshore wind is more optimistic than last year's due to the expansion of existing projects and the announcement of new corporate PPA projects. However, the forecast for concentrated solar power (CSP) has been revised downward due to increasing uncertainty regarding the government's plans for solar thermal. The last tender for a CSP project was opened in 2019, but the project has not yet been awarded.(*)

Oman

Maryam Ahmed Yousef A Nofli,
Faculty Member at the University of Technology and Applied Science, Shinas

RE target by 2030	RE target by 2040	RE target by 2023
30%	13,400 MW by 2040	11%

Source: IRENA

Current situation

The Sultanate of Oman is well-positioned to take advantage of renewable energy sources due to its favourable geography and climate. As part of its "Vision 2040" plan to become one of the top 40 developed countries, Oman has set a number of strategies to increase the share of renewable energy in its energy mix. The government has implemented a range of measures, including royal decrees, orders, directives, initiatives, regulations, and laws, to encourage the use of renewable energy in the country.

In line with the United Nations' energy transition goals, Oman is working to increase the percentage of renewable energy consumption and reduce its reliance on natural gas in electricity generation. By 2030, renewable energy is expected to account for 30% of the total energy demand on the main grid, helping to improve the environmental performance index. Renewable energy-based industries also have the potential to support the economic growth of the country, and the Ministry of Energy and Minerals is actively promoting projects such as solar independent power producer (IPP) projects, wind farms, waste-to-energy facilities, and green hydrogen projects. Foreign investors are also welcome to transfer technology, conduct research and development, sell equipment and services, and participate in the privatisation of government assets.

Challenges and Outlook

Despite progress in establishing renewable energy sources in the Sultanate of Oman, large-scale development faces numerous hurdles. Even though their importance varies from country to country, these problems can be put into four main categories: institutional, technological, cultural, and market-related. Among the most important challenges in the field of renewable energy (RE) in the Sultanate are the following:

- Reliable data and references are necessary for investment and financing agencies to approve RE projects.
- Despite falling conversion device prices, the relatively high cost of RE technologies in comparison to conventional energy is still evident. For example,

the prices of solar cell panels decreased by half, but the costs of solar power plants are still much higher than those of conventional energy.

- To switch from using traditional energy sources to renewable energy to make electricity, the government has to give money, which is an extra burden on the government.
- The percentage of renewable energy contributions to the national energy mix has strategic and long-term implications.

Oman has a significant possibility of using RE, as solar, wind, biomass, and green hydrogen technologies can reach lower costs soon. The efficient application of these technologies would necessitate the development of a competent skill base and increase the level of skilled employment. It would help expand and diversify the economy, as well as the energy sources, in line with the goals of Oman Vision 2040.

Qatar

Ammar Abdelghani, Managng Director, Javlin New Energy

RE target by 2030	RE capacity by the end of 2024	Total Power Capacity by 2021
20% from solar	1,675 MW	10,614 MW

Source: IRENA & Qatar Energy & Country Economy

Current situation

During COP26, Qatar has committed to reducing 25% of its greenhouse gas emissions by 2030, a commitment reaffirmed during COP27. To deliver on its promise, Qatar plans to announce another 2 GW solar plant in 2023 and another 1.4 GW in 2026, further reducing its reliance on natural gas for electricity generation. Having said that, it is worth mentioning that the country intends to build another recycling facilities to help in reducing greenhouse gas emissions emitted from landfill and generate roughly 1 GW of electricity. Finally, Qatar has begun exploratory discussions with international companies in order to assess the feasibility of adding hydrogen to the energy mix.

In April 2022, Qatar released its green building regulation, which outlines new requirements for new buildings to obtain a completion certificate. Sustainability and carbon reduction has been the core of this plan, stipulating that all new building must obtain design and built GSAS certification offered by GORD. This will require an extensive audit of the design and materials to be used and will take into consideration greenhouse gas emissions based on scopes 1, 2, and 3. Existing industrial and retail buildings are also required to obtain Operation GSAS certificates as a condition for renewing licenses.

The Football World Cup 2022 has showcased the determination of Qatar to deliver on its commitment. All stadium has received a 5-star design and built sustainability certificate, which is administered by GORD. Carbon reduction extended beyond the stadium; the entire fleet of buses was powered by electricity reducing carbon emissions drastically. Museums floated tenders to purchase offsetting carbon credits, and Qatar airways launched a platform to sell offsetting carbon credits.

Challenges and Outlook

Changing people's perspectives regarding Renewable energy is the main challenge we have in Qatar. Usually, the decision to switch to renewables, e.g. solar, is often viewed from a financial point of view rather than an environmental one. However, like every MENA country, Qatar requires governmental intervention to effect change. It is worth mentioning that Qatar and all GCC countries rely heavily on water desalination for their water needs. Currently, sea pollution is at such a high level that it threatens our way of living. Water is what keeps us alive, and if we don't start to reduce sea pollution, we will face an existential crisis.

Switching to Solar energy makes sense, especially since Qatar has the highest CO2/KWH emission. However, the low electricity tariff makes such a switch financially infeasible at present. Despite this, there is noticeably more interest in solar energy due to the higher demand for electricity which the grid can't fulfil due to transformers reaching capacity. This will require higher capital expenditure and maintenance costs than solar, so hopefully, it will kickstart the transition to solar.

We do believe that the future is bright. Qatar vision 2030, commitments toward carbon emissions reduction, and new regulations will open the door for

more investments in the renewable industry. I genuinely believe that Qatar, in the near future, will come to be the new big thing in solar.

Saudi Arabia

Moneef Barakat, CEO, Solarabic

Target by 2060	RE target by 2030	RE capacity by 2023	RE capacity by 2030
Net zero carbon emissions by 2060	50% by 2030	9.5 GW by 2023	58.7 GW by 2030

Source: Vision 2023 & Climate Transparency org.

Current situation

Saudi Arabia is expected to add 10 GW of renewable capacity between 2022 and 2027, with solar PV leading the way. This growth will be driven by four procurement mechanisms: competitive auctions, unsolicited bilateral utility contracts, corporate power purchase agreements (PPAs), and state-owned projects. The forecast for this growth has been revised upward from previous estimates due to progress made under all four business models and the announced climate commitments during COP27.

For competitive auctions, PPAs have been signed for half of the projects in Round 3, and Round 4 opened in September 2022 with higher-than-expected volumes on offer. The country's first corporate PPA project was commissioned in 2021 after the implementation of a new Private Sector Participation Law that allows developers to sell directly to consumers. This regulatory change is expected to facilitate the growth of future corporate PPA projects.

Additionally, the government has announced plans to develop another 2.3 GW of renewable capacity through bilateral contracts under the Public Investment Fund and build state-owned projects in industrial cities. However, the pace of auctions for onshore wind remains to be determined, as it took four years to commission the Round 1 projects, and the capacity earmarked for wind in Round 3 is yet to be awarded (source IEA).

The total generating capacity of the National Renewable Energy Program projects in the Kingdom is expected to reach approximately 5.6 million megawatt-hours, with clean electricity generation capacity increasing to around 58.7 GW by 2030. Of this, 40 GW will come from solar energy, 16 GW from wind energy, and 2.7 GW from other renewables.

Challenges and Outlook

Saudi Arabia is actively working to increase the use of renewable energy as part of its goal to reduce reliance on fossil fuels and achieve net zero carbon emissions by 2060. Although there may be challenges in the future, such as competition with fossil fuels and the pace of the adoption of net billing system by consumers, the government has taken steps to improve legislation and increase the self-consumption limit to include large capacities over 2 MW in order to boost the distributed generation (DG) market.

The utility-scale market in Saudi Arabia is currently one of the most important in the Middle East and North Africa region, with annual additions of approximately 1-1.5 GW. Overall, Saudi Arabia is making progress in increasing the use of renewable energy and reducing reliance on fossil fuels.

The Saudi government has taken significant steps in recent years to address the challenges and encourage the development of renewable energy projects. These efforts include the establishment of the Saudi Renewable Energy Project Development Office to oversee the development of renewable energy projects and the launch of the Solar Energy Plan, which aims to install 27.3 GW of solar capacity by 2030. Additionally, the Kingdom plans to launch the greenhouse gas certificates market in 2023 as part of its efforts to reduce carbon emissions. Overall, Saudi Arabia is making notable progress in increasing the use of renewable energy and reducing reliance on fossil fuels.

Sudan

Mohammad Elgadal, Energy Researcher, Energy Research Center (ERC)

RE installed capacity by 2022	RE target by 2030	RE target by 2030
200 MW	2,936 MW by 2030	20%

Source: World Bank & IRENA and Experts

Current situation

Sudan still suffers from the lack of grid access to all regions of the country and the inability of the government to cover energy demand, especially with the high increase in energy demand by 12% annually.

According to the latest statistics of the energy sector in Sudan, the percentage of installed solar energy in Sudan amounted to 200MW. However, the number is expected to be much higher, given that most installed projects are off-grid.

The domestic sector is considered to be one of the largest energy-consuming sectors in Sudan, as it consumes 52% of the energy, and 40% of the energy is used in refrigeration and air conditioning operations due to the prevalence of hot weather in Sudan.

Challenges and Outlook

Sudan is counting on renewable energy projects to fill the power plants' deficit and secure its citizens' needs from the growing demand for electricity. The participation of the private sector in power generation projects still needs to be improved despite the government's facilities to invest in the energy sector.

Tunisia

Jwana Abusafieh, Sungrow Middle East

RE installed capacity by 2022	Targeted RE capacity by 2030	RE target by 2030
472 MW	3,800 MW	30%

Source: International Trade Administration & Energy Data & RCREEE

Current situation

Tunisia seeks to achieve energy independence, diversify the energy mix for electricity production, and reduce the cost of subsidies allocated to the energy sector, through the implementation of alternative energy projects. Because currently, natural gas is used to generate 97% of electricity, while renewable energy sources contribute only 3% to Tunisia's electricity generation.

The continued reliance on natural gas for electricity generation threatens the security of supplies, especially after production recorded a sharp decline. This has prompted the Tunisian government to search for more reliable sources, and solar is likely to be the ideal solution.

Tunisia aims to increase the share of renewables in electricity generation to 30% by 2030, as it plans to produce 3,800 MW of renewable energy projects. If implemented, this large volume of renewable energy will crucially help reduce the country's energy dependency and the carbon footprint of electricity generation. Integrating more cost-efficient and domestic energy sources, in addition to the growth in renewable energy projects, will help reduce Tunisian Electricity and Gas Company's (STEG) vulnerability to global oil price volatility.

Major Challenge

Tunisia has a relatively small but growing renewable energy sector. The country has a target to increase its renewable energy capacity to 30% by 2030, focusing on solar and wind energy.

As of 2022, Tunisia has signed power purchase agreements (PPAs) with a number of large-scale solar photovoltaic (PV) plants, including the 50 MW Sidi Bouzid solar plant, the 100 MW Kairouan solar plant, the 200 MW Tataouine plant, the 50 MW Tozeur plant, and the 100 MW Gafsa plant.

The regulatory environment for renewable energy in Tunisia is fairly supportive, and the government has taken a number of steps to encourage the sector's development. However, there are still challenges to the development of renewable energy in the country, including Economic instability and the need for financing.

Overall, the renewable energy sector in Tunisia is still in its early stages, but the government is actively promoting the development of renewable energy sources, and there is potential for significant growth in the coming years.

UAE

Waleed K. AlHallaj, Head of Business Development - MENA, Amarenco Group

RE target by 2030	RE installed capacity by 2021	RE target by 2030
30% by 2030	2,706 MW by 2021	14,000 MW

Source: MOEI UAE & Global Energy Prize

Current situation

The United Arab Emirates (UAE) is making significant progress in increasing the use of renewable energy and reducing its reliance on fossil fuels. The country has set ambitious targets to increase the share of renewable energy in its total energy mix, with the goal of producing 50% of its electricity from clean energy sources by 2050.

To achieve this goal, the UAE has implemented several initiatives and projects to promote the use of renewable energy. This includes the establishment of the Dubai Clean Energy Strategy 2050, which aims to provide 75% of Dubai's total power capacity from clean energy sources by 2050. The UAE also has a number of large-scale renewable energy projects underway, including the Mohammed bin Rashid Al Maktoum Solar Park, which aims to generate 5,000 MW of electricity by 2030, with the UAE achieving net zero by 2050.

In addition, the UAE has made significant investments in research and development to improve the efficiency and affordability of renewable energy technologies. This includes the establishment of the International Renewable Energy Agency (IRENA) in Abu Dhabi, which aims to support the global transition to renewable energy and promote the adoption of clean energy technologies.

Overall, the UAE is making strong progress in increasing the use of renewable energy and is well on track to achieving its ambitious targets for clean energy generation.

Challenges and Outlook

The United Arab Emirates (UAE) has made significant progress towards increasing its dependence on renewable energy in recent years, with the goal of increasing the share of clean energy in its total power mix to 50% by 2050. Currently, the UAE is one of the fastest growing utility-scale markets in the Middle East and North Africa region, with approximately 2,000 MW of renewable energy being installed annually. However, there are several challenges that the country is facing in achieving its goals.

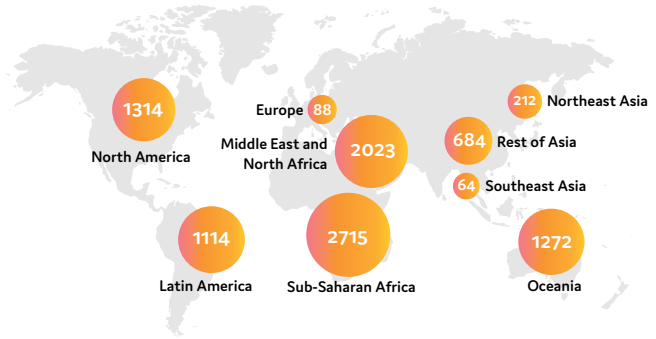
One such challenge is the lack of regulation for the distributed generation (DG) market in the UAE outside the Dubai emirate. However, in November 2021, the UAE announced its intention to adopt a federal law regulating the connection of distributed renewable energy production units to the electrical grid in all 7 emirates. This is expected to greatly revitalise the DG market over the next few years, with an estimated annual increase of 400-500 MW annually once regulations are in place, compared to the current rate of around 60-100 MW annually. This will represent a significant leap for the DG market in the UAE.

In the utility-scale sector, the projects are primarily focused in Dubai and Abu Dhabi. The consolidation of these utility-scale projects makes it very hard for local developers and EPCs to grow in the local utility-scale sector.

Green hydrogen potential in the Middle East and Africa

The Middle East and North Africa (MENA) region and Sub-Saharan Africa (SSA) have significant potential for the production of green hydrogen, according to the International Renewable Energy Agency (IRENA). Sub-Saharan Africa has the greatest potential for producing cost-effective green hydrogen, with a projected cost of less than $1.50 per unit by 2050.

Technical potential for producing green hydrogen under USD 1.5/kg by 2050, in EJ



Source: IRENA
https://www.irena.org/News/pressreleases/2022/Jan/Hydrogen-Economy-Hints-at-New-Global-Power-Dynamics

IRENA's analysis indicates that Sub-Saharan Africa has the highest technical potential, at 2,715 exajoules, followed by the Middle East and North Africa region at 2,023 exajoules, Asia-Pacific at 2,232 exajoules, Latin America at 1,114 exajoules, North America at 1,314 exajoules, and Europe at 88 exajoules.

The production of green hydrogen can also create new economic opportunities and support the development of domestic renewable energy markets in both the MENA and SSA regions. However, the development of green hydrogen projects will require significant investments in infrastructure, including electrolyzers and storage solutions. It will also require policy support and regulatory frameworks to encourage private-sector investment and enable the integration of green hydrogen into various sectors.

The increasing demand for green hydrogen in both the MENA and SSA regions presents a significant opportunity for the transition to a more sustainable and low-carbon future. As the demand for maritime trade continues to grow, particularly in Africa, green hydrogen could play a crucial role in meeting the increasing demand for electricity for synthetic fuels, while also reducing carbon emissions.

An expanding network of hydrogen trade routes, plans and agreements

Source: IRENA
https://www.irena.org/News/pressreleases/2022/Jan/Hydrogen-Economy-Hints-at-New-Global-Power-Dynamics

This extract from "Unlocking the Potential of Green Hydrogen: A Global and Regional Overview, with a Focus on the Middle East and North Africa (MENA)" is provided as an exclusive preview by Middle East Solar Industry Association (MESIA). The full upcoming report produced in collaboration with Solarabic will be published in its entirety in March 2023.

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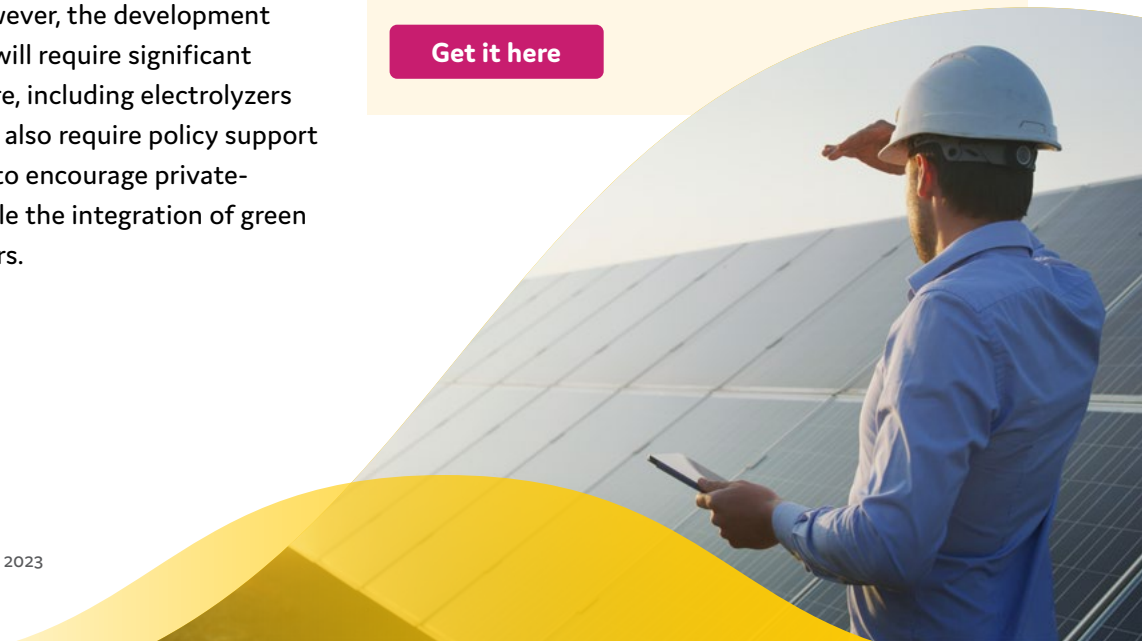


CHAPTER 4

New equipment for new energy: insights from Frost & Sullivan

FROST & SULLIVAN

New equipment for new energy

The outlook for Battery Energy Storage Solution (BESS) and Electrolysers

Author: **Neeraj Sanjay Mense, Consultant – Industrial Practice, Frost & Sullivan**

Top Trends in 2023

As per Frost & Sullivan's recent analysis on Middle East Oulook for the Energy Sector, the year 2023 will be a year of balance for energy. Conventional energy sources (oil and gas) will maintain their prominence in the GCC and the broader Middle East. Investments in new sources of energy will increase, driven by commitments made toward emissions reduction. We expect to see an increased push by utilities, regulators and associated entities toward decentralised infrastructure improvements. This would involve storage, EV integration, and solutions that integrate solar energy for cooling/heating/lighting. Utilities will need to look at new business models, as energy consumption declines.

Top 5 trends to watch in 2023

1. Going decentralised - From buildings to utilities, the focus will be on decentralised solutions.
2. Grid digitalisation and EV integration - Two of the largest investor countries in power in the GCC will see an increased investment in integrating electric vehicle infrastructure into cities.
3. Hydrogen will create new value chains - New business opportunities will emerge from investments in hydrogen infrastructure.
4. Gas and solar continue to co-exist - Investments will continue in building new solar capacity and sustaining gas infrastructure.
5. Oil to maintain highs - Oil will stay at least 15% above 5-year averages, though headwinds are expected.

Here we take a close look at two hardware factors related to these megatrends: electrolyser production; and battery energy storage solutions. A global viewpoint gives the larger context in which to understand these factors in the Middle East and Africa.

Green hydrogen and the drive for electrolyser manufacturing

Inevitable demand

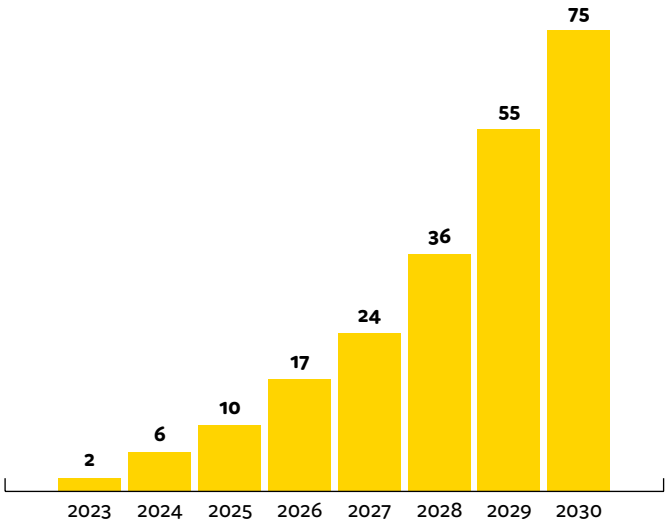
There has been a growing demand for alternative forms of energy storage that can be effectively employed to integrate renewables in the global energy value chain while targeting decarbonisation across multiple energy intensive end user segments. In the quest to decarbonise the economy, one term consistently garnering global attention has been "hydrogen," which can replace as much as 10% of the total final energy consumption by 2050.[i] Depending on the fuel source and the manufacturing process employed, different types of hydrogen vary in terms of their carbon emissions, the most sustainable being "green hydrogen" produced through renewable electricity.

Hydrogen can be effectively used as a long-term energy storage solution to account for seasonal variations arising from high renewable energy capacity in the grid. During periods of excess generation, excess electricity from renewable plants can be used to power electrolysers for hydrogen production, which can then be stored in liquid, gas or chemical (ammonia) form. In periods of peak demand, stored hydrogen can be released to produce power through hydrogen power plants or retrofitted gas power plants.

Electrolysers are modular processing units that use an electrical current to split water into its individual components—hydrogen and oxygen. When the source of electricity used for electrolysis is from a renewable resource like solar, wind, biomass, etc., the resultant hydrogen produced is green hydrogen.

Electrolysers will be a cornerstone of the hydrogen economy, as they will dominate green hydrogen production. Once a relatively niche sector focused on small-scale kW and MW projects, the scale of electrolyser projects will rapidly escalate as industrial customers look for reliable supplies of hydrogen. Reducing electrolyser costs will be vital, and 2023 is likely to see further reductions. Economies of scale will be achieved through new, larger production facilities coming online as well as technological innovation and improved material and component sourcing.

Electrolyser Capacity Forecast, Global, 2023–2030 (GW)



From 0.1% of global hydrogen production in 2022, green hydrogen is anticipated to reach about 23% by 2030, 57% by 2040, and 67% by 2050.[ii]

Three growth opportunities that companies and countries can unlock

1. Achieving cost reductions will be vital to improving competitiveness of green hydrogen, thus investing to automate the production process as much as possible is important. Ultimately, electrolysers will become a commodity product, creating opportunities for suppliers to provide as-a-service outcome-based offerings.
2. Advanced materials will also play a crucial role in reducing the cost of electrolysers creating opportunities for sub-suppliers (e.g., polymers and composites) to provide new alternative materials to manufacturers. Finding ways to reduce the use of rare noble metals in electrolysers will be important as emphasis will also be placed on ensuring a minimum emissions footprint of electrolysers.
3. Colocating electrolysers with a power generation source will also bring opportunities. Offshore wind projects for example can soon have electrolysers on nearby platforms, with some projects dedicated to green hydrogen production.

Demystifying the True Potential Battery Energy Storage Solution (BESS)

Toward energy storage

The energy industry and associated technologies are continually evolving as demand, supply and consumer preferences change, supported and spurred by economic development and advances in technology. In the 21st century, the global energy industry is rapidly shifting toward low-carbon energy sources, with hydrocarbon resources like coal and oil gradually losing penetration. While non-hydro renewables like wind, solar, geothermal and biomass are expected to grow substantially, it is expected that the majority of the global electricity demand will still be met by coal and natural gas through to 2040, with commercial factors playing a defining role in the evolution of the industry.

As we move forward, we can expect to see decentralisation, decarbonisation and digitalisation as the main pillars that will shape the next wave of energy evolution. Decarbonisation as a trend involves the targeted reduction and elimination of hydrocarbon-based fuels from the value chain. Multiple modalities are being adopted to decarbonise the value chain, including renewable-based electricity generation, energy efficiency improvements across industrial, residential and commercial end users, as well as the shift toward cleaner mobility like electric and hydrogen/fuel cell vehicles. Globally, electricity generation has been dominated by traditional hydrocarbon sources like coal and natural gas, cumulatively accounting for over 54% of the total installed capacity globally, with the remaining capacity accounted for by hydroelectric power, renewables and nuclear.[iii] However, the highest growth in installed capacity has been recorded by renewable energy, while fossil fuel-based power generation has witnessed a decline, primarily due to the shutdown of coal-fired power stations in Europe.

Growth in renewable energy capacity has been driven by large-scale investments in wind and solar power generation. Renewable energy growth witnessed over the past decade will continue over the next two decades, with increasing investments in solar PV and wind power capacity. Solar PV capacity is expected to grow more than 4X to over 3,100 GW, and wind capacity approximately 2.5X to 1,850 GW by 2040, according to the International Energy Agency's (IEA) reference Stated Policies Scenario.[iv] Gas-based power generation is expected to play a crucial role in supporting/complementing renewable generation and will witness growth over the next couple of decades.

While renewables are a carbon neutral source of power leveraging an infinite source of fuel, strong grids and energy storage systems are key to addressing the variable nature of resources like solar and wind. Although solar and wind power systems are complementary across certain locations, modern power systems are required to match demand with supply and ensure reliable operation at all time periods. The variable nature of renewable resources like solar and wind is the biggest and most significant challenge for grid networks. High penetration of renewables can lead to system instability and a reduction in the amount of system inertia that is normally provided by turbines and generators at large conventional thermal power plants. Variability in generation resources can require additional mechanisms to balance the system/network. A higher degree of flexibility in the system may be required to accommodate the supply-side variability. Grid operators need to ensure the availability of sufficient resources to account for the considerable variation in renewable generation.

There are several solutions that can be employed to address the challenges posed by large scale renewable integration to the electricity grid. One of the more emerging modalities is the integration of energy storage technologies across the value chain which ensure network flexibility while also enabling demand response strategies, fast dispatch as well as reserves management. Energy storage also has the capability to provide capacity firming, energy arbitrage, and frequency regulation, among other ancillary services. Additionally, energy storage would also play a vital role in deferring upgrades that would be needed for the transmission and distribution networks, reducing the need for additional grid investments.

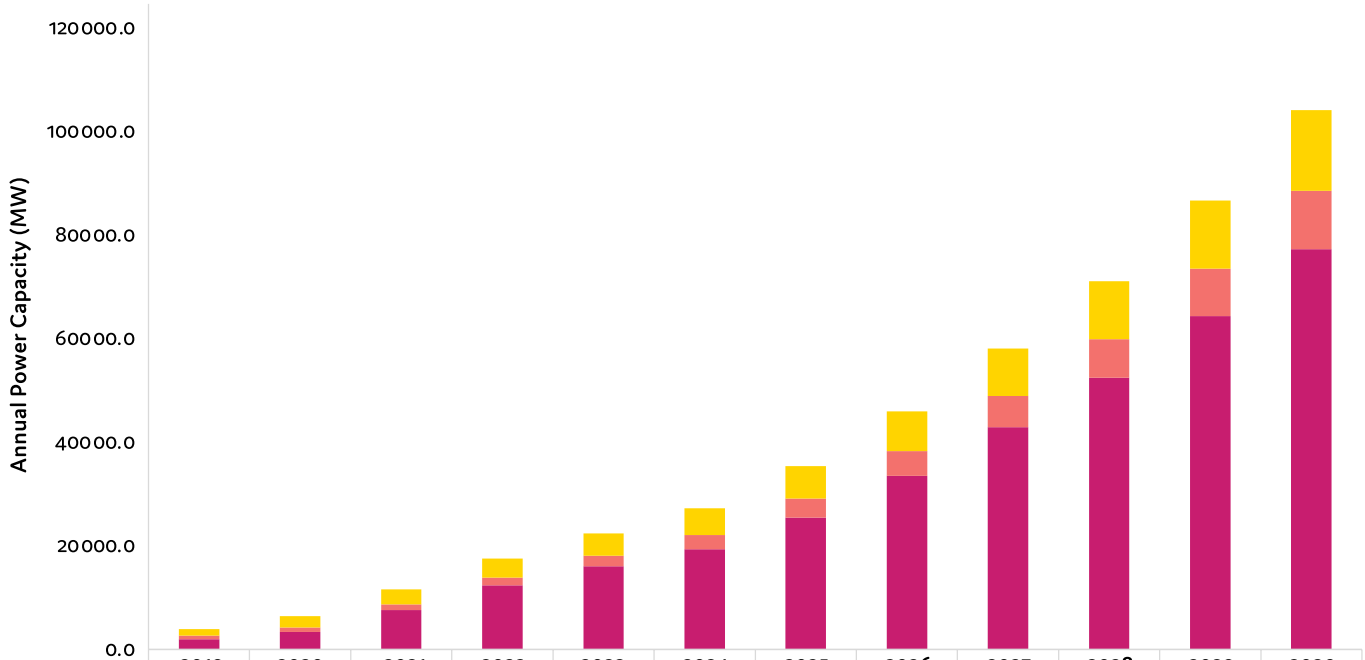
BESS on the rise

Among the different types of solutions, Battery Energy Storage Solution (BESS) is a strong segment, along with Thermal Energy Storage (TES) systems, and the development of green hydrogen storage solutions for integration of renewable energy into the utility grid.

BESS deployment is on the rise globally, driven by falling costs, technological improvements, and governmental support. The technology is set for exceptional growth during the 2020 decade.

Battery Energy Storage: Annual Power Capacity Forecast by Segment, Global, 2019–2030. CAGR, 2022–2030 = 24.9%

Note: All figures are rounded. The base year is 2022.
Source: Frost & Sullivan Battery Energy Storage Growth Generator



	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Residential	1,241.8	2,209.1	2,840.0	3,676.3	4,337.8	5,140.1	6,282.0	7,640.2	9,196.7	11,198.8	13,178.0	15,565.5
C&I	685.5	883.8	1,096.1	1,500.2	2,026.3	2,759.1	3,680.0	4,744.9	5,997.7	7,450.1	9,146.7	11,305.2
Grid Scale	1,974.9	3,354.2	7,641.8	12,367.5	16,049.7	19,359.8	25,422.2	33,549.5	42,908.6	52,472.3	64,356.0	77,275.5

Year

Global BESS capacity deployment is expected to increase from 17.54 GW/38.26 GWh in 2022 to 104.15 GW/301.01 GWh in 2030[v] , driven by an increase in intermittent renewables capacity, supportive government policies, and cost decline. BESS energy capacity growth would be higher than power capacity, recording 29.4% and 24.9% CAGRs, respectively, primarily due to an increase in grid-scale project duration. Maximum grid-scale storage projects have been designed primarily to supply quick power for frequency regulation services, requiring high-power and short-duration batteries. However, BESS will continue to play a growing role in energy arbitrage, time shifting, and capacity firming, requiring higher energy capacity. The grid-scale/utility sector will continue to remain the leading sector for growth in BESS capacity, accounting for an estimated three-quarters of the total installations by 2030, while the less-developed commercial & industrial (C&I) sector will experience higher growth than residential batteries, reaching similar levels of energy capacity.

The grid-scale BESS market is poised for accelerated growth, a segment where annual power capacity increased from 7.64 GW in 2021 to 12.37 GW in 2022, while 2023 is expected to further this trend, with an estimated 16.05 GW expected to come online. Frost & Sullivan estimates grid-scale annual capacity to reach 77.28 GW/247.15 GWh by 2030. Grid-scale projects are expected to expand in number, size, and duration as the global market for BESS transitions from a frequency response/grid balancing provision role to integrating renewables, firming capacity, and energy shifting.

Between 2023 and 2030, regions across the world are forecasted to add 331.39 GW of power capacity. China and the US will be the major sources of those additions, accounting for 63.5% of added power capacity. Meanwhile, India, Australia, and the United Kingdom are expected to surpass 15 GW of additions during same period. Major electricity markets have passed national or subnational (or both) regulations incentivising BESS development.

Drivers and challenges

Some of the key drivers of global growth in BESS deployment are the following:

1. Commitments towards low-carbon electrification and energy security concerns will intensify the deployment of variable RE generation capacity, requiring grid-scale storage solutions to address concerns around grid congestion and achieve effective load balancing;
2. Advancements in the EV market and expansion of battery production capacity translate into system performance improvements and cost reductions;
3. Government incentives and evolving market regulations, including time-of-use tariffs, ancillary services markets, and distributed generation rules incentivising self-consumption will improve feasibility for BESS through creation of alternate revenue streams;
4. Market maturity will result in improved funding availability for manufacturing and deployment of BESS;
5. Rising benefits of decentralised generation and storage for C&I and residential customers in the wake of increasing grid based electricity prices;
6. Rising events of grid outages coupled with reliability issues has placed an impetus on developing alternative reliable sources of backup power by C&I and residential customers.

Despite a positive growth outlook, several challenges exist, which if adequately addressed, provide the opportunity to realise the true potential of BESS, including:

1. In most electricity markets, flat electricity tariffs, inadequate net metering mechanisms, and lack of BESS access to wholesale markets make the business case challenging for front and behind-the-meter installations;
2. BESS System Costs are still high for widespread adoption in commercial, industrial, and residential segments in countries without any incentives;
3. Supply chain constraints, driven by the EV market acceleration has resulted in higher prices in construction materials, metals, and critical minerals, and exacerbated by the geo-political volatility has put cost pressure on BESS projects, deferring or even canceling a few of them.

Despite constraints in the supply of critical minerals and materials, shipping and permitting processes, BESS is poised for accelerated growth. Governments have formed and will continue to formulate policies and plans with long-term effects for renewable energy and BESS, a critical element for the much-needed flexibility and resilience that modern energy systems require.

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- Geographic expansion
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- Improving market share

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[i] IEA Global Hydrogen Review, 2021

[ii] Frost & Sullivan Analysis

[iii] Electricity Generation by Energy Source/Activity, US Energy Information Administration, 2020 (https://www.eia.gov/international/data/world/electricity/electricity-capacity)

[iv] Installed power generation capacity by source in the Stated Policies Scenario, 2000-2040, IEA 2020 (https://www.iea.org/data-and-statistics/charts/installed-power-generation-capacity-by-source-in-the-stated-policies-scenario-2000-2040)

[v] Frost & Sullivan Analysis

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