SOLAR OUTLOOK REPORT 2021

MIDDLE EAST SOLAR INDUSTRY ASSOCIATION

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MESIA جمعية الشرق الاوسط لصناعات الطاقة الشمسية
Middle East Solar Industry Association
Empowering Solar across the Middle East

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Dania Musallam
Research and Content Manager
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"Our hope is for MESIA 2021 Outlook Report to shed complete light on the current solar and storage advancements as well as the future prospects in the MENA region. Many thanks to all contributors, whose research efforts and expertise were key to producing once again this report."

Baynouna 200 MW project, Jordan
Courtesy: Baynouna Solar Energy Company

FOREWORD

Martine Mamlouk
Secretary General of MESIA

2020 has seen further increase of solar power capacities installed globally and in the region, as well as continued improvements of competitiveness's despite low fossil fuels prices. However, the impact of COVID 19 pandemic combined with the economic and financial consequences of the drop of oil and gas prices have triggered some slowdown in the development and launch of new projects in MENA. Reduced electricity demand in some countries may also lead to postponement of investment in additional power production capacity and in some cases to curtailment.

However, beyond the present crisis, the future for solar looks in many ways brighter.

The solar industry has proven to be particularly resilient and adaptable, overcoming difficulties of supplies, of staff constraints, of movement and monitoring of sites. Many end-users in industry and services, the health sector in particular, have fully grasped the security provided by solar energy. Moreover, the COVID 19 pandemic has been an awakening call and triggered larger socio – political support for a "greener" and more sustainable world. Individuals, companies and governments have measured the extent of disruptions and the impact that global warming could trigger in an interdependent planet. The speed and scale of the propagation of the virus, energy and water security as well as sustainability are all issues that have come to the forefront and put renewable energy in the limelight.

Furthermore, leveraging stimulus packages put in place to mitigate the impact of this crisis provides a unique historical opportunity to shift investments towards more green, clean and sustainable technologies and industries further unleashing the solar energy potential. As a number of these stimulus packages around the world have also put special emphasis on improving storage solutions, from batteries to hydrogen that will enable new cost reductions, the industry expects LCOE of solar energy to further decrease. Its integration into the grid is also expected to become easier to manage in the coming years.

As green hydrogen becomes more competitive, paving the way to the next phase of the energy transition, in the next decade in MENA, one of the main drivers of more solar projects.

In this context, the support of governments will play a key role for the industry. Prioritizing green projects in the stimulus package for economic recovery, reducing subsidies to fossil fuels, pricing carbon, adjusting regulation to new technologies, facilitating wheeling and fully enabling the private sector will be essential.

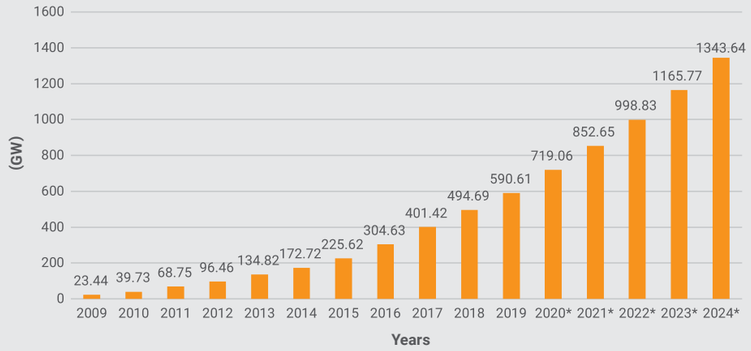
Finally, one can reasonably expect that 2021 will see recovery stepping in and with it a number of delayed solar tenders will reemerge and will be completed.

While we all know that 2020 has not been an easy year, perspectives are more than ever promising for solar energy in the MENA region.

1. INTRODUCTION

Despite present health, economic and financial difficulties, a new era towards solar energy is continuing to thrive. By the end of 2020, the total global installed solar power capacity could reach up to 700 GW. By 2024, the estimated increase is projected to almost double to reach 1300 GW. Solar prices are decreasing dramatically, and technology advancements may lead to further drops.

CUMULATIVE GLOBAL INSTALLED CAPACITY IN SOLAR



Sources: International Renewable Energy Association, DNV GL ET)
*Estimates and forecasts are based on DNV GL experts and external sources

Figure 1: Global Installed Solar Capacity

Today, solar and other renewable energy sources are already paving the way toward electrification and decarbonization of end usages. Green hydrogen could provide the long-term flexibility required for large integration of solar into the energy system. Green Hydrogen is currently being explored worldwide and strategies to engage in this next phase of the energy revolution are in process.

In the Middle East and North Africa (MENA) region, countries have advanced in reaching their renewable energy targets and new projects have come online. Major highlights from 2020 include:

- Noor Abu Dhabi solar PV plant has achieved a net production of 2,000 GWh providing electricity for its first year
- The world largest solar PV project, 2 GW in Abu Dhabi's Al Dhafra region, was awarded
- The first renewable IPP in Oman, Amin PV plant, began commercial operations in May. Amin PV project is currently the world's largest single-unit solar park that adopted bifacial modules
- Ibri PV II, the 500-MW project in Oman, successfully achieved financial closure in Q1
- The first 80 kW offshore floating solar PV project achieved commercial operations in February in Nurai Island, Abu Dhabi
- In Dubai, the Mohammad Bin Rashid Solar Park phase 3 was inaugurated and phase 5 successfully reached financial closure
- In KSA, REPDO issued the RFQs for Round 3 including four solar power projects with a combined capacity of 1.2 GW
- The Moroccan Agency for Sustainable Energy (MASEN) issued an EOI to pre-qualify developers for the construction of the 400 MW Noor PV II solar power plant
- The Tunisian Ministry of Mines and Energy awarded 500 MW solar projects to be built in various provinces in Q1 of 2020
- KSA's Electricity & Cogeneration Regulatory Authority (ECRA) launched a regulatory framework for addressing small-scale solar distribution systems connected to the utility grid
- New rules on net metering were set by the Egyptian Electricity Utility and Consumer Protection regulatory agency (EgyptERA) in April
- Future of solar for C&I in Iraq is becoming more feasible
- KSA, UAE, Morocco, Egypt and Oman, among others, are looking to invest into large green hydrogen projects based mainly on solar

While the global pandemic (COVID19) has impacted the pace of launching new projects and the industry had to face several challenges from supply to maintenance and workforce, the industry has also demonstrated its resilience and capacity to adapt. Despite the global slowdown in issuance of new RFQs and contracts, countries in the region have realized the importance to engage in a more sustainable future. From this point of view, renewable energy – and solar in particular – are more than ever at the forefront to provide adequate answers for decarbonization and energy security.

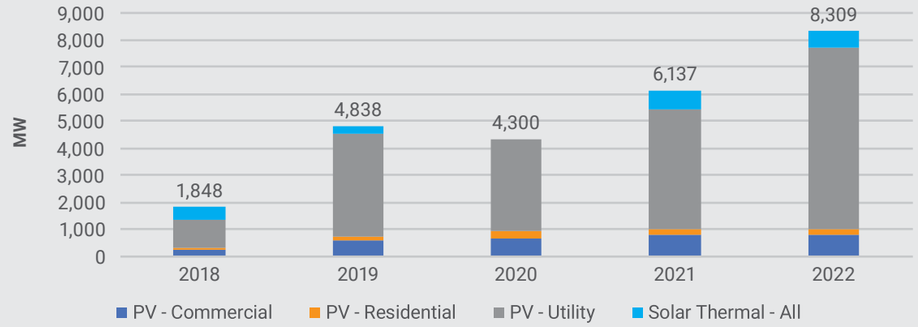
2. »

INVESTMENT IN RENEWABLE ENERGY

Global energy investments have been impacted by the combination of COVID19, drop in energy demand and subsequently the price of hydrocarbons, as well as new priorities of reduced budgetary and financial resources. However, according to Bloomberg New Energy Finance (BNEF) figures, renewables and batteries captured 80% of the total US$15.1 trillion invested in new power capacity. Around $2 trillion or 13% is invested by households and businesses.

Renewable energy is the only energy source for which demand has increased in 2020. Although it was not a significant increase, but this trend continues to reveal how important clean energy sources become to the world. According to IEA, it is anticipated that solar PV will grow at an average of 13% annually and meet one-third of electricity demand between 2020 and 2030. Massive expansions can be anticipated in the next decade for the MENA region, particularly attractive for solar investments with some of the highest solar irradiation levels in the world.

ADDITIONAL YEARLY CAPACITY IN THE MENA REGION



Source: BNEF Data
* 2020 – 2022 data are forecasts

Figure 2: Additional Capacities in the MENA Region in MW

According to BNEF, solar capacity in the MENA region could reach up to 8,309 MW by 2022 as the region is steadily adding more renewable energy projects to meet the countries' targets included in their energy transition strategies. Frost & Sullivan estimates that additional investment in solar in MENA could reach by 2025 $182.3 billion.

» DEVELOPMENT FINANCIAL INSTITUTIONS

In 2020, investment from Development Financial Institutions (DFIs) picked up compared to 2019. During the year, several countries in the MENA region received support:

» ALGERIA

- Became a member of European Bank for Reconstruction and Development (EBRD), opening new access to finance for REN (Renewable Energy) projects

» EGYPT

- Multilateral Investment Guarantee Agency (MIGA) backed the Benban project.
- EBRD is currently considering financing Kom Ombo project.

» JORDAN

- Work is still ongoing by DFIs to finance solar projects in the country. While 2019 saw the largest private-to-private solar project financed by EBRD (37 MWp for up to USD 35Mio), 2020 has seen the commitment of Apicorp extending a USD 50Mio revolving construction facility for development of solar project with YDE, o/w in Jordan

» LEBANON

- EBRD appointed advisors for the development of wind, solar and storage tenders in the country

OMAN

- Financial closing of IBRI PV II with a pool of DFI and commercial banks

TUNISIA

- Discussions are still ongoing for Concession and Authorization regime projects in the country

- EBRD and EU agreed to a €50 million financial guarantee to boost renewable energy in EU Neighbourhood, in particular in Tunisia

UAE

- APICORP funded with debt a portfolio of solar projects in UAE
- APICORP provided financing for Mohammad Bin Rashid Al Maktoum Solar Park - Phase 5

A GROWING INVESTMENT PRIORITY: STORAGE SOLUTIONS

BNEF expects this component of the market to grow with a global addition of power/capacity: 4.6 GW/9.4 GWh in 2020 (against 3.3 GW/6.5 GWh in 2019), regardless of the impact of the global pandemic.

- Morocco has been one of the most active countries in MENA with the installation of a thermal energy storage system at the Noor Midelt Solar Plant. More projects featuring a combination of PV and storage systems can be expected in this country.
- In Oman, the tender for the Tanweer project, consisting of hybrid solar and storage, is in final stage.
- In the UAE, Dubai's Mohammad Bin Rashid Al Maktoum Solar Park Phase 4 marks a significant investment in concentrated solar power (CSP). The project is currently under construction. The Al Dhafra project in Abu Dhabi has a storage option with battery capacity of 108 MW. However, sources indicate that the country may wait for further declines in storage costs and renewed growth of electricity demand before engaging in more storage projects.

RENEWABLE ENERGY INVESTMENT CHALLENGES

COVID19 was a wakeup call for many investors and companies globally. In one way or another, the whole world is impacted, underlining the high level of existing interdependencies and putting pressure on supply chain and energy security. The effort to mitigate the increase of temperatures below 2 degrees remains challenging. According to BNEF, to enable the "power system of the future, $14 trillion in grid investment is needed between now and 2050." Therefore, it is key that the measures to relaunch economic growth prioritize sustainable and green investments.

Due to the exceptional context of 2020, this report is looking at the specific impacts of COVID19 and the decline of oil prices.

Zaya Nurai Island 79.9 kWp Floating PV
Courtesy: Enerwhere

3. COVID 19 AND OIL CRISIS IMPACTS

3.1 SPECIFIC IMPACT OF COVID19

Strict containment measures introduced by governments drastically reduced the activity and weakened consumer demand, particularly in sectors such as tourism, hospitality and retail (e.g., Bahrain, Oman, Egypt, Jordan, UAE, Tunisia, Morocco). The largest impact is likely to be felt by small - and medium - sized enterprises (SMEs). Also, given the higher labor intensity of most of these service sectors, there could be significant second-round effects on domestic demand as unemployment rises and wages and remittances fall.

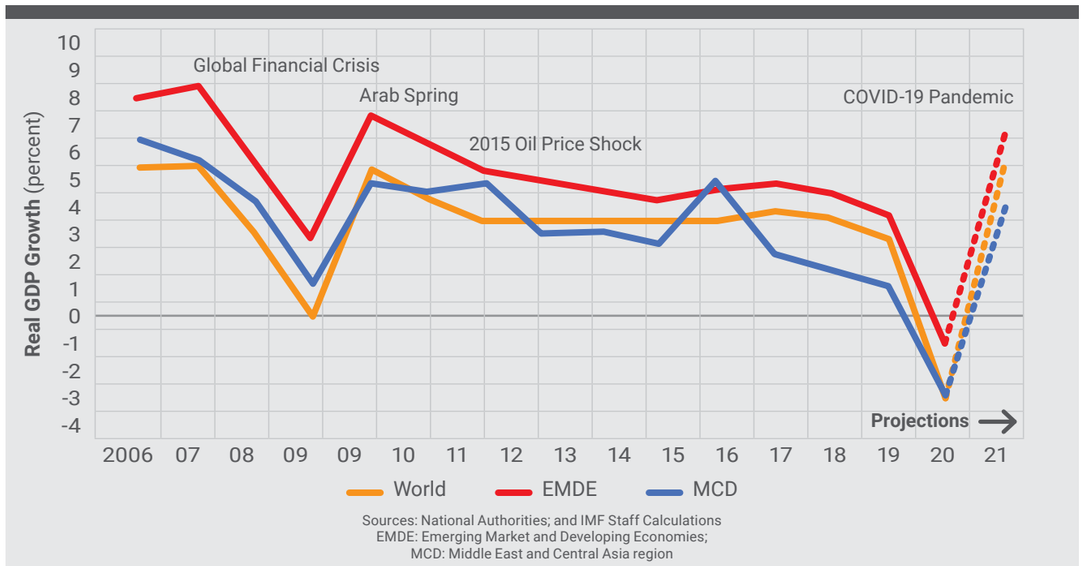
This situation has induced a drop of growth of electricity demand, in particular in the sectors most affected by lockdowns and reduction of activity. BNEF estimated in its "New Energy Outlook 2020", published in October 2020, that power demand in 2020 is down 5%, and will only return to 2019 levels again by 2022.

Moreover, economic activities, including in the energy and solar industry, are being affected through supply-side shocks.

3.2 ADDITIONAL IMPACT OF OIL PRICES

Oil prices have fallen by about 50% since the COVID19 outbreak. The commodity price drop hit the lowest point in more than 20 years (after adjustments for inflation) with a reduced demand due to travel restrictions and the economic slowdown coupled with the absence of a new OPEC+ production agreement. Cut agreement by OPEC+ at the start of April, and additionally by oil exporting G20 economies, provide support, though limited, to oil prices.

Hence, fiscal and export revenues have declined across all oil-exporting countries in the region, putting pressure on budgets and exchange rates. This has particularly impacted countries highly dependent on hydrocarbon exports such as Oman and Kuwait. Moreover, the reduced cost of oil and gas lowered the incentives to shift from conventional to renewable and solar power in some countries.



Sources: National Authorities; and IMF Staff Calculations
EMDE: Emerging Market and Developing Economies;
MCD: Middle East and Central Asia region

Figure 3: Real GDP Growth

3.3 COMBINED OIL AND COVID-19 CRISIS IMPACT ON THE ECONOMIES

In addition to the devastating toll on lives and simultaneous supply and demand shocks, the pandemic had a spinning effect on plunging oil and commodity prices resulting in decreased budgetary resources and tightening financial conditions. As a consequence, growth in the Middle East and Central Asia is projected to fall from 1.4% in 2019 to −6.6 % in 2020— lower than the growth rates during the 2008 global financial crisis and the 2015 oil price shock. However, growth is expected to reach 3.0% in 2021, as threats from the virus recede and global policy efforts spur recovery.

3.4 COMBINED IMPACT ON AVAILABILITY AND COST OF PROJECT FINANCE

3.4.1 DOWNGRADE OF SOVEREIGN CREDIT RATINGS

As a result, rating agencies downgraded several countries in the region: Oman in June and Kuwait in September (large upcoming debt maturities over the next two years may put more pressure on Oman's rating).

Moody's downgraded the ratings KSA, Kuwait, Lebanon, Oman, Tunisia and the emirate of Sharjah in 2020.

Bahrain's outlook has been revised to stable from positive with long- and short-term ratings maintained further to timely support of the country's neighbors; however, it remains very sensitive to energy price shocks.

Globally, rating agencies expect Brent crude oil to average $30 per barrel in 2020, implying more elevated current account deficits and potentially more financial difficulties. However, stability of ratings of countries like UAE or Qatar should be noticed.

2MWp Solar Rooftop Parking at the Mall of the Emirates
Courtesy – Karel Dewinter, Hy-energie FZ

3.4.2 TIGHTENED GLOBAL FINANCIAL CONDITIONS

Major challenges

Meanwhile, global financial conditions have tightened sharply, adding to the challenges. Equity markets are down by 20-30% since their peak in mid-February 2020, with energy sectors among the hardest hit. Global risk sentiment, measured by the Chicago Board Options Exchange Volatility Index, has nearly quadrupled to historic highs over the same period. Despite vigorous monetary policy easing and liquidity operations by major central banks, 10-year government bond yields and sovereign spreads have surged in many countries in the Middle East and Central Asia. According to experts, nearly $5 billion of portfolio flows had left the region in the month of March.

Cumulative portfolio inflows to MENA oil exporters have declined by more than $3.5 billion since early 2020. As a result, external borrowing costs have risen, on average, by 279 basis points in the Gulf Cooperation Council (GCC). These conditions pose major challenges for some countries in particular (Bahrain, Iraq, Oman) and could become a wider concern given the region's estimated $10 billion of maturing external sovereign debt this year.

Mitigating measures

Given fragile growth and generally weak automatic stabilizers, governments have put in place temporary stimulus measures emphasizing in many cases economic diversification. GCC member states and Egypt have earmarked more than $130 billion in economic stimulus packages. Looking at the region as a whole, an average GDP of 2.7% was allocated to fiscal measures, while 3.4% of GDP was directly injected into the economy by central banks.

- Support to the private sector and households impacted by the pandemic included direct cash transfers, suspension of rent and utilities payments and loan modifications. In addition, government guarantees have been deployed (e.g. in UAE) for small and medium enterprises (SMEs) and salaries of quarantined or ill migrant workers maintained (Qatar).
- Relaxed monetary policy was implemented, including interest rate cuts (Bahrain, Kuwait, Qatar, Saudi Arabia, and UAE), lower reserve requirements (Algeria), and substantial liquidity support to banks, particularly those lending to SMEs and hard-hit sectors (Bahrain, Qatar, Saudi Arabia, and UAE).
- Fiscal-based measures injecting about $50 billion into country financial systems to support liquidity during the fight against COVID19.
- Direct support to domestic equity markets (Qatar).

External aid and financing was also provided for some countries (e.g. IMF to Jordan and Tunisia with a plan for a broader group of countries).

With weaker external demand and tighter financial conditions, availability and cost of project finance may become less favorable. Moreover, some countries in the region are faced with delicate choices between reining in social support programs, reconsidering investment priorities in new projects or increasing their budgetary deficit. This situation has led, at least for the moment, to some cancellations or postponements of projects.

The analysis of the impact of these combined crises on renewable energy and solar energy development needs to be pondered.

3.5 MITIGATED IMPACT ON RENEWABLE PROJECTS

The recent report of G20 Task Force 2 on climate change and environment underlines:

"The coronavirus disease of 2019 (COVID -19) has dramatically changed the socioeconomic context for clean energy transitions worldwide. With the global economy heading to a recession and possibly a financial crash, strengthening health systems, minimizing job losses, preventing supply chain breakdowns, and managing return of business to the "new normal" are immediate priorities for government. Since March 2020, there have been growing calls for "green," "just," and "better" recovery and "building back better" by governments, businesses, international organizations, and the civil society.... However, G20 countries have not yet aligned their financial flows with this rhetoric: in April 2020, only 4% of the US$7.3 trillion earmarked for fiscal rescue measures could be categorized as "green" (Hepburn et al. 2020). This mismatch should be addressed urgently."

3.5.1 IN THE SHORT TERM: SLOWING DOWN AND POSTPONEMENTS

The impact of COVID19 has been felt at various degrees. Postponement of trade fairs have limited marketing and new business opportunities, despite the surge of online webinars and workshops.

- Slowdown of tender evaluations, finalization of processes for ongoing tenders and/or launching of new projects has been noticed all over the region given that:
  1. Budgetary difficulties and revised priorities of spending and investments
  2. Travel difficulties make negotiation and signing harder
  3. Reduced services of governmental entities resulted in delayed permitting and awarding processes like in KSA and the UAE
  4. Reduced activities of some major C&I clients (e.g., hospitality, education, etc.) have forced the industry to focus more on other sectors (e.g. food and beverage manufacturers, sanitizer manufacturers, hospitals, etc.).
- Logistical issues, supply of equipment and materials, new constraints of customs clearances, difficulties in access to sites and availability of workforce have slowed down the construction and/or maintenance of renewable power plants, at least for the first phase of the pandemic. According to MESIA members, these issues have mainly been faced in this early stage of the pandemic and solutions have since been developed in many cases.
- To provide businesses some relief, many countries (e.g. UAE – Egypt) have resorted to temporary reductions in electricity tariffs. This adversely impacts solar project development in the short term, as the tariffs now offered could be less competitive and may not support meaningful savings.
- Other countries, such as Jordan, have limited or ordered the shutdown of solar wheeling facilities, which use the grid to connect to energy offtakers, because of tumbling electricity demand. This directly translated into reduced revenues for the developer and unrealized savings for the user.

3.5.2 IN THE LONG RUN: INCREASING USE OF SOLAR IS EXPECTED

In a context where reducing costs is important for many industries, renewable energy is one of the few sectors that has been able to weather the devastating effects of COVID19. Solar plants have been managed efficiently despite supply and manpower disruption and lockdown measures, putting the emphasis on the importance of digitalization and potential of remote monitoring. Moreover, new deals and new records have still been struck globally and as long as the grid can integrate additional power injections, the business case remains strong for renewables and for solar in particular.

On top of the generic stimulus package, some additional factors make solar more competitive which contributes to some positive prospects:

» THE CRISIS HAS BOOSTED SOLAR POWER PLANTS EFFICIENCY AND OUTPUTS

If anything, reduced pollution and improved air quality has increased the yield in many solar plants across the world (Germany, Spain and the UK broke national records in daily solar output). In UAE, clearer skies prompted by a dramatic drop in air and road traffic, have offered an unexpected boost to solar power production due to the improvement of the irradiation and the reduction of the soiling on the surface of the PV panels and CSP mirrors.

Despite lower prices of fossil fuels, the LCOE of larger utility scale solar and wind (see below) remains lower than thermal power generation. Even though international natural gas prices have fallen, the cost of capital has increased. The margin between CCGT and solar PV is narrower, but solar PV still has a clear cost advantage in the energy provision.

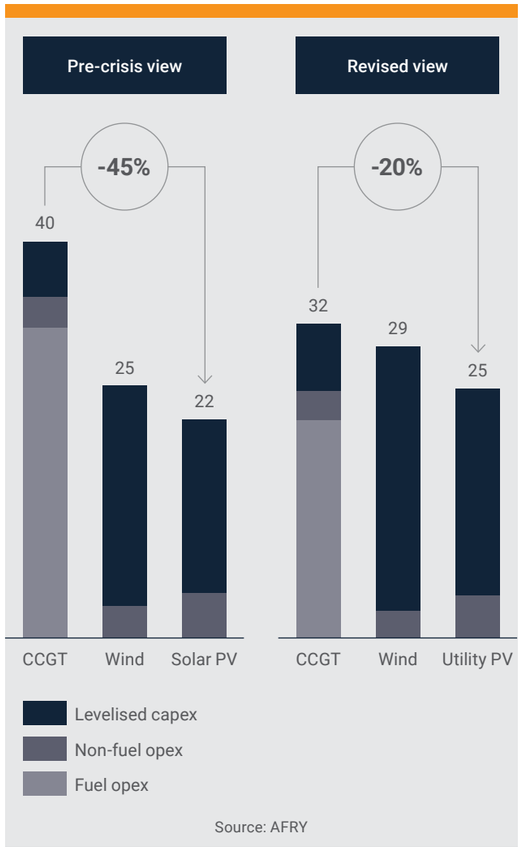


Figure 4: Levelized Cost of CCGT, Wind and Solar PV (based on solar and wind resources in KSA)

» SOLAR SYSTEMS MAKE INCREASINGLY ECONOMIC SENSE FOR COMMERCIAL AND INDUSTRIAL (C&I)

Introduction of solar system can offer to C&I immediate savings at zero upfront costs and protect from fluctuations of electricity prices. C&I systems can be quickly financed by equity now with a possible debt refinancing in a couple of years when the market has settled down to more favorable lending conditions.

» ATTRACTIVENESS OF GOING GREEN AND ADOPTING SOLAR IS MORE IMPORTANT THAN EVER

Attractiveness has grown, as well as the sense of urgency to limit global warming catastrophic risks. This has been illustrated by the increased political, economic and international mobilization at the recent G20 meeting in Riyadh.

Moreover, the plans adopted to boost the economy have given an opportunity to rebuild with more sustainable investments. The drive towards increased use of REN sources and in particular solar, should not change even if some projects are delayed. Following the messages of the G20 meeting in KSA, the recent climate dialogues to prepare COP26 have demonstrated the growing commitment in this direction. As an example, the CA100+investor initiative, whose members are two-thirds of annual global industrial emissions, launched a consultation on a strategy for decarbonizing the power sector.

The COVID19 crisis has underlined the importance of energy security, and solar power is asserting itself as a viable solution for governments and large categories of industries and end users (e.g. hospitals). Regional trends illustrate the continuous commitment of most countries to increase clean energy.

4. »

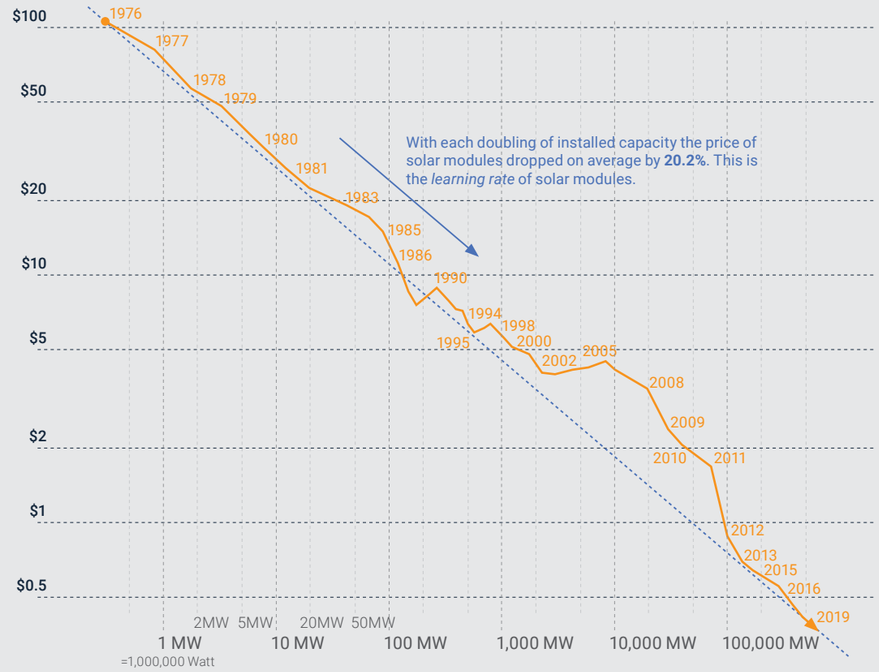
SOLAR TRENDS 2020 – 2022

4.1 SOLAR PRICES

THE PRICE OF SOLAR MODULES DECLINED BY 99.6% SINCE 1976

OUR WORLD IN DATA

Price per Watt of solar photovoltaics (PV) modules (logarithmic axis)
The prices are adjusted for inflation and presented in 2019 US-$. $100 1976



Data: Lafond et al. (2017) and IRENA Database; the reported learning rate is an average over several studies reported by de La Tour et al (2013) in Energy. The rate has remained very similar since then.
OurWorldinData.org - Research and data to make progress against the world's largest problems.

Licensed under CC-BY by the author Max Roser

Source: Our World in Data, Lafond et al. (2017) and IRENA Database

Figure 4: Levelized Cost of CCGT, Wind and Solar PV

The world is continuing to witness tremendous decreases in solar prices. Most recently, the 2 GW Al Dhafra solar project in Abu Dhabi hit another world record low price with $0.0135 per kWh.

There are main drivers on top of the favorable financing conditions up to 2020, supporting the cost decrease: growing economies of scale with increased market volume, improvements of PV technologies and high learning curves in the solar sector.

› **Impact of changing market size demand perspective:** the recent report from the IEA is expecting an increase in volumes to more than 140 GW by 2022 from around 100 GW in 2020. Even if a slowdown of electricity demand is playing a negative role, measures to boost green growth, increase green hydrogen and to ensure energy security for industries and services will play in favor of increase.

› **Impact of improvement in technology:** advancements in technology is key in solar price adjustments: e.g., mono-type and PERC modules with bifacial technology and half-cell module's progress will allow for significant improvements by 2022. They will induce better performance and lower costs with higher yield and lower degradation. Installation will also become less costly as structural enhancements combined with smaller amounts of module installments, as nominal capacity increases, will eventually decrease construction time and improve BOS costs. Therefore, industry experts believe that PPA prices are still expected to fall by least 5-10% by 2022, according to a recent survey of MESIA members.

› **Supply may ease:** as all major solar manufacturers have announced capacity expansions in the coming years, the capacities may triple the normal amounts produced. However, local content regulations and concerns of supply security may lead also to increase in country production and long-term assessment of impact of cost has not been fully evaluated.

A recent MESIA member survey shows that most respondents are not worried about a further decrease of solar prices as long as technology and cost reductions support it.

4.2 C&I AND DISTRIBUTED GENERATION TREND

The solar C&I markets present a unique opportunity for small scale systems to address behind the meter demand and potentially reduce electricity costs for customers across the region. While rooftop and other solar C&I solutions benefit from the overall improvements of solar technologies and cost, specific challenges exist in terms of quality for C&I (structural design compromised, no weather stations).

Countries in the MENA region are focusing their efforts on integrating small scale systems to decrease electricity bills and provide solutions to the public. Initiatives like the Sahim scheme in Oman, Shams Dubai and others are gaining momentum.

Oman's C&I sector is on the rise. The Sahim II program is targeting rooftop installments on 3,000 homes and residential buildings in Muscat Governorate. Over the long run, the authorities aim to cover up to 30% of buildings with rooftop PV.

Shams Dubai in the UAE is growing. A total capacity of 164.2 MW was installed by end 2019. A continuous installation growth is expected with more rooftop projects, despite the net metering policy amendment in Dubai early 2020 (see more in section 9).

Most recently in KSA, the Electricity & Cogeneration Regulatory Authority (ECRA) launched its first regulatory framework for addressing small-scale solar distribution systems of 1 MW to 2 MW connected to the grid.

In Egypt, the C&I sector is already at full speed. The installed capacity by SMEs account for 100 MW under the current net metering scheme. The lifting of subsidies on fuel and electricity tariffs by the government is directly leading to increased number of decentralized solar projects.

Other MENA countries like Bahrain, Iraq, Jordan and Kuwait are also creating initiatives for the C&I sector to grow over the next years. Although 2020 affected the C&I sector from a supply chain perspective and investments were considered to be lower compared to previous years, the situation is slowly improving. We expect that growth of C&I sector will spur over the years to come as concerns of autonomy, reliance and cost increase (see more in Section 9).

4.3 GRID INTEGRATION SOLUTIONS: A MUST

	ATTRIBUTES (INCREMENTAL WITH PROGRESS THROUGH THE PHASES)			
	Phase One	**Phase Two**	**Phase Three**	**Phase Four**
Characterisation from a system perspective	VRE capacity is not relevant at the all-system level	VRE capacity becomes noticeable to the system operator	Flexibility becomes relevant with greater swings in the supply/demand balance	Stability becomes relevant. VRE capacity covers nearly 100% of demand at certain times
Impacts on the existing generator fleet	No noticeable difference between load and net load	No significant rise in uncertainty and variability of net load, but there are small changes to operating patterns of existing generators to accommodate VRE	Greater variability of net load. Major differences in operating patterns: reduction of power plants running continuously	No power plants are running around the clock: all plants adjust output to accommodate VRE
Impacts on the grid	Local grid condition near points of connection, if any	Very likely to affect local grid conditions; transmission congestion is possible, driven by shifting power flows across the grid	Significant changes in power flow patterns across the grid, driven by weather condition at different locations; increased two-way flows between high and low voltage parts of the grid	Requirement for grid-wide reinforcement, and improved ability of the gnd to recover from disturbances
Challenges depend mainly on	Local conditions in the grid	Match between demand and VRE output	Availability of flexible resources	Strength of system to withstand disturbances

Table 1 : Four Phases of VRE Integration (IEA, 2017)

Abu Dhabi, UAE
Courtesy: Joseph Nader

Integrating higher shares of variable renewable energy (VRE) technologies, such as wind and solar PV, in power systems is essential for decarbonizing the power sector while continuing to meet growing demand for energy. However, the challenges to integrate renewables into the grid increases with the level of their share in the energy mix, as illustrated in the table.

For penetration rates between few percentages up to 15% (Phase 1 and 2), utilities and grid operators adapt renewable projects using existing infrastructures. However, above this level, the impact becomes more visible and will require substantial more flexibility and stability of the grid to manage the net demand.

Presently, the penetration rate of solar in the MENA region still varies from one country to another, between less than 10% up to more than 35% in Morocco. Therefore, each country is at a different stage of its integration of variable energy in its grid.

However, given the very low levelized cost of electricity (LCOE) achieved in 2019-2020, below the marginal costs of electricity produced by oil, gas or coal, it is likely that the energy master plans in the MENA region will adopt more and more ambitious target shares of renewable energy, in particular wind and solar. Therefore, it is worth noting some of the latest state-of-the art technologies and strategies to further integrate solar in the system:

- **Curtailment strategy:** in some cases, it is cheaper to over-size the solar capacity and curtail when not required
- **Interconnections and expansion of the grid:** such as the expansion of the grid in Oman, or the interconnections between Saudi and Egypt, or Saudi and Jordan
- **Batteries:** Batteries can play different roles, such as demand-side management (reduction of shifting of the demand), frequency regulation, spinning/non spinning reservations, lowering congestion (on grid virtual transmission lines), or resource adequacy. In particular, an efficient strategy for utilities, in a context of low solar kWh prices, is to overbuild solar capacities and store a portion of the extra-generation, to help shaving the evening peak demand
- **Power-to-gas:** with the development of hydrogen and methanation (production of methane which can be used in CCGT, using CO2 and H2), gas can be stored to cover seasonal fluctuation of power demand
- **Smart grid:** managing variability means better management of transportation and distribution of electricity. Some solutions exist to limit investments in expensive infrastructure, while allowing more solar to flow in the grid. Technologies such as virtual power lines, dynamic line rating or devices can induce impedance and capacitance into specific transmission lines in a network
- **Demand-Side-Management (DSM):** refers to different tools, such as asset digitalization, automation or market signals with different electricity prices for off-peak or peak periods. The electricity consumption pattern can be modified using DSM. As a result, the overall generation profile would improve to ultimately forecast consumption, in terms of quantity and time. It is expected that DSM solutions will play a leading role in the MENA region as a huge portion of the demand, up to 70% in some GCC countries, is driven by the use of A/C which is temperature sensitive.

8.2 MWp, Solar Plant in Amman, Jordan
Courtesy : SUN2000-42 KTL Inverters by Huawei

5. »

PV TECHNOLOGY & NEW FIELDS OF ACTION

5.1 EMERGING PV TECHNOLOGIES

Several of the emerging PV technologies will allow for even more increased efficiency of panels and/or cost reduction.

5.1.1 BIFACIAL MODULE TECHNOLOGY

The bifacial PV module offers greater power output when compared to conventional monofacial PV modules, utilizing sunlight on the front and reflected light on the back simultaneously. The reflected light can come from variety of sources, such as reflection from the ground or from a neighboring row of PV modules. These modules help achieve reduced LCOE through higher energy yields (10 to 20% gain is achievable in outdoor conditions by using Albedo from surroundings), improved reliability (glass- glass modules) and higher specific yield (more KWh per KWp).

5.1.2 MULTI-BUSBAR SOLAR CELL

Multi-Busbar (MBB) means that a solar cell is equipped with nine or 12 busbars instead of four, five or six enabling a higher power output and a higher reliability of the modules. Manufacturers use MBB connectors with round copper wires instead of flat ribbons to interconnect solar cells to strings.

While maintaining the proven reliability of a soldered connection, the concept enables much shorter and narrower grid fingers. Reduced silver consumption and lower series resistance result in higher module power output at lower production costs.

Modules with MBB cells offer other benefits like less shading area in cell due to thinner wires, more reliability due to greater redundancy to micro crack in cell and increased mechanical load performance.

Nowadays the market share of PV modules featuring MBB technology is dominant in the global solar industry.

5.1.3 MODULES WITH N-TYPE SOLAR CELLS

The p-type crystalline silicon wafers have occupied most of the solar cell market today. However, experts consider that, to date, modules made with n-type crystalline silicon wafers attain higher efficiencies due to the material properties offered by n-type crystalline silicon substrates.

Properties such as the absence of boron-oxygen[1] and a greater tolerance to key metal impurities by n-type crystalline silicon substrates are major factors that highlight the efficiency of n-type crystalline silicon wafer modules.

The bifacial design of n-type cells, with good rear-side electronic and optical properties, can be shaped on an industrial scale. Modules with n-type solar cells are immune to Light Induced Degradation (LID) because of the absence of the boron-oxygen defect, as these are doped with phosphorus.

[1] *Light-induced degradation of silicon solar cells containing boron and oxygen impurity atoms (BO-LID)*

5.1.4 MODULES WITH SPLIT SOLAR CELL

A split cell is a standard square cell that has been split into two or three smaller rectangular cells. Splitting cells in this way reduces the internal current by half or one-third and therefore also reduces power loss. As power loss is proportional to the square of the current, the power loss in a triple-cut cell is reduced (by reducing losses in this way, the fill factor, an indicator of cell quality, is increased and gives higher light conversion efficiencies).

One-third cut technology is now slowly overpowering the traditional half cut technology as it solves the problem of high system current and reduces the power loss. With stronger resistance against hotspots and excessive temperature, one-third cut cells can also improve module reliability.

5.1.5 MODULES WITH GALLIUM DOPED SOLAR CELL

As described in 5.1.3, the majority of today's solar cells are made from p-type silicon wafers with boron as the electrically active dopant and possible light induced degradation (LID) occurrence. Gallium-doped monocrystalline silicon fully solves the problem of a PERC module's LID. Gallium-doped PERC cells have a higher efficiency and better anti-LID and anti-LeTID performance compared with boron-doped cells reduction in initial module degradation, lower equipment costs for cell manufacturers and increased profits for the whole PV industry.

5.1.6 HETEROJUNCTION SOLAR CELL

Heterojunction (HJT) technology guarantees high performance and low degradation of the module substantially improving the results of the multi-junction solution and guaranteeing solar PV panels that are more efficient and competitive in many ways. One of the advantages of HJT is its low temperature coefficient.

Experts consider that HJT can produce more energy over the life of the system than a module of similar nameplate wattage by having a lower temperature coefficient than other modules, combined with bifacial technology. They estimate that it is ultimately more cost-effective.

5.1.7 SHINGLED MODULE STRUCTURE

Shingled modules are based on solar cells sliced into several strips and interconnected like roof tiles; to create a cells string, an interconnection material is applied to attach the rear busbar of a cell with the front busbar of the next cell. The cells overlap slightly so that the front busbars are covered by the edge of the adjacent cell.

Since there is no spacing between cells as in conventional modules, as well as no ribbon covering the front surface causing shading, this structure results into modules with extremely high active area to total area ratio. This allows, in principle, very high module efficiency. Most of the manufacturers are considering using this technology in their conventional module layups.

5.1.8 BACK CONTACT SOLAR CELL

An alternative to the conventional process is made possible by using back-contact solar cells. The back-contact cell can have higher efficiency than a front-contact cell due to elimination of grid obscuration losses and has the potential to simplify the module assembly process.

Due to these advantages, there is presently considerable interest in back-contact silicon solar cells. These cells have both the positive and negative external contact pads positioned on the rear surface, and their use can improve the device performance avoiding the front contact shadow loss. In addition, back-contact cells create a homogeneous appearance without any reflectance or visible cells interconnections on the front of the cells.

New areas of progress: As underlined in MESIA's report last year, building integrated PV (BIPV) and organic thin-film PV are also emerging in the industry, bringing in several new advantages.

5.2 FLOATING SOLAR

2020 was a stepping stone for floating solar PV (FPV) advancements with more than 60 countries pursuing the deployment of such projects. So far, at least 350 FPV systems, with a cumulative capacity of approximately 2.6 GW, are operational. FPV is expected to grow by 20% in the next five years.

A collaborative joint industry project (JIP) was launched in mid-2020 by a private entity along with 14 industry participants to develop the sector's first recommended practice (RP) for FPV projects. The RP is anticipated to be ready by Q1 of 2021. Its objective is to provide a standard based on a list of technical requirements for developing safe, reliable and sustainable FPV projects. The project will cover all aspects of developing FPV projects on inland and inshore waters. It will focus on five key topics:

- Site conditions assessment
- Energy yield forecast
- Mooring & anchoring systems
- Floating structures
- Permitting
- Environmental impact

The recommended practice will be technology-based and not location-based. As a result, it will be a reference for FPV projects globally with significant potential.

However, certain challenges still need to be overcome:

› Since FPV technology is still considered not mature, experts are keen to acquire further knowledge and understanding in more protected waters before moving to the wider sea.

› Obstacles can be encountered during project development, potentially limiting the applicability of FPV to specific bodies of water. The impact of the water ecosystem needs to be assessed beforehand, and the installation of FPV plants on water bodies with environmental risks should be avoided. Limitations on the coverage of a body of water with FPV can also be reasonably enforced for specific types of water bodies.

› The magnitude of the benefits of higher efficiency of PV modules with FPV resulting from lower operating temperatures due to water, depends on many factors including location, water body size, depth, climate, temperature, structure layout, etc.

› A common misconception, which used to be reported as a benefit of FPV, is the albedo effect (light reflection on the sea surface). The amount of light reflected (and its energy content) by the water surface is actually lower than the amount of light reflected by other surfaces (eg. concrete, sand, grass), meaning that the light reflected does not carry a significant energy content.

Nevertheless, capital expenditures (CAPEX) of FPV shows higher values compared to ground-mounted PV, but with LCOE, the comparison becomes even more interesting thanks to the increased energy yield (US$/kWp). The technology is fairly new, so there is still room for further decrease in price, making FPV more financially viable and in line with ground-mounted PV costs.

In the MENA region, UAE and Oman are the countries currently putting efforts to deploy FPV.

The UAE launched the first pilot FPV project in Nurai Island in February 2020. The 80-kW project aims to reduce the cost and environmental impact of power generation on the island. The project is the first in the region to apply a near-shore saltwater FPV structure.

Two additional versions of the floating structure will be deployed in the same area enabling installment in rougher sea conditions, lower installation and maintenance costs and use in deep sea applications.

Within the framework of its green initiatives, Oman is currently in the exploratory phase to develop floating solar. Collaborations with local and international universities are exploring the initiative to have the project at Sohar Port and Freezone.

5.3 SOLAR TRACKERS

Solar tracker potential in the region is noticeable. IPPs require solar plant design optimization to achieve the best performance for assets and competitive prices for which solar tracker systems are an advantage. Nearly, if not all the region, has installed solar PV plants with trackers that benefit from several years of operational records at large scale. Today, where terrain is almost flat, practically all the solar PV projects will design and install tracker systems.

So far, tracker systems have not faced issues impacting the lifespan of the panels. The system's movements are also carried out in safe conditions. Rigorous tests are performed to assure the lifespan of the PV modules in extreme weather conditions, together with protective positioning to shield the tracker and the PV module.

Moreover, installations of tracker systems present no risks if handling of PV modules is proper and the right quality control with adequate supervision is performed during construction. Some projects also integrate frameless solutions, currently performing effectively on site.

Hence, solar trackers have proven very competitive for utility-scale solar plants. Furthermore, as the PV module industry is growing, tracker systems are also evolving every year. Progressively, the adoption of the technology is becoming widespread. According to professionals, single-axis trackers combined with bifacial modules is currently the configuration that offers the best cost benefit ratio for most projects around the world. Today, typical gain for a single-axis tracker over fixed-tilt is usually between 15% and 25%, depending on location, weather and configuration.

However, it should be highlighted that different factors, such as wind resilience, must be studied in detail at design phase and carefully tested. Poorly designed products may lead to negative experiences and increased costs.

5.4 PANEL CLEANING

Soiling by dry deposition can drastically affect the power output of PV modules, especially in dry and arid conditions typical for desert regions. Unsurprisingly, soiling losses are frequently reported as the single biggest contributor to the revenue losses of large-scale solar farms. In addition, soiling rates are often seriously underestimated, endangering the return on investment of solar projects in operation today.

Most panel cleaning is still performed manually today, which is a very labor-intensive approach requiring huge amounts of water. In contrast, dry autonomous cleaning robots are a better alternative, but need to be considered at the design stage to be cost-effective. In general, cleaning a PV power plant needs to be seen as an investment. Cleaning cost needs to be paid by additional future energy sales. To evaluate if a cleaning system is an investment worth making, experts need to know the soiling rate. Accurately measuring soiling rate is absolutely essential to any solar project, especially in the desert.

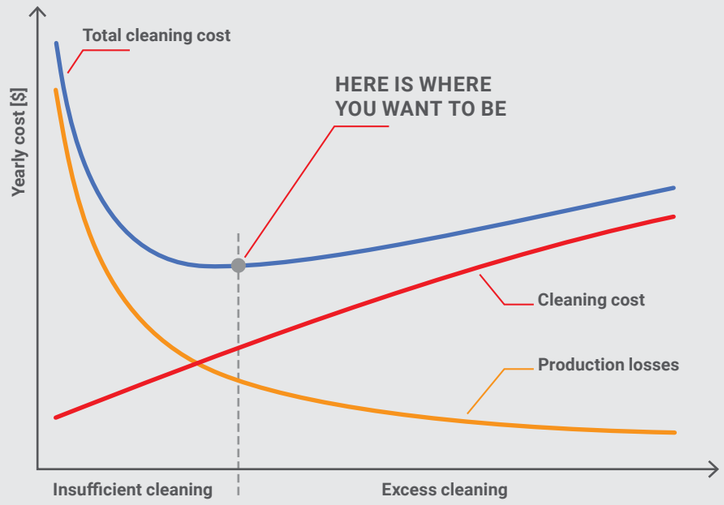
Two families of soiling sensors exist: electrical and optical. The first type of sensors is much more accurate than the second but also more expensive. Optical sensors are much cheaper, but they need calibration, which is site dependent. This may cause wrong soiling rate estimations, if not done correctly.

Even with manual cleaning, there are ways to optimize cleaning costs. Research by some industry members has shown that the cleaning costs of large-scale solar farms can be significantly decreased by actively tuning the cleaning frequency.

One way to tune the cleaning frequency, instead of fixing at a predetermined number of cleanings per year, is local soiling measurement data, which can trigger the cleaning action when and where it is needed. In this way, the cleaning frequency is dynamically adapted to the local site conditions throughout the year, taking into account the soiling effect of seasonal variations and exceptional weather events. In this way, the need for water on the site is reduced.

Besides the cleaning frequency, there is also the cleaning method itself that can be improved. While manual cleaning relies on manpower and a high-water usage, cleaning tractors are a first step to reduce both. Autonomous and dry-cleaning robots have the additional advantage of potentially cleaning the full solar plant daily, thus reducing the soiling losses to nearly zero. However, both solutions may need proper auxiliary equipment and therefore, need to be considered early during the design stage of the solar plant. Yet again, accurate measurements of local soiling rates are crucial to make the right investment decision. For both reasons, investing in intelligent soiling and cleaning solutions usually pays for itself in less than two years.

The goal of the optimization is to minimize the total cleaning cost. The total cleaning cost is the sum of the monetized soiling losses and the direct cleaning cost. If cleaning is insufficient (too few cleanings), additional cleaning would generate more revenues than the cleaning costs. If the cleaning is excessive (too many cleanings), the increase of revenue is not enough to justify all cleanings. In the optimum, the marginal cost of cleaning is equal to the marginal production benefits. To find this “sweet spot”, the soiling rate needs to be known.



Source: ENGIE

Figure 7: Cleaning Economics

5.5 TECHNICAL AND FINANCIAL RISKS MITIGATION IN PV INVESTMENTS

Project investment has been and continues to be a key financial factor that will ensure sustainable growth in PV installations worldwide. When estimating the investment value of a PV project, various financial stakeholders such as investors, lenders and insurers will assess the likelihood of investment risks and their potential impact compared to project objectives. Accordingly, risk mitigation measures may have to be adjusted.

A methodology has been developed for the calculation of the economic impact of technical risks associated with the operation of PV installations. This tool includes cost priority number (CPN) to each category of failure.

CPN METHODOLOGY

The CPN methodology was developed to assess the economic impact of technical risks occurring during the operation and maintenance (O&M) phase of a PV project[2]. Direct impact of failures on the annual cost of running a PV plant is estimated with the CPN. Most recently, the methodology has been further improved for the evaluation of the effectiveness of identified mitigation measures[3].

For risk mitigation, the induced diminution of costs is calculated by evaluating the economic impact of lesser technical risks (reduction of failure occurrence and avoided costs for fixing the failures, such as repair of existing components, substitution by spare components and substitution by new components). The tool has identified different mitigation measures along the entire value chain and assigned for various technical risks. Total CPN value arises from the cost benefit analysis by adding the CPN after mitigation to the cost of the mitigation measures.

Al Nabooda Automobiles - 3.1 MWp
Courtesy: Yellow Door Energy
Ghadir Shaar

[2] *Moser D, Del Buono M, Jahn U, Herz M, Richter M, De Brabandere K., Identification of technical risks in the photovoltaic value chain and quantification of the economic impact. Prog Photovolt.: 2017. https://doi.org/10.1002/pip.2857*

[3] *Jahn U, Herz M, Moser D, Belluardo G, Richter M. Managing technical risks in PV investments: How to quantify the impact of risk mitigation measures for different PV project phases?. Prog Photovolt Res Appl. 2017. https://doi.org/10.1002/pip.2970*

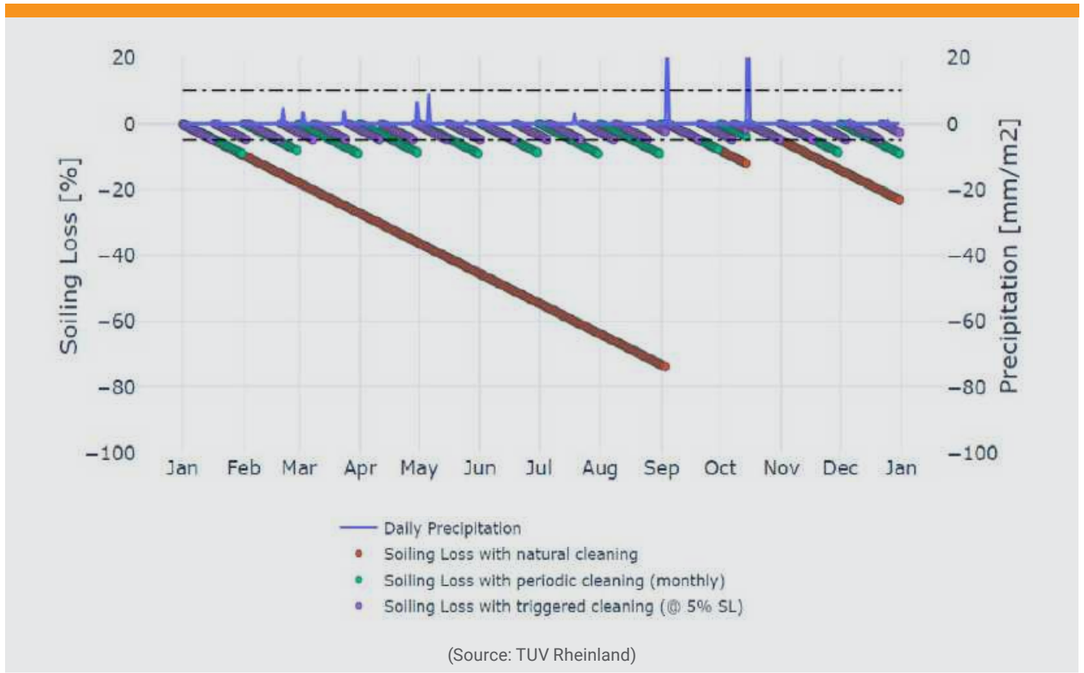
EXEMPLARY RESULTS

The CPN methodology allows the calculation of the impact of different mitigation measures[4]. It identified the following eight generic mitigation measures for PV technical risk management:

- **Component testing** of important plant parts such as PV modules or inverters. The testing can be performed by the manufacturer in the factory, independent testing at certified laboratory or on-site at the PV plant;
- **Design review** and construction monitoring serve to catch issues caused by bad plant design and poor construction workmanship;
- **EPC qualification** focuses on ensuring the competencies of the workers, e.g. by requiring certain technical qualification prerequisites or regular training of the field workers;
- **Implementing advanced monitoring system** for early detection and diagnosis of faults;
- **Basic monitoring system usage** to monitor plant level alarms and notifications;
- **Advanced inspection** (e.g. infrared or electroluminescence imaging) to detect defects not usually visible by with the naked eyes;
- **Visual inspection** to establish any visible changes in PV plant components;
- **Spare part management** to minimize the costs of downtime and repair/substitutions of components.

These mitigation measures (MM) can be grouped into two main categories:

- Preventive measures are applied before the failure occurs to prevent it from happening e.g. testing, design review and construction monitoring and EPC qualification. These measures can be implemented during the early phases of PV project lifecycle and are likely to increase CAPEX.
- Corrective measures are MMs that aim to reduce higher losses and costs if the failure has already occurred. The costs are mostly related to OPEX due to O&M.



(Source: TUV Rheinland)

Figure 6:Impact of cleaning routines on soiling losses of a 10 MWp plant in Abu Dhabi

[4] *Moser D, Del Buono M, Bresciani W, Veronese E, Jahn U, Herz M, Janknecht E, Ndrio E, de Brabandere K, Richter M. "Technical risks in PV projects – report on technical risks in PV project development and PV plant operation," http://www.solarbankability.org/results.html#c8 (accessed 21.09.2017).*

Cleaning routines for PV power systems in desert regions are a typical corrective measure to reduce energy yield losses due to soiling. The impact of different cleaning procedures on the soiling losses over one year are calculated and shown in Figure 6 for a 10 MWp PV plant near Abu Dhabi. The soiling rate is 0.3%/day and only two precipitation events are recorded during one year. If no cleaning (natural cleaning) is performed, soiling losses (brown bars) may reach up to 30% per year and result in annual costs of 2614.000 USD Note: the next chapter looks more in the details of cleaning issues.

In conclusion, the overall CPN methodology allows the estimation of the economic impact of failures on the LCOE and business models of PV projects. This has been developed not only to determine the economic impact of technical risks, but also to be able to assess the effectiveness of mitigation measures. Specific failures must be examined to draw recommendations on mitigating the economic impact for soiling or potential induced degradation (PID). In practice, it is important to understand how mitigation measures can be considered as a whole to be able to calculate their impact and assess their effectiveness.

5.6 PV INVERTERS: FROM GRID ADAPT TO GRID SUPPORT

With the penetration of more renewables into the global grids, there is an acute necessity of transitioning the PV plants from grid adapt to grid support. The biggest contributor for this transition has to be PV inverters, which are the heart of PV plants.

Modern day PV inverters are equipped with the following grid support features:

- Active and reactive power control
- Ramp rate control
- Voltage control
- HVRT/LVRT
- Frequency ride through

However, large-scale solar PV plants are often located in remote areas with particularly poor grid conditions. With vulnerable grid infrastructure and limited short circuit capacity in desolate areas, solar farms tend to connect to weak grids. Coupled with long-distance transmission and high-voltage direct current, large PV plants face the additional challenge of needing to achieve favorable grid connections. When transmission is faulty, this can result in a voltage transient peak at the grid-connected spot near the fault point.

To overcome these challenges, various features are developed in new PV inverters. It is well known that there will be significant technical challenges in integrating the grid-forming inverter operations into a larger power grid. One important element will be the trade-off on level of sensitization of inverters.

PV FEATURES DEVELOPED IN THE NEW PRESENT PV INVERTERS:

» PV + BESS, for coupling Batteries on the DC side

» Integrated multiple algorithms need to be contemplated such as harmonic suppress methods, dynamic damping, series compensation

» Increased switching frequency for the reducing the harmonic content especially for weak grids

» Wide SCR adaptability for weak grids

» Adaptability to consecutive HVRT and LVRT conditions

» Grid forming capabilities such as through DC link capacitors or improving the response time of the inverters to support synthetic/artificial inertia requirements for many grids.

5.7 DIGITALIZATION

1. DIGITAL TECHNOLOGY OFFERS OPPORTUNITIES TO CARRY OUT OPERATIONS IN MORE AUTOMATED, CENTRALIZED AND EFFICIENT WAY, REDUCING DOWN TIMES. IT CAN:

- Create new approaches for operations and maintenance. Digitization will improve plant availability, which could reflect into reduced operation and maintenance costs. For example, digital transformation with various tools can bring more advanced analytics for optimum plant performance and working condition by comparing real-time asset performance, the Internet of Things (IoT), automation, geo tagging etc. This will further help in identifying failures much earlier and improving plant production by reducing unplanned down time.
- Identify problems and underperformance at an early stage in an efficient way which further allows gain of time to repair the plant's equipment, improve asset reliability and availability as well as guarantee long-term plant performance.
- Help in conditioned-based maintenance. This will be carried out only when it's required based on data-driven intelligence without compromising on performance effectiveness. This reduces downtime, lowers costs and maximizes revenues.
- Allow to synchronize plant generation with the weather forecast and better balance the power demand/ consumption curve as per grid requirements by PPC.

2. USE OF MACHINE LEARNING TECHNIQUES

Machine learning techniques analyze the behavior of assets and predict risks. They also provide asset managers with new tools to optimize operational efficiency through improvements on production and O&M cost reductions. Hence it provides valuable opportunities in the renewable energy sector for higher returns on investment.

Machine learning can solve complex data, sorting through various algorithms while learning and improving its logic.

Various machine learning techniques are available today:

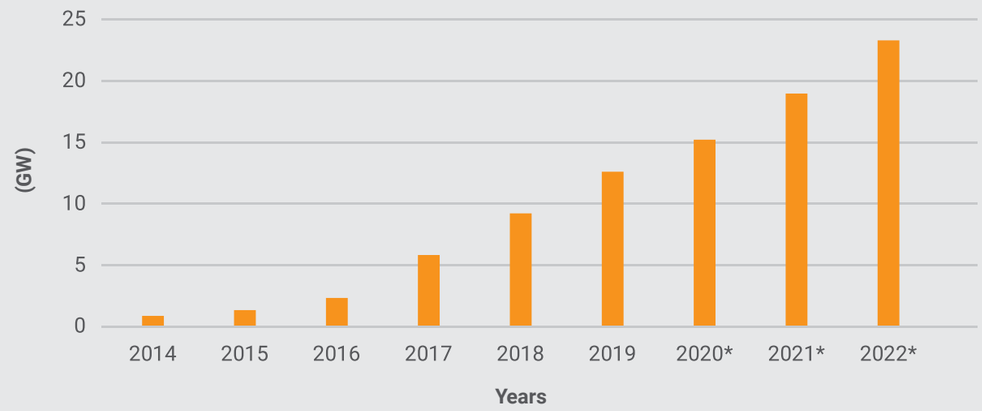
- Weather forecasting techniques – produce realistic and useful prediction using real time and historical data for a given location reducing uncertainty of the variable energy output
- Predictive analytics techniques – improve equipment O&M and predict downtime, extending the lifetime of the equipment
- Anomaly detection techniques – pattern recognition and machine learning tools can predict various plant anomalies real time
- Condition monitoring –inverters and transformer faults in solar plant can be predicted from various models allowing maintenance teams to conduct rapid repairs and ensure operations run smoothly
- Image processing techniques –using drones to capture high resolution image for wind plants and thermal image of solar panels. Machine learning tools can process the images to find any anomalies in the system
- Performance modelling (Solar) – Various modeling techniques in PV degradation, bifacial PV performance, plant loss analysis, shading, soiling and reflection losses, etc. help in understanding plant performance
- Sun position model – checks the actual tracking of sun providing irradiance value (GHI, DNI and FHI) for a clear day and find any issues related to plant equipment.

DIGITALIZATION ADVANTAGES

- **Optimized plant maintenance**
- **Anomaly identification and Predictive Maintenance**
- **Digital operation and control**
- **Digital document management system for process efficiency and optimization**
- **Forecasting**
- **Inventory management**
- **Better resource planning**
- **Real time automated operation**
- **Fast and effective grid demand response, and grid support capabilities**
- **Failure/repair history**
- **Digital twin brings asset lifecycle management**
- **Improving productivity and reducing O&M cost**

6. SOLAR PROJECTS 2020 – 2022

INSTALLED SOLAR POWER CAPACITY IN MENA REGION



Sources: International Renewable Energy Association, DNV GL ETO
*Estimates and forecasts are based on DNV GL experts and external sources

Figure 8: Installed Solar Power Capacity in MENA Region

The total installed solar capacity in the MENA region is increasing exponentially. By 2024, the expected solar installed capacities, taking into consideration the impact of COVID19, could reach up to almost 35 GW. With the constant decrease of solar prices and the ambitions by all MENA countries, more projects are expected to be integrated into the grid. Storage projects are also integrated in the equation of growth expansion. The technology is improving and lithium-ion battery prices are decreasing.

Projects Currently Under Construction 2020

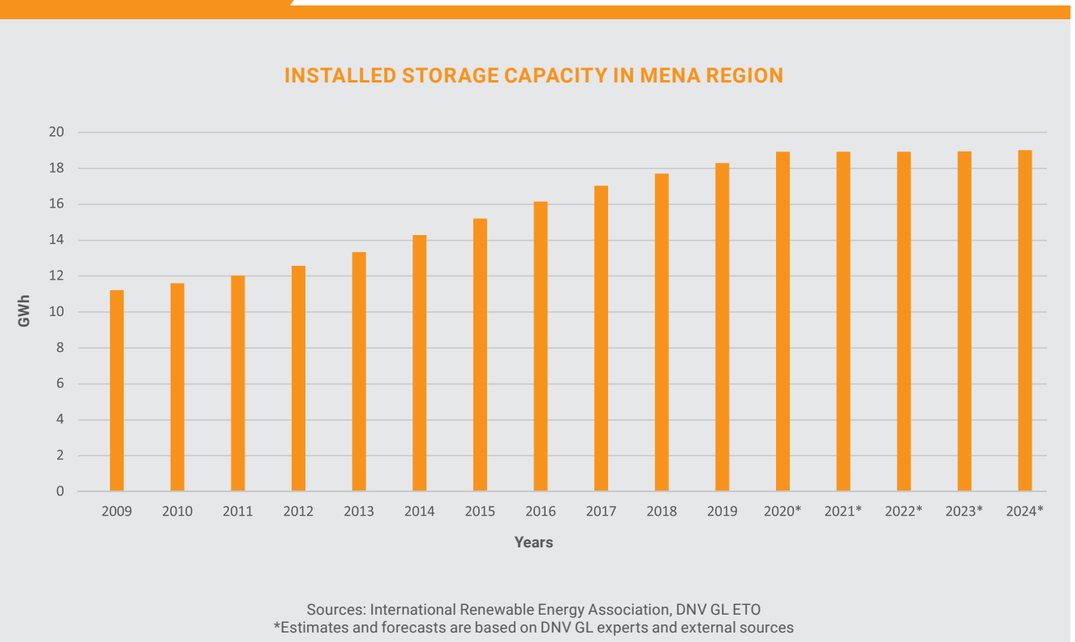
Project Name	Country	Technology Used	Capacity	Status
Askar	Bahrain	PV IPP	100 MW	Construction
Tatweer Solar PV	Bahrain	PV IPP	3 MW	Construction
Kom Ombo	Egypt	PV IPP	200 MW	Construction
Husainiyah Solar Park	Jordan	PV IPP	50 MW	Construction
Ibri II	Oman	PV IPP	500 MW	Construction
MBR Solar Park Phase 4	UAE	CSP	950 MW	Construction
MBR Solar Park Phase 5	UAE	PV IPP	900 MW	Construction

Table 3: Projects Under Construction, 2020

Upcoming Projects				
Project Name	**Country**	**Technology Used**	**Capacity**	**Status**
CREG	Algeria	PV IPP	150 MW	Awarded
Tafouk 1	Algeria	PV IPP	Up to 4GW	Planned
Tatweer Solar PV	Bahrain	PV IPP	8 MW	Planned
West Nile	Egypt	PV IPP	600 MW	Development Phase
Kom Ombo	Egypt	PV IPP	500 MW	Development Phase
Sawa 1	Iraq	PV IPP	30 MW	Tender Phase
Sawa 2	Iraq	PV IPP	50 MW	Tender Phase
Khidhir	Iraq	PV IPP	50 MW	Tender Phase
Iskanariya	Iraq	PV IPP	225 MW	Tender Phase
Jissan	Iraq	PV IPP	50 MW	Tender Phase
Karbala	Iraq	PV IPP	300 MW	Tender Phase
Al Diwania	Iraq	PV IPP	50 MW	Tender Phase
1GW PV Plant	Iraq	PV IPP	1 GW	Planned
Baynouna	Jordan	PV IPP	200 MW	Constructed
Round 3	Jordan	PV IPP	NA	Planned
Shagaya Phase 2	Kuwait	PV IPP	NA	Planned
Noor PV II	Morocco	PV IPP	400 MW	Tender Phase
Noor Midelt 1	Morocco	CSP - PV	800 MW	Awarded
Noor Midelt 2	Morocco	Hybrid	NA	Planned
Manah Solar I	Oman	PV IPP	500 MW	Bidding Stage
Manah Solar II	Oman	PV IPP	600 MW	Bidding Stage
Tanweer	Oman	Hybrid	146 MW	Bid Evaluation
Salalah Sanitary Drainage System	Oman	PV+ Bimethane	NA	Bidding stage
PIF - Sudair	Saudi Arabia	PV IPP	2 GW	Tender Phase
Red Sea	Saudi Arabia	PV IPP	650 MW	Development Phase
Neom	Saudi Arabia	PV + Wind	4 GW	Planned
Quiddiya	Saudi Arabia	PV	447 MW	Tender Phase
Medina	Saudi Arabia	PV IPP	50 MW	Bid Evaluation
Rafha	Saudi Arabia	PV IPP	45 MW	Bid Evaluation
Qurayyat	Saudi Arabia	PV IPP	200 MW	Bid Evaluation
Al Faisaliah	Saudi Arabia	PV IPP	600 MW	Bid Evaluation
Rabigh	Saudi Arabia	PV IPP	300 MW	Bid Evaluation
Jeddah	Saudi Arabia	PV IPP	300 MW	Bid Evaluation
Al-Rass	Saudi Arabia	PV IPP	700 MW	Bidding Stage
SAAD	Saudi Arabia	PV IPP	300 MW	Bidding Stage
Wadi ad-Dawasir	Saudi Arabia	PV IPP	120 MW	Bidding Stage
Layla	Saudi Arabia	PV IPP	80 MW	Bidding Stage
Tunisia PV	Tunisia	PV IPP	500 MW	Awarded
Tunisia PV	Tunisia	PV IPP	70 MW	Tender Phase
Al Dhafra	UAE	PV IPP	2 GW	Awarded
Umm Al Quwain Solar Park	UAE	PV IPP	500 MW	Tender Phase
Abu Dhabi	UAE	PV IPP	2GW	Planning

Table 4: Upcoming Projects in MENA region

7. ENERGY STORAGE



Sources: International Renewable Energy Association, DNV GL ETO
*Estimates and forecasts are based on DNV GL experts and external sources

Figure 9: Installed Storage Capacity in MENA Region

Although intermittency has been one of the main issues for a wider adoption of solar energy, battery storage and CSP help mitigate this risk. Globally – including in the MENA region – a decrease in battery prices are creating a business case for the future of energy storage. By 2024, experts forecast that energy storage installed could reach up to 19 GW.

7.1 SOLAR PV PLUS STORAGE

Solar storage technologies are game changing solutions, but the issue of cost has limited their wider adoption.

The last years dramatic drop in battery prices is changing the outlook, but the competitiveness of different storage system varies. APICORP estimated in its latest Energy Investment outlook that "cost of storage/intermittency remediation still high, offsetting low feed-in tariffs. Tension will be particularly high in countries with already fragile utilities having to absorb the cost difference (Jordan, Morocco)."

In the long run, it is anticipated that there will be a mix of storage technologies. However, lithium-Ion batteries are still the most widely used and advocated technology for grid storage and may continue to be so for the near future. While there have been a few other promising technologies (flow batteries, Zinc-Air, etc.), lithium batteries production is scaling up quickly and will be hard to beat on prices.

Nevertheless, 24-hour storage capability is still not within reach. To achieve that goal, a further substantial cost drop of lithium-based storage or newer viable technologies, such as renewable hydrogen in the medium term, are required.

» CHALLENGES

- Better understanding of the applications and the technical capabilities of storage is still needed to increase penetration
- Condition of implementation of different storage systems can vary widely to maximize benefit, and need to be considered at an early stage of any storage project
- Need for more trained manpower with a good understanding of the application of energy storage projects and the ability to take a project from design to execution
- Lack of standardization of modalities of control of systems and interaction with the grid complicates choosing suppliers
- Deficit of tools to check for financial viability. Since revenue models may become increasingly complex, this element is important to convince project owners. Unlike solar, if a client wants to install a rooftop PV system, there is a very clear process including tools, like PV systems, that are bankable and trusted
- Clear grid codes for C&I clients who want to install energy storage are not available in most countries. Beyond utility size installations, lack of/or restrictive regulations do not allow assessment of innovative revenue models for C&I scale and PV plus storage installations in MENA region.

» PROJECTS

The dramatic decrease of PV prices and the reduction of cost for storage solutions have encouraged the development of some more PV plus storage projects. Most developments in PV plus storage in MENA have taken place these last years in Jordan, Lebanon, Oman, UAE and recently KSA.

JORDAN

- Irbid District Electricity Company (IDECO), the Middle East's largest solar-plus storage project at the time, was signed in 2017 under a 20-year PPA for a 4 MW/12 MWh of lithium-ion based energy storage. Financial close was reached 2018, with the plant becoming operational in February 2019.
- Private industry partners signed a MOU in early-2020 for commercial collaboration for 50 kW in 2020, 3 MW in 2021, 7 MW in 2022 and 15 MW in 2023 planned. The first project is for a steel factory and will have a 50-kW capacity with 13 hours of storage planned to be installed in Jordan Q4 2020.

However, the tender for the important 30MW/60MWh standalone energy storage project in Maan by the Ministry of Energy & Mineral Resources (MEMR), in the pipeline for several years, was canceled due to COVID19.

UNITED ARAB EMIRATES

- Former Abu Dhabi Water & Electricity Authority (ADWEA), now transformed to Emirates Water and Electricity Company (EWEC) has deployed approximately 120 MW of sodium-sulfur (NaS) high temperature batteries in 4 MW or 8 MW systems at various substations, since 2015, throughout its distribution network.
- In 2019, Abu Dhabi Waste Management Center (Tadweer) opened the first 150 MW PV plus storage batteries system in the region at its Al Dhafra landfill.
- The 2 GW Al Dhafra solar PV park project PPA was awarded and signed in 2020, including an option to build on the existing battery capacity of 108 MW. This storage is operational in the current electricity storage system of Abu Dhabi.

Several pilot projects have been launched by industry members:

- 200 kWh batteries project will help firm up unstable power for an industrial microgrid in Sharjah.
- Pilot project in Dubai including a 1.21 MW/8.6MWh lithium-ion battery system is expected to be commissioned soon.
- Project of 49 MW installed capacity by 2025 of energy storage project was launched last summer for Masdar and Khalifa University with a private industry partner.

For the time being, considering the present slowdown of electricity demand, additional need for large scale energy storage systems is not expressed in the near future in the country.

OMAN

Energy storage will be an essential component of the planned development of 11 small-scale solar PV plus storage–diesel hybrid projects in remote areas across Oman of the Rural Areas Electricity Company (Tanweer). The project is in the last phase of attribution.

SAUDI ARABIA

Beyond the long-term necessity to manage the ambitious intake of large shares of renewables in the grid, Saudi Arabia has also non-negligible storage needs with more than 5 GW of offgrid generation. So far, however, the regulatory framework is incomplete.

Storage is not explicitly mentioned in the energy mix objectives or among REPDO-targeted technologies. However, storage solutions are not out of the picture as a 2.4 GW capacity of CSP is expected to be released in the future. An indication, for example, KACARE plans to allocate $2.7 million for energy storage demonstration projects (Technology Localization & Commercialization Initiative).

A major step has been taken in November 2020 with the allocation of the utilities contract for the Red Sea megaproject, which will be 100% powered by renewable energy. It will include the world's largest **battery storage project, so far, with 1,000-MWh battery storage facility,** to ensure 24-hours electricity supply.

OUTLOOK FOR BATTERY STORAGE

There's a need for long- and short-term storage to facilitate integration of additional renewable capacities into grid but the prices are still limitative. Furthermore, the still highly subsidized electricity sector in several countries in the region limits opportunities for behind-the-meter applications and regulatory framework is lacking.

However, in the offgrid setting, solar plus storage is becoming more cost effective in supporting renewable power sources to replace diesel generators especially in countries such as Egypt, Jordan or Morocco. Solar rooftop plus storage combination can also be interesting for energy efficient building. In the long run, prices of batteries will continue to decrease and, beyond batteries and CSP, hydrogen may well in the coming years bring adequate and competitive storage solutions.

Nestlé Factories in Dubai
Courtesy: JinkoSolar

7.2 CONCENTRATED SOLAR POWER

CSP is a technology that is still in its early stages of adoption in the MENA region even though CSP deployment makes the best sense in high irradiation and high direct normal irradiance (DNI) countries with a base load capability of CSP installations that can reach long hours.

CSP presents several advantages compared to intermittent sources of renewable energy such as solar PV or wind. CSP is a dispatchable form of renewable energy, allowing thermal energy storage and therefore generating electricity whenever it is needed, day or night. CSP makes the best sense for long periods of storage.

However, CSP and PV can be complementary, with PV during the day (without battery charging) and CSP allowing thermal storage to be discharged at night. This combination enables lower LCOE. Phase IV 700 MW CSP plant and a 250 MW PV facility at the Mohammed bin Rashid Al Maktoum solar park in Dubai is a good example.

Technological options may vary according to the specificity of the locations of CSP projects. In MENA, CSP towers are considered to be more effective in areas exposed to high DNI and low humidity. For countries located near the sea, such as the UAE, humidity is an issue and using parabolic tough technology is more effective. Yet Morocco or KSA can opt in many areas for either technologies.

Research and development is still ongoing to improve CSP. Studies are currently ongoing to reach higher temperature of molten salt, and/or the delta T between the highest and lowest temperatures, for more efficient receivers. Digitalization is also an important vector of progress in supporting better focalization of towers and mirrors.

Specific challenges exist for MENA countries such as the extensive cleaning required due to geographic and climate conditions. Cleaning robots are being experimented for CSP towers in the region.

Throughout the world, CSP projects are increasing. Even though Morocco and UAE have been initial leaders in CSP, the MENA region is in the waiting position. At this stage, KSA is expected to include some CSP in the projects to be tendered by REPDO in the coming years.

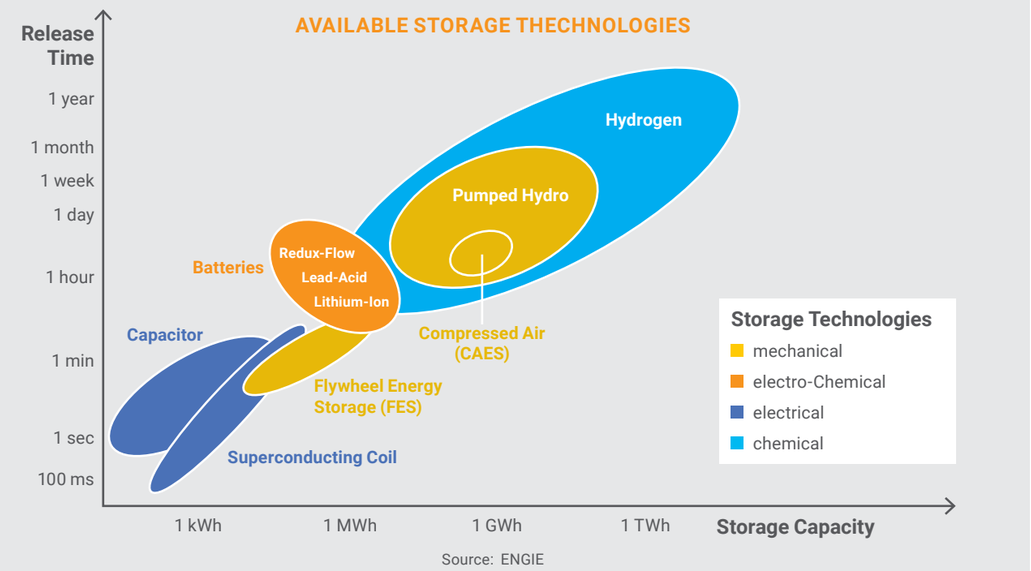
GREEN HYDROGEN: THE NEXT STEP

Renewable hydrogen is hydrogen produced through the electrolysis of water (in an electrolyser, powered by electricity), and with the electricity from renewable sources. The full life-cycle greenhouse gas emissions of the production of renewable hydrogen are close to zero[5].

Green/ renewable h hydrogen produced by electrolysis can be the missing link to achieve a completely decarbonized world. It can be used as a feedstock, a fuel or an energy carrier and storage:

1. Green Hydrogen solves the problem of how to deal with intermittent renewable energy because it can be stored and transported over seasonal or even long periods of time. In regions where solar capacity may have to be curtailed in the next 5 years due to issues of integration in the grid and intermittency, hydrogen can help store the extra energy. As the production of green hydrogen is based on provision of clean electricity, solar energy will be key for its growth.
2. Clean H2 is also a multi-purpose energy vector and can support the decarbonization of high GHG emitting sectors and end uses, providing new unparalleled opportunity to:
   - › Fostering electrification of transport: prototypes and pilots for cars, vans, buses, boats, bikes, garbage trucks exist while applications for air carriers are being developed
   - › Replacing grey hydrogen as feedstock for chemicals and refining process (for desulfurization and lightening of crude oil).
   - › Enabling carbon neutral steel production and/or mining
   - › Facilitate decarbonization of cooling and heating.

It may take a few more years but new prototypes of turbines are developed that would allow also current power generation plants to be converted to use green H2.



Source: ENGIE

Figure 10: Hydrogen Storage Complements Batteries

As the largest component of price of electrolysis to produce green H2 is electricity, the cost decrease of Solar is a dominant driver of the development of green hydrogen applications.

[5] *Renewable hydrogen may also be produced through the reforming of biogas (instead of natural gas) or biochemical conversion of biomass, if in compliance with sustainability requirements.*

A LARGE MARKET

The growth of clean H2 has so far been driven by leaders in hydrogen adaptation in Europe, Japan, Korean, China, US but the MENA region has now engaged on similar pathways with larger projects emerging in particular in KSA and Morocco in 2020.

Projected hydrogen demand could reach 14EJ in 2030 (double to level of 2015), a growth triggered by existing application of hydrogen (feedstock for chemicals, refining) and new segments of applications. Global hydrogen market is expanding at 6% per year and expected to reach 180 – 200 Bn USD by 2025. According to Goldman Sachs market for green hydrogen could be worth 10 trillion euros ($12 trillion at current exchange rates) by 2050.

Scale is a major element to allow green H2 to become more and more competitive. Large initiatives have been launched this year to support the development of large-scale projects and foster technology progress to allow the price of H2 to decrease and become competitive with grey or even blue hydrogen.

A SERIES OF INITIATIVES TO SUPPORT RAPID EXPANSION OF LARGE-SCALE GREEN HYDROGEN:

- The EU has so far 1GW of clean hydrogen electroizers installed. It issued last summer a strategy for the development of clean hydrogen, in support of the European Green deal, considering that "large-scale deployment of clean hydrogen at a fast pace is key for the EU to achieve its high climate ambitions" (EU Q&A on Hydrogen Strategy for a climate neutral Europe). Objectives are 6GW of Clean hydrogen electrolyser by 2024, compared to 1GW in 2020, 40GW by 2030 and large-scale deployment from 2030 to 2050
- Japan in its 19 Bn USD Green Fund stimulus package announced early December 2020 to be giving priority to improving to developing low-cost battery storage and renewable hydrogen. The prime minister of Japan declared "We see hydrogen, of which there is inexhaustible deposits, as a new power source... we will create hydrogen airplanes and hydrogen cargo ships"
- A coalition of seven international firms has been launched in December with the aim to develop 25GW of Green Hydrogen by 2026, a fiftyfold scale up of global hydrogen capacity. The coalition, which is linked to the United Nations Framework Convention on Climate Change's Race to Zero campaign, is also hoping to halve the cost of green hydrogen production, cutting it to less than $2/kg
- Finally, seeking to foster development of green hydrogen abroad due its limited space for production from REN, Germany has announced in December 2020 that it will support development of a prototype of a 20MW alkaline electrolyser for the production of green hydrogen and ammonia in the framework of NEOM project

MENA AND SOLAR ENERGY IN THE GREEN H2 MARKET

Development of green hydrogen is a tool for economic diversification for sun belt countries with large areas of high direct solar radiation, the ones relying largely on hydrocarbons revenues (KSA, UAE, Oman or the ones heavily hydrocarbon dependent (Egypt, Morocco).

Such countries can leverage the excellent and large solar resources of the region, along with its strategic location, to invest in green hydrogen production and green chemicals exports. GCC is at the heart of several future main export routes of renewable energy via hydrogen carriers: Asia, Africa, Europe, Australia and Morocco to Europe.

With the most competitive cost of solar energy in the work, countries in the region may be in a position to deliver the most competitive green hydrogen price. The European commission considered last July that "in regions where renewable electricity is cheap, electrolysers are expected to be able to compete with fossil-based hydrogen in 2030."

Several projects arose in 2020 in the region. All these projects will require substantial renewable energy power input and, for most of it, solar. Hence, Green hydrogen could relatively rapidly become a potential important booster of solar projects in the region. This report is looking at these developments in KSA, UAE, Morocco, Egypt and Oman, knowing that some other countries e.g. Jordan are considered by investors for green hydrogen projects.

KINGDOM OF SAUDI ARABIA

R&D

- In 2019, Saudi Aramco launched a first hydrogen FCEV fueling station project. The fueling station became operational in late 2019. A pilot fleet of FCEVs will be built, using (the high purity compressed hydrogen of this new station.
- King Abdullah University of Science and Technology (KAUST) is conducting several R-&D studies on hydrogen and fuel-cell technologies aiming mainly at the transport sector.

UTILITY SIZE

- In 2020, NEOM, one of the lighthouse Megaprojects of the Kingdom of Saudi Arabia "VISION 2030", located on the Red Sea, signed an agreement for the development of a green hydrogen plant with capacity of 650T hydrogen/day. The plant will be powered by 4GW of solar and wind and will use a 1GW hydrolyzer, one of the largest in the world today. Hydrogen will be exported via green ammonia. The project is scheduled to be operational in 2025. The Saudi Ministry of energy indicated that the renewable energy component may be tendered.
- Saudi Aramco is planning to develop a large-scale hydrogen project to feed a "green" ammonia plant dedicated to export its REN production to Far East Asia. Sources indicate that the objective would be to start production by 2026. The main project scope would include one Solar PV power plant and electrolyser unit of sufficient capacity to supply up to 100 tpd ammonia production facility.

UNITED ARAB EMIRATES

R&D

- In Abu Dhabi since 2014 by Masdar Institute - now merged with Khalifa University – has engaged studies in partnership with an industry and a car distributor. Results have been published in 2020, underlining the importance of hydrogen in the energy transition and identifying favorable prospects for hydrogen mobility in the UAE.
- Since 2014, Khalifa University has engaged in a collaboration with Japan to look at the establishment of a green hydrogen supply chain. A MOU was signed in 2020 with a Japanese company to support this effort.
- A hydrogen station is currently being constructed at Masdar City. Ambitions are rising and by 2050, plans to convert vehicles fleet at Abu Dhabi Police to FCEVs are in process.
- In Dubai, the first solar-driven hydrogen electrolysis facility was inaugurated in 2019 by DEWA, to be fully operational in 2022. The facility is located at the DEWA Research and Development Center of the Mohammad Bin Rashid Solar Park. It will produce and store hydrogen for re-electrification purposes and other uses like transportation. It will be a major demonstration project of the World EXPO in Dubai in 2021, using the hydrogen to generate power to fuel cell electric vehicles (FCEV).

UTILITY SIZE

The federal ministry of energy has been working in recent months on the formulation of a strategy for green hydrogen in the UAE.

During a recent roundtable of EU- GCC clean energy network, H.E. Suhail Al Mazrouei, Minister for Energy and Infrastructure of the UAE, stating *"we look at Europe with excitement seeing all of these (hydrogen) projects and plans by the European Union and by several of our allies in Europe... We are very excited of the recent instruction by HH Sheikh Mohamed bin Zayed, Vice chairman of the emirate's Supreme Petroleum Council, Crown Prince of Abu Dhabi to instruct ADNOC to develop together with the different stakeholders in the country a hydrogen strategy to enable the full potential of hydrogen in the UAE".*

This statement was supported in the end of November by a concurrent announcement of ADNOC's CEO, Dr. Sultan Al Jaber, Minister of Industry and Infrastructure adding *"We are pursuing hydrogen as a potential new venture as part of clean energy and clean technology strategy".*

Similarly, TAQA has shown, since its takeover of all Abu Dhabi electricity and water assets in 2020, an interest in developing green hydrogen production capacities.

MOROCCO

With already large developments and ambitious goals of REN, Morocco is engaging in development of green hydrogen capacities.

Last July, in the framework of the German-Morrocan partnership, it signed with Germany a memorandum of understanding to develop its Power to X (PtX) industry and build Africa's first industrial green hydrogen plant and green ammonia facility. This agreement came after Germany had just announced its hydrogen strategy, including €2bn ($2.38bn) in projects abroad. A first 100MW green hydrogen plant in Morocco is planned to be operational in 2024/2025.

Experts consider that, eventually, one-third of Morocco's green hydrogen would be consumed domestically while two-thirds world exported, using initially molecules (such as ammonia) for transportation and possibly, as technology improves, the existing gas pipeline network of Morocco to Europe.

EGYPT

In Egypt, plans to integrate and deploy hydrogen projects are being considered. The European Bank for Reconstruction and Development (EBRD) expressed its interest to invest in hydrogen projects in the country.

It is anticipated that the country shall integrate hydrogen projects in the very near future, although present plans are rather based on producing blue hydrogen by converting a portion of its natural gas resources into hydrogen, using carbon-capture technology. However, Egypt's 2,450 km coast and 1,530 km of the Nile River as well as its large REN, wind and solar resources, could also allow the country to produce green hydrogen at scale and low costs using electrolysis.

OMAN

Oman is looking at green hydrogen as a way to diversify its economy and take advantage of its geographical position between Asia, Africa and Europe to export eventually clean energy. Hence, Oman's projects of green hydrogen are mainly located in key port areas:

› In Duqm, in the free new economic development free zone of SEZAD, Al Wusta governorate: Oman and Belgium partners have engaged the feasibility study for a hydrogen plant with a 250MW to 500 MW electrolyzer, indicating possible upscaling later.

› Sohar Port and Free zone, a partnership with Amsterdam port – already hosting hydrogen projects – have announced in November 2020 their intention to advance the country's first industrial-scale green hydrogen plant at the industrial port on Oman's Batinah coast. Sohar has the ambition to become a global hub for the 'energy of the future' and to foster use of green hydrogen to power heavy industries, including steelmaking.

All these projects would rely on developing solar parks.

OUTLOOK FOR GREEN HYDROGEN

Considered in the last decade as only an emerging technology, too expansive and with many technological hurdles to overcome, green hydrogen is proving today as the key to what may well be the next decisive energy revolution. However, challenges remain:

› Competition with grey and blue hydrogen is still an issue and governments support and incentives in the first phase of development will be important : today fossil fuels based hydrogen (grey hydrogen is around 1.5 Euros/kg) depending on gas prices and not taking into account the cost of CO2 that may soon be integrated by some regulations; estimated cost of hydrogen based on fossil fuels with carbon capture and storage is around 2 Euros/kg , clean hydrogen based on REN is presently around 2.5 – 5,5Euros/kg

› Some key issues need to be fully addressed: more developments are required in to improve technical and economic feasibility of storage and long-distance transportation solutions (e.g. for use of liquified H2 currently in pilot phase). Reduction of losses safety during conveyance have to be dealt with. However, experts anticipate that a dedicated infrastructure for hydrogen and other gases and fluids will eventually be built to ease transportation.

In MENA region, green hydrogen starts clearly to emerge. We do expect clean hydrogen to become an important component of decarbonization and energy transition strategies, including for the traditional oil and gas major exporters of the GCC. **We do also expect renewable hydrogen to become an important driver for further large-scale solar energy investment in the region.**

In this context, the need for a well-defined regulatory framework providing the necessary visibility to investors and relevant safety measures will come at the forefront.

Moreover, as underlined by IRENA in a recently published a report on "Green Hydrogen, a Guide to Policy Making" the true carbon price to reflect the cost of fossil-fuel-produced material in order to make alternative solutions of green hydrogen cost really competitive will play an important role".

9. HIGHLIGHTS IN MENA'S LEADING SOLAR PV MARKETS

In this section, each country profile briefly summarizes the current energy situation providing updates on both the utility scale and distributed solar segments with a focus on PV, CSP and storage projects.

A. ALGERIA

Total power capacity (2019)	24,194 MW
RE installed capacity	342 MW
RE target by 2030	22 GW

Source: IRENA

I. CURRENT SITUATION AND STRATEGY

Today, 98% of Algeria's electricity still comes from natural gas. However, the country is blessed with solar energy, with one of the highest solar potentials estimated at 13.9 TWh per year. The country receives annual sunshine exposure equivalent to 2,500 KWh/m2. Daily solar energy potential varies from 4.66 kWh/m2 in the north to 7.26 kWh/m2 in the south. Moreover, diversification has become an important economic objective, like in many countries of the region. Hence, it has set objectives of at least 22 GW of power from renewable resources by 2030, including at least 13.6 GW from PV.

Initiatives taken in the past to foster the development of solar energy have faced several difficulties and the pace of implementation has been slow. Total renewable capacity has not grown the last couple of years but is still modest with 342 MW mostly from solar in 2019. Different measures have been put in place recently to create a more conducive environment to launch new projects.

II. UPDATES ON COUNTRY POLICY FRAMEWORK AND REGULATIONS

Algeria's efforts to develop renewable energy projects have faced challenges to mobilize interest from the solar industry. Most of them were related to:

- Lack of competitiveness of REN with subsidized hydrocarbons
- Regulatory and financial framework for foreign investors and foreign investment cap at 49% (rule 51/49)
- Local content constraints difficult to satisfy because of existing limited local production capacities
- Reluctance of local banks to support investments in REN.

Different measures have been taken to create a more conducive environment:

- <u>The policy framework reflects an increasing importance of decarbonization:</u>
  - In 2019, a dedicated renewable energy agency, Commissariat aux Energies Renouvelables et à l'Efficacité Energétique (CEREFE), was set up. This was followed in 2020 by the creation of a dedicated Ministry of Energy Transition and Renewable Energies, finally focusing on diversification of the country energy mix, away from oil and gas
  - In mid-2020, a National Energy Council was established with the mission to improve energy efficiency and formulate a strategy for the future of the energy sector. Emphasis will be put on defining new pricing policies.
    (note: the council will also oversee Algeria's plans to introduce its first nuclear power plant by 2025 to meet the growing demand of electricity)
- <u>The framework for foreign investment:</u>
  - In mid-2020, **ownership rules** by foreign investors were modified. Algeria replaced law 51/49 by law 20 -07 with the objective to unlock and encourage foreign investment. Non-strategic sectors will no more be subject to the cap of 49% ownership and renewable energy projects have been included in this category
  - The government's **pre-emption right** on corporate participations' transfers by or to foreign investors was also lifted.
    (note: however, the wording of the provision does not clearly specify the if liberation of foreign investments is applied to renewables or not)
- Constraints of local content eased: E.g. announcements around the launch of the Tafouk (see sub-section III) project specified that local content rules would be applied with flexibility, taking into account actual local production possibilities.

III. PROJECTS

» 150MW SOLAR PV SCHEME, TENDERED IN 2018

Algerian Electricity & Gas Regulation Commission (CREG) tendered a solar PV IPP scheme for several projects of 10 MW each with a total capacity of 150 MW in 2018, but only successfully procured a 50 MW project in Biskra. Tendering the remaining 100 MW was not very successful to date. Construction of the 50 MW has not started.

» HYBRID SOLAR PV

In 2018, small diesel plants in the south of Algeria were being hybridized using solar PV, 50 MW EPC projects were successfully tendered. The projects vary from 2-3 MW to 10-11 MWs having a total of 10 plants across different locations. The projects were awarded, and contracts were signed. However, construction has not yet started.

» TAFOUK 1 PV PROJECT

A 4 GW project in Tafouk was announced last May in the wake of a MOU of collaboration with Desertec to support its implementation. However, as early as August 2020, the Minister of Energy Transition and Renewable Energy indicated that mobilization of the $3.2 billion to $3.6 billion required for such a megaproject would be difficult and that the country was moving out of Desertec project.

Tafouk 1 is now subject to several modifications and uncertainties. It is expected to be tendered in several mid-sized projects of 50-100/150 MW for total capacity up to 1 GW. The Minister indicated that he will turn towards the private sector for these projects, but detailed modalities are so far not available.

» SONATRACH'S 2030 VISION PLAN

Sonatrach is planning the installation of 1.3 GW of solar generation capacity at its oil and gas sites, and indicated that solar power could "cover 80% of our [power] needs on site."

So far it has signed contracts with two oil major partners for solar power projects. However, development has been slow and only a first 10 MW solar plant built in this framework from 2017.

IV. CHALLENGES AND OUTLOOK

2020 was marked by continuous and increasing economic difficulties for the country. In one year, unemployment rates rose to 15% from 11.4%. Algeria forecasts $10 billion in lost revenue in 2020 due to the fall in energy prices. Foreign reserves at the end of the year stood at $58 billion, less than one-third of 2013's record $195 billion.

As a result, Algeria's budget deficit is set to double from 2019 to this year. The country's financial pressures induced cuts in public spending and delays of planned projects, including the energy sector. In this context, access to finance and investment for REN projects may remain an issue.

According to IRENA, strengthening collaborations between international renewable energy developers and the local industry is necessary for renewable sector market players to engage and foster the development of Algeria's solar energy (local supply, training programs, and technology transfer). Recent announcements of new investment into local production of mounting structures for PV systems are encouraging signs.

In the long term, it is certainly the revision of Algeria's energy pricing and subsidy policy that could be a decisive trigger to enabling the country to make full use of its large solar energy potentials.

B. BAHRAIN

Total power capacity (2019)	8,002 MW
RE installed capacity	7 MW
RE target by 2025	255 MW
RE target by 2030	710 MW

Source: IRENA

I. CURRENT SITUATION AND STRATEGY

Bahrain currently has a 7 MW total renewable capacity in its energy mix, of which 6 MW is solar. It has set a renewable energy target of 5% by 2025 and 10% by 2035 including solar, wind and waste-to-energy technologies. To reach this goal, Bahrain is aiming to integrate 255 MW and 710 MW by 2025 and 2035 respectively. This comprises large scale generation for at least 100 MW. However, due to limited available space for the utility scale solar power plan, its strategy puts emphasis on decentralized urban generation for at least 100 MW (e.g. rooftop and C&I solar) and offshore generation for 50 MW (e.g. wind farms). The government expects to make a cumulative saving of $218 millions, and a carbon dioxide emissions reduction of 3.4 million tones by 2025 compared to the baseline period of 2009-2013.

These plans were supported by Bahrain's estimate of additional electricity capacity by 2030 at + 65%. However, a slowdown in electricity demand in recent years limits, for the time being, the need for new utility size projects.

II. UPDATES ON COUNTRY REGULATIONS

In 2017, Bahrain's Sustainable Energy Authority (SEA) adopted two plans to foster sustainable energy: the National Renewable Energy Action Plan (NREAP) and the National Energy Efficiency Action Plan (NEEAP). To do so, three policies were integrated:

- Net metering policy
- Tender-feed in tariffs
- Renewable energy mandate for new buildings

The country has 22 energy efficiency initiatives across the residential, industrial, power, transport and other sectors. Some of those initiatives include the development of a green building code that requires all buildings in the country to meet a minimum energy-efficiency level. Other initiatives include retrofitting buildings and street lighting as well as smart metering

III. PROJECTS

» ASKAR LANDFILL SOLAR PV PARK

The project, located on a landfill to optimize use of space, was part of the renewable energy action plan put in place in September 2017. Bahrain's Electricity and Water Authority has awarded in 2019 the 100 MW Askar solar PV park tender with a bid of $0.039 per kWh. The project is currently under construction and is the first utility scale renewables project in Bahrain.

» SOLAR ROOFTOP

In March 2020, SEA received proposals from seven bidders on a 3 MW rooftop solar PV plant with the lowest option price of $ 0.053 per kWh. The project is split into three phases of 1.25 MW, 1 MW and 750 kW.

Within the year, several rooftop projects were executed. The Avenues shopping center had integrated on its multi-story car park a rooftop grid connected solar PV system, generating 250 KW at peak. Another rooftop solar system was also installed for a capacity of 43.2 kW on the council of representatives' extension building.

» INNOVATIVE PROJECTS

Recently the Works, Municipalities Affairs and Urban Planning Ministry has started installing public gardens, beachfronts and walkways with solar energy. One of the largest real estate developers in Bahrain has also installed several solar energy trees (2kW to 3kW) within an integrated city.

» SOLAR FOR OIL FIELDS

Tatweer Petroleum has installed first 1 MW solar plant in 2016. It is presently adding to it a 3 MW solar plant, located in the center of Awali island oil field. A third unit will be added in coming years to deliver 8 MW solar capacity to help meet the needs of the oil field operation.

IV. CHALLENGES AND OUTLOOK

The limited land area of Bahrain restricts the country from developing large scale renewable energy projects. However, innovations, such as bifacial solar modules as a solution to increase power generation, could reduce the challenge. Globally, rooftop is a better solution due to these geographical constraints and is currently picking up.

From a financial perspective, support of funds to deploy solar projects was observed in mid-2020. Energy technology solution projects were provided with two financing options to clients from a bank in Bahrain. The first is short-term financing for seven years and the second is long-term funds for 25 years, linked to property financing. Such initiatives will encourage investors within the energy sector to deploy more solar energy projects.

Bahrain is integrating policies and increasing its renewable energy targets gradually. Module manufacturing within Bahrain is emerging which demonstrates the country's long-term engagement.

Al Dhafra Recycling Industries Project
Courtesy: Enerwhere

C. EGYPT

Total power capacity (2019)	64,586 MW
RE installed capacity	5,972 MW
RE target by 2022	increase up to 20% by 2022 and 42% by 2035
RE target by 2035	

Source: IRENA

I. CURRENT SITUATION AND STRATEGY

The 2035 Integrated Sustainable Energy Strategy targets progressive phasing out of the energy subsidy regime, diversification of the electricity mix, with an increasingly growing share of renewable energy sources and energy efficiency along gradual liberalization of the electricity market to foster investment.

By the end of 2019, Egypt had 5,972 MW or 10.8% of renewable energy in its total installed power capacity. Solar energy accounted for 1,668 MW of that total. The country developed most of its renewable projects under IPPs signed in 2017, generating $3 billion-worth of renewable energy investments.

Egypt targets to increase installed renewables up to 20% by 2022 and 42% by 2035. By 2035, it is aiming to have an electricity mix of 55% from thermal power plants, 42% from renewables and 3% from nuclear energy. The 42% renewables will be composed of 3% of CSP, 22% of PV, 14% of wind and 2% of hydropower. According to IRENA, Egypt has even bigger potential and could supply up to 53% of its electricity mix from renewables by 2030.

However, the drop of electricity demand resulting from the impact of phasing out of subsidies and COVID19, with as much as 2GW to 3GW less consumption early 2020, led to measures inducing a pause in renewable energy generation growth in particular to avoid exacerbating the oversupply issue. Actions included, as of May 2020, caps on solar energy private-sector generation (see subsection II) and postponement of some utility size tenders.

II. UPDATES ON COUNTRY REGULATIONS

Egypt initiated several years ago a program of gradual, yet deep electricity market reform (Law 87/2015), targeting transition from a traditional, vertically integrated regulated state monopoly model. The law envisages the gradual liberalization of the electricity sector with extensive private sector participation, including the establishment of a deregulated segment in which eligible private consumers will be able to choose directly their own retail suppliers. EBRD advised Egypt on its implementation.

› **Subsidy reforms** and progressive alignment the tariffs in line with the costs of supply are key in this reform and should play in favor of renewable energy. An important move was in July 2019 with the cut of fuel subsidies and increase of domestic prices between 16% and 30%. However, as part of the measures to soften the economic impact of COVID19, energy prices for industrial users were reduced in March 2020.

› Additionally, in the framework, of the reforms, the **Egyptian Electricity Transmission Company (EETC) is expected to separate from the Egyptian Electricity Holding Company (EEHC)** in the near future[6].

› The country is also engaging changes in legislations governing small and medium scale renewable generation. **New rules on net metering** were set by the Egyptian Electricity Utility and Consumer Protection Regulatory Agency (EgyptERA) in April 2020, effective as of May 20, 2020. To be eligible to net metering, solar plants:

- Must be installed within the boundaries of the customer's premises
- Have a capacity that cannot exceed the maximum load of the owner during preceding year
- The maximum capacity for plants owned by one customer should not exceed 25 MW in aggregate or 20 MW per project

An eligible customer should not be licensed to distribute electricity to the same project. This requirement aims to prevent the distribution companies from benefiting from the net metering scheme, since such system is devised to encourage the use of solar energy by consumers, not distribution companies.

Furthermore, the decree introduces a ceiling of 300 MW of aggregate capacity of solar plants under the net metering scheme across the country. At the issuance date of the decree, there were only 75 MW already licensed by EgyptERA. The remaining 225 MW still available at that date are divided into 125 MW for capacity less or equal to 500 KW and 100 MW for capacity more than 500 KW and up to 20 MW.

[6] *"**Electricity** Law (adopted in July 2015) provided a three-year transition period for EETC to become a transmission system operator independent from generation and distribution (such that a competitive **electricity market** could later emerge on a level playing field), and provided EEHC an eight-year period to be restructured into potentially competing entities to play on that field" Source; World Bank Learning from Power Sector Reform - The Case of the Arab Republic of Egypt, February 2020.*

Payment for excess generated capacity will only be made on annual basis, after off-setting the consumer's consumption at the end of June of each year. It will be calculated according to the most recent purchase price (Egyptian piasters/kWh) contracted between the EETC and a solar energy's producer. A balancing charge will be paid for the cost of integration into the grid based on the voltage and will be reviewed by EgyptERA regularly. It is not considered as a wheeling charge, but rather a fee relating to the production of energy.

Note: These limitations do not apply to projects in Benban solar park.

CUSTOMS LAW

In 2020, the new customs law adopted will help to streamline import procedures and benefit the supply chain of solar projects (e.g. single window system, electronic payments and expedited clearances for authorized companies).

III. PROJECTS

Rapid development of renewables along other energy capacity investments (gas and coal) have led to the oversupply capacity in present context. Egypt produces around 60 GW of electricity for 34 GW peak consumption during the summer. Hence, the government has put on hold the launch of new projects this year (Note: Egypt's 3 GW electricity interconnection project with Saudi Arabia has also been deferred to post-Covid19, postponing the additional flexibility it could bring to manage oversupply).

CANCELED PROJECTS:

› 200 MW PV in West Nile, IPP
› 100 CSP in West Nile, under BOO scheme

*Projects were canceled considering Egypt had reached surplus electricity in a context of low electricity demand, EETC claims.

PROJECTS COMMISSIONED:

› Two 65 MW solar PV projects in Benban, Aswan province of southern Egypt

PROJECTS UNDER CONSTRUCTION:

› 200 MW PV in Kom Ombo, under BOO scheme
› 26 MW PV at Kom Ombo, under Tender EPC scheme
› 50 MW PV at Zafarana, under tender EPC scheme

PROJECTS UNDER DEVELOPMENT:

› 200MW Kom Ombo solar photovoltaic (PV) increased to 500MW agreed in November 2020
› 600 MW PV project in West Nile under Auction scheme
› 20 MW in Hurghada, under tender EPC scheme
› 50 MW PV at Kom Ombo, under tender EPC scheme
› 50 MW PV at Zafarana, under tender EPC scheme
› 200 MW PV at Kom Ombo, under BOO scheme

» C&I AND STORAGE

The current installed capacity by SMEs in Egypt account for 100 MW. The installed projects are solar PV projects under the net metering scheme. The government's lifting of subsidies on fuel and electricity tariffs has played a major role in the increase of decentralized solar projects.

NREA has postponed to January 2021 the tender of the first 20 MW PV solar plant with 10 MW battery storage, located in the Red Sea area of Hurghada, under an EPC scheme. The project is planned to be funded by an $85 million facilitated loan from Japan International Cooperation Agency (JICA).

IV. CHALLENGES AND OUTLOOK

The development of new utility size solar projects has been slowed down by:

› the impact of the combined COVID19 pandemic and the decrease of hydrocarbon prices on electricity demand

› the risk of oversupply capacity with the rapid expansion of investment in new power installations

Small and medium size projects may be less impacted. Upon economic recovery, demand will probably pick up again while the country maintains its commitment to a more sustainable and diverse energy mix.

To manage such a situation and increase flexibility of its grid, an increase in investments is required in storage capacity and may well deserve a specific regulatory framework.

Despite a pause in projects, Egypt's Minister of Planning and Economic Development, Hala El-Said, has recently confirmed that the government was planning additional investments in the electricity sector in 2020/2021. The target of EGP 45.3 billion in electricity sector investments in the fiscal year (FY) 2020/21 represents 6.1% of the country's total investments. This is an indication that new projects could be launched again in the future. Meanwhile, reduction of subsidies and projects under development and construction are anticipated to continue. Furthermore, increasing end use applications such as electric mobility, solar irrigation and the important program of new renewable-powered desalination plants may well support the increase of REN capacity.

D. JORDAN

Total power capacity (2019)	6,369 MW
RE installed capacity	1,642 MW
RE target by 2025	20% of electricity production from renewables by 2025

Source: IRENA

I. CURRENT SITUATION AND STRATEGY

Jordan has engaged in an important effort to diversify its energy mix. The country's current electricity production from renewables accounts for almost 16% of its energy mix. By the beginning of 2020, around 1,642 MW of electricity was generated from renewables with almost 1,000 MW from solar alone. In mid-2020, Jordan updated its energy strategy and announced a target to produce 20% of electricity production from renewables by 2025. It is anticipated that the country will have a capacity of 2,400 MW by the end of 2021.

II. UPDATES ON COUNTRY REGULATIONS

To manage the integration into the grid with increasing shares of renewables, the government decided in early-2019 to put a hold on net metering and net wheeling projects above 1 MW. During 2020, no changes occurred but several exemptions were granted for C&I projects due to an economic need to decrease their operational costs.

Because of COVID19 and the resulting economic slowdown, Jordan faced a decrease of electricity demand and load versus a high production of electricity from solar plants. To preserve the stability of the electricity transportation network, the authorities decided in March 2020 to disconnect all unsubsidized solar plants, which use the grid to connect to direct energy offtakers, for a couple of weeks. The measure was applied only to wheeling projects rather than to all large-scale solar plants in Jordan.

Baynouna 200 MW project, Jordan
Courtesy: Baynouna Solar Energy Company

III. PROJECTS

» CANCELED STORAGE PROJECT

In Q2 2020, Jordanian authorities confirmed the cancellation of a 30 MW/60 MW energy storage tender. The submitted EOIs, dated from 2018, had 23 parties eligible to submit bids. The project was supposed to help integrate the output of several large-scale solar plants in Ma'an. It is anticipated that energy storage projects in Jordan will rise again when costs of lithium-ion batteries further decrease.

» ROUND 3 SOLAR PROJECTS

The suspension of renewable energy projects excluded Round 3 projects. Nevertheless, request for EOIs was postponed. Yet half of the capacity assigned for Round 3 projects was awarded to the industrial sector (see below).

For the remaining capacity under Round 3 projects, the release of requests for EOIs is still not yet known and will most probably be linked to the development of the national grid.

» ROUND 3 WITH THE INDUSTRIAL SECTOR

In early-2020, the Kingdom Chambers of Industry announced that an exclusive tender will be announced for a solar energy project with an expected capacity up to 100 MW. The project marks the first community solar project in Jordan. A specific company shall be formed to build the project. It is anticipated 100 MW will be completed by the end of 2021.

» BAYNOUNA SOLAR PV SCHEME

The largest single solar energy project developed under PPA scheme is already constructed. It is anticipated that the 200 MW project shall be commissioned in the end of 2020 or early-2021. The project is estimated to produce enough electricity to power approximately 110,000 homes while displacing 360,000 tons of CO2 annually.

» HUSAINIYAH SOLAR PARK

After successfully achieving financial close in early-2019, the 50 MW solar project is currently under construction. The project's commercial operational date was anticipated to be in late-2020 or early-2021. It will supply 42,000 households with affordable, clean energy and avoid at least 100,000 tons CO2 emissions annually.

» JREEEF'S SOLAR SUPPORT SCHEME

The Ministry of Energy's Jordan Renewable Energy and Energy Efficiency Fund (JREEEF) is offering financial and technical assistance to several sectors in Jordan to install solar heaters and cells.

In mid-2020, the second phase of a cooperation program was agreed with local associations to subsidies the installation of solar heaters and cells with 30% of their costs. Beneficiaries are free to choose the implementing company and service providers. Local associations allow them to pay in installments the remaining 70% share of the cost. The first phase of the program successfully witnessed the installation of 26,000 solar heaters and 700 solar cell systems.

IV. CHALLENGES AND OUTLOOK

Even though Jordan wants to expand and add more renewable energy projects to the electricity production capacity, grid enhancements are vital to be enable integration of more renewable power in the network.

Like other countries in the region, Jordan is waiting for the maturity of battery storage technologies and additional decrease in prices to develop more utility size storage projects.

Jordan is also looking at smart digital solutions to improve the management of the electricity intake.

According to IRENA, the Jordanian private sector is facing challenges and concerns such as unexpected cancellations of tenders as well as sudden changes to local content requirements. As a result, investors confidence in Jordan's long-term strategy could be an issue.

The country is currently very close to producing 20% of electricity from renewables. Jordan, like many other MENA countries, is looking into grid development and storage to achieve even higher targets of renewables, beyond the present health and economic crisis.

E. IRAQ

Total power capacity (2019)	33,290 MW (Generating 18 GW only)
RE installed capacity	37 MW
RE target by 2022	1 GW

Source: IRENA, The Global Economy

I. CURRENT SITUATION AND STRATEGY

The country has suffered from electricity shortages due to previous destructions and insufficient replacement facilities for several years. The main effort in the country focused first on additional gas turbines capacity.

Iraq has vast solar energy potential, as the global horizontal irradiation (GHI) is above 1,899 kWh/m2 in some areas of the west and the south, such as Muthana and Anbar provinces. The Federal Government Program (2018-2022) has an objective of 1 GW of solar energy. Solar energy utility scale capacity totaling 550 MWp was set for the end of 2019 and 450 MWp by end of 2020. Solar rooftop pilot projects on government-owned buildings were also planned for 8 GW. By the end of 2019, a total of 37 MW of solar power connected to the grid had been developed.

However, most of these plans were later adjusted. The Ministry of Electricity stated earlier this year that it is now aiming "at long term 40% share of renewables in the energy mix of the country" by adopting wind, solar, waste-to-energy and geothermal technologies.

II. UPDATES ON COUNTRY POLICY FRAMEWORK AND REGULATIONS

REGULATORY FRAMEWORK IN THE MAKING

A regulatory framework for the renewable energy is very briefly laid out in Article 2 (5) of the Electricity Law No. 53 (2017). A specific draft law for renewable energy was submitted to the Ministerial Energy Council for review in early 2019. It aims, among many objectives, to encourage the public and private sector to participate in developing renewable energy. It still has to be submitted to the Parliament.

The draft law incorporates articles to stimulate renewable energy in Iraq, increase energy efficiency, contribute to energy security and achieve sustainable development. Until the law is finalized, the Ministry of Electricity is the regulatory and executive authority for renewable energy sector adoption, investment and promotion.

It is important to also note that the Ministry of Science and Technology supports solar development with its Solar Energy Research Center.

AN ENCOURAGING FRAMEWORK

Feed-in-Tariffs (FIT) have been abandoned for utility size projects. The planned facilities will be tendered and developed under BOO and IPP schemes. Winning companies will be treated under the revised Federal Investment Law of 2006 as 'investors'. Renewable energy developers will enjoy free access to government-owned land, reduced customs fees and ability to repatriate profits free of taxes. Permits are valid for 20-50 years, depending on the type of investment projects.

Public and private entities have the right to generate renewable power on their premises for own use. They have also access to the national transmission and distribution grid for allocation of power to their other premises (geographically far) or to sell to the Ministry of Electricity under a PPA.

For households, rooftop solar (above 500 kW capacity) benefit from a FIT along smart metering measures. Since 2019, the Ministry of Electricity, Ministry of Finance and Energy Council have devised a technical and financial support mechanism for citizens' direct access to small loans for purchasing and installing roof-op solar units from manufacturers and suppliers approved by the Ministry of Electricity (3 kW, 5 kW, 10 kW and more).

III. PROJECTS

» PILOTS

Early in 2020, the United Nations Development Program (UNDP) signed a letter of agreement with the Governorate of Duhok to establish a pilot solar park that will provide a minimum of 2 MW of electricity within two years.

» 750 MW SOLAR TENDER

The Ministry of Electricity has put the first solar tender for 755 MW on hold after launching it in 2019, merely because of the economic situation of the country and COVID19. The seven plants were anticipated to begin commercial operations in 2020. However, it is now projected to take longer until 2022-2023. The Ministry will be the offtaker of the electricity of the projects that will be developed under a BOO model.

Project (IPP)	Capacity (MW)	Province
Sawa 1	30	Muthana
Sawa 2	50	Muthana
Khidhir	50	Muthana
Iskandariya	225	Babil
Jissan	50	Wassit
Karbala	300	Karbala
Al-Diwania	50	Diwania

» 1GW SOLAR PV PLANT

As a government-to-government initiative, a private developer proposed developing a 1 GW solar PV plant in Iraq. The project shall be executed once the government gives permission to proceed. The developer proposed tariff of $0.065 per kWh and negotiations are said to be in process.

» ROOFTOP PV & C&I

Since 2016, six families were selected to receive rooftop solar systems as a pilot project having the support of the Global Environment Fund (GEF). The pilot project's goal was to raise awareness and demonstrate the potential benefits of solar energy. This project installed solar PV units in Baytti district, Najaf and Al-Mansour Factory in Baghdad, as well as a solar PV energy Test Station at the Ministry of Science and Technology Baghdad. UNDP and GEF suggest that Iraq increases trained and experienced personal to maintain and repair solar systems.

Technical surveys of several government buildings have also been conducted to assess their suitability for solar power generation.

IV. CHALLENGES AND OUTLOOK

Power shortages remain one of the biggest challenges for Iraq and a key component of the next government plan for a socio-economic development and reconstruction program. The country still suffers from a continuous burden of importing most of its electricity from Iran and is currently seeking to lower its dependency. The need to address population's electricity shortages has led to put the emphasis on thermal power for several years.

Renewable energy and solar projects have started to emerge to help meet electricity needs. However, COVID19, low oil prices and the expected huge deficit in 2020 federal budget, have heavily impacted Iraq's new renewable energy plans, as the country is expecting tough economic measures and huge budget cuts in 2020-2021.

Nevertheless, the current situation puts the emphasis on the importance of energy security and could encourage Iraq to diversify more its renewable energy mix. The adequate incentives and framework are progressively put in place even though the policy and draft law for renewable energy has still not been adopted.

F. KUWAIT

Total power capacity (2019)	19,372 MW
RE installed capacity	106 MW
RE target by 2030	supplying 15% of peak electricity demand from renewable energy sources by 2030

Source: IRENA

I. CURRENT SITUATION AND STRATEGY

The country has one of the highest solar irradiation levels in the world, estimated at 2,100 – 2,200 kW/m2 per year. However, Kuwait has only a total installed renewable energy capacity of 106 MW including 93 MW from solar. The Kuwaiti government strategy is aiming to diversify its electricity mix through the Kuwait National Development Plan 2035. The plan was set in place to reduce the country dependence on oil-export revenues. Kuwait has a target of supplying 15% of peak electricity demand from renewable energy sources by 2030. The pace towards these targets stays slow and projects experience postponements.

II. UPDATES ON COUNTRY REGULATIONS

Kuwait is still suffering from the expiration of its public debt law in 2017 and the lack of a replacement law. This situation is preventing Kuwait from accessing international financing of its debt. With an increased budget deficit, the strain on public finances is growing. Despite revised PPP laws and regulations, projects move slowly beyond the advisory stages.

III. PROJECTS

» SHAGAYA RENEWABLE ENERGY

Under the first phase, a CSP project with a planned production capacity of 50 MW, was built on site. The plant is a part of the Shagaya phase 1 complex that came online in 2018. The first phase also includes a 10 MW solar PV plant and a 10 MW wind farm.

The project was anticipated to increase its installed generation capacity to 4 GW, with the construction of CSP plants, solar PV farms and a wind farm by 2027.

» CANCELED PROJECT

Due to COVID19, Kuwait has cancelled plans to launch this year the Al Dibdibah solar PV project also referred to as Shagaya phase 2. The project was initially set to be developed by the Kuwait National Petroleum Company and had a project capacity of 1,500 MW. However, the government may announce re-tender of the project in a year or more. It was also decided that Shagaya phase 2 should be tendered under an IPP format (as a result, project implementation is transferred to Kuwait Authority for Partnership Projects, or KAPP).

» SOLAR ROOFTOP

Kuwait Institute for Scientific Research (KFSA) has developed a number of energy efficiency projects, including rooftop solar PV with the National Technology Enterprises Company, the Ministry of Electricity and Water (10 buildings totaling 3.64 MW and expected in 2022), Al-Zahra Co-operative Society, Al-Adailiya Co-operative Society, the Association of Cooperative Societies and the Nahtam Volunteer Team from the Voluntary Work Center. Emergency Department - Main Workshops is developing an installed capacity 2.7 MW and power stations spaces at 5 MW, expected Q2 2020.

IV. CHALLENGES AND OUTLOOK

COVID19 and low oil prices will induce increased budget deficit in 2021 and slow down new projects. However, the country's potential for renewable energy is considered high when it comes to resources. Its goal to reach 15% of renewable energy in its energy mix by 2030 has not been put in question. Importantly, like for other sectors, the PPP framework will have to be further developed to support acceleration of projects.

G. MOROCCO

Total power capacity (2019)	10,990 MW
RE installed capacity	3,264 MW
RE target by 2030	Producing 52% REN by the end of 2030

Source: IRENA

I. CURRENT SITUATION AND STRATEGY

The total renewable energy installed in Morocco accounts for 35% of its electricity output. By the end of 2019, the country had 736 MW of solar energy out of 3,264 MW of its total renewable energy mix. However, Morocco is one of the most advanced countries in successfully planning and executing its renewable energy strategies. The country is focusing on producing 42% of renewable energy by 2020 and 52% by the end of 2030 in the capacity mix. Those ambitious plans are supported by local governmental engagement coupled with favorable policies to expand the renewable energy sector.

II. UPDATES ON COUNTRY REGULATIONS

Morocco's Agency for Sustainable Energy (MASEN) is executing a national renewable policy looking at the way a future grid can operate reliably with 100% renewables. Abderrahim Jamrani, the Technical Director of Masen stated "as we are making our studies for 2050, we now can see that we can really achieve 100% renewable in our country."

III. PROJECTS

Morocco did not commission new solar power plants in 2019, but MASEN announced several projects in 2020 to achieve the country's further ambitious targets. These projects are largely supported by international and bilateral financial institutions.

» ENERGY STORAGE PROJECT INAUGURATED AT NOOR SOLAR COMPLEX

MASEN was looking for a solution to store solar and wind power to ensure 24-hours provision of electricity and heat for the Noor Complex (that should reach 2 GW). A R&D project has been entrusted to a private entity. Ultimately in March 2020, the storage system was installed and volume production is expected in 2021.

» NOOR PV II - 400 MW SOLAR PV PLANT

In early-2020, MASEN issued a call for EOI to pre-qualify developers for the construction of a 400 MW solar power plant. The plant is part of the first phase of Noor PV II project. It will consist of several PV arrays to be built across nine locations, each having a capacity of 40 MW.

» NOOR MIDELT 1: PV & THERMAL STORAGE PROJECT

The first hybrid project in Morocco was awarded in Q2 2019 with a record-low tariff at peak hours of $0.07 per kWh. This 800 MW solar hybrid project at Midelt will be the first solar project in the world to include thermal (heat) storage of PV as well as CSP. The production of the PV plant can be saved in the thermal energy storage of the CSP portion of the project. This scheme provides the necessary flexibility "to feed into the grid what is missing at the time when it is missing".

» NOOR MIDELT 2 IPP ON HOLD

In July 2019, Masen launched a tender for a hybrid plant with thermal CSP and solar PV components under IPP. The initial plan was for a total capacity of 800 MW, matching that of the initial Noor Midelt 1.

It differs from the first Noor Midelt project with the addition of a battery storage (BESS) option alongside the molten salt storage for the CSP component (150-190 MW and a minimum of five hours of thermal storage). It extended the tender deadline to late-2019. However, due to COVID19, MASEN has decided to review the procurement timeline and capacity of the project once the pandemic ends.

» HYDROGEN

Morocco is currently creating a hydrogen roadmap; several pilot projects are being defined and early discussions are taking place concerning scale-up possibilities.

The country signed an agreement with Germany to develop:

- With MASEN, a "Power-to-X" project based on a 100 MW renewable energy plant to produce green hydrogen.
- A research platform on 'Power- to-X' for the transfer of knowledge and to build skills with the Institute for Research in Solar Energy and New Energy (IRESEN).

IV. CHALLENGES AND OUTLOOK

Morocco's ambitious commitment for sustainable and clean energy is supported by several concerns: health and environment with high estimated deaths due to air pollution, as coal is still a main source of energy for the country, energy independence and potential for exportation of renewable energy to Europe.

The efforts put in place by Morocco to create green policies increased rapidly since its support and signature of the Paris Agreement. The country is committed to implement its renewable energy strategy. Despite some uncertainties due to COVID19, its targets for 2020 were expected to be reached as well as its ultimate goal to produce 52% of its electricity from renewables. Rapid growth of additional share of electricity from renewables induces, similarly to other countries, issues of integration to the grid and Morocco is increasingly looking into smart digital solutions.

One can reasonably foresee that Morocco's recent engagement in green hydrogen developments may trigger additional shares of renewables in its energy mix, while facilitating storage solution to better manage integration of REN into the grid.

H. OMAN

Total power capacity (2019)	12,050 MW
RE installed capacity	8 MW
RE target by 2025	12% of total power generation by 2025
RE target by 2030	covering 30% of its electricity demand from REN projects by 2030

Source: IRENA

I. CURRENT SITUATION AND STRATEGY

Oman has one of the biggest potentials for development and deployment of solar energy projects. The country's global horizontal irradiance is 2,261 kWh/m2. Oman had only 8 MW of solar power in its energy mix by the end of 2019, but the country is moving forward with an ambitious goal of covering 30% of its electricity demand from renewable energy projects by 2030. Solar energy is expected to constitute 12% of total power generation by 2025.

II. UPDATES ON COUNTRY POLICY FRAMEWORK AND REGULATIONS

In early-2020, Petroleum Development Oman (PDO) announced its transition into a broad-based energy development holding company with an enlarged mandate to cover investments in renewable and alternative energy resources, among other areas. Energy Development Oman (EDO) will be a holding company of PDO and a number of investments.

Oman's electricity sector is being liberalized providing new opportunities for private sector involvement at all levels, including renewable energy, generation, transmission and distribution. So far, solar projects are mainly launched in classic frameworks of IPPs with PPAs.

III. PROJECTS

» 2020 OPERATIONAL PROJECT

Amin Photovoltaic Solar Park

PDO's contract to develop, finance, build, operate and maintain the Amin PV plant was awarded in January 2019. The 125 MW project, the first renewable IPP in Oman, has started commercial operations in May 2020. Amin PV project is currently the world's largest single-unit solar park that adopted bifacial modules.

PROJECTS UNDER CONSTRUCTION

» IPPS

i. Ibri II PV

The Ibri II PV IPP project is located in Oman's Al-Dhahirah governorate, with a total installation capacity of 500 MW. The project has successfully achieved financial closure in Q1 2020. Ibri II has completed the first 10 MWp shipment of 24,700 of its 405-watt bifacial solar panels, the shipment considered as a milestone given the challenges posed by the pandemic. Approximately 1.4 million solar panels will be installed to supply an estimated 33,000 homes with electricity. The project will offset 340,000 tons of CO2 emissions a year. Once fully operational, the Ibri II Solar PV IPP will be the largest utility-scale renewable energy project in Oman.

ii. Manah Solar I & II

The Oman Power and Water Procurement Company (OPWP) selected eight of nine pre-qualified bidders for the RFP of Manah Solar I IPP and Manah Solar II IPP development projects with a capacity of 500 MW and 600 MW, respectively. The scope of each project covers the development, financing, design, engineering, construction, ownership, operation and maintenance of a solar PV power plant and associated facilities. The RFP was published in July 2020 with the deadline for bids on December 2, 2020.

iii. Tanweer Hybrid Project

Rural Areas Electricity Company (Tanweer) is planning to build solar-diesel-storage projects in 11 isolated rural areas with a combined capacity of 146 MW. The hybrid plants (70MW of diesel generation and 48 MW of solar PV) will be constructed on a build, own, operate and transfer basis. Selected projects will be granted a 15-year PPA. The project will have a total storage capacity of 28 MW to provide up to 14 MW hours of storage. Sixteen firms were prequalified, and bids were received on October 15, 2020. At least two companies submitted offers with results expected soon.

» C&I

The A'Namaa Poultry SAOC unit of Oman Food Investment Holding launched a 15 MW solar plant tender for its facilities in Wadi Al Sawmahan at Ibri in the Al Dhahirah governorate.

» SOLAR DESALINATION PROJECT

Public Authority for Water (Diam) is exploring desalination powered by solar energy for remote communities located beyond the reach of the country's water distribution grids. More largely, the Sultanate is looking at increasing efficient use of solar energy in desalination.

» ROOFTOP PV

The first phase of the Dubbed Sahim-II program aims to install rooftop solar PV in approximatively 3,000 homes and residential buildings in Muscat governorate. Over the long term, the Authority for Electricity Regulation (AER) Oman target is to cover between 10 – 30% of residential homes in the Sultanate.

The AER and the Supreme Committee for Planning (SCP) initiated the establishment of Oman's first "Green Zone" in 2019, creating synergy between the Sahim residential solar project and energy services companies (ESCOs) "to improve building energy efficiency and installation of solar capacity in government buildings located in Muscat's ministries district", according to the Authority 2019 Annual Report.

To encourage green buildings, the Authority has also recently decided to power mosques with solar energy.

» GREEN HYDROGEN

Oman's Ministry of Energy and Minerals is spearheading the exploration of the Sultanate's opportunities in the green hydrogen sector. In early-2020, the Sultanate opened the Oman Hydrogen Center at the German University of Technology – in coordination with Hydrogen Rise from Germany – aiming to facilitate the development of the hydrogen economy in Oman, touted to be valued at $20 billion by 2050. Several projects are under formulation, in particular in Duqm (200 to 500 MW project) and Sohar port (based on potential 3.5 GW solar energy capacity and in partnership with the port of Rotterdam free zones).

Note: The port of Rotterdam is host of the large green hydrogen project and develops an extensive backbone for hydrogen across the port to the future electrolyzer facilities.

» FLOATING SOLAR

Oman is currently exploring the addition of a FPV structure at Sohar Port and Freezone. The project is currently in the exploratory phase in collaboration with local and international universities.

IV. CHALLENGES AND OUTLOOK

With lower solar energy costs and increased market competitiveness, Oman has engaged more decisively in the development of renewable energy solutions. However, issues relating to the intermittency and low-volume output generated from renewable energy sources continue to be a concern. Technical developments and reduced costs in relation to storage are expected reduce such challenges in the near future.

In its transition towards cleaner energy, Oman's government expects the use of domestic natural gas to reduce over the next decade due to the increased cost of gas production. To reach the renewable targets, more tenders are expected in the coming years to focus on solar energy in both solar PV and CSP.

However, in a context of financial and budgetary difficulties and relative slowdown of electricity demand growth, the main driver of further solar developments in Oman may well be on one hand the use of solar in the oil and gas industry, in the wake its first 100 MW solar project of PDO in Mirah and Amin, and on the other hand for exportation via hydrogen.

I. SAUDI ARABIA

Total power capacity (2019)	77,335 MW
RE installed capacity	397 MW
RE target by 2024	27.3 GW
RE target by 2030	58.7 GW

Source: IRENA

I. CURRENT SITUATION AND STRATEGY

The electricity generated from renewables in Saudi Arabia increased by more than four times from 2018 to 2019. By the end of 2019, the country had a total renewable energy capacity of 397 MW, with more than 95% being solar. The country is thriving in its strategy towards sustainability, reduced dependency on oil and diversification of its energy mix and economy. The ambitions of Saudi Arabia's National Renewable Energy Program (NREP) are on track to install 27.3 GW by 2024 and 58.7 GW by 2030. This includes 40 GW of solar PV and 2.7 GW of CSP.

II. UPDATES ON COUNTRY POLICY FRAMEWORK AND REGULATIONS

1. In early 2020, the Kingdom put in place a Supreme Committee for Energy Mix Affairs to reinforce coordination of projects. The committee will focus on enabling localization programs in renewable energy in the country, and ensure alignment on policy and decision-making, since renewable projects involve several governmental entities and sectors.

2. The Electricity & Cogeneration Regulatory Authority (ECRA) launched a long-awaited regulatory framework for addressing households and small-scale solar distribution systems connected to the utility grid. A formal introduction of net billing and a cap for each solar system's capacity per facility was included, ranging from 1 kW to 2 MW. However, the total installed small-scale solar PV system capacity may not exceed 15% of a substation's transformer rated capacity. The regulation was issued with immediate effect on July 1, 2020.

3. Regulation of local content is evolving. Government tenders and procurement law, hence local content regulation, do not apply to certain privatization/PPP projects. Regulation to privatization tenders is not mandatory to these projects. However, local content requirements for such projects are usually stated in their specific RFP (e.g. by REPDO).

Local content objectives for REPDO had initially been set to increase progressively from 30% to 40% and 60%. In 2020, under Round 3 of its program, the minimum requirement has been fixed for the construction phase at 18% of local content and will be calculated with the mechanisms defined by the new Local Content and Government Procurement Authority.

Other government-controlled enterprises in Saudi Arabia are increasingly introducing local content requirements for foreign firms. Saudi Aramco's In-Kingdom Total Value Added (IKTVA) program, for example, strongly encourages the purchase of goods and services from a local supplier base and aims to double Saudi Aramco's percentage of locally manufactured energy-related goods and services to 70% by 2021. Since IKTVA's launch, Aramco's local content index has increased from 35% at the end of 2015 to 56% by end of 2020, said the statement.

III. PROJECTS

» REPDO PROJECTS

i. Round 1 - Sakaka

By the end of 2019, the 300 MW Sakaka project was connected to Kingdom's national grid. The project's commercial operation date initially planned for the end of 2019, was achieved in Q2 2020.

ii. Round 2

Having a combined total capacity of 1.47 GW for Categories A and B, project bids were submitted in early-2020. It was anticipated that the projects shall be awarded in Q4 2020. Firms are shortlisted and negotiations began with the offtaker. The table below shows the projects along with the lowest LCOEs for both categories.

Project	Capacity (MW)	Lowest LCOE Offers
Category B		
AlFaisalia Solar PV	600	Pending
Jeddah Solar PV	300	1.624 cent/kWh
Rabigh Solar PV	300	1.702 cent/KWh
Qurayyat Solar PV	200	1.783 cent/kWh
Category A		
Medina Solar PV	50	1.94 cent/kWh
Rafha Solar PV	20	3.487 cent/kWh

iii. Round 3

In early 2020, REPDO issued the RFQ for the four solar energy projects of Round 3, with a combined capacity of 1.2 GW. It was planned that an 850 MW wind project will also be launched, but this component was postponed to next round. Similar to Round 2 projects, the four solar projects were divided into two categories: smaller projects classified as category A and larger projects classified as category B. Furthermore, they will carry a minimum requirement of 18% of local content, up from 17% in Round 2.

Project	Capacity (MW)	Location
Category B		
Al-Rass Solar PV IPP	700	30km from Al-Rass city
SAAD Solar PV IPP	300	85km from Riyadh city
Category A		
Wadi ad-Dawasir Solar PV IPP	120	10km from Wadi ad-Dawasir
Layla Solar PV IPP	80	5km from Layla city

Despite challenges caused by COVID19, Saudi Arabia's energy ministry issued RFPs for round 3 of both categories A and B in Q2 2020, but with modified timeframe to submit proposals because of restrictions caused by the pandemic.

With 49 prequalified bidders and client visits to project sites in mid-2020, the tender closing date for Round 3 has recently been postponed to March 2021.

» PIF 2 GW SUDAIR SOLAR PROJECT

70% of the target capacity of 58.7 GW of the Kingdom by 2030 have been assigned to PIF, while REPDO will undertake competitive tendering for the remaining 30%. As the first solar scheme overseen by PIF in KSA, the Sudair PV project will be split into two 1 GW packages. MOUs have been signed with potential developers and EPCs. Finalization of negotiated project agreements for both packages was held up by COVID 19, and any attempt to renegotiate tariffs could see further delays.

» NEOM

Reflecting on the future, the $500 billion project shall grow and diversify Saudi's economy. Renewable energy is a key focus as part of NEOM and two key innovative projects have been initiated:

- The world's first solar dome desalination plant is set to be built in the megacity. It is claimed that the technology generates zero carbon emissions, produces less brine than facilities using conventional reverse osmosis technology and will reduce cost of processing drinking water compared to traditional plants.
- A $5 billion world-scale green hydrogen-based ammonia production facility powered by renewable energy will be built in NEOM. The facility will include innovative integration of over 4 GW of renewable power from solar, wind and storage. Hydrogen will be produced by electrolysis. It is anticipated that the facility will be operational in 2025 and green ammonia will be exported to global markets

» RED SEA MEGAPROJECT

In Q4, the Red Sea Development Company (TRSDC) awarded its highest-value contract to date to a consortium that will design, build, operate and transfer the Red Sea project's utilities infrastructure. This will include the provision of renewable power 9,650 MW, potable water, wastewater treatment, solid waste management and district cooling for phase 1 of the project.

Similarly, Megaprojects of Qiddiya should soon see selection of consortium for provision of utilities including solar PV source of energy.

» BATTERY STORAGE INITIATIVES

A new firm in KSA was formed to develop a battery production facility. To help the country achieve its objectives and targets for 2030 Vision, the firm aimed to start the construction of the manufacturing facility in 2020 with production expected to begin in 2021. Its annual production capacity will reach 3 GWh and manufacture energy storage systems for use alongside utility-scale renewables projects, telecom towers, mining sites, remote cities and off-grid locations.

IV. CHALLENGES AND OUTLOOK

No specific regulation has been developed for a renewable energy utility size project. Currently, electricity law and its implementing regulations, which apply to conventional power projects, also apply to renewable energy projects. The main issue remains the lack of complete and adequate framework for wheeling conditions for C&I projects. Not being able to feed into the grid excess production may impact the cost of decentralized solar solutions.

With the current Kingdom's goal of producing 50% of its electricity from renewable sources by 2030, Saudi is on track. The year continues to show that the country has firm targets and is accelerating its efforts to integrate greener solutions into its grid. The solar projects of Rounds 1 and 2 are almost awarded and in the next coming years, will lead to almost 3 GW of solar energy added to the grid.

With COVID19, some delays of projects and tenders occurred, but it is expected that the country will gradually return to its normal operations and resume its renewable energy developments. Solar components of some megaprojects, starting to be contracted, will contribute to it.

Finally, Saudi Arabia's decisive ambitions in hydrogen will trigger the development of additional solar energy production capacity in the future. A first major step is now engaged by NEOM, as described in the dedicated chapter on hydrogen. This trend will position Saudi Arabia as major player on the international green energy export market in the future.

J. TUNISIA

Total power capacity (2019)	6,155 MW
RE installed capacity	373 MW
RE target by 2030	4.2 GW

Source: IRENA

I. CURRENT SITUATION AND STRATEGY

Having only 3% of Tunisia's electricity generated from renewables, the country is increasing its efforts to diversify its energy mix. In its 2016 Renewable Energy Action Plan 2030, Tunisia targets an additional 3.8 GW capacity of renewables by 2030, representing 30% of the energy mix. The estimated investments required to realize those ambitions between 2016 and 2030 reaches around $5.5 billion.

II. UPDATES ON COUNTRY REGULATIONS

The country did not introduce any major changes of policies or regulations in 2020; however, concurrent views consider the need to establish an independent energy regulator.

III. PROJECTS

» PV PROJECTS

After two first rounds of solar tenders, respectively for 70 MW in 2017 and 60 MW in 2019, Tunisia launched two more rounds in 2020. Round 4 will, like Round 1 and 2, be split in small sizes projects of 1 MW to 10 MW.

i. Third Round: 500 MW Solar Tender

The Tunisian Ministry of Mines and Energy launched the 500 MW tender in 2018. After a long process, the project was awarded in early-2020. It includes a 200 MW solar plant in the province of Tatouine in the Sahara Desert, two 100 MW solar PV facilities in the provinces of Kaiouran and Gafsca and two 50 MW solar parks in the provinces of Sidi Bouzid and Tozeur. Contracts were signed with developers in 2020. Although the initial plan for Gafsca province was 100 MW, recent updates confirms that the plant will produce up to 120 MW of power.

ii. Fourth Round :70 MW Solar Tender

In October 2020, the Ministry of Mines and Energy invited firms to bid by the end of February 2021 for 16 solar PV projects for a total capacity of 70 MW. This includes six projects having 10 MW each and 10 projects totaling 1 MW each. The solar scheme is a part of the fourth round of the renewable energy program.

» PROJECTS BY HYDROCARBONS PLAYERS

Traditional hydrocarbons players are developing solar PV projects in partnership with Tunisian National Oil company and the Tunisian Company of Electricity and Gas (STEG) as the offtaker (e.g. in May 2019 the construction of a 10-MW a solar PV plant started near Tataouine).

IV. CHALLENGES AND OUTLOOK

According to IRENA, Tunisia REN developments are facing difficulties that could be overcome with improvements aiming to increase attractiveness of investors and lift the competitiveness of renewables in the country. Some recommendations include:

- Improving bankability of PPAs for renewable energy projects
- Supporting financial capabilities of local commercial banks
- Establishing an independent energy regulator

The economic outlook of Tunisia has also been impacted by COVID19. The EBRD expects Tunisian economic growth to contract to -2.5% in 2020, after it already declined to 1% in 2019. As a result, the unemployment rate in the country reached more than 15% in early 2020. Tunisia received $1.5 billion of international financial assistance funds and it is expected that 2021 could be a recovery year in which solar projects could resume.

K. UNITED ARAB EMIRATES

Total power capacity (2019)	30,979 MW
RE installed capacity	1,885 MW
RE target by 2050	Produce 50% of its energy

Source: IRENA

I. CURRENT SITUATION AND STRATEGY

The UAE has adopted exemplary long-term sustainability goals. The Energy Strategy 2050 aims to produce 50% of its energy targets from clean sources by investing AED 600 billion. Its energy mix would be composed of 44% renewable energy, 6% nuclear energy, 38% natural gas, and 12% from clean fossil energy. The country is successfully moving steadily towards these objectives.

The emirate of Dubai has already surpassed the previously set milestone for 2020 and has reached 9% of energy produced from renewable sources. Dubai aims to have the lowest carbon footprint in the world by 2050.

The total renewable energy capacity of the country, mainly solar, reached 1,885 MW by the end of 2019. Additional projects are in the pipeline. However, as a combined result of the health, oil and economic crisis, a slowdown in the launch of new projects occurred in 2020 in the UAE like in other countries of the region. Moreover, the decrease in electricity demand while large new solar PV parks and the first phase of nuclear power came online complexified the management of the grid. This situation may impose some revisiting of the planning and phasing of additional power capacities, at least for the short term as far as utility size projects are concerned. Uncertainty continues also to prevail of connection to the grid of corporate REN projects.

II. UPDATES ON COUNTRY POLICY FRAMEWORK AND REGULATIONS

- In July 2020, all public shares in Abu Dhabi's energy and water assets were transferred by Abu Dhabi Power Cooperation (ADPC) to TAQA, creating a vertically integrated utility (conventional and renewable energy production, transport and distribution). The Emirate's ambition is to turn Taqa into a major player in the international energy sector.
- In January 2020, the Dubai Electricity and Water Authority (DEWA) introduced changes to the Shams Dubai net metering scheme impacting distributed energy in the emirate. The announcement included changes in regulations to no longer include ground mounted solar projects under the scheme and a cap of 2.08 MW was set for rooftop installations, putting a hold on a number of projects for C&I and other institutions.

III. PROJECTS

UTILITY SIZE PROJECTS

» MOHAMMAD BIN RASHID SOLAR PARK

The largest single site solar park in the world will have a capacity of 5 GW. Phases 1,2 and 3 are already operational while the remaining phases are progressing. The solar park's full capacity shall be fully operational by 2030.

Phase 3

The 800 MW project was scheduled in three stages. The first stage of the project, 200 MW, has been operational since 2018. After some delays, phase 2 and 3, of 300 MW each, were inaugurated in November 2020.

Phase 4

In 2019, the fourth phase of the solar park was ahead of schedule. Construction is still in progress to produce the largest single-site concentrated solar power (CSP) project in the world. In mid-2020, DEWA announced that it will start the commissioning stage in Q3 2021. The project broke many world records including the lowest LCOE of $0.073 per kW/h for CSP and $0.024 per kW/h for 250 MW PV panels.

Phase 5

The 900 MW solar project was tendered in 2019. It witnessed the lowest tariff ever at that time, in 2019, $0.01693 per kWh. In 2020, the project was awarded. The fifth phase is supposed to be operational in Q2 2021. Financial close was reached in Q3 2020.

» AL DHAFRA SOLAR PLANT

In 2019, Emirates Water and Electricity Company (EWEC) tendered a 2 GW solar plant. The project was awarded in mid-2020 to the lowest bid of $0.0135 per kWh. Financial closure of the project was reached in December 2020. The Al Dhafra plant is expected to produce power in the H2 2022. Once in operation, the plant is expected to reduce Abu Dhabi's CO2 emissions by more than 2.4 million metric tons per year.

» UMM AL QUWAIN SOLAR PARK

In January 2020, the Federal Electricity and Water Authority (FEWA) invited companies to submit expressions of interest to develop a 500 MW solar PV power plant in Umm Al Quwain. The project will be developed under a IPP scheme and will be the first of its kind to be implemented in the Northern Emirates.

» FLOATING PV SOLAR

In Abu Dhabi, the first near shore open sea FPV project achieved commercial operations in February 2020 at Nuria Island. The 80-kW project was built to reduce the cost and environmental impact of the power generation on the island. Work in progress for two additional versions of the structure for rougher sea conditions shall be deployed.

» SOLAR ROOFTOP - SHAMS DUBAI

Shams Dubai continues to grow gradually every year increasing the amount of installed solar rooftop capacity. By the end of 2019 a total of 5,620 solar installations were connected to DEWA's grid, totaling 164.2 MW. The latest updates on the net metering scheme produced by DEWA, however, stopped some projects from being executed as of early-2020.

» INNOVATIVE PROJECT

Dubai inaugurated the region's first freehold green building in early-2020. The residential building has 440 PV panels spread over a surface area of 9,300 square feet with a capacity of 100 kWh.

» SOLAR ROOFTOP IN ABU DHABI

Miral, Abu Dhabi's leading curator of experiences, launched in November 2020 the realization of Abu Dhabi's largest rooftop solar photovoltaic (PV) project to date at Warner Bros theme park in Abu Dhabi's Yas Island. The project will include approximatively 16,000 solar modules across 36,000 square meters of roof of the theme park for a total peak capacity of 7 MW. It should be able to provide nearly 40% of its annual energy demand of the park.

The project is scheduled to be operational in Q4 2021, and once complete, Warner Bros World Abu Dhabi will become the largest solar-powered theme park in the GCC.

» RAS AL KHAIMAH DISTRIBUTED SOLAR PROJECT

In 2020, the Energy Efficiency and Renewables Office (REEM) of Ras Al Khaimah Municipality launched its first 15 MW solar distributed solar project. Contracts shall be signed in 2021 to start operations in 2022, to be executed in multiple locations in the emirate. The municipality prequalified 20 companies in December 2020.

» HYDROGEN AMBITIONS

The country's Ministry of Energy is currently working on a strategy for hydrogen. As described in the dedicated chapter on hydrogen, in the present report, pilot projects are engaged in Dubai by Dewa and in Abu Dhabi by Masdar, several years focus on R&D have raised awareness and TAQA is looking at green hydrogen options.

A recent declaration of HH Mohammed Bin Zayed Al Nahyan, Crown Prince of Abu Dhabi, indicated increased interest in development of green hydrogen, followed by similar declaration of the ADNOC CEO, HE Dr. Sultan Al Jaber, also serving as the Minister of Industry and Advanced Technology. Potential for exporting solar energy may spur with the engagement of such projects. It is also noticeable that the UAE is looking at green hydrogen as a mean to decarbonize end use such as transport.

IV. CHALLENGES AND OUTLOOK

Tackling the integration of the energy mix into the grid is a growing challenge that is currently the focus of the country. While additional important power is coming online with the first nuclear reactor of Barakah that has started production and the input of additional solar from latest Dubai and Abu Dhabi projects, the slowdown of demand for electricity triggered by the health, oil and economic crisis have put this issue at the forefront.

This situation may induce some pause in the immediate launch of new large utility size solar project, unless strong economic recovery or new delays of electricity from nuclear sources are imposed to resume faster the launch of additional capacity. Emerging green hydrogen may also be the next steppingstone for engaging ambitious solar projects and will most certainly offer new perspective for the industry in the decade to come.

The UAE is on the frontline in the energy transition with the highest portfolio of renewables in the region. The country integrated FPV for the first time in 2020. It is considering engagement in the development of green hydrogen. The efforts put into driving the country towards the 2050 energy and climate change goals and targets are on track.

In this context, the competition will stay fierce in a country that has achieved world records in its integration of renewables and spearheaded the decrease of solar prices, demonstrating its competitiveness.

As indicated earlier, balancing the grid will stay an important issue but flexible planning, increased digitalization and new storage solutions may help the country to face this challenge.

10. »

CONCLUSION

Countries in the MENA region are executing the planned strategies to diversify their economies and transition towards cleaner energy. Renewable projects and particularly solar projects have grown significantly in 2020, despite the slowdown of tenders due to COVID 19. With the decrease of solar prices, solar is becoming increasingly competitive and the launch of new projects is expected to resume in 2021.

Utility scale storage projects are still in a limited number. However, battery storage prices, lithium-ion batteries in particular, are expected to further decrease, facilitating the management of intermittency and allowing larger inputs of electricity from solar sources into the grid. Combined PV and CSP projects, e.g., developed in Morocco, could also pave the way to overcome intermittency.

The industry can expect distributed energy and the C&I market to further pick up. In 2020, despite COVID 19 challenges, this bracket of the MENA region's solar market has continued to grow. Regulatory framework for C&I still needs improvements. Currently, rooftop projects are contained at limited power capacities and countries such as Egypt and KSA have clarified net metering conditions. Wheeling still needs to be more largely authorized in the MENA region. With the development of improved digitalized grid management tools, regulations could become more flexible.

In the framework of the countries NDC's and clean energy objectives will continue to be the main driver in the MENA region.

Utility scale projects and clean energy objectives will continue to be the main drivers in the MENA region. In countries such as KSA sustainable megaprojects will bring additional impetus.

Meanwhile, 2020 has seen the emergence of renewable clean hydrogen projects in the region, offering long-term opportunities to the MENA countries to:

- Integrate larger shares of renewable and solar energy into the grid,
- Export renewable energy to third countries in Asia, Europe and Australia,
- Accelerate the reduction of GHG emissions from sectors which are often the most difficult to decarbonize (transport, oil and gas, steel, mining..).

Over the long run, with the rise of Hydrogen, solar resources of MENA regions may well end up rapidly playing the role that oil and gas have played in the international energy market for the last decades and trigger the development of more large utility scale solar power plants.

160MW Noor 1 CSP complex - Morocco
Courtesy - ACWA Power pictures archives

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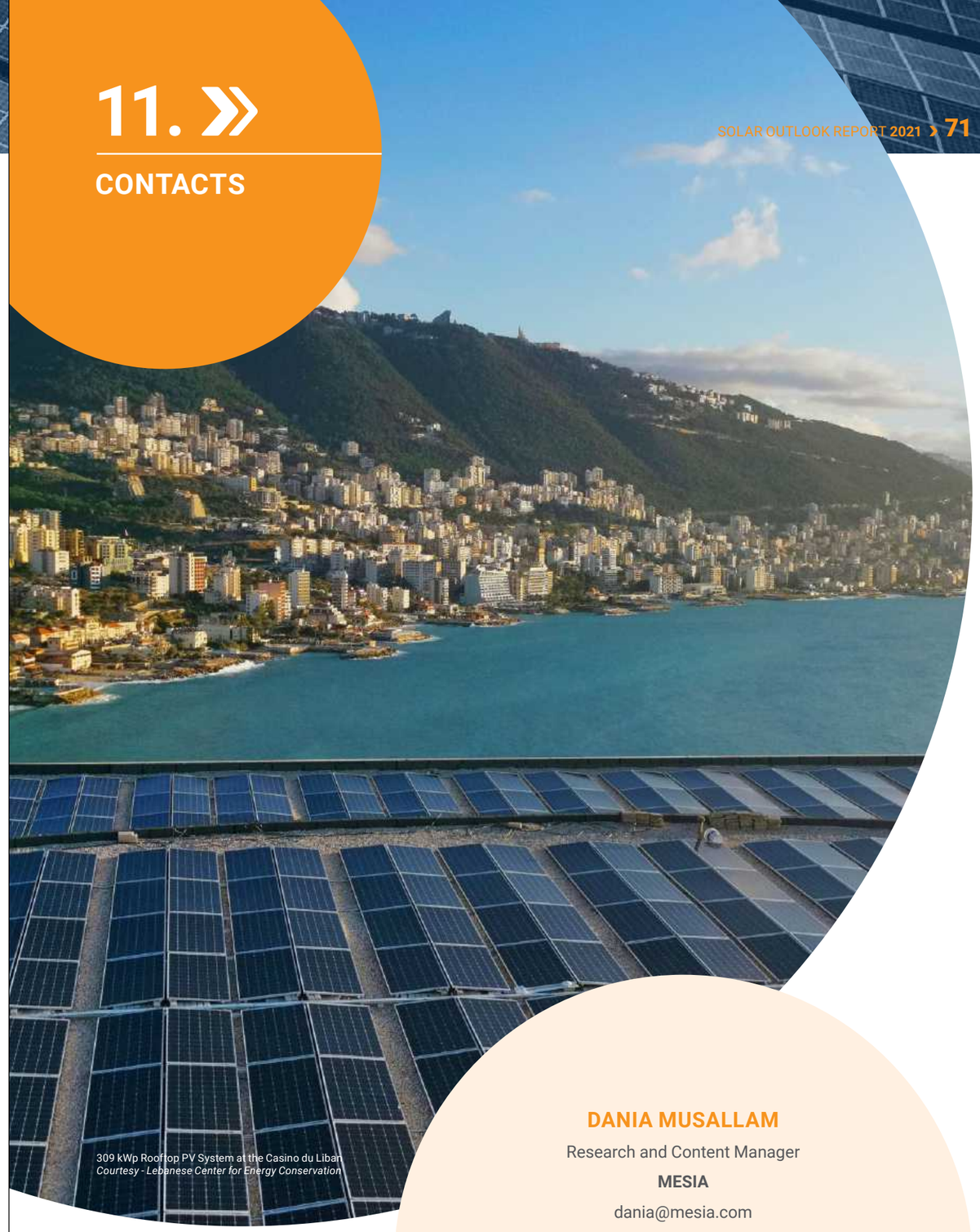
CONTACTS



309 kWp Rooftop PV System at the Casino du Liban
Courtesy - Lebanese Center for Energy Conservation

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GLOSSARY OF TERMS

ADNOC	Abu Dhabi National Oil Company
ADPC	Abu Dhabi Department of Energy
ADWEA	Abu Dhabi Water & Electricity Authority
AER	Authority for Electricity Regulation
APICORP	Arab Petroleum Investments Corporation
BESS	Battery Energy Storage System
BIPV	Building Integrated Photovoltaics
BNEF	Bloomberg New Energy Finance
BOO	Build Own and Operate
C&I	Commercial and Industrial
CEREFE	Commissariat aux Energies Renouvelables et à l'Efficacité Energétique
CPN	Cost Priority Number
CREG	Algerian Electricity and Gas Regulation Commission
CSP	Concentrated Solar Power
DEWA	Dubai Electricity and Water Authority
DFI	Development Finance Institution
DNI	Direct Normal Irradiance
DSM	Demand Side Management
EBRD	European Bank for Reconstruction and Development
ECRA	Electricity Co-generation Regulatory Authority
EDO	Energy Development Oman
EEHC	Egyptian Electricity Holding Company
EETC	Egyptian Electricity Transmission Company
EOI	Expression of Interest
EPC	Engineering, Procurement and Construction
ERA	Electricity Regulatory Authority
ESCOs	Energy Services Companies
EWEC	Emirates Water and Electricity Company
FCEV	Fuel Cell Electric Vehicles
FEWA	Federal Electricity and Water Authority
FIT	Feed-in-Tariff
FPV	Floating Solar PV
FY	Fiscal Year
GCC	Gulf Cooperation Council
GDP	Gross Domestic Product
GEF	Global Environment Fund
GHI	Global Horizontal Irradiance
HIJ	Heterojunction
HVRT	High Voltage Ride Through
IDECO	Irbid District Electricity Company
IEA	International Energy Agency
IKTVA	In-Kingdom Total Value Added
IPP	Independent Power Producer
IRENA	International Renewable Energy Agency

IRESEN	Institute for Research in Solar Energy and New Energy
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
JIP	Joint Industry Project
JREEEF	Jordan Renewable Energy and Energy Efficiency Fund
KACARE	King Abdullah City for Atomic and Renewable Energy
KAPP	Kuwait Authority for Partnership Projects
KFSA	Kuwait Society for Science Advancement
LCOE	Levelized Cost of Electricity
LID	Light Induced Degradation
LVRT	Low Voltage Ride Through
MASEN	Moroccan Agency for Sustainable Energy
MEMR	Ministry of Energy & Mineral Resources
MENA	Middle East and North Africa
MIGA	Multilateral Investment Guarantee Agency
ML	Machine Learning
MM	Mitigation Measures
MOEI	UAE Ministry of Energy and Infrastructure
MOEIMR	Industry and Mineral Resources
MoU	Memorandum of Understanding
NEEAP	National Energy Efficiency Action Plan
NREA	New and Renewable Energy Authority
NREAP	National Renewable Energy Action Plan
NREP	National Renewable Energy Program
O&M	Operation and Maintenance
OPWP	Oman Power and Water Procurement Company
PDO	Petroleum Development Oman
PID	Potential Induced Degradation
PIF	Public Investment Fund
PPA	Power Purchase Agreements
PPP	Public-Private Partnership
PV	Photovoltaics
R&D	Research and Development
REN	Renewable Energy
REEM	Energy Efficiency and Renewables Office
REPDO	Renewable Energy Project Development Office
RFP	Request for Proposal
RFQ	Request for Qualification
RoI	Return on Investment
RP	Recommended Practice
SCP	Supreme Committee for Planning
SEA	Sustainable Energy Authority
SME	Small and Medium-sized Enterprises
TLC	Technology Localization & Commercialization
TRSDC	The Red Sea Development Company
UNDP	United Nations Development Program
VRE	Variable Renewable Energy

13. »

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Al Jalila Cultural Centre for Children PV Project
Courtesy – Enerwhere

Nestlé Middle East Manufacturing "Al Maha" Factory Solar Plant, UAE
Credit: Nestlé Middle East & North Africa

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