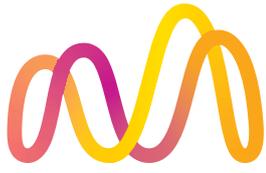


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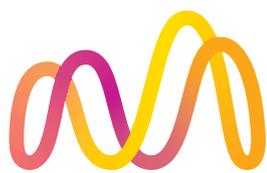
Middle East and North Africa 2024 Energy Industry Outlook



Table of Contents

Chapter 1: The Middle East and North Africa Outlook	03
Chapter 2: Renewable Energy in MENA Region	08
Chapter 3: Energy Storage in the MENA Region	12
Chapter 4: Clean Energy in MENA Region	16

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Chapter 1

The Middle East and North Africa Outlook



Introduction

The countries of the Middle East and North Africa (MENA) play a central role in the global economy as a result of their hydrocarbons resources.

The region is home to 52% of global oil reserves and 36% of worldwide production. It is also well placed with natural gas, with 43% of reserves and 22% of global output, according to data from the Energy Institute. This wealth of natural resources has underpinned local economic activity for decades, particularly in the Gulf, but the global push to decarbonise means the region will not be able to rely on oil and gas to fuel its economies indefinitely.

The Gulf stands out as a particularly heavy user of energy, thanks to its reliance on air conditioning, desalinated water and other energy-hungry technologies. Energy consumption in Qatar was almost 700 gigajoules (GJ) per person in 2022, according to the Energy Institute, while the figure for the UAE was 535GJ and Kuwait was 374GJ. To put that in context, the global average that year was just 76GJ per capita. The North African economies of Algeria, Egypt and Morocco all came in well under that global benchmark.

MENA countries are often relatively small and the regional electricity market is dominated by a few big players. Saudi Arabia, Iran and Egypt between them accounted for 54% of the 1,757TWh of electricity generated in 2022.

The need to address climate change issues means countries are changing their approach, investing increasing amounts in renewable energy for domestic electricity generation, while also striving to make progress on energy efficiency initiatives.

The region is highly vulnerable to the impact of climate change and temperatures have been rising more quickly in the Middle East than the world as a whole, according to the Paris-based International Energy Agency (IEA).

In the longer-term, the region's ample solar and wind power potential could lead to different sorts of

exports to replace oil and liquified natural gas (LNG) shipments. There are a number of schemes to pipe electricity from North Africa into Europe and renewable energy also underpins hopes of producing 'green' hydrogen for export.

Current Energy Mix

The electricity industry across the MENA region is having to expand to meet the needs of growing populations. Total generation rose by around 38% from 2012 to 2022, taking it to 1,757TWh by the end of that period.

Renewable electricity generation galloped ahead far faster, though. Non-hydroelectric renewable generation grew more than tenfold over the same period, from 3.6TWh in 2012 to 45.6TWh a decade later. Including hydroelectric power brings the clean energy total to 72TWh. To take one example of how the energy landscape is changing, the UAE has gone from having almost no renewable generating capacity in 2012 to 7TWh by 2022.

However, for all the billions of dollars being poured into solar, wind and other renewable schemes, the vast majority of the electricity consumed around the region still comes from burning fossil fuels.

Oil, natural gas and coal collectively accounted for around 96% of electricity generated across the MENA region in 2022, according to data compiled by the Energy Institute.

The highest proportion of renewable energy in the mix was in Morocco, where it accounted for 17.4% of the total, followed by the UAE with 11.9%. At the other end of the scale, renewables made up just 0.2% of electricity generated in Saudi Arabia and 0.3% in Kuwait.

In the Middle East, burning oil had provided the majority of electricity generation up to the late 1980s, but natural gas overtook it in 1989 and it has been the dominant fuel ever since. Gas accounted for 72% of total electricity production in the Middle East in 2022. Oil-fired power stations provided a further 22%, down from 36% a decade earlier.

Coal use peaked in 2001/02, when it accounted for 7% of generation, but it is now a peripheral element in almost all countries, with a regional market share of less than 1.5%.

Among the few places where it still plays a more important role is Morocco, where Jorf Lasfar, Safi and other coal-fired plants provide around 70% of the total electricity supply. Change is on the way, though, with Morocco signing up to work with the Powering Past Coal Alliance (PPCA) in December 2023.

Hydroelectric power has been developed in about half the MENA countries, but it is only a significant element in a handful of them. According to the International

Hydropower Association (IHA), Iran has the largest installed capacity in the region with 12,187MW, followed by Egypt with 2,876MW and Iraq with 2,753MW.

Despite its smaller capacity, Egypt produces the most hydroelectric power, generating some 14TWh a year from its River Nile dams. The output of Iran's hydroelectric plants has fallen sharply in recent years, to just 7.5TWh in 2022 – due, in large part, to drought conditions.

The UAE is joining the hydropower club, with the development of the 250MW Hatta dam in the Hajjar mountains in Dubai. It will be the first hydropower plant in the Gulf Cooperation Council (GCC) and also includes a pumped storage element.

Nuclear remains a minority pursuit, with Iran and the UAE currently the only countries to produce atomic power, at their Bushehr and Barakah plants respectively. However, Egypt is also developing a plant at El Dabaa on the Mediterranean coast.

Recent Trends

Governments in the MENA region have made a concerted effort to engage with the shift in global attitudes to energy use, while maintaining a focus on exploiting their existing hydrocarbons reserves as effectively as possible.

Egypt hosted the COP27 climate change summit in the Red Sea resort town of Sharm El Sheikh in November 2022. The following year, Dubai hosted the COP28 summit, where governments from around the world pledged to work together to triple the world's renewable energy generation capacity to 11,000GW by 2030 and double the global average annual rate of energy efficiency, as part of efforts to keep the global temperature limit of 1.5°C within reach.

“Whilst we didn't turn the page on the fossil fuel era in Dubai, this outcome is the beginning of the end,” said UN Climate Change Executive Secretary Simon Stiell at the conclusion of COP28.

In the short-term, the MENA region's hydrocarbons producers seem in little hurry to bring about the end of the oil era, but they are taking action to develop more renewable energy plants and reduce the amount of oil and gas used domestically, if only so that more is available for export. They are also taking other steps to reduce their domestic carbon emissions.

Solar and wind power plants have now been developed in most parts of the region, as governments seek to diversify their energy mixes. For energy importing countries, such projects have the benefit of improving their energy security as well as reducing their import bills.

Nuclear power is also growing, although it remains a minority pursuit. Iran's only nuclear plant is the Russian-built reactor at Bushehr, but work on a second reactor at the site began in 2019 and in February 2024, the Atomic Energy Organisation of Iran (AEOI) chief Mohammad Eslami announced construction work had begun at a 5GW nuclear plant at Sirik, Hormozgan province.

Iran's nuclear programme continues to be mired in controversy, with critics claiming it is being used as cover for developing a nuclear weapons capability. Tehran denies those charges, but it has acknowledged enriching uranium far beyond what is needed for electricity generation.

Despite the controversy often attached to nuclear power, others are joining the atomic club. A Russian-designed plant with four reactors is currently under construction on Egypt's Mediterranean coast at El Dabaa. Saudi Arabia is also moving in the same direction, with a plant proposed for Duwaiheen in the Eastern Province.

Challenges

The attacks on commercial shipping in the Red Sea and Gulf of Aden by Yemen's Houthis which began in late 2023 and continued into 2024 underlined the ability of geopolitical tensions to disrupt the region's energy trade. QatarEnergy was among those to announce that its westward-bound LNG shipments would go around the southern tip of Africa rather than through the Suez Canal to avoid Houthi drones and missiles.

Energy exports are a critical element underpinning the economies of the Gulf countries, but Houthi attacks are a relatively small inconvenience compared to the broader global push to reduce the use of carbon-based fuels.

That trend presents a serious long-term threat to the region. The answer that Middle East oil and gas producers have hit on has been to reduce hydrocarbons use in their domestic economies, in order to free up more to sell overseas while there is still a market. Gulf countries aim to be among the last producers standing, selling crude long after others have capped their wells. That ambition is helped by lower production costs than many other parts of the world.

Abu Dhabi National Oil Company (Adnoc) is aiming to expand its production capacity from around 4.5m b/d now to 5m b/d by 2027. Kuwait Petroleum Corporation (KPC) said in 2023 it would raise its maximum output to 3.15m b/d within four years.

However, Saudi Arabia surprised the markets in late January 2024, when the Ministry of Energy told Saudi Aramco to abandon a plan announced in March 2020 to raise its maximum production capacity from 12m b/d to 13m b/d.

Saudi Arabia has been producing far below its potential in recent years, as a result of a succession of agreements between the Opec cartel and Russia and other non-Opec members. The Opec+ agreements to voluntarily reduce output have been an attempt to bolster market prices, but have had mixed success.

Environmental concerns are also a critical challenge for countries around the region. The Middle East is particularly vulnerable to higher temperatures, scarcity of water, increased desertification and rising sea levels and, while the oil-rich countries in the Gulf may have the financial ability to address these issues in the short-term, the poorer, oil-importing countries in the region will find it far harder to deal with the consequences of climate change.

Opportunities

The changing nature of regional and global energy markets offers opportunities alongside the challenges. In particular, there is the potential to export electricity generated from renewable power sources from North Africa into Europe.

Some ambitious schemes have been launched to tap into this opportunity, including the Xlinks Morocco-UK Power Project to send solar and wind energy from southern Morocco to Britain via a 3,800km, subsea cable. The project's backers say they will be able to generate enough zero-carbon electricity to supply 8% of the UK's electricity needs.

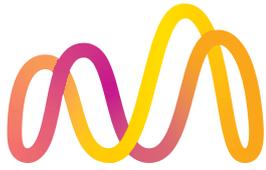
Other projects include the €921m (\$999m) Elmed-Tunita high-voltage direct current (DC) connection between Tunisia and Sicily, which should be completed by 2028.

Gulf countries are also looking to use their expertise and capital to develop renewable energy schemes beyond the region, including in Africa and central Asia. Among the most active players are Abu Dhabi's Masdar and Saudi Arabia's Acwa Power.

Other emerging fuels could provide opportunities for the region to switch from being an exporter of oil and gas to a seller of clean, next-generation fuels. In particular, the likes of Oman and Egypt are pushing to develop large 'green hydrogen' schemes, which use renewable energy to produce zero-carbon hydrogen and ammonia which can be shipped to customers around the world and used as fuels. Such projects require substantial investment in gigawatts of renewable generating capacity, but the business case remains unclear, given the lack of an existing large pool of customers for such fuels.



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Chapter 2

Renewable Energy In Mena Region



Overview of Renewable Energy

The Middle East was a relatively late adopter of renewable energy. For many years, thanks to its ample oil and gas reserves, there was little incentive for governments to look for alternative forms of power, although hydroelectric power plants were developed in some places including Algeria, Egypt, Iran, Iraq and Morocco.

While investment in solar and wind projects has been rising sharply in recent years, particularly in the Gulf countries, traditional fuel sources still dominate the electricity supply industry. In 2022, around 72% of electricity generated in the Middle East came from natural gas-fired plants, and a further 22% from oil-fired plants. Renewables (including hydroelectric plants) accounted for a little under 3%, with nuclear making up a further 2%, and coal-fired plants a little over 1%.

Solar and wind power account for almost all non-hydro renewable energy schemes, but there is a notable difference in the technologies that are preferred in different parts of the region.

North African countries have generally focused more on wind power, with 10.8TWh of wind power generated in 2022, compared to 7.8TWh of solar power.

Elsewhere, the opposite has been true. In the Gulf and Levant, relatively little has been invested in wind energy, with 23.7TWh of solar power in 2022 against just 3TWh of wind.

Other forms of renewable energy have yet to find a sizeable market in the region. Total generation from geothermal energy, biomass and other forms of renewable energy has been broadly static since 2016, at around 0.3TWh.

Market Growth

It was not until the early 1990s that the development of non-hydroelectric renewables sources really began in the Middle East. The growth in renewables output was slow, however, and it was only in 2006 that the amount

being generated by wind and solar rose above 1TWh, with North African countries taking the lead.

North Africa still accounted for more than half of all non-hydro renewable generation across the entire region until as recently as 2019.

In more recent years, it has been the Gulf countries that have been making the running, thanks to a shift in approach by governments. Renewable generation grew by 300% between 2017 and 2022 in the likes of Kuwait and Qatar, more than 800% in the UAE and over 1,000% in the case of Saudi Arabia.

In contrast, renewable output growth in North Africa has generally been slower, growing by around 30% in Algeria over the same time period and doubling in Morocco. Egypt has come closer to matching the Gulf countries, posting growth of 275%.

The rapid expansion of renewable projects in recent years has come as a result of several factors. Oil exporters in the Gulf and North Africa have gained from high crude prices over this period, providing the capital to invest in new sources of energy. At the same time, many of those same governments have been keen to reduce oil and gas use in their domestic markets (including in power plants) in order to have more hydrocarbons to sell abroad to maximise their revenues.

Both private and public sector actors have been involved. In the UAE, for example, Dubai Electricity & Water Authority (DEWA) is developing the 5GW Mohammed bin Rashid Al Maktoum Solar Park in a number of phases. In neighbouring Abu Dhabi, the state-owned developer Masdar has worked with Abu Dhabi National Energy Company (Adnec), France's EDF Renewables and China's JinkoPower to develop the 2GW Al Dhafra Solar PV project.

Challenges and Barriers

Global investments in energy transition technologies reached \$1.3tn in 2022, according to the Abu Dhabi-headquartered International Renewable Energy Agency (IRENA), but within the MENA region there is a large financing gap between what is needed and what is being spent, particularly in poorer countries.

A UN Economic and Social Commission for Western Asia (ESCWA) report in 2022, titled Climate finance needs and flows in the Arab region, concluded that MENA countries, including Egypt, Iraq, Jordan, Mauritania, Morocco, Palestine, Sudan and Tunisia, needed \$570bn in climate funding.

Abderrahim Assab and Al Hamawi Hala of the Natural Resource Governance Institute have pointed out that governance challenges across the region have made it harder to draw in climate finance and many countries lack comprehensive frameworks to tap in to the UN Framework Convention on Climate Change and other sources of climate funds.

In an October 2023 policy brief, the authors said “The absence of detailed sectoral plans, strong governance, clear climate finance policies, accurate cost estimates for NDCs [Nationally Determined Contributions], and strategies for engaging the private sector makes it challenging for regional governments to determine which green projects to support and how to finance them.” The authors also noted that such shortcomings can also deter potential investors and donors.

Globally, most of the funding needed for a transition away from hydrocarbons is expected to come from private sector sources. The IEA has estimated that around 70% of clean energy investment over the next decade will need to be carried out by private developers, consumers and financiers.

However, state-owned enterprises play a greater role in MENA economies than is the case in many other parts of the world – something that can squeeze out private sector players. Governments also need to ensure the right financial and regulatory frameworks are in place to ensure sufficient green energy finance is forthcoming.

A 2022 report by the Mohammed Bin Rashid School of Government, Financing a Green Transition in the Middle East, said financing mechanisms and policy measures that encourage climate-compatible development were being used across the GCC, Egypt and Iraq but untapped opportunities remained to use new tools or policies that could shift finance towards investments for a green and fair transition.

Among other recommendations, the report said governments needed to build up local understanding of the benefits of sustainability as well as the risks of inaction, noting that “while awareness of the risks is growing, articulating the opportunities is less clear, especially in fossil-fuel dependent countries”.

It also called for state-owned enterprises and sovereign wealth funds to play a bigger role in the energy transition and said frameworks needed to be developed for green debt issuance.

Future Outlook

According to the IEA’s Renewables 2023 report, renewable generating capacity in the MENA region is expected to increase by 62GW in 2023-2028, with the pace of growth accelerating to more than three times the rate seen in the previous five-year period. Solar photovoltaic power is expected to make up over 85% of the increase, with smaller contributions from onshore wind and concentrated solar power.

More than one-third of the growth will be in Saudi Arabia, the report predicted, followed by the UAE, Morocco, Oman, Egypt and Jordan. These countries will between them account for over 90% of overall growth.

The MENA region is helped by the fact that it is rich in solar resources and the ready availability of large tracts of land mean it has been possible to develop large

projects which can benefit from economies of scale. Tenders for solar PV projects in the Gulf region have repeatedly set new world records for low prices over the past decade.

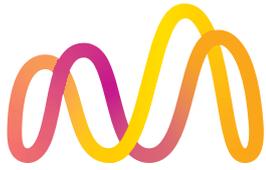
The use of competitive auctions has also helped to drive down prices, but such processes are often slow. From launching an auction to signing power purchase agreements can take several years and there is the risk that market dynamics may have shifted in the interim, making an initial bid suddenly uneconomic for a contractor.

In response, IRENA says some countries have been testing other mechanisms, including signing unsolicited bilateral contracts.

In any case, demand for renewables is expected to increase sharply in the coming years – both from existing residential, commercial and industrial users, but also from emerging sectors such as ‘green hydrogen’ projects. IRENA estimates that hydrogen projects could account for more than 13% of the region’s renewable capacity growth in the coming years. The region’s solar and land resources, combined with its advanced energy export infrastructure, means it has the potential to become a key supplier of the new low-carbon fuel to Europe and Asia if the market develops as some anticipate.

The targets set for renewable energy by various governments give an indication of how the market could grow in the coming years. While in many cases, renewables accounted for less than 1% of total electricity generation in 2021, Gulf countries are targeting rates of between 20-50% by 2030, with Saudi Arabia the most ambitious. In other parts of the region, Algeria is aiming for 37% of installed capacity to be renewable by 2030, while Morocco is targeting 70% by 2040. In the Levant, Jordan is aiming for 31% of its generation to be based on renewable energy sources by 2030.

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Chapter 3

Energy Storage In The MENA Region



Introduction to Energy Storage

A challenge for many renewable energy plants is intermittency – when the sun dips behind the horizon or wind speeds drop, electricity can no longer be generated. If renewables are to represent a viable alternative to conventional energy sources, then it is necessary to develop ways to store excess electricity generated when supply outstrips demand and release it to the grid when the reverse is true.

For the Gulf countries which have favoured solar energy, the availability of their photovoltaic plants is relatively predictable, even allowing for periods of lower daytime generation when cloud cover is heavier. Wind power, which is favoured in North Africa, can be more variable. Hydropower plants can also suffer from periods of lower-than-average rainfall, reducing their ability to generate electricity.

To date, the most popular way to store excess energy has been pumped storage hydropower plants, but battery energy storage systems (BESS) and thermal storage in the form of molten salts used in concentrated solar power (CSP) plants are also in use in the MENA region.

Current Energy Storage Technologies

In terms of capacity, the most important energy storage technology in the MENA region is pumped storage, although only a small number of countries have developed facilities to date. More investment is now being made into battery storage (particularly in the UAE) and CSP plants.

Pumped storage

Iraq was an early leader in using pumped storage, with a 240MW facility installed at the Mosul Dam on the Tigris river, in the north of Iraq, in the late 1980s. At times of excess generation, water is pumped up to a reservoir above Lake Dahuk, which can then be released down to two 120MW turbines when demand rises.

In 2004, Morocco became the second MENA country to install pumped storage, with a plant commissioned at Afouer with an initial capacity of 233MW, rising to 464MW the following year.

No further capacity was added for the next decade, until Iran commissioned the 1,040MW Siah-Bisheh pumped storage plant in the Alborz mountains in Mazandaran province. This remains the largest such facility in the region.

In total, there was 2,044MW of pumped storage capacity across the MENA region as of 2022, according to IRENA.

More pumped storage is though planned. In the UAE, the Dubai Electricity and Water Authority (DEWA) is developing a 250MW plant at Hatta, which will be the first of its kind in the GCC. Water will be pumped from the Hatta Dam to an upper reservoir during off-peak-hours, with water then travelling back through a 1.2km subterranean canal to generate electricity when demand rises. It is due to be completed by the end of 2024.

In Morocco, the state-owned Office National de l'Electricité et de l'Eau Potable - Branche Electricite (ONEE-BE) is also developing the 300-400MW El Menzel pumped storage plant in the northern province of Séfrou, which is due to start operating by 2028.

Also in Morocco, a 350MW pumped storage plant is being developed at Abdelmoumen, near Agadir. It was due to be completed by 2022, but has suffered some delays and is now expected to be commissioned by 2024.

In Saudi Arabia, the Saudi Electricity Company is planning to develop the 1,000MW Magna pumped storage plan at in Tabul province.

A number of other plants are under consideration in Egypt and Jordan.

Battery storage

While the technology for pumped storage is well-established and responsive (DEWA says its Hatta plant will be able to start supplying electricity within 90 seconds), the plants are also capital intensive and less efficient than other storage technologies. The use of the technology is also constrained by the limited number of suitable sites.

Instead, battery storage is expected to be the main area of growth in energy storage systems in the MENA region over the medium-term, according to a report by the Arab Petroleum Investments Corporation (Apicorp), Leveraging Energy Storage Systems in MENA . It expects batteries to account for 45% of the region's operational energy storage system market by 2025. That compares to 7% in 2022, most of which was in the UAE.

While the cost of battery storage has been a disincentive in the past, prices are falling as battery technology improves, making it more economically viable. However, while lithium-ion (Li-Ion) batteries are the most popular option around the world, their efficiency is worse in hot climates.

To date, the UAE has been the leader in installing battery storage systems, with a 108MW sodium-sulphur (NaS) project developed by the Abu Dhabi Water and Electricity Authority (ADWEA) as a virtual power plant across ten locations in 2019.

DEWA has also developed NaS and Li-Ion storage capacity of 2.4MW, including a 1.2MW NaS pilot project at the Mohammed bin Rashid Al Maktoum Solar Park.

In August 2023, Emirates Water & Electricity Company (Ewec) launched a tender for a 400MW capacity BESS, based on the independent power project (IPP) model. A few months later, in December, Abu Dhabi Future Energy Company (Masdar) signed a joint development agreement with Jordan's Ministry of Energy and Mineral Resources to develop a 1GW wind project with a BESS component near the port of Aqaba, to support a planned green hydrogen production facility.

Concentrated solar power

Another storage option is molten salts, which are used in CSP plants. These facilities are expensive to develop and relatively rare around the world, but there has been some uptake in the region.

The world's largest CSP plant is the 510MW Noor-Ouarzazate facility in Morocco. The 160MW first phase was commissioned in 2016 with a three-hour storage; the 200MW second phase and 150MW third phase both have seven hours of storage.

Dubai is also developing a 100MW solar tower as part of phase four of the Mohammed bin Rashid Al Maktoum Solar Park, with 15 hours of storage capacity.

Applications and Benefits

Energy storage systems can be used in a number of different ways, including energy arbitrage, stabilising the grid and offsetting the variability of supply from solar and wind power plants. As such, they can play a vital role in supporting the rollout of renewable energy capacity and the transition away from hydrocarbon-fuelled power.

The main use for storage systems in the Middle East is to support the grid rather than seek arbitrage opportunities.

Emirates Water and Electricity Company (EWEC)'s executive director for strategy and planning Bruce Smith told Informa's Energy & Utilities in September that the battery storage systems it was planning were "not there to provide arbitrage as such ... It's more about providing an immediate, milli-second level response to variations in frequency in the grid and also providing secondary reserves, which would traditionally be provided by gas turbines."

Front-of-the-meter (FTM) storage applications are expected to dominate in the future. Apicorp has estimated that such storage systems (which are connected to the generating plants or the transmission and distribution networks) will account for 96% of planned on-grid energy storage capacity. The alternative option of behind-the-meter storage – which refers to facilities on consumers' own premises – will make up a tiny portion of the market.

Among other things, it suggests that energy storage should be viewed as a distinct asset class, separate from generation, transmission and distribution, and that governments should set specific targets for energy storage capacity as part of their national energy policies. It also suggests that tax and other incentives should be offered to attract private sector investment in the sector and time-of-use tariffs adopted to ensure the economic viability of energy storage systems.

Challenges and Opportunities

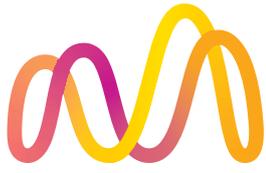
While there are a number of factors that will underpin the growth of the energy storage market in the MENA region in the coming years – not least the need to support the wider rollout of variable renewable energy generating capacity – there are also a number of financial, regulatory and structural barriers holding things back.

Among the difficulties is the fact that the procurement models used in the region for large renewable schemes do not always provide enough incentives for developers to invest in energy storage systems. Instead, the auction systems typically preferred tend to focus on securing the lowest possible price for electricity, alongside technical competency.

Apicorp has suggested a number of policy options that governments could adopt in order to encourage more widespread adoption of storage systems into regional electricity supply systems.



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Chapter 4

Clean Energy In MENA Region



Clean Energy Initiatives

Preparing the MENA region for a decarbonised future will require a multi-faceted approach, combining large investments in renewable energy generating capacity, far greater energy efficiency, the production of green hydrogen and other sustainable fuels for hard-to-abate sector such as aviation and heavy industry, greater electrification of sectors such as ground transport, and the development of carbon capture, utilisation and storage (CCUS) initiatives.

The take-up of these options varies from country to country but, in general, the region is in the early stages of rolling out such initiatives. While some energy importers such as Tunisia have long put an emphasis on the need for energy efficiency, other countries – particularly the oil and gas exporters of the Gulf – are far less advanced. According to the World Economic Forum (WEF), the GCC countries account for 70% of all emissions in the MENA region – a consequence of exceptionally high per capita energy use.

However, in most cases the Gulf countries have the advantage of plentiful oil revenues to help pay for the transition to clean energy and have been investing heavily in solar power plants, as well as CCUS facilities. They have also in some cases been willing to invest in nuclear energy – a controversial choice given concerns about nuclear weapons proliferation, but one which does offer reliable baseload power compared to the intermittency of solar and wind plants. The costs of atomic power are prohibitive for most countries, but Iran and the UAE both have plants in operation, Egypt will soon join that club and Saudi Arabia is moving in the same direction.

Energy Efficiency

According to the International Energy Agency (IEA), energy efficiency is the single largest measure which can be taken to reduce energy demand. Given that such measures often result in cost savings for consumers, they can also encourage wider economic activity, providing a secondary benefit.

Energy efficiency can also provide some of the quickest and most cost-effective ways to reduce harmful emissions and strengthen energy security (the latter is a key consideration for the region's energy importers). Reducing energy demand also allows governments to more easily reduce the amount of money they spend on energy subsidies.

However, there is much to be done in the MENA region, where surveys suggest that most businesses have yet to engage with the issue. According to the WEF, just 12% of businesses in the region have committed to net-zero targets and only 7% have explained how they are going to achieve these goals.

The Arab Future Energy Index (Afex), launched in 2013 and produced by the Regional Center for Renewable Energy and Energy Efficiency (RCREEE), ranks 20 countries across the region based on key renewable energy and energy efficiency indicators. The most recent edition ranked Morocco highest for energy efficiency, followed by Tunisia, Jordan, the UAE and Bahrain – all with scores of 80% or higher. At the bottom was Yemen, at just 16%.

According to Afex, only six Arab countries have energy efficiency policies for the industrial sector, while ten have developed financing mechanisms for sustainable and effective implementation of energy efficiency programmes.

Compared to other economies around the world, even some of the better-placed Arab country performs relatively poorly.

The International Energy Efficiency Scorecard produced by the American Council for an Energy-Efficient Economy ranks 25 of the world's largest energy users, based on 36 metrics across four categories: buildings, industry, transport and national efforts. The three MENA countries included in its league table are all towards the bottom, with Egypt in 20th place, Saudi Arabia at 23rd and the UAE last at 25th – in part because of a paucity of data around energy efficiency standards or policies.

Some steps are being taken by these countries to address the issues at hand though.

Egypt has adopted a National Energy Efficiency Action Plan, which aims to cut energy consumption by 18% by 2030 and offers multi-sectoral tax credits and loans to incentivise energy efficiency. However, the country lacks comprehensive building codes and fuel economy standards for vehicles.

In 2018, Saudi Arabia updated its building code to strengthen energy efficiency requirements. The Saudi Energy Efficiency Centre, chaired by energy minister Prince Abdulaziz Bin Salman Al-Saud, aims to improve the efficiency of energy production and consumption and has been developing targets for industry, the construction sector, transport and other areas. Among its work it has been updating standards for thermal insulation materials and looking for ways to improve the efficiency of household appliances such as air conditioning units and fridges.

In the UAE, energy efficiency policies vary from emirate to emirate, but there have been some national initiatives. In February 2024 the federal government set out details of new regulations covering energy management in industrial facilities, with the aim of improving energy efficiency and reducing energy demand in the sector by 33% by 2050.

Elsewhere in the region, a number of Levant countries have set up funds to encourage greater energy efficiency, including the Jordanian Renewable Energy and Energy Efficiency Fund and Lebanon's National Energy Efficiency and Renewable Energy Action.

According to the IEA, progress on improving energy efficiency has been stagnant across much of North Africa in recent decades, although there are some exceptions – it describes Tunisia's energy efficiency policies as being "some of the most effective in the world". This has been a long-term policy issue for Tunisia, which is a net importer of energy and declared energy efficiency a national priority in 1985.

Across the region, more could be done to reduce energy consumption, particularly in urban areas where new materials, technologies and designs can be used to improve the efficiency of existing and new buildings.

Governments could do more to set incentives for consumers, such as technology replacement or scrappage programmes for household appliances, LED lighting replacement plans; and tighter regulation on the age and fuel efficiency of cars. In industrial settings, motor replacement, heat recovery and heat pump programmes could also help to deliver greater energy efficiency.

Alongside efforts to reduce direct energy demand, governments also need to reduce water demand, given the energy requirements of water desalination plants.

Such policies can have wider benefits, including job creation – a key consideration for rich and poor governments around the region.

Emission Reduction Efforts

According to the International Monetary Fund (IMF), the Middle East's share of global emissions has climbed rapidly in recent decades. It estimates the MENAP region – an area that covers MENA, Afghanistan and Pakistan – has gone from a 1% share of global CO₂ emissions to 8% over the past 40 years.

Almost all MENA countries have vowed to reduce their carbon emissions, through their nationally determined contributions (NDCs) pledges made in response to the 2015 Paris Agreement.

Reaching their targets will not be easy though. An IMF report in November 2022, *A Low-Carbon Future for the Middle East and Central Asia*, estimates around a third of the region's countries would need to reduce per capita emissions by more than 25%.

There are a few options for cutting emissions. One is to reduce the burning of fossil fuels in key areas such as electricity generation, industry and transport. Alternatively, the carbon emitted in power plants or factories could be captured and stored.

Both approaches are being adopted in the region. Major investments are being made in renewable energy plants, so fossil fuel plants can be retired. In addition, there is a shift towards greater electrification of transport systems which, as more grid electricity is supplied by

renewable energy sources over time, will help to reduce emissions.

Policymakers – particularly in the oil exporting countries – are also putting a lot of effort into carbon capture and storage (CCS) and the closely-related area of carbon capture, usage and storage (CCUS).

Such initiatives could play an important role in helping to clean up heavy industries such as steel, chemicals, fertiliser and cement production – where high heat requirements mean electrification and renewables are unsuitable replacements for existing energy supplies.

Carbon capture projects

While CCS technology remains unproven at scale, investment is pouring in to the sector to try and prove it can work.

The region already has a wealth of facilities where carbon can be readily stored, in the shape of depleted oil and gas fields. The Global CCS Institute has estimated the MENA region could store 170bn tons of CO₂. Countries such as Oman have already developed expertise in enhanced oil recovery, which involves re-injecting gas into oil fields to maintain their output for longer.

There are a number of significant CCS and CCUS projects already up and running and more planned, with national oil companies often to the fore.

Existing plants include Abu Dhabi National Oil Company (Adnoc)'s Al-Reyadah facility which can process up to 800,000 t/yr of CO₂ per year captured at Emirates Steel Arkan. Adnoc is also developing the Habshan CCUS project, which will be able to capture and store 1.5m t/yr underground.

Overall, Adnoc has a \$23bn decarbonisation budget which it is using to invest in both domestic and overseas projects and it aims to increase its CCS capacity to 10m t/yr by 2030.

Adnoc is also working on a pilot project to capture carbon from the air, mix it with seawater and store it the Hajar Mountains in Fujairah. The project is being developed with Fujairah Natural Resources Corporation and Omani company 44.01 – the latter said the

technology could be rolled out to other countries and “has the potential to eliminate billions of tons of CO₂ internationally.”

In Saudi Arabia, Saudi Aramco launched a CCS project at its Uthmaniyah and Hawiyah natural gas liquids (NGL) facilities in 2015. Aramco is also building a CCS hub in Jubail with capacity for up to 9m t/y of CO₂.

QatarEnergy is developing a CO₂ sequestration project in Ras Laffan, linked to its liquified natural gas (LNG) output. This will be capable of capturing 4.3m t/yr of CO₂ from the LNG trains which will then be injected into wells.

QatarEnergy is also developing the Ammonia-7 project in Mesaieed Industrial City with Qatar Fertiliser Company (Qafco). This has been described as the world's largest blue ammonia project, will see around 1.5m t/yr of CO₂ generated during the production of ammonia captured and stored. The project is expected to start operating by early 2026.

Low-carbon fuels

A number of MENA countries, including Egypt, Oman and Saudi Arabia, have also been investing in the development of low-carbon fuels, although at the moment it remains unclear if a viable international market will develop at sufficient scale for green hydrogen and green ammonia to become commercially viable propositions.

Among the largest schemes are the Neom Green Hydrogen Project in Saudi Arabia, which will use 4GW of solar and wind energy to produce some 600 tonnes a day of hydrogen by 2026.

In Oman, the state-owned Hydrom in 2023 signed up five projects in its first auction round. The schemes involve combined investment of more than \$30bn, the development of 18GW of renewable power and output of some 750,000 t.y of hydrogen. The results of a second auction round involving three more projects are due by the end of March 2024.

In Egypt, the authorities have to date signed a dozen framework agreements for green hydrogen and green ammonia projects.

In the UAE, Abu Dhabi Future Energy Company (Masdar) is pursuing a target of 1m tonnes of green hydrogen production by 2030 as part of the UAE's ambitious plan to capture 25% of the global low-carbon hydrogen market by 2030.

While commercial viability is still an open question, there have been some test shipments of low-carbon ammonia – categorised as such because CO₂ from the manufacturing process was captured and used in downstream applications. In September 2022, Adnoc's Fertiglobe subsidiary sent low-carbon ammonia to Germany and, in April 2023, Saudi Aramco sent a low-carbon ammonia shipment to Japan.

Outlook for Clean Energy

A combination of changing consumer preferences and government action will ensure the market for clean energy will continue to grow quickly in the coming years and decades. The combination of increasing electrification – not least in terms of cars and other vehicles – and the relatively low development cost of solar PV and onshore wind compared to conventional power plants create clear incentives for renewables to take an ever-greater share of the region's energy mix.

At the same time, demand for energy is likely to also be rising fast. To take just one example, the effect of climate change is going to result in higher temperatures in the MENA region, creating greater need for energy-hungry air conditioning units. As such, there will be greater pressure on the authorities to introduce more energy efficiency measures.

Industrial energy use presents a more difficult problem to solve. While CCS projects could offer a partial solution, lower carbon fuels such as green hydrogen and ammonia are likely to play an important role. As yet, however, the pace at which this market might develop remains unclear.

Conclusion

The MENA region is in the early stages of a revolution in its energy markets, in terms of both its domestic generation and its exports.

While renewable energy still accounts for only a small minority of electricity generating capacity in most countries, the speed at which it is growing means it will become ever-more important in the coming years.

According to the IEA's Renewables 2023 report, renewable generating capacity in the MENA region is expected to increase by 62GW in 2023-2028

The targets set by various governments give an indication of how things are set to change. Gulf countries are aiming for renewables to account for 20-50% of their energy mix by 2030, with Saudi Arabia the most ambitious. Elsewhere, Algeria is aiming for 37% of installed capacity to be renewable by 2030, while Morocco is targeting 70% by 2040. In the Levant, Jordan is aiming for 31% of its generation to be based on renewable energy by 2030.

In tandem with that, change is also coming to the biggest driver of the region's economy: the oil and gas sector. Export markets remain robust for now and, according to the WEF, even the most ambitious net-zero scenarios expect oil and gas to meet 15-40% of global energy demand by 2050. That is equivalent to as much as 40m b/d of oil demand, compared to a current figure of some 100m b/d.

MENA exporters are well-placed to retain a sizeable chunk of that shrinking market, given their low production costs. However, market dynamics could change more quickly as the costs of renewable technologies fall, rates of electrification increase and emerging fuels such as hydrogen gain wider acceptance.

The MENA region has the ability to respond, not least because of the plentiful solar and wind resources at its disposal and the potential to develop a green hydrogen exporting industry.

Tapping into that potential to generate sufficient electricity to power the region's growing cities and expanding populations and to serve new industries will require huge levels of investment. The oil-rich countries of the region can afford to develop such power plants, but poorer countries will find it harder to do so. The right mix of incentives will need to be drawn up to attract sufficient private sector investment.

Alongside the need to scale up renewable energy, the region could also do far more to improve energy efficiency and reduce emissions.

There is a clear environmental imperative to act. The MENA region is warming twice as quickly as the global average and by 2050 could be as much as 4°C warmer than it is today. Such a change in climate would further stress the region's limited water supplies, risk greater desertification and could lead to wider negative economic and social consequences.

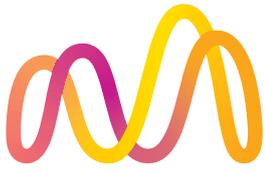
While the region's oil-rich countries may have the financial ability to address these issues in the short-term, the poorer, oil-importing countries in the region will find it far harder to cope with the consequences of climate change. Even for the more affluent parts of the region, political instability in poorer countries could well reverberate across their borders, meaning it is in everyone's interests that the region moves forward together.



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