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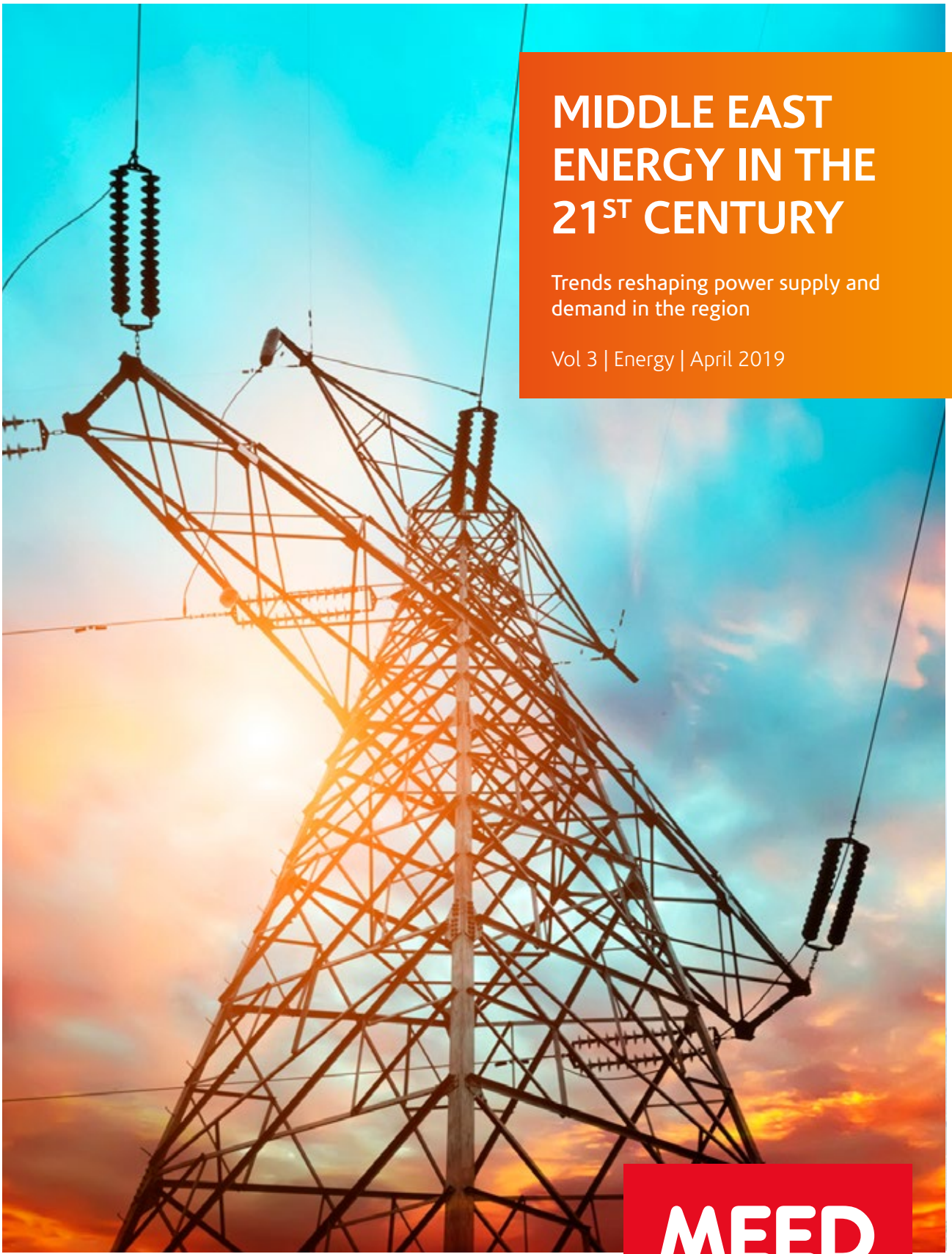

MIDDLE EAST ENERGY IN THE 21ST CENTURY

Trends reshaping power supply and demand in the region

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MEED
Middle East business intelligence

BEYOND THE HORIZON

Middle East oil producers are looking beyond their dependence on fossil fuels to sustain an energy future

With an abundance of low-cost hydrocarbons, spending on energy supply capacity in the Middle East has traditionally focused on huge capital investments in large-scale oil and gas-fuelled power and desalination plants, largely owned and operated by government utilities.

But as governments become increasingly concerned about the unsustainability of oil and gas, the approach is changing. Other factors are also driving the new mindset.

Burning hydrocarbons is a significant contributor to carbon dioxide emissions, as well as other environmental hazards. Separately, as the region's primary source of export revenues, governments would prefer to sell or save their most-prized resource rather than burn it.

Across the Middle East, there is a growing interest in pursuing cleaner energy sources. Governments are rolling out energy diversification strategies that will lead to a much larger share of energy supply coming from alternative sources such as solar, wind and nuclear.

The International Renewable Energy Agency's (Irena's) 2019 Renewable Energy Market Analysis for the GCC highlights that a total of nearly 7GW in renewable power generation capacity is planned to come online by the early 2020s, led by the UAE, Oman and Kuwait.

Further, Irena's analysis suggests that achieving renewable energy deployment targets in the GCC by 2030 could save 354 million barrels of oil equivalent in fossil fuel consumption in the power sector (a 23 per cent decrease over the baseline). It would also help reduce emissions by 136 million tonnes of carbon dioxide; create more than 220,000 direct jobs; and reduce water withdrawal for power production and associated fuel extraction by 11.5 trillion litres (a 17 per cent decrease).

One of the challenges facing emerging renewable energy sources such as solar and wind power is their lack of capacity to provide a reliable base-load. When the wind drops, so does wind power generation. This is one of the key reasons why fossil fuels will continue to be the most significant component of the energy supply mix throughout the 21st century. This will be supplemented by the expansion of nuclear power plants, which, despite controversial associations, are being transformed in terms of size, cost and security.

The development of utility-scale energy storage systems and batteries is the next frontier for the energy sector, and pioneering projects underway could have major implications for the future of renewable energy in the region.

Factors such as digitalisation and the electrification of industries are transforming not just energy supply and demand, but also the way we live and work.

In this special report, MEED examines the major trends reshaping the energy sector in the Middle East and assesses its future shape in the 21st century.

EXECUTIVE SUMMARY

- Rising population and major industrial projects are driving increased demand for electrcity in the GCC. Based on current growth rates, MEED estrimates that installed electricity generation capacity in the Middle East and North Africa region must increase by about 40 per cent by 2025.

- Expenditure for energy supply capacity in the Middle East has largely focused on huge capital investments in oil and gas-fuelled power and desalination plants, driven by government utilities. However, renewables are increasingly contributing to the energy mix

- The falling cost of renewables, reinforced by private sector involvement and political will for carbon-free energy, is setting up the Middle East to be a global power in renewable energy development

- As variable and non-synchronous sources of generation, integrating solar photovoltaics and wind energy systems creates a number of technical challenges for system operators. Careful system planning and operation can help overcome these challenges

- Electric vehicles find increasing favour following widespread availability, new models and cheaper battery costs. Renewable energy is seen as an effective solution for 'clean electricity', thereby reducing the dependency on internal combustion engine vehicles

- Improved energy storage will help grids manage fluctuating renewable energy supply by allowing wind and solar power to be stored for later use, while developments in battery and other storage devices will enable vehicles to travel longer distances on a single charge

- Digitalisation has helped optimise performance in both conventional and renewable energy plants, through sensors and predictive analysis. Digital disruption is also supporting the development of smart power grids, which provides benefits such as better electricity transmission, reduced peak demand and integration of renewable energy systems

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CREATING A LOW-CARBON ECONOMY

While a clean energy future is the end goal, hydrocarbons will be called on to finance the region's economic transformation

The Middle East's energy developments present an odd paradox. To escape from dependence on volatile oil and gas prices, the region is seeing a new wave of investment in energy projects. This evolution makes more sense when we realise that in building a new economy, the leading countries are trying to build on a foundation of strength.

Key trends

There are four key energy trends that will dominate in the decades to come. The first is economic might, and so energy demand is shifting ever more towards Asia, and particularly in favour of the giants China and India. While China's demand growth is slowing, it is from a much higher base than its early 2000s' boom. India is set to be the world's fastest-growing area for energy consumption, at 3.1 per cent annually to 2040, according to BP's latest energy outlook released in February 2019.

Secondly, the rise of North American shale oil and gas has turned the continent from an importer into a growing exporter of oil and liquefied natural gas (LNG).

Thirdly, there are concerns over future oil demand, given the competitiveness of electric vehicles, pressure to act on climate change and worries about plastic pollution.

Fourthly, an environment of low oil prices paired with the financial challenge of relying on wildly varying commodity prices has emphasised the need for the Middle East to generate more diverse economic growth, exports and employment.

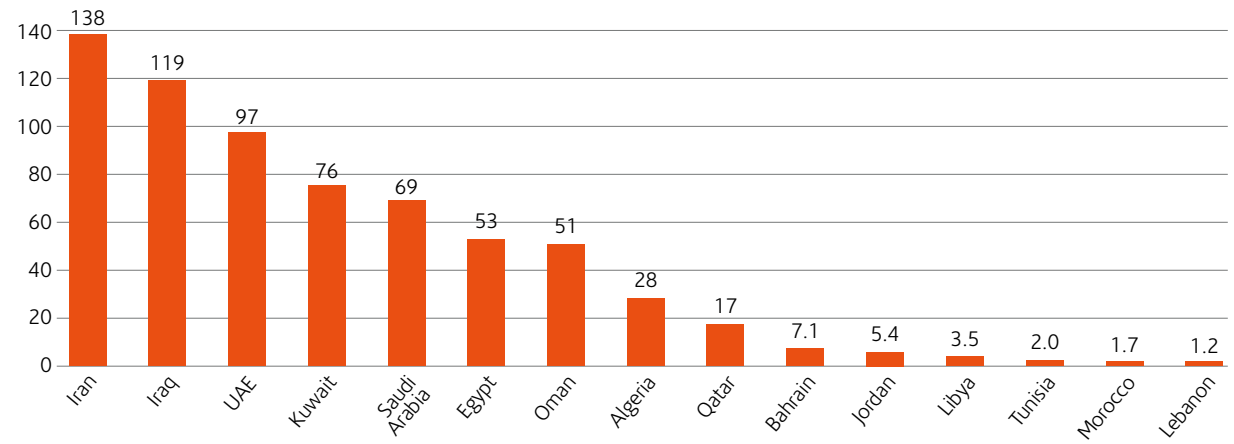
In response, the region's energy industries show a sharp divergence. Some are leading the change, some are adapting, while others, often through no fault of their own, remain in stasis. There is only a limited window of time for the laggards to get moving or they will fall behind irreparably.

Middle East governments' new strategies are carried out by their national oil companies (NOCs), sovereign wealth funds and state-owned utilities, either independently or in cooperation with international investors guided by policy. They have to create new commercial relationships; generate value beyond the simple export of crude oil and gas; and adapt to a low-carbon future.

Sustaining production

The leading regional producers—Saudi Arabia, Iraq, UAE, Kuwait, Iran and Qatar—are not short of resources. State behemoth Saudi Aramco's recent reserves audit indicated a slight rise on its previous official numbers, to 268.5 bil-

Value of oil and gas projects planned or underway in the Mena region ($bn)



Source: MEED Projects

lion barrels of oil, more than a 70-year supply at current production rates, and 325 trillion cubic feet of gas.

Iraq will lead the region's production growth with investments by Asian, Russian and Western firms in its giant fields, while independent companies lead the autonomous Kurdistan region's renewed expansion. Security has greatly improved and new technocratic ministers in electricity and oil understand the challenges. However, the country's energy infrastructure remains ramshackle, its commercial terms uninviting, and corruption and bureaucratic inertia are still severe problems.

Next-door Iran remains tied down by US sanctions, exacerbated by its own political infighting. Despite improved domestic capabilities, shortage of technology and finance coupled with closed-off export markets will continue to prevent it from realising its potential.

Kuwait's upstream production plans, after a brief boost, remain mired in parliamentary wrangling. Meanwhile, the small petroleum industries of Yemen and Syria, devastated by war, show tentative signs of recovery in places.

Some countries' fields are becoming mature and all seek to save costs and stretch their human resources further, putting more stress on the deployment of advanced technologies: digitisation, automation, artificial intelligence and drones.

Oman has been a regional leader in enhanced oil recovery (EOR), using solar-generated steam for heavy oil production and the injection of miscible gas and polymers. The sultanate has also pioneered the extraction of gas from tight (low-permeability) reservoirs, helping to turn around declining exports.

> **"Most countries in the region are seeking to save on government budgets and energy waste, and preserve hydrocarbons for export by slowing unsustainable demand growth"**

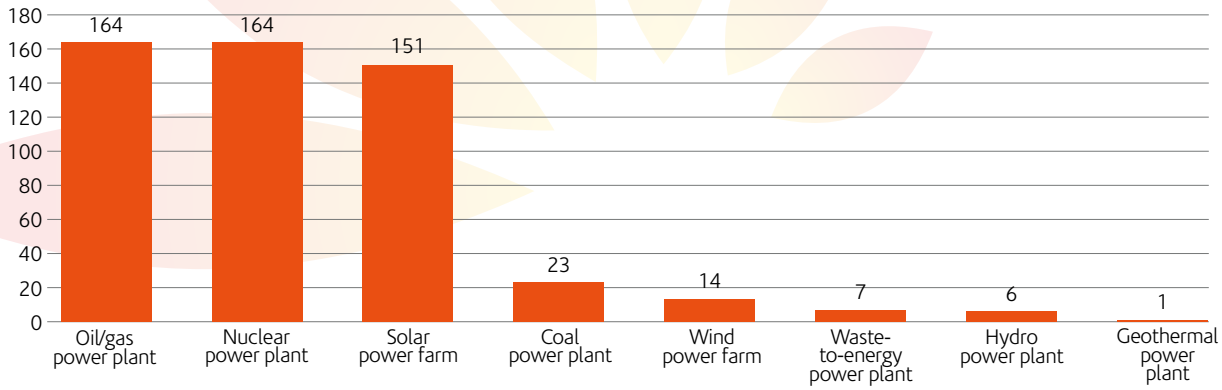
Bahrain hopes for world-first production of offshore unconventional oil and gas. Shale gas is a key part of Aramco's plans to double gas output over the next 10 years.

These upstream plans represent improvements to the long-time core businesses of these countries. Beyond this, the most progressive NOCs are becoming more commercially minded, finding new partners and actively investing overseas. The proposed initial public offering (IPO) of Saudi Aramco has been rescheduled for early 2021, but Energy Minister Khalid al-Falih told the Financial Times in early February that "the world is going to be Saudi Aramco's playground".

Channelling downstream

Downstream—oil storage, refining and petrochemicals—has for decades been a major focus for Aramco, with refineries in the US and China, among others, as well as

Value of power projects planned or underway in the Mena region ($bn)



Source: MEED Projects

for Kuwait Petroleum, as it seek to anchor and perhaps create demand in the most important markets.

But Aramco is now also open to worldwide upstream, the exploration and production of oil and gas, with ambitions to create a global gas business to compete with the Western supermajors. It has looked at LNG opportunities in the US and Russia. It will also become a world-leading petrochemicals firm with the acquisition of the majority 70 per cent stake of compatriot Saudi Basic Industries Corporation from the Public Investment Fund (PIF), freeing the latter to pursue new targets such as Uber and Tesla.

Adnoc strategy

Abu Dhabi National Oil Company's (Adnoc's) transformation has been the most striking. From a staid and essentially domestic company, it has recently started a push into international downstream too, partnering with Aramco for a $44bn refinery and petrochemicals project in the western Indian state of Maharashtra. It has launched an IPO of 10 per cent of its fuel retail arm, sold 35 per cent of its refining arm to Italian supermajor Eni and Austria's OMV for $5.8bn, and announced a $45bn plan to create what it calls the world's largest refining and petrochemicals hub at Ruwais in western Abu Dhabi.

CEO Sultan al-Jaber highlighted the company's "strategy to grow its presence across the energy value chain and secure greater market access for its products, as well as the integral role that partnerships will play in this journey".

In its core upstream business, Adnoc has restructured all of its expiring concessions, swapping out older shareholders such as Shell and ExxonMobil for a bigger role with long-term partners Total and BP, and new entrants including Eni, Spanish refiner Cepsa—and, most significantly, Asian firms China National Petroleum Corporation, Zhenhua, GS and KNOC of South Korea, and a consortium of Indian state oil companies.

It has also announced a massive expansion of gas production in a bid to be self-sufficient, by developing both its costly offshore sour gas fields (with a high content of toxic, corrosive hydrogen sulphide) and onshore shale gas resources. And it is saving on greenhouse gas emissions by capturing carbon dioxide from a steel plant for EOR.

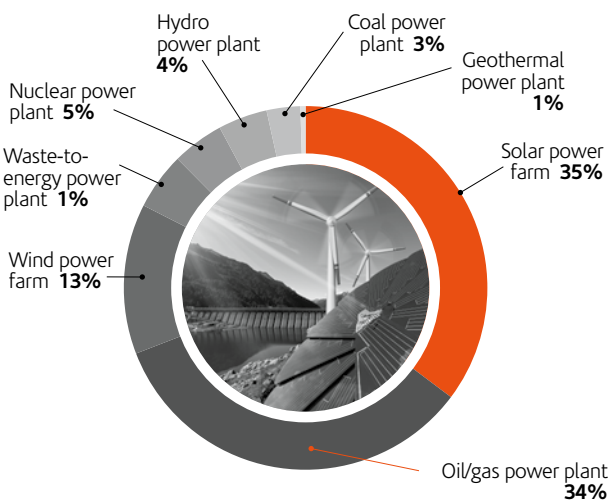
Qatar Petroleum's approach has reflected its different circumstances. With a mature and slowly declining oil sector, it has taken larger stakes at home as international firms' contracts have expired. It has taken steps towards a major expansion of its core LNG business, firstly by announcing an expansion from its current 77 million tonnes a year (t/y) capacity to 110 million t/y by 2023-24, and secondly by committing in early February to its $10bn, 16 million t/y Golden Pass LNG export project with ExxonMobil in Texas.

A growing need

These moves by the NOCs do not take place in a vacuum. Most countries in the region are seeking to save on government budgets and energy waste and preserve hydrocarbons for export by slowing unsustainable demand growth.

Iran reformed energy subsidies in 2010, with mixed success, but more recently, the UAE and Oman have linked road fuel prices to world levels, and electricity and water tariffs have been raised across the region. Energy efficiency policies include 'green building' codes, appliance efficiency standards, public transport systems such as urban metros,

Type of power projects planned or underway in the Mena region



Source: MEED Projects

and district cooling plants for air conditioning.

More dramatic has been the rise of renewables. Dubai set a world record for the cheapest solar photovoltaic power in 2014, at 5.85 $cents a kilowatt hour ($c/kWh), then halved that cost with bids in 2016, and also attracted a record low bid for concentrated solar power in 2017.

Saudi Arabia and Abu Dhabi have subsequently gone even lower. Bids below 2 $c/kWh are likely this year. Saudi Arabia set a record low onshore wind price of 2.13 $c/kWh in January.

With Jordan and Egypt moving ahead enthusiastically with solar and wind, and Oman finally making progress on renewable electricity too, 2019 is likely to be the year in which other regional countries awaken to the potential.

This success points to a contradiction. Middle Eastern states have the world's lowest production cost for oil in the world, yet ultimately they are all chasing a declining pool of demand, whether that decline begins in the 2030s or 2040s. They are expanding in petrochemicals, and moving into more complex and demanding speciality products. They see the market opportunity in gas, yet except for Iran, Iraq and Qatar, they have lost the advantage of low-cost resources. Gas, too, will eventually have to adopt carbon capture and storage to remain compatible with climate targets.

Hydrocarbons will be called on to finance the region's economic transformation. The end-goal is a sophisticated, clean energy economy that supports a wealthy yet sustainable lifestyle. While some Middle East states have taken their first steps towards that,

Robin Mills
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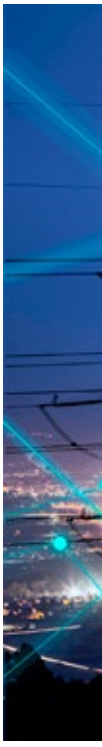
DISRUPTING THE EQUATION

Digitalisation can help both conventional and renewable power plants to run more smoothly



Technological innovation has always led humans to new ways of producing and consuming energy. In pre-modern times, windmills made the processing of grinding grain and pumping water much easier, thereby spurring economic development. The commercial introduction of electricity transformed human productivity, while the internal combustion engine revolutionised transportation.

Today, new technologies will play a central role as we stand at a crossroads as we address climate change while simultaneously enabling sustainable development around the world. These technologies will again change human economic activity by impacting both sides of the energy generation-consumption equation.

While renewable power, with its increasing efficiency and declining costs, as well as electric vehicle advances, and building design and management are vital developments, topping the list are two technologies that could be the most impactful: digitalisation and energy storage.

Digitalisation benefits

Like electrification, which began more than 150 years ago, digitalisation is liable to touch almost every aspect of our lives—including the energy value chain. On the production side, technologies such as digital twins, Big Data analytics and software, and open, cloud-based internet of things (IoT) operating platforms such as MindSphere allow for more efficient energy generation.

Both conventional and renewable power plants can use digitalisation to optimise performance while lowering costs. Using predictive analytics, operators can anticipate failures and make repairs before anything goes wrong, thereby improving uptime and output.

Along the energy value chain, digitalisation enables the development of smart power grids that give insights that can be translated into system-wide efficiencies and allow operators to move in real time to efficiently balance supply and demand. This can reduce fuel consumption, allow for improved capital and operational cost management, and lower emissions—all while ensuring availability of power supply. Smart grids can also empower demand reduction, for instance through pricing mechanisms.

For utility customers, digitalisation means smart meters in homes and businesses that give insights into ways to lower consumption. Industrial customers and manufacturers can use digitalisation to improve manufacturing processes, increase output, reduce inputs and costs, and enhance the quality of their goods.

We expect the Middle East to require a total of 483GW of power generation capacity by 2035, an addition of 277GW from 2016. Within this, the share of renewables in the power mix is expected to more than triple from 5.6 per cent (16.7GW) in 2016 to 20.6 per cent (100GW) in 2035. This increase highlights the need for reliable and efficient energy storage solutions, as well as mixed power generation sources to overcome the intermittent nature of renewables and achieve grid stability.

> **"… Digitalisation enables the development of smart power grids that give operators insights that can be translated into system-wide efficiencies that allow operators to move in real time to efficiently balance supply and demand"**

Storage beyond batteries

Energy storage is another key technology transforming the energy value chain. On the generation side, improved energy storage can help grids better manage fluctuating renewable energy supply by allowing wind and solar power to be stored for later use. Today, this electricity must be fed into the grid, whether it is needed or not.

On the demand side, improvements in battery and other storage devices could drastically change transportation, with long-lasting, high-capacity batteries allowing cars and trucks to travel longer distances on a single charge. It also could change the way we use many other powered devices and how individual customers draw electricity from the grid through the use of onsite battery storage.

High-performance lithium-ion batteries offer some of the best options available today, but as with other with traditional storage solutions, including capacitors, molten salt storage and compressed-air storage, they offer storage periods measured in minutes or hours.

Hydrogen storage

Siemens' researchers are looking at solutions that will convert electricity into forms of energy that lend themselves to long-term storage, such as hydrogen. By converting fluctuating power from renewable sources into hydrogen (or hydrocarbons), surplus energy can be flexibly monetised, stored using existing natural gas infrastructure and re-electrified in gas turbines.

One notable benefit of this is to create a future for gas turbine plants—even in a decarbonised world. Hydrogen can also be used to power transportation ranging from cars to trains.

In a significant move for the region, hydrogen storage is becoming a reality in Dubai. Siemens is working with Dubai Electricity & Water Authority (Dewa) and Dubai Expo 2020 to develop the Middle East and North Africa's first solar-driven hydrogen electrolysis facility at the Mohammed bin Rashid al-Maktoum Solar Park in Dubai. The hydrogen electrolysis facility, which broke ground in February 2019, aims to test and showcase an integrated megawatt-scale plant to produce hydrogen using renewable energy from solar photovoltaics located at the park. The pilot project will produce, store and deploy the hydrogen gas. Uses include providing fuel for power generation and transportation, or as an input for industry.

The hydrogen electrolysis plant not only embodies both digitalisation and energy storage, but also represents the distinct transformed energy landscape we are likely to see, all carried forward to powerful new technologies. It also means we will see more sector coupling – the concept of interconnecting energy-consuming sectors, such as buildings, transport and industry, with the power-producing sector.

Sector coupling allows us to get the most out of excess generation with the help of distributed energy systems. The result will be a future of power generation that helps us address climate change, while also enabling communities around the globe to pursue their sustainable development.

Dietmar Siersdorfer is CEO of Siemens in the Middle East

CLEANER PROSPECTS AHEAD

The spread of renewables across the region is driven by the slow but steady pursuit of energy diversification

The energy revolution is truly underway across the Middle East as the energy sector embraces the opportunity offered by significant cost reductions in renewable energy. Countries dubbed as the leading and lowest-cost oil and gas producers, with the majority of their wealth and economic growth tied closely to substantial oil and gas resources, are now starting to add renewable energy to their fuel mix to generate power within their own countries and benefit from a progressive reduction in the cost of generated electricity. The swing to renewable energy will be faster than can be reasonably forecast, as evidenced by the recent spectacularly increased pace of activity in certain countries in the region.

The breaking of the Middle East's reliance on fossil fuels through resource diversification is driven by several factors; first is the recognition that with all that technological advances can offer today, oil has a higher value in being converted to chemicals than to power. Renewable energy, on the other hand, is still considered as more competitive to supply the energy we consume while the sun is shining than fossil-fuel-generated electricity, even if we were to price fossil fuels at little over the cost of extraction.

"The UAE currently produces more solar power than any other GCC country at prices that have made it compelling for all its neighbours to follow its footsteps"

Next, making electricity available at the lowest possible cost (without subsidy and at full cost reflective rate) will have a multiplier effect on social and economic development given the significance of the resource input on all human endeavour. Finally, there is a clear acknowledgement of the need to reduce greenhouse gases by increasing clean energy content in the fuel mix to mitigate climate change.

This fuel mix transition is against the backdrop of increasing demand for electricity and water (the latter

The 950MW fourth phase of the Mohammed bin Rashid al-Maktoum Solar Park is the largest single-site concentrated solar power plant in the world

being intrinsically linked to energy due to the need for desalination) due to a very young population, with up to 30-40 per cent below the age of 15. These demographics will ensure soaring demand over the next decade as more and more people move into the employable and economically active bracket; thus, fuelling the need for social services and for industrialisation and economic activity expansion.

In simple terms, increasing adoption of renewable energy in the Middle East will diversify the energy mix, contribute to sustainable development and improve socio-economic conditions across the region.

State of renewable energy

The Middle East has considerable renewable energy potential and is well-placed to exploit solar energy in particular, given that the sun is shining most of the year in this part of the world. As hub heights increase and technological advancements keep bringing cost down, there is also growing room for wind energy to serve as a primary power source in countries such as Jordan, Saudi Arabia, Kuwait and Oman.

The UAE, over a span of three years, has become the host of nearly 80 per cent of solar photovoltaic (PV) energy capacity in the Gulf region. It will also soon be home to the world's largest single-site concentrated solar power (CSP) plant in the world: the fourth phase of the Mohammed bin Rashid Solar Park – 950MW Noor Energy 1, which is being developed by Dewa and Acwa Power. The UAE currently produces more solar power than any other GCC country at prices that have made it compelling for all its neighbours to follow its footsteps.

Although the region is keen on utilising PV as a favourable solar technology since it is fast emerging as the cheapest source of electricity generation, CSP is also galvanising attention. It has the capability to offer 15 hours of storage, making it a dispatchable alternative to natural gas, even to serve the peak evening demand. Record-breaking bids in renewable energy auctions, particularly in the UAE and Saudi Arabia, have consistently challenged cost, leading to the lowest global tariffs for both PV and CSP-generated electricity; thus, helping to accelerate the much-needed energy transition and decarbonisation of electricity generation across the world.

Solar power was once perceived as incapable of entirely removing the need for conventional power sources to keep the lights and air conditioning units switched on once the sun is down. However, small-scale batteries and innovative technology such as the use of molten salt have now come into play. Molten salt is able to hold the heat of the sun captured during daylight

hours with CSP technology, allowing it to be deployed at larger scales. Aggregately, batteries, molten salt and other technologies provide an intermediary storage solution to eliminate the intermittency issue of solar and wind-generated electricity.

The cost of thermal storage is declining and can now be less than 7 $cents/kWh, as utilised in Noor Energy 1. Battery cost—with electron battery technology likely to come on board—is also forecast to decrease to an estimated $70/kWh by 2030, a 67 per cent cost reduction from today, making it possible to supply power reliably to the grid around the clock at an increasing scale. These technologies offer the strong value proposition of being lower cost than fossil fuel generated power, totally devoid of price volatility and environmentally sustainable.

Socio-economic development

The continuing need for increased capacity and transformation of the fuel mix has also opened up tremendous opportunities to increase employment, foster industrialisation and generate overall prosperity within societies in the region. The evidence is compelling. As documented in the International Renewable Energy Agency's (Irena's) Jobs Report, renewable energy deployment across the world accounted for an additional 10.3 million jobs in 2017. The report goes on to estimate that decarbonisation of the global energy system could create up to 28 million jobs by 2050, highlighting the significant benefits of nurturing and investing in the sector.

Irena's recent Renewable Energy Market Analysis: GCC 2019 report reveals deeper analysis on the socio-economic benefits gained from renewable energy

installations in the Gulf. To state the facts, by 2030, renewable energy could save 354 million barrels of oil equivalent in fossil fuel consumption, reduce emissions by 136 million tonnes of carbon dioxide, create 220,500 jobs and cut water withdrawals in the power sector by 11.5 trillion litres (17 per cent reduction).

That only accounts for the Gulf region, and the mind boggles at the potential of figures that could be extrapolated onto the wider Middle East. These figures also show that deploying more renewable energy would have the added benefit of aligning country objectives to those of wider global as targeted by the UN Sustainable Development Goals.

What the future holds

As the demand for electricity and water soars over the next decade, governments' willingness to eliminate subsidies and seek full cost recoverable tariffs will intrinsically promote efficiency of utilisation and shape consumer behaviour.

The continuing rapid advances in renewable energy technology, digitisation, artificial intelligence, long-distance direct current transmission, solid-state electronics in grid management to support increasingly efficient distribution, increased scale of rooftop PV applications along with household-level battery storage facilities, and innovation in business models will all help to reduce the cost of both electricity and water, as well as improve quality of service and access to power.

The viability and efficiency of the sector will continue to be enhanced as the public and private sectors become more confident in working together, reciprocating respect for one another's capability and capacity to accept, mitigate and manage risk. This will ensure that the required level of funding keeps being provided essentially by private sources for these vastly capital-intensive sectors and much-needed skills are marshalled.

As advances in technology, methods of construction and business models continue to drive down costs for renewable energy and water desalination across the board, Acwa Power remains committed to reliably delivering electricity and desalinated water at the lowest cost, while striving to increase local content and maximise local employment for a healthier, wealthier and happier future, not only for the people of the communities and countries we serve, but also for future generations.

Paddy Padmanathan is president and CEO of Acwa Power

FUNDING THE FUTURE

As the nature of power projects shifts in the Middle East, energy stakeholders may be forced to adopt better finance models

Traditionally, the Middle East has adopted an older model of government financing and procurement to develop their power projects. Oman and Abu Dhabi were the first to embark on an independent power producer (IPP) programme nearly two decades ago. This resulted in equity participation from the international developer community and, after a few years of successfully 'banked' projects, we saw strong interest from local and regional investors.

The larger impact, of course, was the role of banks, which financed about 70-80 per cent of project costs, over long tenors of approximately 20 years. This represented a paradigm shift in the traditional financing model.

Over a period of time, this IPP model has become the de facto standard across the GCC. The larger pipeline of projects has attracted a wider community of developers and lenders, which in turn increased competition and led to the envelope being pushed—leverages climbed to 85 per cent, equity bridge loans were introduced, terminal values increased aggressively and Islamic finance pools were tapped for specific tranches.

The advent of renewables, first launched at utility-scale by Dubai Electricity & Water Authority (Dewa) about five years ago, seems to have started an avalanche of similar projects in every GCC nation.

While the overall transaction structures are quite similar, there are some specific differences. Successful bidders have been focused and creative in tapping into financing pools. We are already seeing some interesting trends.

Some jurisdictions attract Chinese financing; some are reliant on export credit agency financing; certain other jurisdictions attract Japanese financing; Saudi and Omani markets are also reliant on a fair amount of local bank participation.

This typically follows the developer profile, their intent and competitive positioning in those markets.

What does the future hold?

We know that there are liquidity concerns in the short term, and there are simply too many competing projects. This has already resulted in mini-perm financing becoming the order of the day. Government procurers cannot avoid it, developers have to factor this into account and lenders more often than not start with this position.

Yet, we have not seen enough attention paid to the looming question of refinancing. My personal view is that one potential solution has not been tested sufficiently—project bonds. This could well be a pool that will emerge quickly. It requires some work, but I believe there will be decent appetite. Most GCC government paper continues to be attractive and some offtakers are in a good financial position. The fact that the IPP has a few years of successful operations at the time of refinancing, and backed by a long-term power-purchase agreement (PPA) will certainly be helpful.

Local pension funds represent a large pool of financing, which has not been tapped into in this sector. Once again, it is my personal belief that they could supplement the local lending pool in most GCC jurisdictions, and that the effective interest rate could still be potentially attractive on a local pension fund on the basis of risk-adjusted returns.

Taking this argument further, international insurance players and pension funds could also present an alternative source for developers in the near future.

The suggestions above try to tackle the larger issue of new sources for debt financing, but there is also a similar issue on the equity side. With the exception of Oman, governments take a large equity position (typically 50 per cent or more) in the project companies. While this is understandable during the initial years of project setup and operations, it may be a good idea for governments to divest a large part of their holding to the public through the local capital markets (the Oman model is a good example). This delivers three important results—allows the citizens to participate, deepens the local bourse and reduces government commitments.

Finally, looking across the waters, it may not be a bad idea to create a regional green fund, much like the South Korea-based Green Climate Fund or the Green Investment Bank in the UK, which could participate in such projects across the region.

"… There are liquidity concerns in the short term, and there are simply too many competing projects. This has already resulted in an interesting trend—mini-perms are the order of the day"

Producing consumers

And let's not forget about the impact of prosumers (producing consumers). The rooftop programme is an initiative launched in several countries, and while this is relatively small, it is beginning to make a difference.

Dubai now has almost 50MW [of rooftop solar power], and this will only grow. Such rooftop solar capacity is being financed by a completely new lending group—either the prosumers themselves or through market aggregators under the own-to-lease model.

This is a relatively new source of financing that certainly crept up under the radar and cannot be ignored going forward.

Rajeev Singh is a partner for infrastructure advisory and project finance at Ernst & Young Middle East

ELECTRIC CAR TIPPING POINT NEARS

A combination of rising automaker spending and growing charging infrastructure is fuelling the adoption of electric vehicles

Electricity is the only widely available and domestically produced form of energy for transportation that addresses the simultaneous needs for fuel diversity, energy security, reduced greenhouse gas emissions and improved air quality. The transition of transportation energy from petroleum to electricity represents a paradigm shift for electric utilities to the role of fuel provider for vehicles.

Electric vehicles (EVs) are appearing around the world in a variety of shapes, sizes and forms, ranging from electric sports cars to electric buses and ferries. The performance and operational benefits of an electric motor also help reduce costs for all customers, while improving air quality and reducing greenhouse gases (GHGs) for all of society. So, do recent events indicate that we are approaching a tipping point for widespread, global adoption of electric transportation? Consider the following trends:

Rising spending

Automakers are spending billions of dollars to develop electric cars, trucks, buses and off-road vehicles. In one of many examples, Bloomberg Markets reports that Volkswagen AG secured $25bn in battery supplies to back its push to build up to three million EVs a year by 2025. According to a Reuters study, automaker investment in batteries and EVs now totals $90bn.

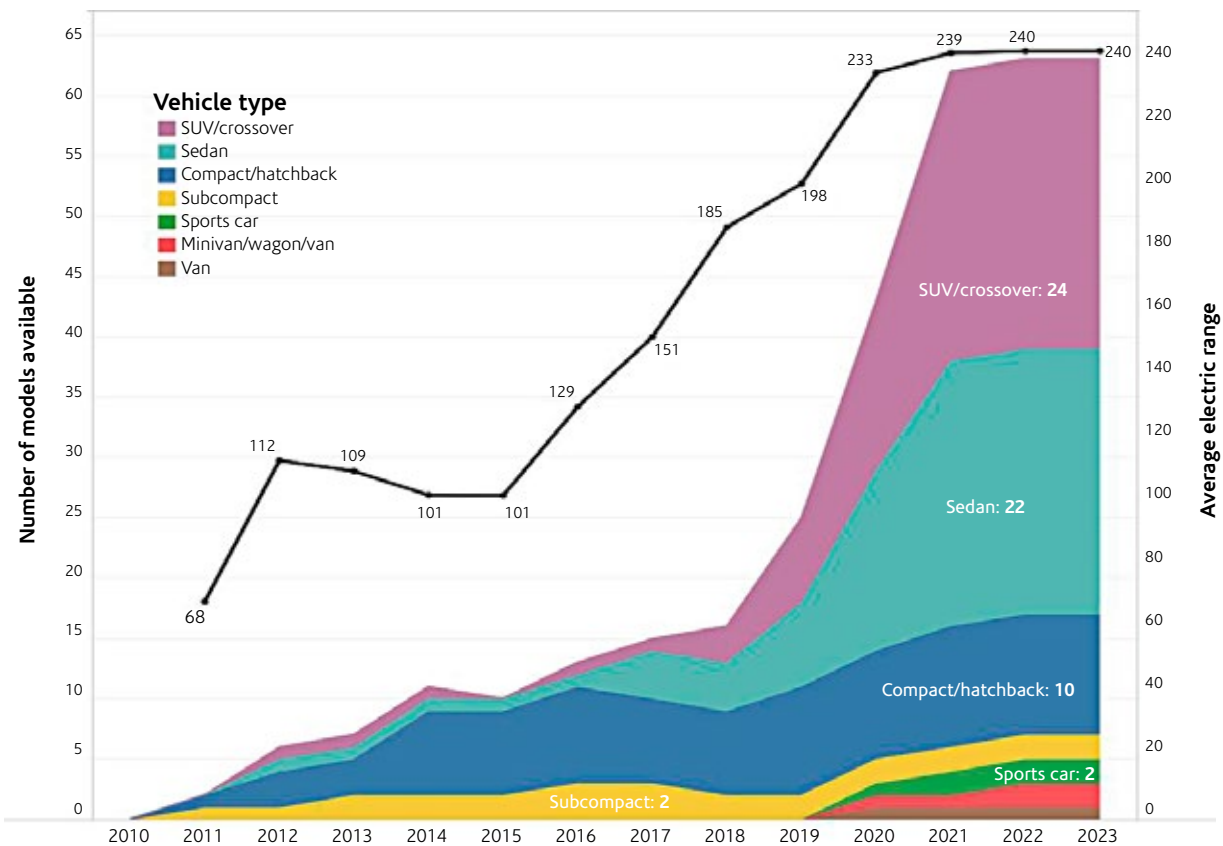


Figure 1: By 2020, average electric range of EVs will reach 230 miles, and 63 different battery EV models will be available worldwide (more than 40 per cent of which will be SUVs and crossovers). ***Source: EPRI***

"With continued declines in battery costs, as well as new model designs and more widespread availability, electric vehicles will soon become cost-effective alternatives to conventional internal combustion engine vehicles"

Growing number of EVs

Automakers are now offering, or soon plan to offer, a large number and wide range of EVs to the public and businesses. To fulfil the growing demand for EVs, automakers such as Tesla, Volkswagen, Ford, Volvo, BMW, Mercedes, Porsche, Maserati and others have announced various global EV plans. Nearly 140 different EVs, including battery EVs and plug-in models, will be available by 2023 at US car dealerships, and more than 40 per cent of those will be SUVs and crossovers.

What's more, we are now seeing the arrival of mass market-priced vehicles (about $35,000-$40,000). The average electric range of EVs will be roughly 350 kilometres by 2020. These are huge developments in this market (see Figure 1).

Countries weigh in

Cities and nations around the world are declaring their plans to phase out petroleum-fuelled vehicles and phase in EVs—often on aggressive schedules. The list of countries with requirements or plans includes France, Germany, UK, Norway, India, China, the Netherlands and others. Quoting Bloomberg New Energy Finance, journalist Jeremy Hodges points out that China adds the equivalent of a London bus fleet every five weeks (9,500 electric buses). Major cities, including Paris, Madrid, Athens and Mexico City, are moving towards banning diesel cars.

More charging infrastructure

Cities, states and countries are adopting and installing a broadening system of EV charging infrastructure. About $2bn of the $14.7bn mitigation and zero-emission vehicle investment settlement with Volkswagen AG is allocated to beefing up the US' EV charging infrastructure, while another $2.7bn is allocated to reducing emissions (nitrogen oxides). As of October 2018, North American utilities were proposing about $3.7bn in EV charging infrastructure.

At the same time, private companies and others continue to advance charging technology and lower costs. For example, ChargePoint recently unveiled a 2MW charger for electric semi-trucks and electric aircraft. Daimler-Benz, Freightliner and the CharIN group are working towards a 4.5MW connector, theoretically for long-haul Class 8 trucks.

Advancing autonomy

While highly uncertain, some analysts argue that the impending proliferation of autonomous vehicles is likely to further stimulate adoption of electric transportation. A Brattle Group brief published in March 2018 provides three reasons why autonomous vehicle technology could accelerate EV adoption:

- Help ease customer concerns over EV range and maintenance requirements
- Improve EV economics via increased vehicle utilisation
- Help enhance charging infrastructure by optimising charging patterns

Impact on energy supply and demand

Electric transportation will have a big impact on final energy supply and demand. The Electric Power Research Institute's (EPRI's) US National Electrification Assessment (USNEA) examined customer adoption of electric end-use technologies over the next three decades, along with key implications for efficiency, the environment and the grid.

The transportation sector, especially light-duty cars and trucks but other segments as well, represents the single largest opportunity for efficient electrification. More than 40 per cent of US final energy is used for transportation, and nearly two-thirds of that (a quarter of US total final energy) is consumed as liquid fuels for light-duty passenger vehicles.

With continued declines in battery costs, as well as new model designs and more widespread availability, EVs will soon become cost-effective alternatives to conventional internal combustion engine vehicles (ICEVs). Their slightly higher purchase price, charging equipment costs and occasional range limitations will be more than offset by lower operating costs, in terms of both fuel and maintenance, for most drivers.

Light-duty individual vehicles sit parked for more than 20 hours each day; this provides plenty of excess capacity and time to fuel many EVs.

The USNEA 'reference' scenario projects that light-duty EVs will comprise 75 per cent of new vehicle sales and 70 per cent of vehicle miles travelled (VMT) by 2050, compared to essentially zero today (see the left side of Figure 2).

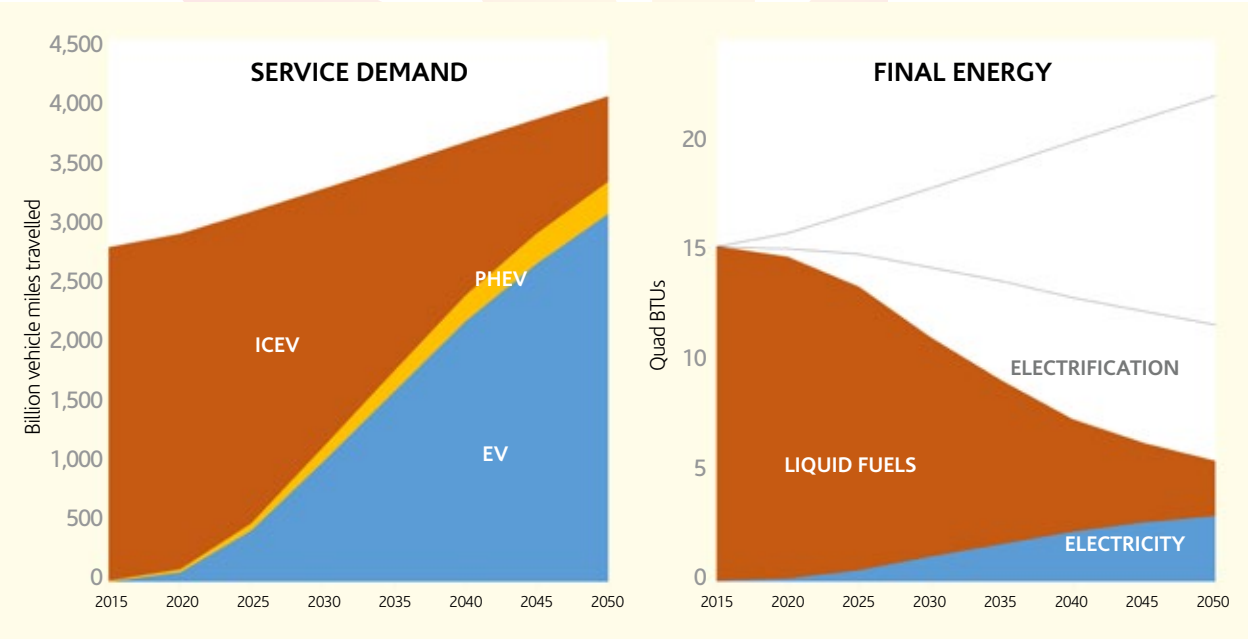


Figure 2: In EPRI's US National Electrification Assessment, the reference scenario for light-duty vehicles projects that 70 per cent of vehicle miles travelled in 2050 will be EVs (left side of figure), and final energy for light-duty vehicles will decrease by 60 per cent, due to electrification and efficiency improvements (right side of figure). ***Source: EPRI***

The study also predicts that this shift, combined with large efficiency improvements in internal combustion engines, will decrease final energy use for light-duty vehicles by 60 per cent by 2050, despite an assumed increase in VMT of almost 30 per cent (see the right side of Figure 2).

A growing synergism

Growth in renewable power generation (for example, wind and solar) provides 'clean' electricity to power the rising amount of electric transportation.

EPRI and the Natural Resources Defence Council produced a report titled Environmental Assessment of a Full Electric Transportation Portfolio to provide in-depth analysis of the environmental impact of electrifying a range of vehicles, including US light-duty and medium-duty transportation and industrial equipment such as forklifts. The study simulated emissions and air quality impacts of a significant shift from ICEVs to EVs and equipment.

The study based its analysis on projections that the electric grid will rely more on renewable energy and non-emitting power generation. It corroborates earlier findings that a decarbonising grid accommodating a fleet of EVs would reduce emissions relative to scenarios in which transportation, industrial and other fleets continue to rely primarily on petroleum fuels. With the widespread adoption of EVs, greenhouse gas emissions can be reduced, even when compared with more efficient conventional vehicles. Electrifying vehicles and non-road equipment will lead to better air quality.

Potential scenarios

The study analysed two potential scenarios of the future electric sector. In the 'base GHG' scenario, the study estimates that by 2050, the electricity sector could reduce annual greenhouse gas emissions by 1,030 million metric tonnes relative to 2015 levels, a 45 per cent reduction.

In the 'lower GHG' scenario, the study estimates that by 2050, the electricity sector could reduce annual greenhouse gas emissions by 1,700 million metric tonnes relative to 2015 levels, a 77 per cent reduction.

Dan Bowermaster is research programme manager for electric transportation at the Electric Power Research Institute

RENEWABLE ENERGY ON THE RISE

While the Middle East is playing catch-up with other international markets, the growing momentum behind solar and wind energy is unstoppable

Rapid growth in solar photovoltaics (PV) and wind farms across the world has been driven by sharp falls in technology cost and increased concern about climate change.

Despite the global growth, solar PV and wind are still nascent forms of energy in the Middle East. They form less than 1 per cent of the electricity generation mix today compared to 13 per cent in Europe.

There has been much hype and many conferences organised on this topic. However, the reality is that the Middle East is playing catch-up with markets such as Ireland, Portugal and Denmark, which now produce more than 25 per cent of their electricity from solar PV and wind.

Drivers for change

There are two underlying trends that mean this picture is likely to change drastically in the coming years. The first is a rapid drop in the costs of solar PV and wind. This has been driven by falling panel prices, falls in the financing costs and high developer competition.

Secondly, greater value is being placed on gas reserves in the region. Driven by new gas reserves becoming more expensive to exploit, gas is increasingly being seen as a tool to promote industry (such as petrochemicals) and employment. Continued development of the international liquefied natural gas market makes the option of exporting gas more attractive. These trends mean that solar PV and wind are now unquestionably the cheapest source of electricity in the region.

Challenges faced

Solar PV and wind are variable, non-synchronous sources of generation, which create several technical challenges for system operators (summarised in Figure 1).

International experience is that these challenges can be overcome with careful system planning and operation. There are large markets today where up to 60 per cent of instantaneous demand can be met through wind and solar PV. This limit is being constantly pushed and as the Middle East deepens its solar PV and wind penetration, it will be able to learn from other markets.

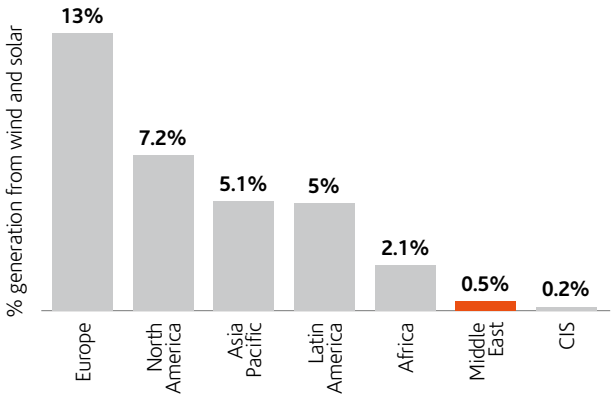
Enablers of integration

The march of wind and solar PV in the region seems unstoppable. The resource is excellent, finance costs are low and developer interest is high.

The main long-term barrier to renewable deployment is potential system integration issues. Figure 2 breaks down the options for integration and their enablers.

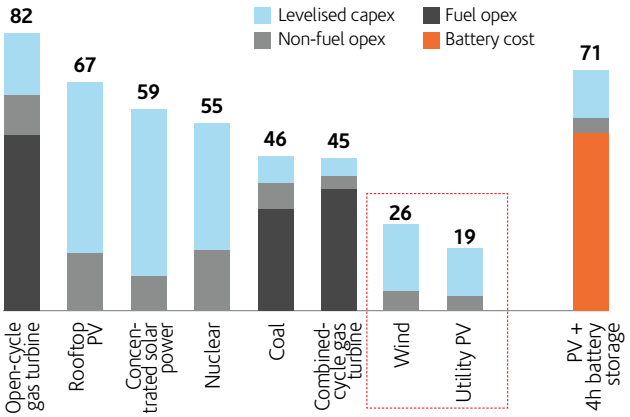
We believe that an evolution in the regulatory framework is likely to be a key enabler of renewable integration. The long-term power-purchase agreement (PPA) tender

Middle East's wind and solar energy contribution to the global electricity generation mix



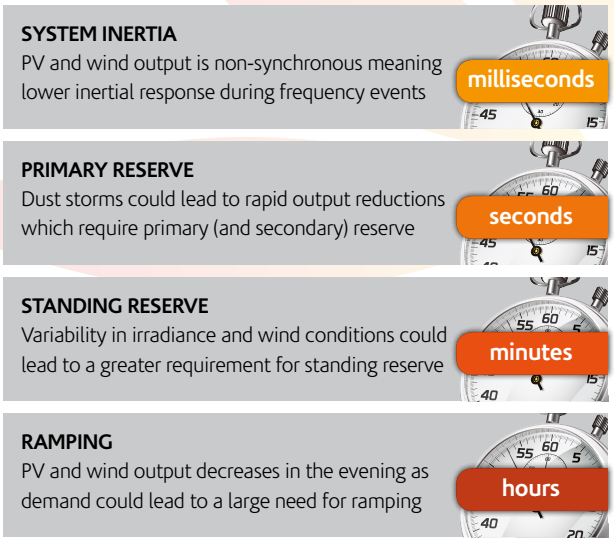
Source: BP world energy statistics 2018

Levelised cost of electricity of different forms of technology ($/MWh)



Source: Pöyry (coal priced at $3.5/mmbtu and gas at $5.5/mmbtu)

Figure 1: **Challenges created by solar PV and wind systems**



model has been very successful and has delivered world record-low tariffs for the first renewable projects. This model has significant limitations for technologies that can support renewable integration. The standard PPA structure is rigid and may not provide the full flexibility of the asset to the offtaker. A short-term signal is needed to incentivise interconnector flows and demand-side response. This could be from placing an hourly value on electricity—either from actual spot pricing or shadow pricing.

Some private sector companies in the region have been lukewarm on the prospect for a spot market in the region. The poor return on investment from power generation in European wholesale markets is cited as a cause for concern. However, when properly implemented, a spot market has the potential to unlock the future flexibility needed and allow the private sector to add additional value.

Oman will continue working towards making its spot market live in 2020 and Saudi Arabia is again considering options for a market opening. The future may be closer than some people think.

The Middle East's warm and arid climate means that electricity consumption to power air-conditioning and desalination will be structurally higher than elsewhere in the world. This makes the impact of electricity prices far higher than elsewhere.

Effective system planning and renewable integration can harness the solar and wind resources and deliver reliable, low-cost electricity that is essential for the future economic development of the Mena region.

Brendan Cronin is head of management consulting for the Middle East at Pöyry

Figure 2: **Integration methods and enablers for renewable energy sources.** *Source: Pöyry*

METHOD	DESCRIPTION	ENABLERS
Flexible thermal generation	Thermal generators move into a more flexible operating pattern It will become increasingly common for gas generators to have load factors below 20 per cent per year with daily start and stops	Move away from measuring the value of flexible generation on a levelised energy cost basis
Flexible demand	Contracts for load reduction in industry Consumers respond to dynamic electricity pricing linked to system conditions	Hourly (real or shadow) pricing Smart metering infrastructure Transfer of technology and best practice
Interconnection	The regional generation mix will become more diverse leading to increased cost differentials and opportunities for regional trade	Hourly (real or shadow) pricing of electricity Cross-border trading arrangements
Storage (batteries, CSP or pumped hydro)	Storage will be used in different ways; provision of spinning reserve Shift generation from daytime to night-time and from winter to summer periods	Hourly (real or shadow) pricing of electricity Alternative PPA models that can represent the cost structure of storage technology
Integration of electricity and transport sectors	Increased use of electricity and hydrogen in transport to deploy excess PV and wind generation in the transport sector	Hourly (real or shadow) pricing of electricity

LONGER-TERM SOLUTION

DECOUPLING WATER AND ELECTRICITY

The region's power and water sector is on a transformation path, with utilities developing water production plants separately from power generation units

With solar farms sprouting in more areas in the GCC and their tariffs breaking records at each project launch, it is clear that the energy market is steadily heading towards a transition. At the same time, another transition is occurring in the water sector with sea water reverse osmosis (SWRO) breaking foreseeable forecasts both in terms of energy consumption and tariffs.

A sector revolution is taking place and will generate a gradual decoupling of water and power generation. However, the details of how this decoupling is going to unfold remain uncertain.

Handling thermal assets

On the surface, decommissioning a thermal desalination plant producing water at a tariff of 1-1.5 $cent/cubic metre and huge energy costs appears a simple decision against the alternative of a SWRO plant at 0.5 $cent/cm tariff and 2.9 kWh/cm. In reality, the technicalities of the nexus between thermal power and thermal desalination are much more complex.

Some of the thermal desalination plants providing the bulk of water generation in the GCC countries were commissioned less than a decade ago and the majority of these plants have between 10 to 20 years of residual life until the end of their commercial operation.

The first challenge is taking advantage of the benefits of recent SWRO tariffs and at the same time dealing with the existing thermal fleet until the investment costs are recovered.

The other challenge is related to the water and power nexus. A number of existing large thermal desalination plants operate in a cogeneration scheme with the power plant; as such the desalination plant is the condenser for either a back-pressure steam turbine or a pass out steam stream.

In recent years, some project companies have started retrofitting a heat reclaimer to reduce the fuel consumption for when thermal desalination is underway without power demand, and thus to improve the poor water to power seasonal matching. However, retiring a thermal desalination plant would simply be impossible without

"A number of existing large thermal desalination plants operate in a cogeneration scheme with the power plant"

identifying how to beneficially condense that steam, increasing the thermal power generation efficiency or finding alternative clever solutions to reconfigure the entire power cycle. This is slated to be the challenge in the coming years.

Lowering tariffs

Presently, the industry approach to desalination is based on steady state operation. This is a practice inherited by the old power culture whereby production has to be continuous as electricity, unlike water, cannot be stored. Desalination plants therefore became extremely resilient on the production side, whereas the storage system downstream production, with an autonomy of 24 hours, remained relatively fragile.

As a consequence, government clients and developers have invested significantly in SWRO plants to protect them against extreme weather and oil spills. For instance, all SWRO plants in the GCC are presently fitted (or retrofitted) with dissolved air floatation (DAF) to withstand the effects of algal bloom, red tides or oil spills. However, DAF does not come cheap. It requires an investment amounting to between 5-10 per cent of the capital expenditure (capex) of the plant, a large land and energy footprint of 0.05-0.1 kWh/cm.

A water tariff of 0.5 $cent/cm between seven to 10 days per year of red tide occurring every year until the end of the concession time would be required to justify the investment. As severe as a red tide could be, the statistics of this occurrence indicate that the investment in the DAF simply does not make sense.

It would be wiser to invest in storage, reduce the DAF and afford the curtailment of the plant when extreme events occur. In holistic terms it would clearly be more advantageous to invest in recovering all treated sewage effluent (TSE) from the wastewater treatment plants to prevent the eutrophication of our oceans.

Recoupling for efficiency gains

If the idea that a SWRO plant has to operate on steady mode at 100 per cent production is put aside for a moment, and if we consider storage tanks not only as reservoirs of water but also as a buffer of energy, then more opportunities arise and a different synergy between the water and power sector can occur.

Water produced by a SWRO plant has an inherent energy of 3-4 kWh/cm; therefore storing 200 million imperial gallons a day of production, for instance, becomes not only water storage but a storage of 3,000-4,000MWhours of inherent energy.

Potable water reservoirs can also be thought of as an energy storage solution if we move away from the steady state concept and accept a dynamic operation, whereby the reservoirs can be filled with water during excess energy availability and can be emptied when a grid peak load needs to be managed.

Decoupling the two sectors upstream in generation and coupling them downstream in water and power dispatch management would enable efficiency gain, resilience and capex optimisation, and the opportunity to take full advantage of the extremely low energy prices made available by photovoltaics.

Corrado Sommariva is founder and CEO of Sustainable Water & Power Consultants

TAKING THE NUCLEAR OPTION

Nuclear power could deliver the dream of a cleaner, sustainable energy future

Nearly all of the power generated by utilities throughout the GCC is thermal based, with fuel sources being either natural gas or oil. Indeed, this lack of diversity has its consequences. Thermal fuel accounts for at least 75 per cent of the operating cost, and when fuel prices rise this means that the actual cost of electricity rises proportionately. Since end-user electricity prices tend to be heavily subsidised, GCC governments end up paying higher subsidies to offset the higher costs.

The fact that some of the fuel sources are local is not of much help, merely because the fuel used in electricity production is also heavily subsidised by government policy. Moreover, when market forces drive up the cost of fuel, there is a high 'opportunity cost', whereby the fuel is sold in the open market at a much higher price. This means lower revenues for government at a time when scarce capital could be used for other applications.

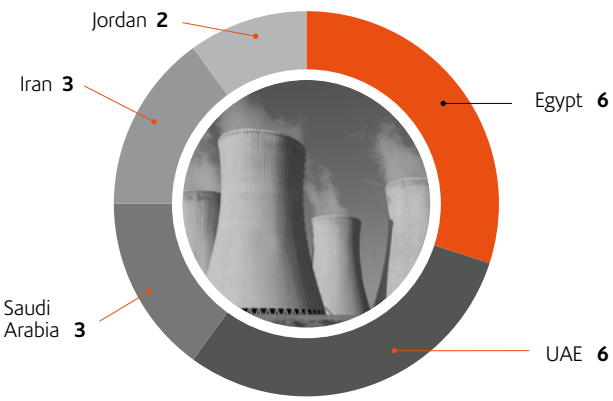
Despite being aggressively pursued throughout the GCC, renewables are not expected to be a significant contributor to the generation mix in the short run . Unlike thermal-based generation, renewables are not dispatchable. When the sun does not shine or the winds are not blowing, it is a challenge to generate electricity from these two predominant energy sources in the GCC. Competent and economical battery storage could turn the tide, but this is still in its infancy and will take years before it positively shapes the dispatchability of these renewables. Power utilities will continue to rely on thermal sources as a back-up.

Nuclear promise

Nuclear power is seen by some as a solution for the much-needed diversity. It frees up fuels such as natural gas and oil for other uses, and since the uranium feedstock makes up such a small percentage of operating costs (less than 15 per cent), the price impact on electricity is far more manageable due to uranium price swings. And given the lower lifecycle costs of nuclear, all of this translates into lower subsidy payments.

"By 2050, the UAE plans to have at least 50 per cent of its electricity generated from nuclear power and renewables"

Number of nuclear power plant projects planned or underway in the Mena region



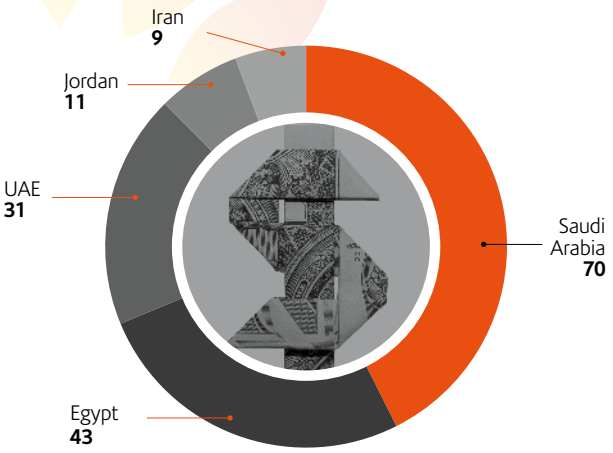
Source: MEED Projects

UAE's tryst with nuclear power

By 2050, the UAE plans to have at least 50 per cent of its electricity generated from nuclear power and renewables. Abu Dhabi, the first government in the GCC to commit to such a programme, began its nuclear journey in 2009. It awarded a $20bn contract to a South Korean consortium to construct four power reactors totalling 5.6GW of installed capacity (about 5.38GW net power) at the Barakah site. Ground-breaking took place in early 2011, with the expectation that units 1 and 2 would reach commercial operation in 2017 and 2018, respectively. All four units were planned to be in place by the end of 2020, supplying 25 per cent of electricity needed at significantly lower prices, compared to existing thermal plants fuelled by natural gas.

The Korean solution was chosen in part due to the unit's highest capacity factor, overall low capital construction costs and shortest construction time, among other well-known bidders from France, the US and Japan. However, two of these three advantages are already in jeopardy.

Value of nuclear power plant projects planned or underway in the Mena region ($bn)



Source: MEED Projects

Since awarding the contracts, construction costs have so far increased 22 per cent to $24.4bn, or about $4,357 per installed kilowatt, though still within the range of expected costs for a typical nuclear plant. Construction delays, while justified, mean that commercial operation for units 1 and 2 is now scheduled for late 2019 or early 2020, nearly three years later than planned. Reaching full commercial operation by the end of 2021 is a challenge, with 2022 or possibly even 2023 being more realistic in-service dates for the rest of the units.

Regional commitment

To date, no other GCC country has committed to nuclear power to the extent that the UAE has. Saudi Arabia announced in 2009 that it was considering a major nuclear power programme, establishing the Nuclear Holding Company in 2013 to oversee its development. Original plans included 16 nuclear power reactors that would account for about 20 per cent of the kingdom's electricity generation. The plan called for construction to start in 2016.

To date, construction contracts are yet to be awarded, though discussions are in place to explore various nuclear options, including small-scale nuclear reactors to supply power for some of the kingdom's desalination plants.

The kingdom produces more than 40 per cent of the world's desalinated water, a process requiring significant amounts of electricity. The nation is also exploring potential sites in-country for uranium production in support of its planned nuclear programme.

Kuwait was considering the possibility of a nuclear programme until 2016, following which it cited concerns over costs and ended its quest.

Qatar recently announced its intention to establish a scientific research and legal base for nuclear energy, as part of its 2030 Sustainable Development, but has not progressed substantially beyond this.

Oman has made a $120m investment in a uranium development project in Spain. However, there is no mention of a nuclear programme in Oman Power & Water Procurement Company's seven-year statement, which provides an outlook for future power and desalinated water supply. There is a move in Oman to diversify the fuel mix with greater reliance on renewables (up to 10 per cent of the generation mix by 2025) and the adoption of clean coal (up to 3,000MW by 2030). This could turn out to be a brilliant investment play, especially if and when the state progresses further with its nuclear programme.

Robert Bryniak is CEO of Golden Sands Management Consulting

UTILITIES TURN TO BIG BATTERIES

While the cost of battery energy storage systems has fallen significantly, the biggest challenge is quantifying the value of storage to a system

There is an energy transition underway, with power systems across the world moving towards a more decarbonised energy system. DNV GL's Energy Transition Outlook forecasts that by 2050, 70 per cent of electricity generation will come from solar and wind, with an additional 10 per cent from other renewable sources. In the Middle East, further electrification of energy systems is expected to increase power demand threefold by 2050.

Due to the intermittency of solar and wind generation, energy storage is a potential solution to support the integration of large amounts of renewable power into the electricity network. Up to 50TWh of battery energy storage is expected to be required to support the global energy system by 2050, as shown in Figure 1.

Utility-scale batteries

There are over 1.7GW of lithium-ion battery storage systems installed around the world. Over 1GW of these are in North America, with Germany, the UK, South Korea and Australia making up a significant percentage of the remaining amount. Each country is taking a different approach to how and why storage is installed based on the technical system needs. There are typically two approaches: top down and bottom up.

Countries such as the US have put policy in place to mandate storage to be installed, and those such as the UK have put frequency markets in place where the service is entirely provided by storage. Germany has also introduced a tax benefit to drive growth in domestic storage.

On the other hand, countries such as Australia are finding applications for storage based on existing markets and tariffs, without the need for top down support.

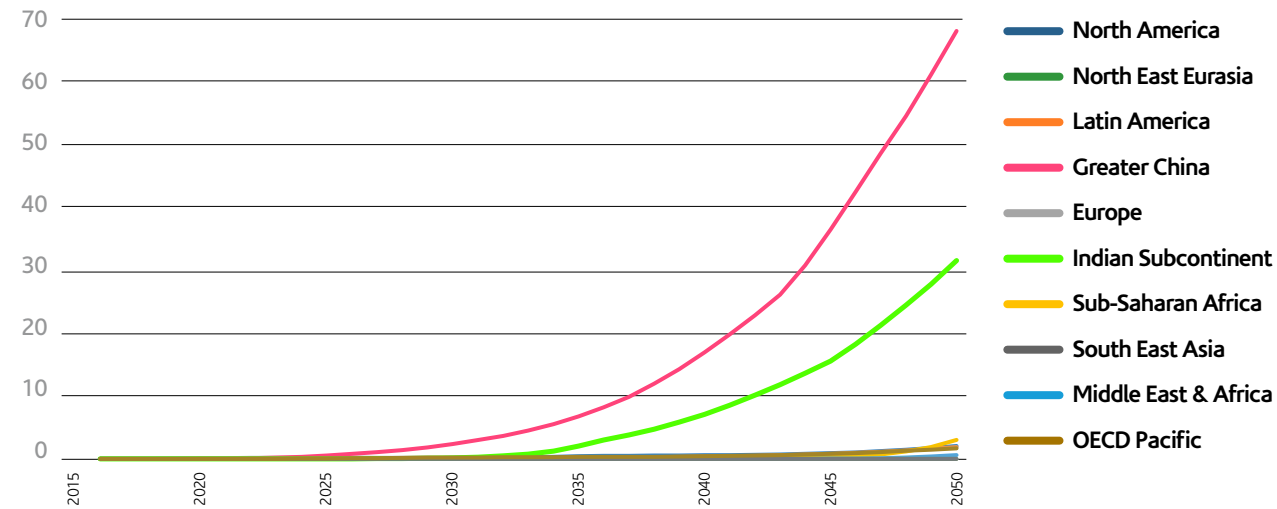
Price and technology

Although the cost of battery energy storage systems has fallen significantly over the past five years (and is forecasted to continue to decline), the technology is still considered expensive by the market.

Lazard's Levelised Cost of Energy Analysis (LCOE) reports are the most highly regarded cost forecasts and they put the LCOE of storage at around $200-$300/kWh for a single cycle a day battery. For a fully wrapped EPC, the market is at around $350,000-$600,000/MWh, though the price per megawatt hour varies significantly depending on the region and size of the system.

The significant driver to bring down the cost further will be supply chain maturity and advancements in the density and make-up of the lithium-ion technology (primarily driven by the electric vehicles industry).

***Figure 1*: Forecasted battery storage dedicated to power sector by region (GWh)**



Excludes storage from EV batteries. Source: DNV-GL

Storage project types being deployed across the globe	Benefits to the system
Standalone storage: These are systems installed on a standalone basis to support the local network or a national system	Standalone systems across the globe are used to support local networks (delaying conventional network reinforcement), providing ancillary services such as frequency response to the system operator and increasing the system flexibility as more renewables come onto the system
Co-located storage: These are storage systems co-located with another generation source such as solar, wind or combined-cycle gas turbines	Co-located storage is used to capture curtailed energy from renewables systems, reduce imbalance charges, decrease the required size of a grid connection, smooth the output of intermittent generation and support non-dispatchable generation in becoming dispatchable
Behind-the-meter storage: These are storage devices located behind a meter customer's demand meter	Primarily, these devices are used to increase security of supply, increase self-consumption of local renewable generation, and reduce customer bills by providing arbitrage services and minimising the amount of energy bought at peak time

Policy and markets

Storage rarely fits into the existing energy policy; it is dependent on both demand and generation and so, there are challenges with getting planning permission and defining how storage interacts with existing commercial and subsidy arrangements. Countries that have put in place policy that enables storage to compete on a level playing field with other technologies have seen significant benefits and growth in battery storage uptakes.

Value to storage

The biggest challenge for the battery storage industry around the world is quantifying the value of storage to a system. Storage can add significant benefits to a system that other technologies cannot provide. As an example, storage can provide dynamic frequency services that can respond in 300 milliseconds, unlike considerably slower conventional technologies such as gas or diesel. However, the industry is finding it difficult to both quantify this benefit and put in place a market that allows the technology to benefit or the additional value it can add to the system.

Market demand

There is significant interest across the region in battery energy storage. Investors, asset owners and utilities are considering storage with new projects they are deploying, as well as retrofitting storage to their existing assets to extract more value from the systems.

As an example, the recent Jordan tender process for a 30MW/60MWh system had more than 20 bidders respond to the request for proposal. The number of responders shows the interest in stakeholders wanting to get involved in storage projects.

Across the Middle East, there are many studies underway (as well as actual installations such as in Abu Dhabi) assessing both existing renewable developments where storage can capture excess generation and also to help strengthen power system stability.

There are also economic reasons where power dispersed from storage at critical times can offset the need for expensive spinning reserve. As an indicator for the future, the West Africa Power Pool is looking at the economic integration of storage resources to assist with balancing and trade across the system. It is conceivable, subject to economics, that energy storage could also be part of the value chain solution for demand response (DR) services where DR providers curtail load from the system and supplant temporary supply from storage.

The real opportunity for large-scale battery storage systems in the region is to support the integration of renewables and to integrate and develop a more refined approach to managing system flexibility in an energy system with less conventional dispatchable generation. Several utilities across the region are beginning to explore potential business models for deploying systems and exploring and gaining a better understanding of the potential energy storage supply chain.

Looking to the future, and with the increased expected penetration of electric vehicles, we see blockchain technology as the enabler to facilitate a platform for value creation by which energy storage in different mediums can export to and from the grid whilst monetising the benefit for all participants. Such transactions will be based on 'smart contracts' which exist on distributed ledgers and for which pricing and settlement is seamless.

Mohammed Atif is area manager for energy, Middle East and Africa at DNV GL - Energy

5G FANFARE BECOMES A REALITY

The next generation of mobile communications technology is set to transform all aspects of life and work

After a long wait, the fifth generation of cellular mobile communications is now a reality, with many operators announcing its commercial launch across the globe.

Unlike 4G, which mainly provided mobile broadband services with better speed compared to earlier generations, 5G can instantly provide enhanced mobile broadband (EMBB) services with much higher bandwidth, reaching up to 20 times higher speed compared to LTE and provide fibre-like experience in home broadband scenarios also referred to as fixed wireless access (FWA). This can enable higher video resolutions such as 4K and 8K videos as well as augmented and virtual reality applications for both mobile and home users.

In addition to EMBB, by the year 2020, 5G will enable more massive machine type of communication (MMTC) and ultra-reliable low latency communication (URLLC).

Future internet of things (IoT) will also flourish under 5G, where everything will be connected under the umbrella of a smart city; from smart wearable devices for tracking to sensors. All of these will enable smart factories, smart agriculture and so on. For this to happen, we need around one million connections per square kilometre.

URLLC will also enable several business and mission critical use cases such as autonomous driving, remote surgery and remote rescue.

Potential benefits

5G is important for all the available and potential use cases mentioned above. 5G will help to transform our lives. We expect 5G to change the world and bring benefits to the entire economy and society. Sectors such as education, healthcare, agricultures, retail and emergency services will all benefit from such revolutionary technology. Several nations have already recognised these benefits, which is why we see several national strategies and visions to encourage and accelerate the adoption of 5G.

Very soon autonomous driving, smart cites and further immersive entertainment will be available because of 5G. Huawei announced 30+ commercial contracts during the 2019 edition of the Mobile World Congress (MWC) in Barcelona in February.

"Renewable energy has already been adopted for the base station in recent years, particularly for remote sites where access to commercial power is difficult and limited"

Upgrading systems

We trust that current infrastructure can enable 5G, barring some minor and simple upgrades on the radio access part (RAN). Introducing the 5G active antennae will make the network able to deliver all kinds of EMBB services. In simple words, adding 5G radio unit to the current site is allowing operators to launch 5G services. Other network elements need to consider the added traffic from 5G.

Huawei's ultra-broadband, simplified and intelligent end-to-end (E2E) 5G solution comprises several upgrades to enable a smoother transition to 5G.

5G devices, which includes the first 5G indoor and outdoor customer premises equipment for wireless home broadband use case, enabled the earliest 5G commercial networks in 2018. Huawei also unveiled the world's fastest 5G foldable phone during MWC 2019.

Simplified RAN supports massive multiple-input multiple-output (MIMO) to guarantee the user experience and can be flexibly deployed in all scenarios, including rooftops, lamp poles and towers.

The 5G microwave solution fully supports the additional backhaul requirements of 5G services, offering intelligent solutions in various deployment scenarios.

The converged transport solution, based on a simplified architecture, expands transport capacity for a lower cost per bit and supports 5G transport lifecycle automation.

Further, the 5G core supports a converged, centralised and autonomous control plane for all services (2/3/4/5G – standalone and non-standalone networks). It also features a distributed and programmable user plane.

Global services include 5G precise planning, digital engineering and AI technologies to accelerate 5G deployment, achieve automatic and intelligent operation and maintenance (O&M) processes.

5G sites are simpler to deploy than 4G networks and more power efficient on a per-bit basis. The intelligent power control solution, based on artificial intelligence (AI), makes 5G more efficient in terms of power consumption per bit compared to 4G. Huawei also utilises AI capabilities to simplify 5G deployment and O&M processes.

Impact on energy

There will be more energy consumption impact on the telecom networks after 5G deployment. The adoption of 5G network directly affects the operational expenditure (Opex) and cost, therefore the operators have to focus on the 5G power efficiency from end-to-end, including telecom equipment power optimisation through hardware and software, cooling systems, power efficiency and new energy storage systems such as lithium battery storage.

Renewable sources will definitely be a trend for the long run to reduce energy OPEX and CO2 emissions from a social responsibility perspective. Renewable energy has already been adopted for the base station in recent years, particularly for remote sites where access to commercial power is difficult and limited.

We believe with the rapid development of renewable energy technology and applications, the renewable energy solution will be adopted more and more in the 5G era.

An Jian is president of the Carrier Networks Business Group at Huawei Middle East

SHIFTING GEARS

As a hydrocarbons-rich economy, the Middle East is striving to find the balance between oil production and renewable energy generation

As Middle East governments seek to maximise returns from oil reserves and reduce pressure on limited gas supplies, utilities and industrial companies are turning to clean energy resources to play a central part in meeting the growing demand for power.

But while alternative fuels such as coal and nuclear power are being integrated into the region's power mix, renewable energy projects will far outstrip them as the primary alternative to natural gas for power generation moving forward.

Blessed with some of the highest solar radiation levels in the world, the Middle East and North Africa is ripe for the development of significant solar capacity to meet the growing demand. There are also significant opportunities for developing wind power on the Red Sea coasts of Egypt and Saudi Arabia and at multiple locations in the Levant area.

Solar and wind power are transforming from expensive, supplemental power sources into mainstream power generation technologies, which are already achieving cost parity and beating conventional thermal power facilities.

The move towards reducing carbon emissions has become an increasingly important priority, epitomised by regional support for the 2015 Paris climate agreement. The primary driver behind the Middle East's shift towards renewable energy is the significant fall in the cost of clean energy technologies, with the cost of wind and solar having fallen by more than 70 per cent since 2009.

Rather than just following a trend, the Middle East is in many ways driving the growth of renewables, with world-record tariffs continuing to be achieved for wind projects, and photovoltaic and concentrated solar power.

Hitting energy targets

For the region to meet many of its long-term clean energy goals, utilities face sizeable challenges in the form of storage and transmission of renewable energy. Regionalised issues such as dust and continued subsidies for oil and gas-based fuels will also present a stiff challenge for power providers.

While new technological solutions are improving at a rapid pace, more work is required. The rising influence of digital technologies such as the internet of things and big data will also provide ample opportunities for the region's utilities to deliver reliable and cost-efficient power. Electrification of transport will also have an impact on the demand and supply of energy across the region.

The ambitious renewable energy programmes will not just reduce government fuel bills, but will also pave the way for new jobs and opportunities for diversification of manufacturing sectors. If approached properly, the regional energy boom will bring significant benefits for governments and their people across the Middle East.

ABOUT MEED

MEED has been integral to delivering business information, news, intelligence and analysis on the Middle East economies and activities for over 60 years. Attracting a key senior management audience through its content and activities, MEED is a media brand, publication and data business that covers a spectrum of services which inform, engage, connect and ultimately support our subscribers and partners in their business development and strategic growth.

Recently acquired by GlobalData Plc, MEED is now part of one of the largest data and insights solution providers in the world with the capacity to build global communities for our clients.

Our purpose is to support the region's companies make better and more timely decisions through our innovative data solutions and grow through our comprehensive and world-class marketing solutions.

To find out more email: info@meed.com

ABOUT MASHREQ

Established in 1967, Mashreq is the oldest bank in the UAE, with award-winning financial solutions and services. Throughout its 50 years' history, Mashreq has differentiated itself through innovative financial solutions, making it possible for its customers to achieve their aspirations.

Today, Mashreq has a significant presence in 11 countries outside the UAE, with 21 overseas branches and offices across Europe, the US, Asia and Africa.

Mashreq launched its new Vision and Mission recently, outlining its commitment towards its clients, colleagues and the community. In line with its vision to be the region's most progressive bank, Mashreq leverages its leadership position in the banking industry to enable innovative possibilities and solutions for its customers across corporate, retail, international, treasury and Islamic banking.

Mashreq is proud to be the first financial institution in the UAE to be awarded the Gallup Great Workplace Award for four consecutive years from 2014-17. Mashreq also continues to invest in recruiting, training and developing future generations of UAE national bankers.

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