

# SOLAR OUTLOOK REPORT 2020

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JANUARY  
2020

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## TABLE OF CONTENTS

Foreword	04
1 Introduction	06
2 Investment in Renewable Energy	08
3 Solar Trends 2019 - 2021	11
4 Solar Projects 2019 - 2021	21
5 Energy Storage	25
6 Highlights in MENA's Leading Solar PV Markets	32
A. Algeria	32
B. Bahrain	34
C. Egypt	35
D. Jordan	38
E. Kuwait	41
F. Morocco	44
G. Oman	46
H. Pakistan	48
I. Saudi Arabia	51
J. Tunisia	55
K. United Arab Emirates	57
L. Iraq	60
7 Conclusion	61
8 Glossary of Terms	63



## FOREWORD



**Martine Mamlouk**  
General Secretary of MESIA

The Middle East and North Africa saw 2019 again confirm the growth and importance of solar power in the region's energy landscape. Leading countries of the region are steadily commissioning large projects and launching additional phases of their renewable energy and solar programs (Morocco, Egypt and the UAE) and other countries of the region are coming on board. Projects in the pipeline are now tendered in Oman, Kuwait, Tunisia and countries like Pakistan and Iraq are engaging their first large utility size projects.

Figures illustrate this trend: According to Frost and Sullivan, the value of solar projects that are currently operational in the region is estimated at \$ 5 billion to \$ 7.5 billion and the total value of projects expected to come online by 2024 at \$15 billion to \$ 20 billion. APICORP values the total investment in renewables in MENA between 2019-2023 at 34% of the total investment in the power sector (USD 210 billion) which amounts to an estimated USD 71.4 billion.

### Solar energy is spreading beyond utility scale projects

Even when large utility size projects may still be limited, demand for rooftop and decentralized projects for commercial, industry and residential is picking up. In countries where electricity access, renewable energy is more and more favored over conventional fuel generators. A decrease of subsidies is furthering this movement as well as adoption of regulatory frameworks.

Moreover, solar energy for the end user is spreading with integration in buildings, desalination and district using renewable energy, and clean transportation are engaging in this transition, opening the door to new market opportunities for the solar industry.

### Increasing competitiveness and innovation

The MESIA 2020 Outlook shows how these trends are spreading throughout the MENA region, supported by further decline of levelized cost of solar electricity (LCOE), making grid parity a reality in many places. The continuous and significant drop of costs of solar panels is one of many factors that have contributed to reducing CAPEX for both utility scale and distributed solar projects.

Advances in technology is leading. New solution, including e.g. bifacial modules, half-cut cells, heterojunction cells and organic thin film as well as improved robotic cleaning are introduced. New fields are also being explored such as floating PV. More efficient CSP is tested.

Finally, easing of global financial conditions has continued to play an important role as access to low cost capital has helped offering of low solar prices. This may not last. but one can expect that in the long run, solar industry financing will also be supported by an increase in green financing solutions, green bonds or sukuk, as well as cryptocurrencies.

### The increasing share of renewable energy and solar in the energy mix raises new challenges

In order to trigger full deployment of solar potentials of the region, more favorable regulatory frameworks and removal of fossil fuel subsidies remain necessary. Diffusion of rules of local content are challenging companies. Underlining the need to fully integrate the development of solar capacity in the pursuit of economic diversification, industrialization and employment of the countries of the region. Clarity of conditions and open dialogue between authorities and the private sector will be necessary to support further investment in the sector.

The main challenge will be grid stability and flexibility as more renewable energy projects come online. New interaction between traditional energy providers and consumers will complicate this issue further: Jordan has halted its program to assess the impact of integration of additional renewable based electricity to the grid Abu Dhabi has established a new interactive planning tool to better handle this problem.

Solar PV projects plus storage, combination of PV and CSP storage are coming up as highlighted by report and grid parity is not far. Further R&D into energy storage will help.

### New Solutions are at Reach

**High level AI** opens a wide range of new opportunities: digitalization and artificial intelligence (AI) are on the top of the agenda to devise improved smart demand response, smart EV charging, more distributed energy and, according to IEA, should " reduce curtailment of solar photovoltaics (PV) and wind power from 7% to 1.6% in 2040, avoiding 30 M T of carbon dioxide emissions in 2040".

They can also foster efficiency of plants, e.g. use of precise data management and software to align a large array of mirrors extremely accurately to reflect sunlight on to a single target will allow concentrated solar energy to exceed 1,500°C. Thus, this advanced technology, will allow larger application of CSP for industries, green hydrogen or syngas.

**Green Hydrogen** may be the next major breakthrough for large and long-term storage and to enable full use of enormous potentials for the region to export clean energy to countries less blessed with solar resources.

### Increased engagement in carbon pricing and carbon market

With more and more interest of the industry and consideration by countries like Saudi Arabia (cf. the recent announcement of His Highness, Prince Abdul-Aziz Bin Salman, Minister of Energy of KSA) these mechanisms may become in the long run an important game changer that can only benefit the deployment of solar energy.

As the world struggles to implement all the engagement of the Paris treaty, the industry is bringing increasingly technical, environmentally friendly innovative and viable competitive solutions that will be carried and spread via the market. The effort requires however pro-active and inventive collaboration between governments, public sector and private companies. PPP are key for funding in many cases while working on a friendly regulatory framework should be on the top of the agenda to support that trend.

A special word of thanks to our MESIA members who were instrumental in helping to bring this report to fruition – in particular to Alex and Mathieu. And last though certainly not least, our MESIA team, Dania, who was essential in this endeavor, and Micheline for her guidance throughout this process.



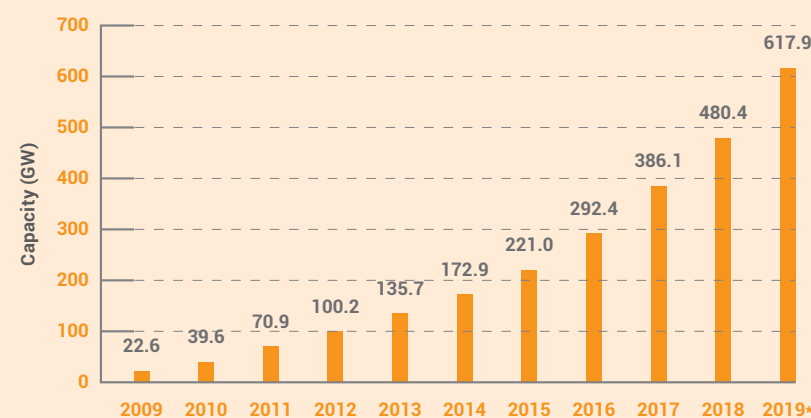
## 1. Introduction

Renewable energy has been growing significantly over the past 12 months. This trend will continue to increase as solar power prices reach grid parity. In 2019, the global estimated additions of solar photovoltaic (PV) reached almost 133 GW (Figure 1). Within the Middle East and North Africa (MENA) region, the increased industrial activity and drive towards renewables is reflected in each country's strategy. Continuous population growth and economic development has placed pressure on existing power assets and in some cases, created a significant gap between electricity production and demand. Affordable renewable energies in the region – mainly solar – have become an obvious solution.

**As MENA countries move towards achieving their respective renewable energy targets, major highlights from 2019 include:**

- UAE: Noor Energy Solar Park, in the Emirate of Abu Dhabi, at Sweihan entered commercial operation in mid-2019 with 1.17 GW. The US\$-871 million project has more as 3.2 million panels and provides power for 90,000 people. In addition, a second large project of 2GW of PV at Al Dhafra has been tendered in 2019 and a third project of 2GW is planned by Abu Dhabi tender in 2020.

GLOBAL SOLAR PV CAPACITY, 2009 - 2019



\*Estimates based on data obtained through multiple sources

Figure 1: Global Solar PV Capacity (Source: IRENA, IEA, PowerWeb, Frost & Sullivan)

- In Dubai, a 900MW PV IPP project in the Mohammed Bin Rashid Al Maktoum Solar Park was awarded at a world record low bid of \$0.0169 per kWh, in October 2019. It will constitute the fifth phase of the total planned 5GW of the Park at Al Maktoum Solar Park.
- In Egypt, main components of Benban Park have been completed with 1.4GW commissioned and a first contract for 200MW in Kom Ombo allocated.
- Low tariffs were achieved in Tunisia's 200 MW Tatatouine solar PV project with a price of \$0.0244 per kWh as well as Egypt's Kom Ombo 200 MW PV project at \$0.02752 per kWh.
- KSA: The 300MW Sakaka solar PV plant, the largest of KSA to date, was brought online in November. In addition, the Renewable Energy Project Development Office (REPDO) invited 60 prequalified companies to bid for six solar energy schemes with a combined capacity of 1.5 GW. Another six projects are expected to be tendered in early-2020.
- The tender of Noor Midelt 1 Hybrid Solar Plant project (800 MW) – in Morocco broke the world price record of \$0.071 cents per kWh at peak hour.
- Oman engaged the tendering process of two additional phases, of 500 MW solar PV each.
- In Tunisia, 500MW were allocated, in December 2019, to three consortiums respectively for 300 MW, 100 MW and 100 MW, with lowest bid at \$2,5 cents /kWh.
- In Jordan, the government is studying how the grid could be able to absorb more renewable energy projects halting new grid connection licenses above 1 MW.
- Pakistan is moving ahead with a more decisive policy and objectives of 30% of renewables (excluding hydro) in 2030.
- Iraq has fixed first objectives of renewable energy of 10% and interest for distributed renewable energy is on surge with increasing recent electricity shortages.
- The region's C&I market is picking up as fossil fuel subsidies decrease in several countries and regulatory frameworks are progressively put in place.
- Huge gaps remain between MENA countries. Egypt, Jordan, Morocco and the UAE are the main leaders in solar development and KSA is about to join them.

As renewable energy increases, grid capacity and stability challenges underline the importance of adequate storage solutions. CSP, PV and storage solutions are starting to enter the MENA region as seen in Morocco and the UAE supported by declining prices.

## MESIA Solar Outlook Report 2020

### ► Standard Series

Standard Modules

### ► HiPerforma Series

Bifacial Double Glass Modules

### ► HiPower Series

High Power Modules

### ► HiDigital Series

Smart Modules

### ► HiSpec Series

Lightweight Modules





## 2. Investment in Renewable Energy

The total corporate funding in the global solar sector saw an 11% increase year-on-year at \$109.4 billion in the first half of 2019. More than \$2.6 trillion has been invested in renewable energy over the past decade.

Global solar power capacity increased by more than 25 times in this decade, from 25 GW at the beginning of 2010 to 617.9 GW anticipated by the end of 2019. Overall investment in the MENA energy sector could reach \$1 trillion between 2019 and 2023, with the power sector accounting for the largest share of the spending at 36%.

As the unit rate for solar energy investment is reducing year-on-year, a decrease in capital does not represent a slowdown in the industry (Figure 2). Instead, this indicates the price decline in renewable energy technologies as the amount of gigawatts installs remain high.

### GLOBAL INVESTMENT IN RENEWABLE ENERGY (USD BILLION)

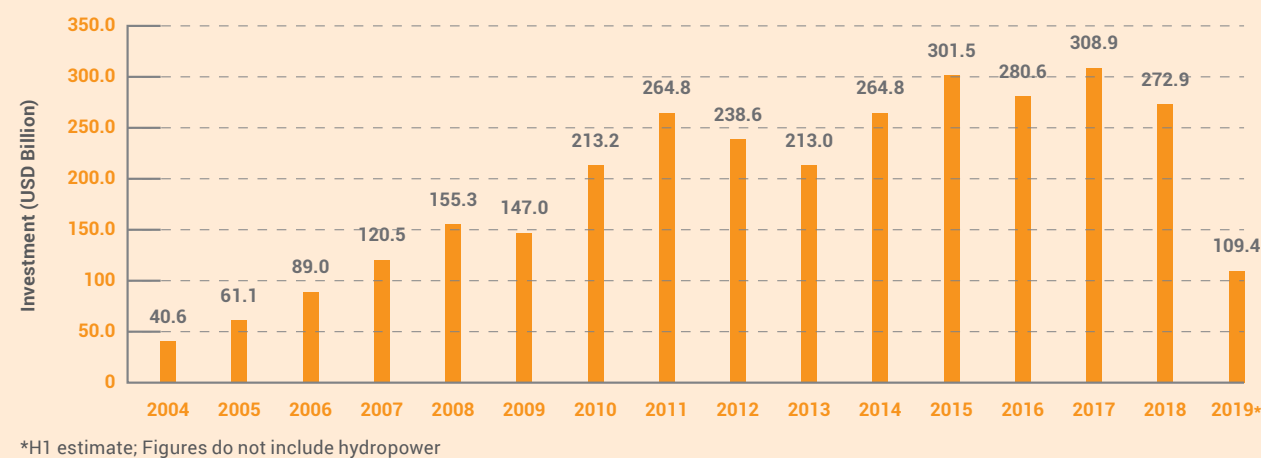


Figure 2: Global Investment in Renewable Energy (Source: IRENA, BNEF, Frankfurt School, UNEP and Frost & Sullivan)

## DEVELOPMENT FINANCE INSTITUTIONS

Investment from Development Finance Institutions (DFIs) showed signs of stalling in 2018 compared to 2017. This is mostly due to a smaller number of eligible projects in the region, yet DFI funding remains substantial. Figures for

first half of 2019 indicate that a number of large projects had not yet reached financial closure. Thus, DFIs only financed some smaller projects. It should be noted that DFI's financing is often channeled through credit lines

given to local banks, and that DFIs have launched and continued a large number of support projects to help governments tender or develop solar plants.

## INVESTMENT PRIORITIES

### Storage Solutions

The stationary battery storage market size will surpass \$170 billion by 2030, according to Global Market Insights. Energy storage systems are also growing in interest across the GCC as they form a crucial component to enable grid flexibility. In addition to the growing share of intermittent sources of energy, industrialization across the emerging economies and increasing demand for energy storage systems will stimulate the stationary battery storage market growth.

### CSP Investments

More cost-effective technologies and project bankability will play an important role to further CSP investment; however, the takeoff may take some time. CSP requires more innovation, such as plant configuration, hybridization parameters and use of artificial intelligence.

### Grid Interconnectivities

The GCC countries' grid inter-connectivity is expected to generate US\$ 33 billion in investments, economic and energy savings over the next 25 years. At country level, Jordan's investment in the Green Corridor project is keen for the development of its renewable energy capacities.

## RENEWABLE ENERGY INVESTMENT CHALLENGES



**Investment in commercial-scale solar development in the MENA region faces a number of challenges but also opportunities. Though challenges vary in each market, the main issues include:**

- **Grid parity** – when renewables are competing with heavily subsidized fossil fuel generation assets.
- **Policy and legislation** – most markets require government support to encourage the adoption of solar energy. In addition to setting high renewable energy targets, stable tariff regimes, clear permitting rules, net metering, wheeling and grid connection conditions are required. Incentives, such as

rebates to switch to solar energy, may play an important role in some countries. An example of this can be seen in the UAE as Dubai's regulatory framework has helped reduce costs, increased project design optimizations and provided a bankable procurement process. At global level, IRENA's work on project standardization aims to foster such approach.

- **Awareness** – in some markets, solar is still a relatively new concept so educational and informational campaigns are needed.
- **Training** – there is a shortage of required skills to meet the demand. Partnerships and collaboration with high schools,

trade schools and universities are growing. The industry can play a major role in supporting the development of training and fostering local talent which will play a key role to increase the solar industry throughout the region.

- **Finance** – as the region's renewable energy market matures, lenders use progressive financing mechanisms, such as soft short-term loans which can encourage developers to refinance after a set time, to lower lending costs.



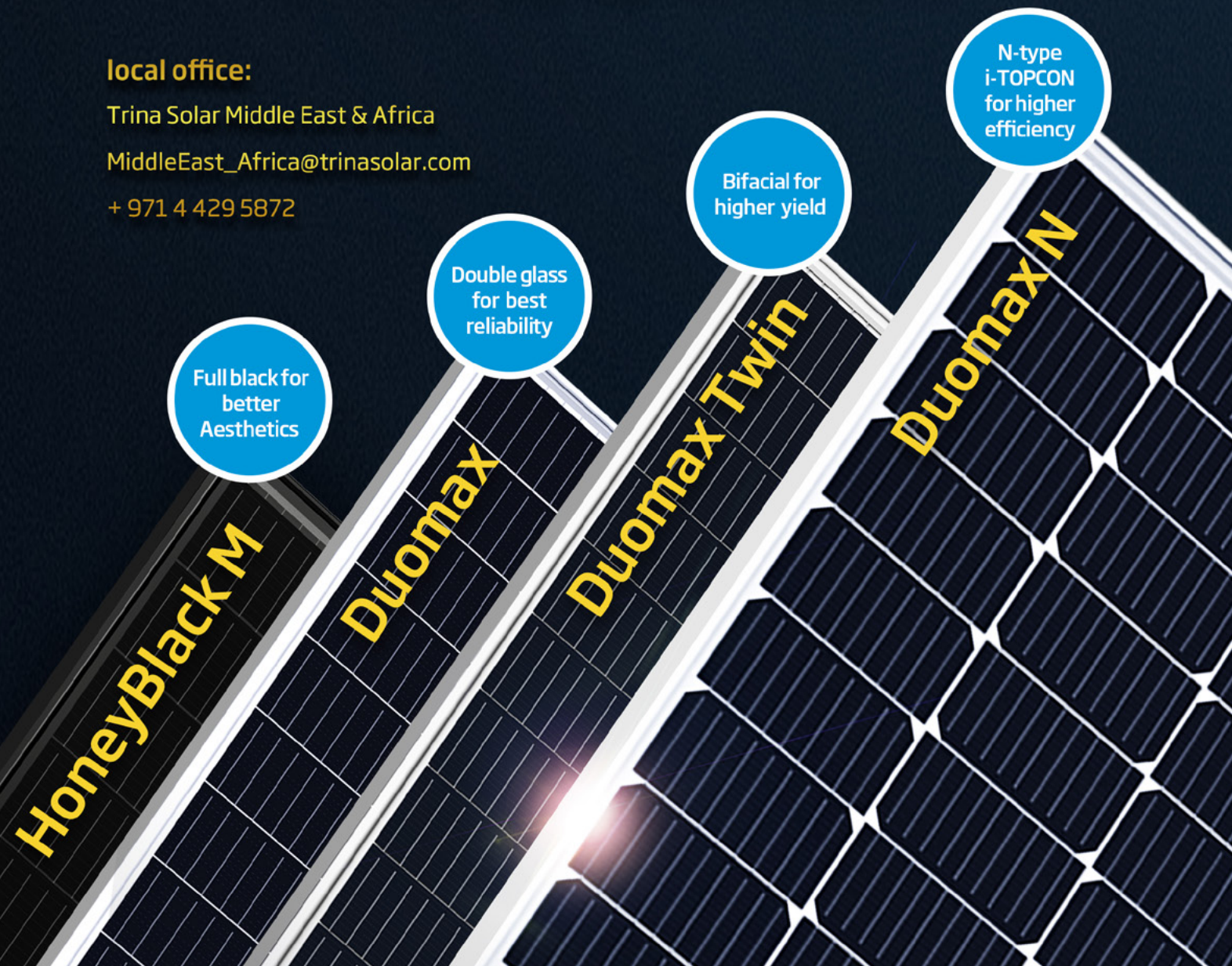
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## 3. Solar Trends 2019 – 2021

### 3.1 DECREASE IN SOLAR PRICES

Most recently, Dubai's 900 MW solar tender hit another low-price record with \$0.0169 per kWh.

The continuous drop in costs for solar panels is one of the factors that have contributed to reducing CAPEX of utility scale projects. It is important to note that the reference prices for solar electricity usually refer to utility-scale ground-mounted solar; however, the decrease of panel prices has also contributed to make rooftop solar a more viable option for businesses.

Figure 3 shows how solar price has sharply declined parallel to a significant increase in solar auctioned capacity.

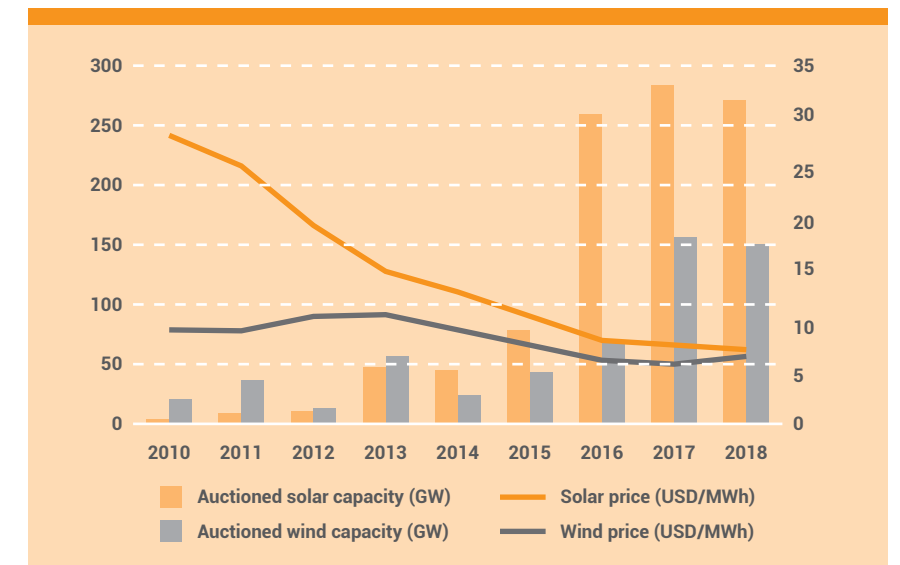


Figure 3: Global Average Prices Resulting from Auctions, 2010-18, (Source: IRENA)

An important factor driving down panel prices over the past two years is China's decision to restrict its own domestic demand. This led to Chinese panel manufacturers to increase offerings to foreign markets, particularly in the Middle East.

### 3.2 GROWTH IN ENERGY STORAGE SOLUTIONS

Many MENA countries are looking to energy storage. The niche market of storage solutions evolved, and its competitiveness increased. So far, molten salt is used both as a heat transfer fluid (HTF) as well as a thermal energy storage medium. Similarly, lithium batteries' efficiency properties are still the best compared to many substitutes entering the market (see Section 5 for more in depth information). Ongoing R&D is looking at reducing levelized cost of electricity (LCOE) through the use of a thermal storage medium that is capable of a wider temperature range than molten salts – the current state of the art storage fluid used in tower CSP. Hydrogen as a storage solution is also an up and coming technology. It should be noted that first compressed air energy storage projects are also being launched.



### 3.3 CELLS AND MODULES

#### 3.3.1 HIGH EFFICIENCY BI-FACIAL MODULES

High output modules, called bi-facial, are offering high efficacy modules in the market. They are expected to take a large share in the market, particularly in utility scale projects.

Bifacial modules use both its front and rear side of the solar panel. The ground reflectivity, also called as albedo effect, increases energy generation. Different ground surfaces affect the level of efficiency of modules. As a result, the design of bi-facial solar PV plants tries to ensure minimum shading to benefit from the rear side of modules. Power generation gains can be more than 25%, helping to optimize LCOEs.

Bifacial technology is expected to increase in the region and has already been implemented in Egypt's solar park in Benban.

#### 3.3.2 HALF CUT CELLS

Manufacturers now offer modules with half-cut cells. Half-cell modules offer lower resistance losses and improved shading performance. This technology also has the potential to improve reliability as the operating current of each cell is reduced by 50% and mechanical failures risks decrease due to the smaller size of each cell. Hence, half-cell modules could provide improved energy yield and reliability across the MENA region.

#### 3.3.3 PEROVSKITE SOLAR CELLS

Perovskite solar cells can absorb light more efficiently than silicon cells, allowing them to be extremely thin. They are flexible, semi-transparent and lightweight. The transparency allows the installation of solar panels in farmlands and remote locations. Perovskites solar cells have reached efficiencies of 27.3% in labs but have not yet resulted in stable market products. Current challenges include toxicity, stability and lifespan issues due to sensitivity to air and moisture.

#### 3.3.4 HETEROJUNCTION CELLS

Several manufacturers offer heterojunction modules or heterojunction with Intrinsic Thin-layer (HIT) cells. These modules generally utilize N-type cells that offer improved thermal coefficients for a greater energy yield at higher operating temperatures.

#### 3.3.5 GALLIUM ARSENIDE (GAAS) SOLAR CELLS

GaAs solar cells are already showing better results than silicon cells used in PV panels. However, Gallium Arsenide is a more expensive semiconductor material often used for space technologies. However, GaAs solar cells are considered very efficient. Researchers at National Renewable Energy Laboratory (NREL) believe that GaAs solar cells could reach an efficiency up to almost 30% and does not lose efficiency when operating at high temperatures. Their flexibility, lightweight and good low light performance make them an attractive technology.

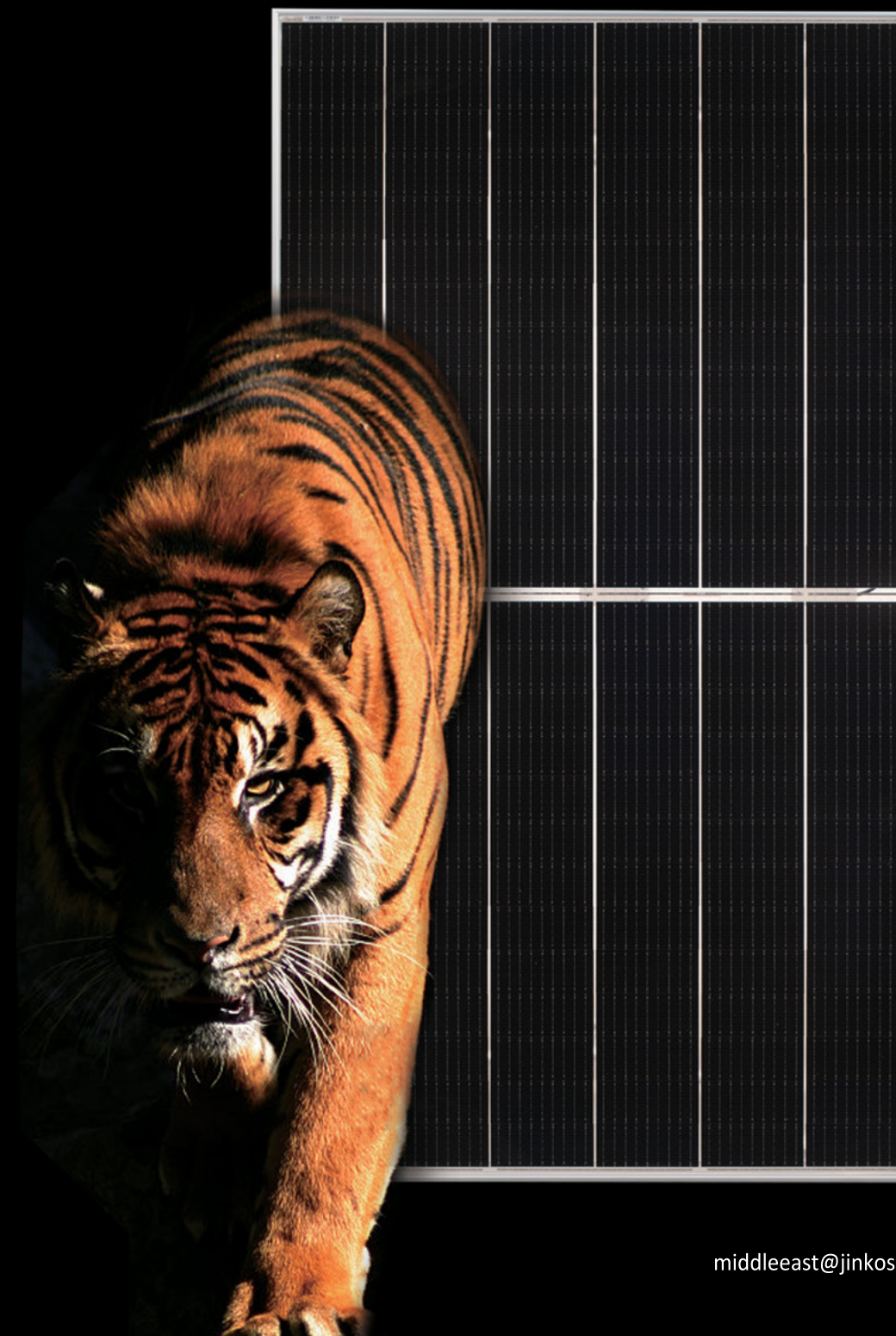
#### 3.3.6 OTHER NEW EXPLORED TECHNOLOGIES

Other technologies being considered include shingling, N-type and multi-busbar (MBB) modules. Improved performance and reliability are important, but these other technologies are still being explored and require to be developed further.

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### 3.4 NEW FIELDS OF ACTION

#### 3.4.1 FLOATING SOLAR

Floating PV arrays are mounted on platforms in the water instead of rooftops or land-based areas. This opens new avenues to increase solar power installations in the MENA region. They allow the conservation of land for other purposes than power generation and bring several advantages:

- Designing in a unique structure by providing self-buoyant bodies for PV panels to be directly affixed at tilted angles
- Reducing CAPEX due to limited

site preparation and construction work

- Reducing OPEX as a result of minimal cleaning
- Positive impact on the environment by reducing water evaporation as solar panels cover the surface of water curtailing algae growth, improving water quality

Floating solar panel installation is still an emerging industry. Existing projects are mainly installed in

hydro plants, water reservoirs or lakes and a few on the sea.

Despite advantages of floating PV, environmental concerns, such as possible habitat loss resulting from blocked light, and risks, in particular for materials in highly salted water, remain and need to be further studied.

Currently, the Dubai Electricity and Water Authority (DEWA) has developed a feasibility study for the implementation of such a project in the UAE.

#### 3.4.2 DEVELOPMENT OF BUILDING INTEGRATED PHOTOVOLTAICS (BIPV)

Building Integrated PV (BIPV) could be implemented with the use of organic PV or concrete PV cladding. However, BIPV applications are still developing in the MENA region with very few installations. Distributed generation across residential and especially commercial establishments is a key target segment for BIPV. As such, development of regulation and policy around distributed generation, net metering and grid feedback will be key for the success of the technology in the region. Subsidy reform is also a key factor that could define the level of adoption of distributed generation projects and technologies like BIPV in the region.

#### 3.4.3 ORGANIC THIN-FILM PHOTOVOLTAICS

Thin-film cells are formed by depositing extremely thin layers of PV semiconductor materials onto a support material such as glass, stainless steel or plastic. According to the International Energy Agency (IEA), thin-film modules used to have lower conversion efficiencies than basic crystalline silicon technologies. However, this has changed in recent years and now the technology has the potential to be less expensive to manufacture than crystalline cells.

Organic thin film PV is still a relatively new PV technology since it follows a dramatically different approach by using organic absorber layers of less than a micrometer. This leads to

high flexibility, ultra-low weight and an ultra-thin solar solution. OPV solutions provide unique characteristics and are suitable for:

- Non-straight surface application (curved rooftops)
- Buildings with low static characteristics (old buildings, light weight industrial buildings) integration into building materials because of its thickness
- Flexibility and lightness, such as tiles, rooftop materials, metal, membranes, glass, etc.

The biggest challenge to this technology is transforming from R&D to a competitive market

product in terms of performance, reliability and cost. Since OPV is a revolutionary product, it will require a lot of pioneer work in terms of education and training users, installers, projects partners, engineers, etc.

Currently, R&D is focused around three key topics of improvement: enhancing efficiency, reliability over lifetime and increasing cost competitiveness.

OPV projects are expected to be launched in the MENA region mid- to end-2020, latest by 2021. Diamond Developers are presently experimenting OPV for some installation at Sustainable city in Dubai.

#### 3.4.4 ROBOTIC CLEANING

Due to soiling, solar plants are suffering from 0.4-1.1% of power output losses on panels. The longer the dust is left on solar panels, the greater these numbers increase.

The way cleaning robots are attached to panels affects a number of variables that have a bearing on the lifetime of a project and the effectiveness of the cleaning process. Therefore, robots have been field-tested for over six years. So far, panels are still showing damage over time with some types of robots.

For these systems, reliability will always be an issue. There is an extremely limited track record at scale in tough environments. Many systems are beginning to fail after operating in harsh desert conditions. Only quality robotic systems will survive in such environments in the future.

DEWA has focused its efforts on R&D solutions to soiling issues through installing sensors and devices to monitor solar plants. The Dubai utility has revealed its findings on the degradation rate of PV modules in desert conditions, if linear degradation rates are assumed;

- The best performing PV modules are mono-Si;
- Poly-Si PV modules degradation was 1.46% per year based on sensor-based approach whereas it was of 0.55% per year based on clear-sky approach;
- Copper Indium Gallium Selenide (CIGS) solar cells had the worst performance with 3.9% per year based on the sensor approach and 3.3% per year in clear sky approach;
- Cadmium Telluride (CdTe) PV modules showed high degradation rate of 2% per year based on the sensor approach and 0.84% per year in clear-sky approach.



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### 3.5 FOSTERING END USE THROUGH SOLAR ENERGY (TRANSPORT, DESALINATION, COOLING)

Being remote or grid-connected, small- or large-scale PV installations can provide clean and reliable energy sources that can be used in many end user's sectors. Most applications developed are standalone, such as water pumping, street lighting, cathodic protection and communication sites.

The dramatic drop of price of solar energy coupled with increasing competitiveness of storage solutions will allow solar energy for a number of usages that have traditionally been large consumers of fossil fuels and are a major source of GHG such as transport, desalination, cooling and heating.

Fostering end use through solar energy is developing:

• **There is an increasing consciousness that combustible engine automobiles and even electric vehicles (EVs), when electricity still generated by fossil fuels, make little sense environmentally. Attention is turning to solar powered charging stations with expected rise of EVs (turning point is anticipated around 2023-2024 with the arrival of a wide range of new generation competitive EV cars on the market).**

• **The share of desalination in the region is expected to represent 15% of the total final energy consumption by 2040. Hence, the use of clean energy for desalination may have a major impact on the region carbon emissions:**

#### Large scale applications on site for desalination are becoming possible:

- Increase of capacity and decrease cost of storage bring solutions to the issue of intermittency and necessary stability of power for reverse osmosis (RO becoming the rule for desalination in the region). Combined with cheaper solar power, clean desalination is becoming a more economically viable option.
- New technologies are under development in which the desalination process may, in the future, also contribute to the grid excess electricity.

#### Large scale clean desalination on grid is also becoming an option:

- Increasing initiatives advocate provision on grid of renewable energy through wheeling, clean electricity certificates or specific Power Purchase Agreements (PPAs) between utilities and/or investors in solar energy and end user facilities.

In MENA, Morocco is already developing clean desalination facilities on a large scale and recent tenders in the region, in UAE and KSA, have allowed the inclusion of component of electricity from renewable energy sources. The UAE's Sharjah Electricity and Water Authority (SEWA) has also announced that it aims to convert its desalination installations to clean energy by 2035.

### 3.6 HYDROGEN AND SOLAR ENERGY

Green hydrogen could play a key role in a clean, secure and affordable energy future; however, it is still in the development stage.

Green hydrogen, produced through electrolysis of water using electricity from renewable energy, presents a number of important advantages that can contribute to acceleration of energy transition, and filling some voids, as it:

- Allows production of hydrogen without CO2 emissions and/or polluting particles
- Enables the storage of renewable energy in large quantities and over a long period of time, providing the increased flexibility and facilitating management of inter-seasonality issues
- Provides solutions to face the challenge of balancing supply and demand that will continue to grow with the increase of renewable energy. Hydrogen offers the opportunity to be used for transmission system operators as a load for primary and secondary control power. "Hydrogen produced from

renewable electricity – achieved through an electrolyser – could facilitate the integration of high levels of variable renewable energy (VRE) into the energy system." According to IRENA's Hydrogen from Renewable Power report in 2018.

- Completes the missing link to a 100% carbon free energy system as it is a multipurpose energy vector (industrial processes, injection in gas networks, reconversion into electricity via fuel cells and gas turbines, possible fuel for vehicles, solutions for cold and heat thermal needs of buildings).
- Can be utilized to produce chemical carriers such as ammonia that may be transported and used at destination to produce electricity
- Could be in the future even more environmentally friendly with direct solar water splitting or photolytic processes using light energy to split water into hydrogen and oxygen. These processes are currently in the very early stages of research

but offer long-term potential for sustainable hydrogen production with low environmental impact.

Ultimately, green hydrogen can provide the region with abundance of competitive solar energy resources and means to export electricity to other markets lacking sources of renewable energy. It may enable fossil fuel producing countries to better face diversification and to remain key players in the international energy market.

The future of direct solar water splitting processes started evolving in the GCC. DEWA has launched the development of first pilot project that is deployed on the site of EXPO 2020. An increasing number of stakeholders in UAE, KSA and Oman are looking into even larger projects.

### 3.7 FURTHER GROWTH IN DISTRIBUTED GENERATION

**Distributed solar** is on the rise and will play a growing role in the future in the optimization of the new energy mix.

- The UAE, in particular Dubai, is taking the lead in the region. The Shams Dubai program was launched in 2015 to build PV capacity for residential, commercial and industrial buildings. In October 2019, 1,354 photovoltaic installations in Dubai were already connected with a total capacity of 125 megawatts (MW).

- After the successful introduction of the Safaqt project in Hatta, UAE, whereby 640 villas were retrofitted with solar rooftop panels, the approach was expanded to other buildings under the Shams program. The Safaqt was based on provision of a complete PV kit and zero percentage finance. In January 2019, Dubai launched an initiative to further boost the movement with support to equip 10% of homes in the emirate with rooftop solar as part of the 50-

year charter for the emirate as announced in January 2019.

- Provision of solar panels is becoming an integrated part of energy retrofitting of existing buildings and sustainable real estate new projects.



- DEWA connected a number of distributed solar projects at its own premises, e.g. 1.5 MW plant at Jebel Ali Power Station and partnered with 19 government entities to equip schools, mosques and facilities.

- Abu Dhabi and the Northern Emirates are also developing similar projects, but issues related to management of the grid have led Abu Dhabi to slow down the adoption of a net metering system. Tools to manage the grid with connection by increasing number of sources are going to be essential.

- Oman has engaged phase 2 of its Sahim rooftop solar.

- In Egypt, all administrative buildings in the New Administrative Capital are expected to be equipped with solar rooftop.

- In Kuwait, if price of electricity remains low, the private sector will not be incentivized to invest in solar power. The leadership decided in 2018 that government buildings shall include no less than 10% of the building peak. Total capacity for 73 projects for 10 government institutions are estimated at 2,200 MW.

- In Bahrain, key projects call for 50 MW of energy to be generated via decentralized solar at government buildings, along with 30 MW from new housing units through the Ministry of Housing and 10 MW from new town developments.

- In KSA after a first deployment of solar PV on the roof of a Mosque in Riyadh, deployment to other mosques has been recommended by King Abdullah Petroleum Studies and Research Center (KAPSARC). The signing of a first PPA for on-site solar PV for an agro-industry has also led to more interest in the industry and a pipeline of projects is developing over the country for industrial facilities. The launch of a financing scheme recently by Saudi Industrial Development

Fund (SIDF) will foster this trend. Regulatory framework to allow exchanges with the grid is under study by the Electricity Co-generation Regulatory Authority (ECRA).

Jordan, Lebanon, Tunisia, Bahrain, Pakistan and to some extent Morocco and Egypt, have adopted net-metering policies. Similarly, recommendations for it have been issued in Algeria.

### C&I Segment Specificity

Distinguishing itself from the residential and utility-scale solar industry sectors, commercial and industrial solar—or C&I – is visibly growing.

C&I drivers are based on:

- Reductions of subsidies of electricity tariffs (at different stages in UAE, KSA, Oman, Jordan)
- Setting up of regulatory framework, in particular for wheeling and net metering (UAE, Oman, Jordan, under study in KSA)
- Incentive policies with programs like Shams Dubai or Oman's Sahim, covering larger areas of solar rooftop application contribute to trigger a movement towards use of solar PV (and/or hybrid sources of energy, in Oman for example).

C&I projects in Morocco are developed under Law 13-09 of 2010 on renewable energy. The law allows free installation under 20 kW and simple declaration with light procedure between 20 kW and 2 MW. Four European banks have launched a funding line, Morocco—Sustainable Energy Financing Facility (MORSEEF), that can cover up to 10% of the CAPEX. Therefore, many small projects between 50 kWh -100 kWh, as well as 2 MW projects, have been implemented in particular around Casablanca and Marrakech.

C&I pipeline is large and encompasses a wide variety of customer types, solar designs and project sizes. Often, regulation is not an issue for the development of solar production capacity in the premises of the installations themselves. However, land availability is the issue in the absence of net metering or wheeling regulation. Cost effectiveness of the overall project is also impacted due to increased need to add storage capacities to absorb excess power production issues.

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### 3.8 INCREASED FOCUS ON ENERGY PLANNING

Input to the grid is increasing with;

- large utility scale renewable energy projects entering in operation;
- growing number of distributed sources of energy that can upload additional electricity.

Combined with development of Internet of Things (IoT) connected devices of peer-to-peer networks and with impact of energy efficiency gains, these trends make the energy system more and more complex.

Better understanding of this

complexity is key for policy, regulations, investment choices, identifications of necessary backups (energy security) and adequate measures to foster the transition from uni-directional power flow to the multi-directional flow. All of this requires framework that can allow for dialogue with all categories of stakeholders.

IRENA energy roadmaps for several years already supported better understanding of challenges and opportunities to foster transition at global, regional and in some cases, such as the UAE, national levels. However, the need for more detailed hands on analysis and

predictive tools is becoming more pressing.

The Department of Energy of Abu Dhabi is leading the way. It has engaged the development of a projection of the emirate's potential energy future until 2050 through an Integrated Energy Model, allowing to assess trade-offs and opportunities. Such flexible planning tools may prove themselves increasingly necessary as sources of clean energy multiply and diversify and frontiers between energy producers and users blur, creating intricate interactions.

### 3.9 SOLAR COIN

As a reward for energy producers and to incentivize real world environmental initiatives to produce solar, SolarCoin was produced. Blockchain digital tokens are made by the SolarCoin Foundation at a rate of one SolarCoin per MWh of solar energy generated. Any solar plant may receive digital solar coins as a reward for their positive contribution to the environment. It is global, decentralized and independent of any government. Receiving SolarCoins requires plant owners to register solar systems with the SolarCoin Foundation. The coins are distributed once production totals have been submitted.



## 4. Solar Projects 2019 – 2021

Table 1: Projects Under Construction, 2019

Projects Currently Under Construction 2019				
Project Name	Country	Technology Used	Capacity	Status
Benban	Egypt	PV	1.8 GW	Construction (1400 MW commissioned)
Al Husainiyah	Jordan	PV	50 MW	Construction
Noor Tafilalet	Morocco	PV	120 MW	Construction
Miraah CSP	Oman	CSP	1 GW	Construction
Sakaka	Saudi Arabia	PV	300 MW	Construction
Al Maktoum phase 4	UAE	CSP -PV	950 MW	Construction

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Table 2: Upcoming Projects in MENA region

Upcoming Projects				
Project Name	Country	Technology Used	Capacity	Status
Project Name	Country	Technology Used	Capacity	Status
West Nile	Egypt	CSP	600 MW	Planned
Round 3	Jordan	PV	150 MW	Announced
KNPC	Kuwait	PV	1500 MW	Tender Phase
Shagaya Phase 3	Kuwait	PV	1.2 GW	Announced
Shagaya Phase 3	Kuwait	CSP	200 MW	Announced
Al Kharsaah	Qatar	PV	700 MW	Tender Phase
Noor Midelt	Morocco	CSP - PV	800 MW	Awarded
Noor-Tafilalet	Morocco	PV	120 MW	Tender Phase
Noor-Atlas	Morocco	PV	200 MW	Tender Phase
Noor Argana	Morocco	PV	200 MW	Tender Phase
Ibri	Oman	PV	500 MW	Awarded
NA	Oman	PV	1000 MW	Planned
Sindh Solar Energy Program	Pakistan	PV	400 MW	Announced
	Pakistan	PV	20 MW	Announced
Medina	Saudi Arabia	PV	50 MW	Tender Phase
Rafha	Saudi Arabia	PV	45 MW	Tender Phase
Qurayyat	Saudi Arabia	PV	200 MW	Tender Phase
Al Faisaliah	Saudi Arabia	PV	600 MW	Tender Phase
Rabigh	Saudi Arabia	PV	300 MW	Tender Phase
CREG	Algeria	PV	150 MW	Tender Phase
Askar	Bahrain	PV	100 MW	Awarded
West Nile	Egypt	PV	600 MW	Development Phase

Upcoming Projects				
Project Name	Country	Technology Used	Capacity	Status
West Nile	Egypt	PV	200 MW	Development Phase
Kom Ombo	Egypt	PV	200 MW	Awarded
West Nile	Egypt	CSP	100 MW	Announced
West Nile	Egypt	CSP	100 MW	Announced
Jeddah	Saudi Arabia	PV	300 MW	Tender Phase
Mahd al Dahab	Saudi Arabia	PV	20 MW	Tender Phase
Al-Rass	Saudi Arabia	PV	300 MW	Announced
SAAD	Saudi Arabia	PV	300 MW	Announced
Wadi ad-Dawasir	Saudi Arabia	PV	70 MW	Announced
Layla	Saudi Arabia	PV	40 MW	Announced
Mahad al-Dahab	Saudi Arabia	PV	20 MW	Announced
PIF	Saudi Arabia	PV	2.6 GW	Planned
ANME	Tunisia	PV	1,700 MW	Announced
Tunisia PV	Tunisia	PV	500 MW	Awarded
Al Maktoum 5	UAE	PV	900 MW	Awarded
Al Dhafra	UAE	PV	2000 MW	Tender Phase
Abu Dhabi location to be defined	UAE	PV	2000 MW	Expected
Sawa 1	Iraq	PV	30 MW	Tender Phase
Sawa2	Iraq	PV	50 MW	Tender Phase
Khidhir	Iraq	PV	50 MW	Tender Phase
Iskanariya	Iraq	PV	225 MW	Tender Phase
Jissan	Iraq	PV	50 MW	Tender Phase
Karbala	Iraq	PV	300 MW	Tender Phase
Al Diwania	Iraq	PV	50 MW	Tender Phase





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Use of renewable energy sources is growing at a tremendous pace. A once static power generation landscape of large, central power plants is transitioning into a flexible, intelligent, and increasingly distributed system comprising many different actors. The intermittent, fluctuating nature of electricity feed-in from distributed generating sources, however, poses major challenges for power grids, and significantly affects the stability of medium-voltage and low-voltage networks.

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5. Energy Storage

Intermittency has been one of the main issues for a wider adoption of solar energy. Increased competitive storage solutions are, however, quickly changing the landscape. Storage solutions supplying a demand for 24 hours seems to be within reach. CSP projects are anticipated to reach 16 hours of energy storage in the upcoming projects in the UAE and Morocco.

Today the total global energy storage capacity stands at 187.8 GW with over 181 GW of this capacity being attributed to pumped hydro storage systems. So far, pumped hydro storage has been the most commonly used storage solution (Table 3). However, PV plus storage as well as CSP solutions are paving the road towards a different future.

Table 3: Storage Solutions

Storage Technology	Rated Capacity (MW)
Compressed Air Energy Storage (CAES)	7.40
Electrochemical Storage	3,297.1
Hydrogen Energy Storage	20.5
Liquid Air Energy Storage	5.4
Pumped Hydro Storage	181,190.6
Thermal Energy Storage (TES)	3,275.1

5.1 SOLAR PV PLUS STORAGE

MENA countries benefit from high level of solar irradiation, giving solar energy an advantage to produce power during the day. However, with competition of subsidized fossil fuel based continuous energy production, intermittent solar energy is at a disadvantage. Therefore, solar projects combined with storage solutions will be necessary to allow more extensive growth of competitive solar energy.

With the dramatic drop of price of solar energy such combination is tending to reach grid parity. Solar plus storage solutions are evolving from a niche market to a large

market. Growing exponentially, 25 GW of battery storage projects exist presently with roughly 77% under development. According to a study made by Bloomberg New Energy Finance (BNEF) in 2018, almost 4 GW of battery storage systems went online and by 2020. This number could double, as market research experts predict.

Lithium Ion Batteries Dominate the PV Plus Storage Market

Lithium ion batteries capability to act as quickly as a few milliseconds beats the response time of gas turbine generators.

Such properties are making solar-plus-storage more appealing to several applications such as:

- **Peaker Plants:** Solar PV plus storage solutions are seen as peak power demand replacers to gas fired plants at much lower costs and shorter construction periods. Integrating battery storage with solar is a reliable source that could easily and effectively align demand and supply needs of peaker plants. With further decrease of prices, storage could become a very useful tool for load shifting and increase of flexibility of the grid. ▶



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According to Wood Mackenzie's Global Solar PV Inverter Market Report - April 2019

- Other solutions such as renewables integration, peak shaving, energy shifting, ancillary services, microgrids, Transmission and Distribution, investment deferral and backup are attracting economically viable and reliable solutions to the market.

Lithium Ion batteries are becoming cheaper with the volume weighted average of lithium-ion battery pack price fell 85% between 2010 and

2018 (Figure 4). Looking closely at the recent years, battery prices decreased by almost 40% between 2016 and 2018. Furthermore, the average lithium-ion battery pack in 2030 could see a decline in cost as \$62 per kWh, according to BNEF.

Lithium-ion batteries are so far the most commonly used in the market with 87% of the storage capacity is installed, under construction and announced (leaving out pumped hydro). However, substitutes

to lithium-ion batteries have been introduced and are under development. In the future, other technologies based on flow batteries and hydrogen storage could develop. Nevertheless, those alternatives need to be more mature and require additional R&D to be competitive in terms of pricing, reliability, speed of deployment, weight, and energy density.

### BATTERY PACK REAL PRICE (2018 USD/KWH) : VOLUME WEIGHTED AVERAGE

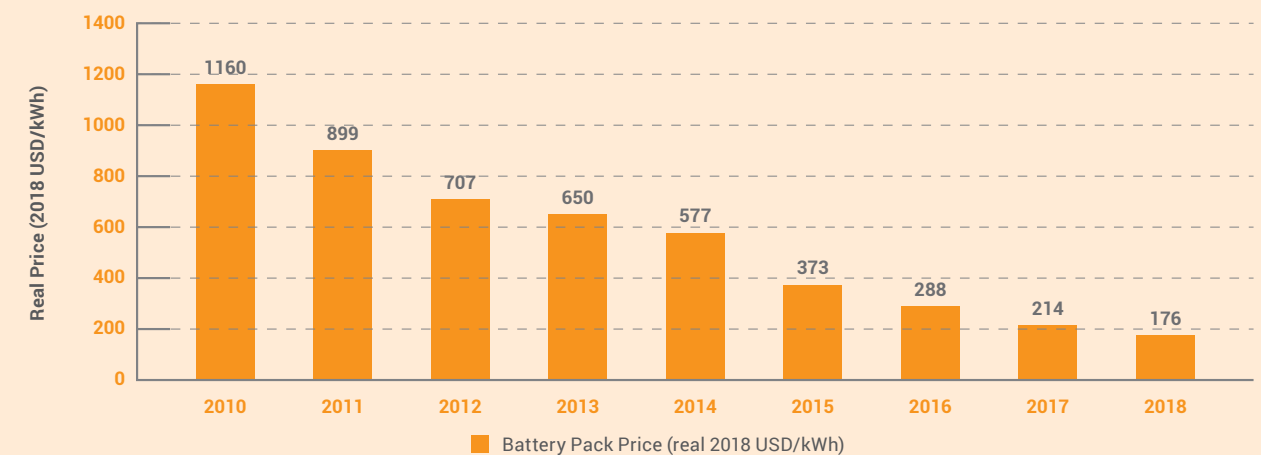


Figure 4: Lithium Ion Battery Pack Prices Trend (Frost & Sullivan)

According to a study made by BNEF in 2018, almost 4 GW of battery storage systems went online. By 2020, this number could double, as forecasted by market research experts.

### Recent developments:

- Jordan:** Solar Plus Storage Plant in Al Mafrq is currently operating at a total capacity of 23 MW solar PV plant and a 12.6 MW energy storage component. Phase 1 of 12 MW of solar PV went online in October 2015 and was followed by Phase 2 for 11 MW PV and 12 MWh of lithium-ion battery-based energy storage. It is the largest and the first PPA power storage project in MENA.
- Lebanon:** Early 2018, Lebanon's Ministry of Energy and Water received 75 expression of

interests (EOIs) to develop a 300 MW solar battery storage capacity. Evaluation of the proposals has been a difficult issue and European Bank for Reconstruction and Development (EBRD) announced in 2019 that it will provide assistance.

- Oman:** Oman's state-owned Rural Electricity Company (Tanweer) tendered in August 2019 eleven solar-diesel-storage hybrid projects with a combined capacity of 146 MW for non-interconnected areas. The project capacity requirements include 48 MW of solar, 70 MW of diesel

generator and 28 MW of battery storage system. Projects will be under a build, own, operate and transfer (BOOT) model with 15-year power purchase agreement (PPA).

- UAE:** In Abu Dhabi, the ongoing tender for the Al Dafrah PV Park, totaling up to 2 GW, includes an option for a 300 MWh battery storage. The project is expected to be fully operational by 2022, marking the first time in the region that solar and storage will be integrated at this scale.



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### 5.2 CONCENTRATED SOLAR POWER

CSP is still marginal and considered to be expensive; however, in 2018, the MENA region's CSP capacity had doubled compared to the previous year reaching 725 MW of installed capacity (Figure 5). It is expected that CSP projects will become even more competitive in the future.

CSP has the ability to be dispatchable, consistent power throughout the day and night which will foster solar energy in countries that have a high direct normal irradiance (DNI).

According to the US Department of Energy's SunShot initiative was launched in 2011 to reduce the total cost of solar energy by 75%. The solar industry achieved the 2020 cost target in 2017 of \$0.06 per kWh for utility scale PV solar power. The program set new goals that included 2030 targets for CSP:

**\$0.05** per kWh

**for baseload configurations**

(with a minimum of 12 hours of storage)

**\$0.10** per kWh

**for peaker configurations**

(with less than six hours of storage) designed to deliver electricity only when it is most highly valued by grid operators

Such targets are very competitive with other dispatchable power generators that will make fossil fuel and other subsidies less advantageous.

#### MENA CSP CAPACITY

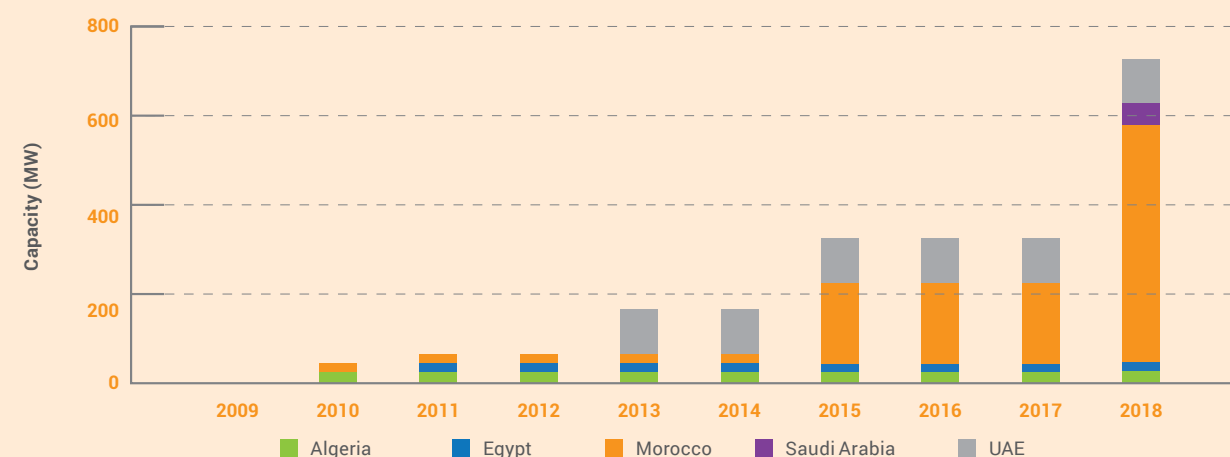


Figure 5: MENA CSP Capacity (Frost and Sullivan)

Yet CSP development, due to high DNI requirements, will be limited to some countries only, while PV will benefit from a wider market. In addition, CSP has a longer cycle of development and execution compared to other renewable technologies given the land size required, detailed studies and design, complex financing and longer construction periods.

To further reduce the cost and boost CSP projects, the development of a sustainable project pipeline to allow the industry to mature is key requiring:

- Enhancing the supply chain to drive down the cost of key components

- Creating a knowledge transfer of cost-efficient, time-saving construction methods

CSP technology using parabolic panels is a mature and efficient technology. However, the ambition to move into power towers (central receiver systems), which operate at higher temperatures, still requires improvements.



In MENA, the main concern is dealing with dust, humidity and other atmospheric substances that affect the system's efficiency. Since the distance between the last heliostat and the solar tower receiver is in the range of 1 kilometer, these external factors impact the output of the system. Many consider that alternative solutions, such as multiple tower concept or having a smaller heliostat field, could be more efficient.

- New advanced technology is arriving on the market allowing CSP to exceed 1,500°C (and will allow use for more industries, green hydrogen or syngas) using precise data management and software to align a large array of mirrors to accurately reflect sunlight on to a single target.

CSP is coming back into the picture with such breakthroughs. To solve intermittency, co-locating and integrating PV and CSP could:

- Cover the auxiliary power consumption of the CSP plant during the day

- Hybridize the generation to focus each technology to the period of the day when it is the most competitive (PV during the day, CSP during the night).

Decrease of prices will support that trend (see Figure 6):

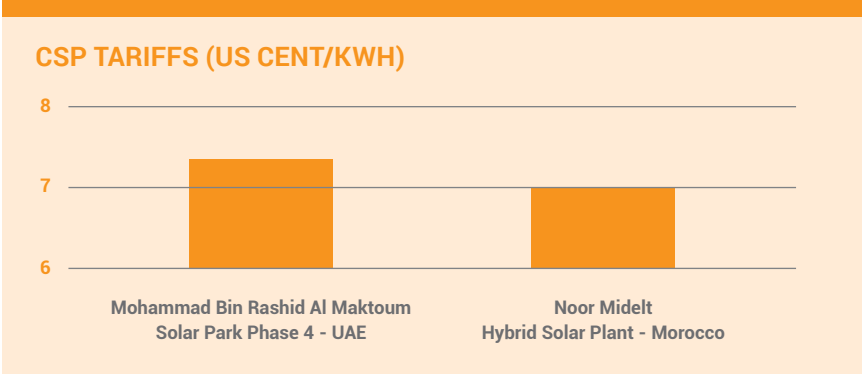


Figure 6: Recent CSP Tariffs (US Cent /kWh)



CSP's Regional Leaders

UAE and Morocco are the top countries in CSP projects in the MENA region.

The Noor Midelt Hybrid Solar Plant (800 MW) in Morocco, awarded in mid-2019, will provide dispatchable solar energy during the day with until five hours after sunset. The construction of the project is expected to start in end 2019 and the commercial operation is set for 2022.

In the UAE, the Mohammad Bin Rashid Solar Park Phase IV (950 MW) will feature the tallest solar tower (260 meters) using parabolic CSP and PV. The phase will generate 700 MW of CSP (600 MW from a parabolic basin complex and 100 MW from a solar tower) and 250 MW from PV panels.



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## 6. 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 and CSP.

### A. ALGERIA

#### Current Situation:

Demand for electricity has grown by average 6.91% annually over the past years, fed by a yearly increase of population around 1 million (one of the highest rates in the world). Algeria primarily uses oil and gas to meet domestic demand. Only a small fraction of domestic consumption derives from coal, hydroelectric and renewables with total fossil fuel subsidies remaining at 9.5% of the country's share of gross domestic product (GDP).

At the same time, the country has witnessed a slow start to the energy transition. Algeria adopted as early as 2004 the first renewable energy feed in tariff (REFIT) in Africa to speed up the adoption of renewable energy sources. The scheme pertained to plants with power generation capacity exceeding 50 MW. The

REFIT is a premium paid per kWh above a base tariff (average annual electricity price in Algeria). The country's REFIT is expressed as a percentage of the base electricity tariff including 300% of the base for PV and 200% for CSP.

However, the share of renewable energy in Algeria's generation mix growth is still limited. In 2018 according to IEA, installed renewable energy capacity was of 670 MW out of which solar energy represented 343 MW (2.5% of the total energy capacity). IRENA underlined that most of the PV development has so far taken place in isolated areas in the southern part of the country.

Although targets have been set, the National Program for the Development of Renewable Energies (NPDRE) is lagging. In 2015, the country updated

its 2011 Renewable Energy and Energy Efficiency Development Plan, putting greater focus on deployment of utility scale PV and onshore wind. However, it reduced the previous objectives to a capacity target of renewable generation share to 27% by 2030.

The updated version of the program aims to install 4,500 MW of new projects until 2020 and overall of 22,000 MW until 2030 Algerian capacity, split as follows:

- Solar PV: 13,575 MW
- Wind: 5,010 MW
- Solar thermal: 2,000 MW
- Biomass: 1000 MW
- Cogeneration: 400 MW
- Geothermal: 15 MW

- A mini-grid application of solar energy was brought about by a cooperation of Korean and local groups. The mini solar power plant has a capacity of 28 kW and was installed on the rooftop of a research division in the province of Adrar.

- In March 2016, a 48 MW of solar PV capacity in the same province was commissioned consisting of six plants in Adrar (20 MW), Zaouiet Kounta (6 MW), Reggane (5 MW) Aoulef (5 MW), Timimoun (9 MW) and Tsabit (3 MW).

- A utility-scale project of 20 MW PV was commissioned in September 2017, in the province of M'Sila.

#### EXISTING PROJECTS

- In 2011, a 150 MW hybrid plant in Hassi R'Mel was commissioned, of 132 MW gas and 30 MW solar by an Algerian-Spanish joint venture.

- In January 2016, the country commissioned its first utility scale PV facility, a 233 MW solar plant located in the province of Adrar. The solar complex comprises of 16 separate solar parks and reduced issues of power shortages in the region.

#### PRESENT PROJECTS

A new auction system introduced in 2016/2017 was followed by the approval, in June 2018, of several projects having a total capacity of 200 MW of PV. The new tenders, which will be open to both domestic and international players, will select grid connected IPP projects totaling 150 MW and offgrid hybrid projects using gas or diesel coupled with solar for

a combined capacity of 50 MW. The grid connected projects, from 10-50MW, will be developed on a build, own and operate (BOO) basis under a 20-year PPA.

- The Algerian Electricity and Gas Regulation Commission (CREG) tendered 150 MW in southwestern region (Ghardaia, Biskra, Ouragla and El Oues) but received only eight proposals for a total of 90 MW. It declared only one successful bidder which was

awarded 50 MW in the form of 5 projects of 10MW each.

- Sonelgaz tendered 50 MW for offgrid hybrid gas/diesel and solar projects in December 2018.
- Projects coming along in the next few years are aimed at drastically lowering the cost of existing power generation stations in the south of Algeria, which are primarily via fossil fuels.

#### Outlook:

The country's challenges to expand solar power include:

- A strong reliance on fossil fuel subsidies
- Domestic content rules and obligation to produce PV components locally, limiting the range of participating companies resulting in facilities encountering delays in production and project scheduling.

- Access to financing from international banks and institutions due to a ban on foreign debt in country; local borrowing is expensive as interest rates are high and tenures are low.

- Procurement and installation costs of solar panels as well as generating solar energy remain high compared to natural gas.

- There is a lack of government incentives particularly for the C&I segment.

However, recent declarations seem to indicate a new determination to develop solar energy more massively. In August 2019, the Algerian Minister of Energy announced a plan to launch 22 solar projects of 400 MW each. This was followed at the end of 2019 by the signature of a memorandum of understanding with DII Desert Energy indicates in an effort to revive the Desertec project.

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## B. BAHRAIN

### Current Situation:

Bahrain is highly dependent on fossil fuel for energy, and with a rapid population growth, demand for power has grown to 3.6 GW in 2019. It is expected to reach up to 7.5 GW in 2035. This has driven the government to search for ways to curtail demand, for cooling in particular and to diversify the energy supply.

Bahrain's 2030 Economic Vision aims to transform and shift from an oil dependent economy to a more diversified and competitive landscape. In addition, the National Determined Contribution of Bahrain is mainly based on small scale utility-based renewable energy projects and increased energy efficiency in transport, buildings and industry.

The Kingdom's plans evolved with the introduction of the National Renewable Energy Action Plan (NREAP) and the National Energy Efficiency Action Plan (NEEAP) in 2017:

- The NREAP plans policies, targets

and initiatives to implement renewable energy options. It aims at 5% of renewable energy by 2025 and 10% by 2035. To achieve this target, net metering and tender-based FIT schemes as well as mandatory renewable energy requirements for new buildings will be implemented.

- The NEEAP includes 22 initiatives across all economic sectors that target a national energy efficiency increase of up to 6% by 2025 equating to energy savings of 5,800 GWh on primary energy equivalent basis. Cumulative energy savings for the years 2016 – 2025 will exceed 25,000 GWh on primary energy equivalent basis.

### PROJECTS

In early-2019, a first 100 MW PV Park at the Askar site (\$360 million) was awarded. It will be built under a BOOT model on a landfill site, taking into consideration the limited space to develop large scale solar parks in Bahrain.

Due to the scarcity of available

land, the country is also focusing on rooftop and private projects with an aim to install 255 MW by 2025 using net metering. So far, a 3MW solar array rooftop project was launched at eight locations in 2019. The project is split into three phases of 1.25 MW, 1 MW and 750 kW. The electricity generated from the 3 MW solar plant will be sold to the offtaker at a fixed price for a period of 20 years under a PPA.

### Outlook:

The country is moving forward with Askar Solar PV project that targets Bahrain's REN goals. However, with physical space limitations, Bahrain is focusing its efforts on developing its C&I segment. The current rooftop projects under tender will be used to generate power for self-consumption with excess power being fed to the grid.

The country is also currently exploring various modalities of incentives for the private sector investments in renewables and energy efficiency. As a result, a diversified energy mix is anticipated to develop in Bahrain.

## C. EGYPT

### Current Situation:

With the electricity demand reaching up to 27.6 GW in 2019 and a forecast, by Frost and Sullivan, of 67 GW in 2030, Egypt is in need of substantial additional power capacity.

As specified by the Integrated Sustainable Energy Strategy (ISES)

to 2035, the Egyptian government has set renewable energy targets of 20% of the electricity mix by 2022 and 42% by 2035. The ISES includes 52 GW of both large-scale and distributed on grid renewable energy by 2035. Over the past few years, a favorable policy to foster the development of renewable energy projects covering new and existing projects through

Investment Law No 72/2017 was put in place with incentives such as tax reductions.

To foster the development of renewables, Egypt uses different frameworks:

### NET METERING

Introduced in 2013, by Egypt Electricity Regulatory Authority (ERA), this method promotes distributed solar power and encourages the C&I sector to feed the electricity into the national grid. The maximum capacity allowed recently increased from 5 MW up to 20 MW. However, such projects, mostly PV, are still limited due to intermittency and power stability issues, and their further development will depend on increase of storage capacities.

### REFIT PROGRAM

- Round 1: The REFIT program, which ran between October 2014 to 2016, targeted large-scale renewable energy projects for a total of 4,300 MW of solar and wind by 2017. It had a decisive impact and resulted in a number of 20 MW to 50 MW projects. In addition, the program proposed tariffs for residential distributed PV (usually below 10 kW) up to systems between 200 kW to 500 kW.
- Round 2: Launched in September 2016 and aimed at implementing 2 GW of renewable energy. It resulted in a substantial increase in the number of projects achieving financial close in comparison with Round 1. Although the ambitious target was not achieved, the program has completed between 1.4 GW and 1.8 GW of additional renewable generation capacity at a competitive tariff of \$0.084 per kWh. This was a significant step-down from the tariff of the Round 1 Program (\$0.1434 per kWh). Benban Solar Park is implemented with this scheme.

Despite tariffs fixed up to 40% lower than round one, the long-expected currency guarantees and the inclusion of international arbitration terms played a major role to secure financing from multilateral financial agencies and banks and allowed the success of the second round of Egypt's REFIT program.

### IPP MODEL PROJECTS

Wind and solar projects from 100 MW to 600MW are found under competitive bidding scheme based on IPP model. In August 2018, Egyptian Electricity Transmission Company (EETC) and New and Renewable Energy Authority (NREA) invited both local and foreign developers to participate in the auctions for the 250 MW wind project, 200 MW of PV and 50 MW of CSP.



## KEY PROJECTS STATUS

• **The Benban Solar Park**, under the FIT model, has an estimated investment up to \$4 billion and is currently under construction with a planned total capacity of 1.8 GW. Benban will include 41 solar power plants located in the Aswan governorate. Once operational, the solar park will cut carbon emissions by two million tons per year.

In May 2019, 19 projects of the Benban Solar Park were reportedly connected to the grid. Six months later, in November, Dr. Mohamed El-Khayat, NREA chairman, said that a total of 32 plants with a capacity of 1,465 MW were completed and started commercial operation.

Currently, the construction of four additional new solar power plants with a capacity of 200 MW is engaged on the Benban solar park site.

Egypt saw the first tenders outside of REFIT program with the introduction of:

• **Kom Ombo PV Solar Project** : In October 2019, the EETC signed a solar PPA with a developer for a 200 MW plant at a price of \$0.0275 per kWh. This long-awaited project, in the pipeline nearly a decade, is expected to be completed in Q1 2021.

• **West Nile Solar Plant** : With a capacity of 600 MW, the EETC and the International Finance Corporation (IFC) signed in April 2019 an agreement to fund projects selected under auction system.

The EETC launched the tender for the 600 MW project in December 2017 signaling the procurement of the country's first tender for solar under a BOO model. In February 2018, it was reported

that 18 offers had been received ranging in size from 200 MW to 500 MW. In September 2018, EETC indicated that bids would only be accepted for a maximum of \$0.025 per kWh after seeing the price of solar power fall below the \$0.03 threshold a month earlier at Kom Ombo.

Details on implementation conditions of West Nile Solar project are expected to be released soon.

## C&I AND STORAGE

The lifting of subsidies on fuel and electricity tariffs by the government that started in 2016 as well as the development of energy storage solutions will play a major role in the increase of decentralized solar projects.

The first tender for a 20 MW PV solar plant with battery storage, located in the Red Sea area of Hurghada, was announced by NREA for end 2019. The PV-storage project will be funded by a \$85M facilitated loan from Japan International Cooperation Agency (JICA).

## Outlook:

Two aspects of Egypt's regulatory framework will have to followed:

- The country aims to introduce a competitive electricity market, based on bilateral contracts together with spot, balancing and ancillary services' markets.
- The NREA formed a committee to bring together all the electricity sector stakeholders and was tasked to draft the Exclusive Regulations of the Renewable Energy Law No. 203/2014. The work of the committee is expected to be released in the Q4 2019.



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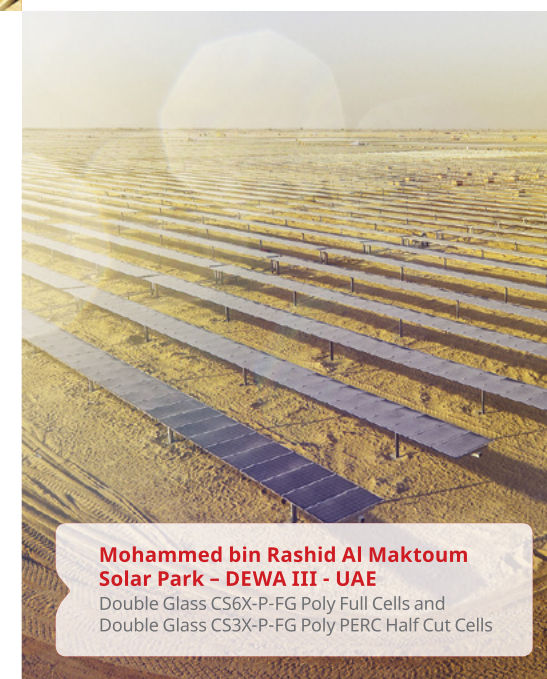
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## D. JORDAN

### Current Situation:

Jordan is seeking to reduce its high level of dependency on fossil fuels (which are mostly imported) that reached 92% in 2018, with a total cost of \$2.82 billion equal to 10% of its GDP. Jordan is also facing a 0.2% annual growth of electricity demand.

As a result, Jordan has put forth an effort to diversify its sources of energy and to foster locally produced renewable resources. By the end of 2018, Jordan produced 1,130 MW of power from renewable energy sources, accounting for about 11% of total electricity requirements.

The country's objective is:

- Reach 16% of renewable energy production by the end of 2019.
- Achieve a 20% renewable share in energy mix in 2020.
- Double the present renewable energy capacity by 2021 to reach 2,400 MW, accounting for 30% of electrical installed capacity and 20% of electricity generation.

To achieve these goals, Jordan has used a combination of utility-scale IPP projects with a smaller solar rooftop initiative.

### UTILITY SCALE SOLAR PROJECTS

#### • Jordan's Renewable Energy Program:

##### › Round 1:

The first round of direct proposals to build under IPP scheme featured 12 PV projects totaling a capacity of 204 MW. The projects implemented 10 solar plants in Ma'an and one in each Aqaba and Irbid that began operations in 2016.

##### › Round 2:

Four projects of 50 MW each were awarded. Three are located in Mafraq Development Zone and one in Safawi. The projects will be developed with feed-in tariffs of \$0.0613 per kWh, \$0.0649 per kWh, \$0.0691 per kWh and \$0.0767 per kWh, respectively. Two 50 MW PV, Mafraq I and Empire PV solar plants, are already under operation as of end 2019.

##### › Round 3:

150 MW of solar and 50 MW of wind power, including a storage option, are being carried out in Ma'an and were planned to be completed in 2020. The electricity tariff bid for a 50 MW PV project was \$0.0249 per kWh which is significantly lower than the prices offered in round 2.

#### • Baynouna Project:

The 200 MW Baynouna project is the largest single solar energy project developed under PPA scheme. The project is estimated to produce enough electricity to power approximately 110,000 homes while displacing 360,000 tons of CO2 annually. It is expected to be fully operational in the first quarter of 2020.

### NET METERING AND WHEELING

In 2018, 300 MW were attained through net metering and wheeling. Those schemes have attracted the C&I sector seeking to reduce their electricity bills. Supermarkets chains and hospitals, for example, have turned to wheeling solutions. A dedicated regulatory framework has made adoption of distributed solar more widespread.

However, the government decided in early-2019 to suspend both net metering and wheeling projects above 1 MW until grid capacity and conditions to adjust to the increasing uptake of renewable energy have been fully assessed.

### SOLAR HEATING

The Jordan Renewable Energy & Energy Efficiency Fund (JREEEF) has launched a project to bring hot water to all parts of Jordan using solar. Awarded in 2017, 20,000 solar water heaters are expected to be installed in the residential sector between 2013 and 2019.

### ENERGY STORAGE

Energy storage is pivotal to Jordan's solar capacity development. To this end, the country is introducing energy storage projects. It should be mentioned that it tendered in 2019 a feasibility study for a 30 MW pump storage system to be installed on dams.

### INTEGRATION INTO THE GRID, A CHALLENGE

In early 2019, the government had suspended the development of new renewable energy generation projects until the completion of technical studies to assess the capacity of the electrical grid to handle additional capacity. However, the continuation of the following projects was authorized under certain conditions:

- Round 3 projects are now required to demonstrate a reduction of energy costs, though the amount of the reduction has not been specified.
- Wheeling or net metering projects with a capacity under 1 MW.

### Outlook:

Jordan is evaluating its solar energy mix and has some challenges determining and assessing the integration of CSP technologies including storage solutions. Feasibility studies should provide more information on whether CSP would be an option between now and 2030.

At this stage, Jordan's capability to strengthen the grid, commitment to achieve increased energy efficiency and develop additional storage is key for the future market attractiveness.





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## E. KUWAIT

### Current Situation:

Much like its neighbors, Kuwait's demand for electricity and power has been rising sharply over the past few years. The country's population grew by 2% from 2016 to 2017 while demand for electricity increased by 3%.

Kuwait had set an objective of integration of 5.7 GW of CSP, 4.6 GW of PV and 0.7 GW of wind into the energy mix and targets 10% of renewables in 2020. Moreover, in December 2017 the new Minister of Electricity and Water indicated the country's determination to reach 15% by 2030.

After the launch of a first solar plan of 10 MW in Sidrah by Kuwait Oil Company (KOC), an additional 60 MW of renewable capacity was due to come online by the end of 2017. The country now has only around 70 MW of installed renewable energy against a 2030 target of 4,320 MW.

## KEY PROJECTS

### KNPC Project

Kuwait Petroleum Corporation (KPC) and its subsidiaries are targeting 15 per cent of their total electricity consumption to come from renewable resources.

Kuwait National Petroleum Company (KNPC), a subsidiary of KPC is engaging in the development of 2,500GW of solar energy by 2025 with Al - Dibdibah Scheme.

Prequalification for a first phase of a 1.5 GW PV facility renewable energy complex has been engaged in 2017 and in September 2018, the tender launched for a 25-year EPC contract. Submission deadline was 16 December 2018 and the contract is yet to be awarded.

### Al Abdaliyah Project

High uncertainty prevails on the proposed integrated solar combined-cycle (ISCC) facility of Al Abdaliyah (60 MW of solar power and 280 MW of natural gas). The project, under Kuwait's public-private partnership (PPP) program was initially launched in 2008.

A request for proposals (RFP) was launched in November 2015, but the tender was cancelled in April 2017. Kuwait's decision to retender the planned Al Abdaliyah ISCC plant without a specified

date further indicates the country's difficulties in the materialization of PPP schemes.

### Shagaya Complex

Marking the start of renewable energy implementation, Kuwait Municipality and Kuwait Institute for Scientific Research (KISR) developed plans for a 20 GW renewable energy park, located 100 kilometers west of Kuwait City, focused primarily on solar power generation. The Shagaya initiative was first conceived in 2009, but not formally announced until 2013.

The project has 3 components totaling more than 4,000 MW capacity.

- The first phase was a pilot under which, KISR awarded contracts for a 50 MW CSP plant, a 10 MW wind farm and a first 10 MW PV that started commercial operations in December 2018.

- The second phase includes the KNPC project of Al Dibdibah and several projects of KISR. It is expected to start commercial operation in Q1 2022.

- The third component of the project, Al Atrag, consisting of several packages is targeting at least 200 MW of CSP, 1.2 GW of PV and 100 MW of wind. In July

2019, the Kuwait Authority for Partnership Projects (KAPP) announced that a tender for the third phase of Shagaya complex would be launched in current fiscal year which ends in March 2020.

By 2030, Shagaya should include 1,150 MW of concentrated solar power, a 700 MW PV plant (split into 14 projects) and a 150 MW wind farm, providing a combined total installed capacity of 2 GW.

**BY 2030**

**SHAGAYA  
WILL  
PROVIDE A  
COMBINED  
TOTAL  
INSTALLED  
CAPACITY  
OF 2GW.**



## ROOFTOP PV

- According to the Ministerial decree 126/2018, all governmental buildings are required to have at least 10% of their building's peak demand come from rooftop solar. The Ministry of Electricity and Water (MEW) and Ministry of Public Works (MPW) rooftop solar initiative have integrated a total of 1 MW capacity into their buildings. The MEW parking and six storage buildings have also integrated 0.18 MW and 3.7 MW, respectively.
- With the increase of PV integration, MEW reservoirs will also install solar PV to 25 locations with a total capacity of 300 MW. A capacity of 30 MW will

be integrated in the first phase at Subiya, expected to be tendered in Q4 2019.

- Kuwait Society for Science Advancement (KFSA) promotes and funds solar rooftops. It introduced a pilot program for PV panels on the roofs of 150 Kuwaiti homes (1.6 MW) and several cooperatives such as Al Zahra and Al Adailiya.
- The Ministry of Education created a scheme for solar rooftop on 100 school buildings of 1 MW and KPI fosters their installation in the commercial sector.
- Kuwait's Public Authority for Industry (PAI) signed a memorandum of understanding (MoU) with local firms Equate

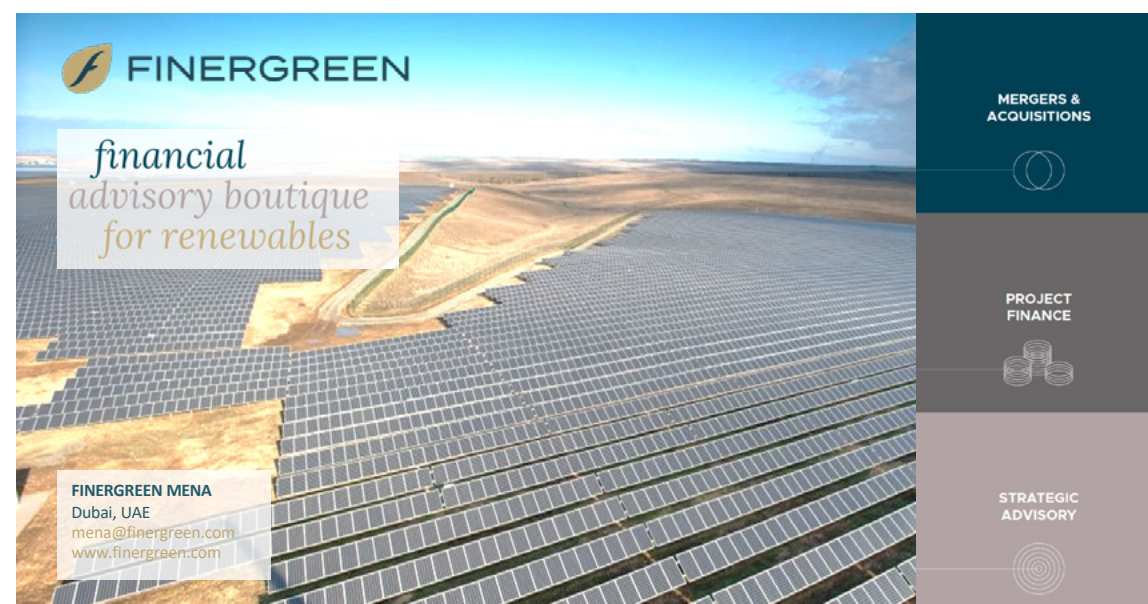
Petrochemical Company and the National Technology Enterprise Company (NTEC) to install a rooftop solar at the PAI office.

**Upcoming PV rooftop tenders** include PV installations on the roofs of existing and new parking areas at:

- Emergency Department - Main Workshops - Installed Capacity 2.7 MW
- Power Stations' Spaces - Installed Capacity 5 MW (expected Q2 2020).
- 10 MEW's buildings 3.64 MW (expected in 2022).

## Outlook:

Kuwait has several governmental institutions that participate in the power sector. However, those institutions have different mandates and the lack coordination thus affecting the country's deployment of renewable energy projects. The Higher Energy Committee was tasked to improve that situation to implement renewables in 2018. Similarly, the limited recourse to PPPs in the power sector is still affecting the speed of investment for renewable energy deployment.



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## F. MOROCCO

### Current Situation:

Even though the local demand of electricity has been stable in Morocco in 2018, the production has known some significant increase with the connection to the grid of a few projects (both renewables and traditional) and has grown by 8.2%. In H1 2019, the demand increased again by around 2.4% while the production grew by 25.1%.

Strategie Energetique Nationale Horizon 2030 includes an objective of 2 GW of renewables including hydropower, solar and wind making up 42% of the country's energy mix by 2020 and 52% by 2030. The investment cost for meeting the 52% target is estimated at \$30 billion by 2030.

The Moroccan Agency for Sustainable Energy (MASEN), a public-private venture, was established to lead the world's largest solar energy projects development, Noor and Midelt. Once completed these projects will provide 38% of Morocco's annual electricity generation.

- The Noor Ouarzazate Project-Phase1 to3:with a total capacity of 2000 MW, PV and CSP, developed in five major sites: Ouarzazate, Ain Bni Mathar, Fom Al Oued, Boujdour and Sebkhath Tah.

Noor Ouarzazate 1 was the first of the five sites that has reached commercial operation and is online since February 2016 with 160 MW (CSP) and 3 hours of energy storage capability. Noor Ouarzazate 2 with 200 MW (CSP) and Noor -Ouarzazate III (CSP) 150 MW were grid connected in 2018.

- Noor phase 4 - PV Project: This phase, which became operational in Q1 2018, consisted of three sections: Noor Ouarzazate IV, Noor Laayoune and Noor Boujdour having capacities of 72 MW, 85 MW and 20 MW, respectively. The project has been awarded with under a 20-year BOOT.
- Noor Midelt 1: The project will have a total installed capacity of 800 MW. It is the world's first advanced hybrid-station

of CSP and PV technologies. On completion, it will provide dispatchable solar energy during the day and until five hours after sunset. The project was awarded in Q2 2019 with a record-low tariff at peak hours of \$0.07 per kWh. The 200 MW Noor Midelt Phase 1 plant is located 20 kilometers north of the town of Midelt, with construction expected to start towards the end of 2019 and connection to the grid planned for 2022.

- Noor Midelt 2: July 2019, MASEN launched prequalification for a hybrid power plant. using PV and thermodynamic solar energy (SPC), combined with various thermal or battery storage technologies for 190 MW during peak hours (evening) and 230 MW during the day. MASEN has extended the deadline for the entries by developers to October 2019. Noor Midelt project is part-financed by the World Bank (\$125 million).

### OTHER PROJECTS

Over the next few years, Morocco is also planning projects outside of MASEN:

- ONE's Solar Projects: ONE has also launched its own separate project program calling for the development of 500 MW of PV capacity by 2020. The project will be completed over three phases: Tafilalt, Atlas and Argana. All projects are required to be completed within a five-year period after which operation will be transferred to MASEN.
- Noor Atlas: In January 2019, ONE started the pre-qualification process for selection of EPC contractors for the 200 MW scheme to deploy seven PV plants in the south and east of the country. The tender is divided into two lots: one lot for the construction of five plants – in Ain Beni Mathar, Bouanane, Boudenib, Boulemane (Enjil) and Outat El Haj – all in eastern Morocco; and a second lot for facilities in Tata and Tan-Tan, in the south. German development bank KfW is backing the project.

### DECENTRALIZED SOLAR

Morocco Solar Home Systems (SHS) was introduced in 2018 providing 19,438 solar home systems in over 1,000 rural villages. Each of the installed systems consist of two solar panels having a total capacity of 290 MW and two batteries with

sufficient storage capacity for up to 72 hours. The solar systems ensure uninterrupted supply of power and will provide, along with other electrification initiatives, 99% of rural Morocco with access to energy.

The country has also adopted a development program for solar water heaters (PROMASOL): it

entails the installation of 440,000 square meters of thermal solar sensors in 2012 and 1.7 million square meters in 2020. In terms of thermal energy produced annually, these figures will correspond to 1190 GWh by 2020. The program will reduce carbon emissions by 920,000 tons per year and create 920 permanent jobs.

### MOROCCO'S ISSUE OF GRID CONNECTION

A study has been commissioned in 2018 by EBRD to assess whether or not the medium voltage grid was able to absorb new renewable energy projects. After the implementation of Law 58-15, net metering for solar and wind power plants was introduced. It has increased the hydropower threshold from 12 MW to 30 MW and has allowed private investors to sell the excess electricity production to the national network of high voltage (HV), very high voltage (VHV) and low voltage (LV), but not more than 20% of their annual production. In parallel, other laws and new institutions were created to be involved in the national energy strategy. Law 48-15 established the national regulation entity named the "Autorité Nationale de Régulation de l'Électricité (ANRE)", responsible for determining tariffs for using medium voltage grid; however, it is not fully operational yet.

### Outlook:

The deployment of the renewable energy plans (solar and wind) in Morocco rely mainly on large-scale projects. The IEA considers that "this development of solar energy has been facilitated through the creation of MASEN as a dedicated agency with strong support from the government and ability to mobilize grants and concessional financing through public-private partnerships and to manage siting, permitting and tendering processes in a well-structured way as on shop stop".

Morocco is on the way to reach its ambitious goal, but challenges remain:

1. At \$30 billion, the amount of investment required till 2030 is important;
2. Clear rules and net metering to facilitate C&I and allow grid access to private projects need to be completed;
3. Present power system is more flexible as other thanks to pumped hydro, CSP with integrated storage and interconnexion with Europe, but ONE expects issues of integration on the grids once the share of wind generation will have grown further.

Morocco is also looking at sizeable potential for greater uptake of renewable heat or electricity in industry or renewables for export as electricity as well as hydrogen-rich chemical and fuels.



## G. OMAN

### Current Situation:

The demand for electricity is expected to increase from 7.7 GW in 2019 to 16 GW in 2030. Oman is mainly reliant upon hydrocarbons for power generation.

The country has a significant potential for renewable energy with one of the world's highest solar energy densities. The National Energy Strategy for 2040 foresees 10% of the total energy

mix to be supplied by renewable energy sources by 2025. PV and wind projects are the main drivers of renewable energy in the country. These objectives are supported by Oman 2020 Vision and Seven-year Development Plan calling for economic diversification and reduced dependency on oil revenues.

The share of renewable energy generation objectives have been

reviewed to higher targets. The sultanate has forecast an increase in peak power demand of 53%, reaching 9.96 GW by 2023. Of this total, 11% of electricity generated will come from renewable energy sources. By 2030, renewable energy should account for over 30% of the energy mix.

### UTILITY SIZE PROJECTS

- The 500 MW Ibri II Solar Independent Solar Project, around \$400 million, was awarded in early-2019 and is expected to be commercially operational in June 2021.
- Petroleum Development Oman (PDO) signed a 23-year PPA agreement for the 105 MW Amin Solar PV project in early 2019. Commercial operation is scheduled for May 2020.
- In the second phase of its solar program, Oman Power and Water Procurement Company

(OPWP) launched in July the prequalification phase for two IPPs with a combined output of more than 1GW. The Manah Solar I IPP solar facility and the Manah Solar II IPP will each have capacity between 500 and 600MW. The qualifications of 9 consortiums have been announced on the 17th of December 2019. OPWP is currently working to finalize the request for proposals (RFP). Contracts are expected to be awarded in Q3 2020 with the commercial operation planned in Q4 2022.

- Several distributed generation power projects from 10 MW to 40 MW in Sohar Port are planned to

replace natural gas to power local businesses.

- OPWP is planning to install a CSP plant with a capacity of up to 600 MW plus battery storage systems. The project is anticipated to proceed only if Oman's plan to deploy a Clean Coal Independent Project is not pursued.

### OFF GRID AND MINI-GRID

The Rural Areas Electricity Company (RAECO) is looking to add 90 MW of renewable energy capacity by 2020. In 2018, RAECO announced an initiative to hybridize the existing 11 small-scale diesel power plants at off grid sites, transforming the plants into a combination of solar PV and diesel power hybrids and storage; 48 MW of solar PV capacity, 70 MW of diesel generation capacity and 28 MW of battery energy storage systems. The projects shall be developed and operated by the private sector under a BOOT basis under a 15-year PPA.

## SOLAR ROOFTOP

In May 2017, Oman Authority for Electricity regulation launched Sahim I, allowing large households and businesses to install small grid connected PV systems at their own costs and to sell power back to the grid at prevailing bulk electricity tariff.

In mid 2019, Oman was consulting for a second phase, Sahim II. This renewed scheme aims the deployment of a wider scale of small grid connected PV systems for around 10% to 30% of residential premises. Unlike Sahim I, the cost of procuring, installing and operating PV roof systems will not be met by the consumer but by private developers, selected on a competitive base. Private sector solar developers will recover their costs through contracts with licensed suppliers. Participating customers will make contributions to Sahim II based on expected savings on their electricity bills. The pilot batch of Sahim will target 3000-5000 houses in Muscat to reach 100,000 houses by 2023.



### Outlook:

Oman continues to further develop its renewable energy deployment and OPWP plans to procure 2.6 GW of renewable energy projects. However, for the solar sector to meet its full potential, further regulatory policies, fiscal incentives and public financing is needed.



## H. PAKISTAN

### Current Situation:

While total power generation capacity of Pakistan has reached 25,374 MW, population growth and industrial and economic development have resulted in a growing gap between demand and supply of electricity. Shortages are numerous and 51 million people still do not have access to electricity according to latest figures available (2017).

However, Pakistan is also aiming to reduce dependency on costly imported fossil fuels, representing today 40% of its electricity generation. Moreover, the country is seeking to increase climate change mitigations and to meet SDG goals engagements.

Pakistan, located in the sun belt, has an enormous solar potential existing in particular in provinces such as Sindh, Baluchistan and

some southern parts of Punjab. These areas receive 2 MWh/m<sup>2</sup> solar irradiation and 3,000 hours of sunshine per year.

### ALTERNATE ENERGY DEVELOPMENT BOARD (AEDB)

To support the development of alternative energy, AEDB was established in May 2010. The organization has a mandate to explore and implement renewable commercial projects for the public and private sectors. In addition to AEDB, Pakistan Council of Renewable Energy Technologies (PCRET) has also been acquiring technical expertise for a wide the promotion of solar and wind technologies.

However, the share of renewable energy is still limited to 4% installed capacity of renewable power. The last two years have seen the emergence of central government level Quaid-e-Azam Solar PV Park, with a designed capacity to generate 1,000 MW. Yet this project is currently producing only 400 MW. Initiatives are also launched by local states and according to AEDB, up to 28 projects of 956.8 MW solar capacity are presently under development.

### NEW IMPULSE

In February 2019, the Cabinet Committee on Energy (CCoE), chaired by the Finance Minister, approved proposals from the Ministry of Energy (for all future renewable energy projects to be treated under the Renewable Energy Policy 2019).

CCoE decided to permit renewable energy projects that have letter of support issued by AEDB to proceed towards achieving their required milestones in accordance to Renewable Energy Policy 2006.

In addition, the National Transmission and Despatch Company (NTDC) in early 2019 has submitted to the National Electric Power Regulatory Authority (NEPRA) an indicative generation capacity plan 2018-40 recommending policies and regulations across the value chain of the electricity sector to reshape the generation mix of Pakistan.

Moreover, based on a draft policy report by the Renewable Energy Policy in 2019:

- NEPRA has switched from a FIT model to auction-based bidding in 2019
- The government has announced in Q3 of 2019 a target of 60% of renewable energy in its energy mix by 2030, out of which 30% from hydropower.

So far, AEDB launched, in November 2019 a tendering process under IFC funding of 11 wind IPP projects totaling 560 MW. Solar projects are expected to follow.

### SINDH SOLAR ENERGY PROGRAM (SSEP): A LOCAL PROVINCES LEVEL INITIATIVE

The government of Sindh in Pakistan has launched in 2018 a framework for a major solar initiative. The World Bank committed \$100 million of funding in 2019. The plan aims to support solar deployment in the province across utility-scale, distributed generation and residential segments.

This includes up to 400 MW of solar park capacity (50-200 MW per park) starting with 50 MW, which will herald the first tariff-based competitive auctions in Pakistan – originally announced in late-2017. The solar park concept aims to help to reduce the risk profile for private sector developers by ensuring that land is secured, permits obtained and power offtake is pre-arranged.

A pilot of a 50 MW site near Manjhand, Jamshoro District totaling \$40 million, was launched. The project will be operational by 2020 and private sector developers are encouraged through risk reduction, secured land permits and power offtake.

The program also aims to integrate 20 MW of solar power through PV rooftop projects such as in Karachi. Solar is targeted to be placed on public sector buildings as well as home systems in the country. It is expected to have tariffs from approximately \$0.06 to 0.10/kWh for distributed solar projects that are lower than the retail tariff charged by utilities.

### UNSOLICITED PROJECTS

For unsolicited projects, asset owners can opt for either “cost-plus” or “upfront tariffs”. In each instance, NEPRA determines “the technical and financial parameters for capital and operating expenditures and applies a rate of return on equity”. For example:

- In January 2019, the Javed Solar Park (49.5 MW) filed an application for 25-years of tariffs: \$0.0855/kWh for the first 11 years, \$0.0565 for the next two years and \$0.02969 for the remainder

of the contract. The levelized tariff would be \$0.07145/kWh, according to NEPRA.

- NEPRA has received four applications relating to 200 MW of solar PV projects along the Quetta-Chaman Highway in Balochistan.
- In June, a project was submitted to NEPRA to build four 50 MW projects at Kuchlak, each with just under 150,000 solar modules of 335 Wp rating and installed on single-axis trackers. Each project, to be completed by June 2020, is set to cost \$36 million, financed

by 80% debt and 20% equity.

- NEPRA received an application for a 50 MW generation license from a private company in August 2019. According to the documentation submitted, the company intends to install a PV plant in Saleh Pat in the district of Sukkur, in the Sindh region. Should the plant be granted a license, it will start commercial operation by 2021 and the electricity generated will be sold to the Central Power Purchasing Agency (Guarantee) Limited.

### DECENTRALIZED ENERGY, ROOFTOP AND OTHER SOLUTIONS

There has been a strong surge in domestic installation of rooftop photovoltaic panels in larger cities. For projects under 1 MW, net metering regulations came into effect in September 2015. The government is targeting at least 1 million customers and adding approximately 3,000 MW of solar power through net metering.

Cost of electricity being high (0.14US cent/kWh), industries will be more interested in rooftop solar solutions. Hence, decentralized solar shows good potential. With important issues of access to energy still existing, solar should be in the rise for affordable off grid or mini grid solutions.

### ENERGY STORAGE

Energy storage is being deployed for small scale residential and commercial applications. The new REN Policy draft consider this as a “new technology” to promote if it allows lower LCOEs.



## SOCIAL AND ENVIRONMENTAL IMPACT ASSESSMENT

The Environmental and Social Management Framework' (ESMF) released in 2018 aims to identify the social and environmental impact of the projects. The framework is in line with the World Bank safeguard requirements and the national and provincial regulatory bodies. It details mitigating methodologies to address social and environmental impacts.

### Outlook:

Previous renewable energy policy in Pakistan provided multiple incentives to the private sector to develop renewable energy projects. However, the absence of an action plan complementing the policy framework undermined the effort.

Availability of finance will be a key factor for local developers, but development of the grid must also follow.

With the implementation of the Indicative Generation Capacity Expansion Plan (IGCEP), the country sees a way forward with a better coordinated strategy for the country's power sector. AEDB provides a one window facility to the investors in setting up ARE -IPP projects in Pakistan under this policy. Overall, the future of the energy sector in Pakistan relies on government-created initiatives to achieve a demand and supply balance in the energy sector.



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## I. SAUDI ARABIA

### Current Situation:

Saudi Arabia's energy demand has been rising with consumption increasing by 60% in the last 10 years. The demand for electricity in 2019 is about 62.7 GW and is forecast to increase by up to 120 GW in 2030, according to Frost and Sullivan.

Based on vision 2030, the Kingdom of Saudi Arabia is aiming to reduce its dependency on oil revenues, diversifying its energy mix and

developing its significant potential of renewable energy. A dedicated structure within the Ministry of Energy, the Renewable Energy Project Development Office (REPDO) was established.

In 2018, the ambitions of Saudi Arabia's National Renewable Energy Program (NREP) were substantially increased with a 5-year target of 27.3GW and a 12 years target of 58.7 GW, including 40 GW of PV and 2.7 GW of CSP. In total, the government is aiming

investments in renewable energy up to \$50 billion until 2023.

Measure to foster the development of solar industry include:

- **Renewed legal and regulatory frameworks** within the NREP.
- **The Mutjadedah Program**, to support the development of the private renewable energy sector focusing on renewable energy component manufacturing, IPPs and distributed solar electrical generation projects.

## PROJECTS

### Round 1

The initial round of the NREP included the launch in 2017 – 2018 of the two first tenders of REPDO:

- PV project of 300 MW at Sakaka, awarded in 2018
- Wind farm of 400 MW at Dumat al Jan dal, awarded in 2019

### Round 2

Carrying a minimum requirement of 17% local content as calculated by the mechanisms defined by the Local Content & Government Procurement Authority (LCGPA), six projects for a total of solar PV capacity of 1.47 GW, divided into two categories are under tendering:

- Category A for smaller projects - require consortium members to partner with at least one local man aging member
  - Medina (50MW)
  - Rafha (20MW)
- Category B for larger projects - allowing a maximum of four and a minimum of three winning bidders
  - 600 MW Al Faisaliah (complementary of larger project of PIF to provide a total of 2.6 GW to Mecca)
  - 300 MW Jeddah
  - 300 MW Rabigh
  - 200 MW Al Jawf

### Round 3

Six projects (Table 4) are expected to be tendered early 2020.

Table 4: Saudi Arabia Round 3 Projects

Project	Capacity (MW)	Location
Yanbu wind independent power project (IPP)	850	80 km from Yanbu city
Al-Rass solar PV IPP	300	30 km from Al-Rass city
SAAD solar PV IPP	300	85 km from Riyadh city
Wadi ad-Dawasir solar PV IPP	70	10 km from Wadi ad-Dawasir
Layla solar PV IPP	40	5 km from Layla city
Mahad al-Dahab solar PV IPP	20	15 km from Mahad al-Dahab





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#### C&I AND ENERGY STORAGE IN SAUDI

With the engagement of electricity price reform, interest for solar C&I is growing. Authorities, in particular ECRA, are currently working on devising a clear regulatory framework for such projects. It is anticipated to be launched in mid-2020. The Mutajadedah program, designed by the SIDF could be the main driver to push forward more projects like the off-grid system at Nadec (30 MW). With this program, the fund offers financing for rooftop solar captive systems for 12 years, with a three-year grace period and attractive interest rates.

Even though storage is not explicitly mentioned in the energy mix or among REPDO-targeted technologies, storage solutions are not out of the picture as a 2.4 GW capacity of CSP is expected to be released in the near future.

#### MAJOR CHANGES IN KSA:

- Focus on local developers, for which Category A projects were dedicated. An addendum to the RFP was introduced to relax some regulations for the local PV module manufacturers.
- The Local Content and Government Procurement Authority was established to oversee and audit local content compliance across all government procurement activities.
- Higher local content requirements were mandated for Round 2 solar projects from 30% in Round 1, to 40%.
- Launch of a Renewable Energy Financing package by SIDF to support the growth of utility and distributed generation sectors.

#### Outlook:

The National Industrial Strategy strongly emphasized on the need to cooperate with the private sector that could lead into significant developments within the country. A stronger dialogue between the public and private sector is anticipated to speed up the expansion of the solar market. Ultimately, with the development of framework, regulation and business models, the C&I sector will offer significant opportunities for increased distribution generation projects.





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J. TUNISIA

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ENERGY

ACTION PLAN

AIMS TO

HAVE 30%

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COME FROM

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### Current Situation:

The national consumption of electricity in Tunisia has slightly increased between 2017 and 2018, from almost 15.6 GWh to 15.8 GWh. At the end of 2018, renewable energy represented 5.7% of the national energy production capacity (240 MW Wind, 10 MW Solar, 60 MW Hydro).

The new regulatory framework that was introduced in 2015/2016 by the Ministry of Industry and Small and Medium Enterprises is leading the country to a major transition. Moreover, The 2030 Renewable Energy Action Plan aims to have 30% of the total energy production come from renewables

This includes installations of 1,000 MW total capacity during the first period 2017-2020 and an additional 1,250 MW during the period 2021-2030.

The country is following three different regimes for project development which are as follows:

#### • Auto consumption regime:

For producer's sole consumption with possible grid connection. Projects authorized based on simplified procedures are granted after undertaking complete studies of projects. Many such small-scale projects have been approved (total of 16 MW).

#### • Local consumption regime:

Electricity production sold exclusively to STEG under a PPA, with a tariff fixed depending on size and permitting process:

› For authorisation regime (small scale projects: >10 MW for solar PV and > 30 MW for wind) with simplified tender process. Two first rounds totalled 134 MW PV were mostly dominated by international developers and are currently under construction and development.

However, few projects awarded were completed. This demonstrates that the government's internal evaluation of bids need to be improved in order to select more realistic bids (the government award process was focused on the lowest kWh prices offered by bidders as a first selection criterion, rather than on technical and financial qualifications of each bidder. i.e. how they are financed, experience of the developer, etc. as a second selection criteria).

A third tender for the development of six 10 MW and ten 1 MW projects was kicked off in July, 2019 with a bidding deadline on the 26th November, 2019.

› For concession regime (medium to large scale projects: < 10 MW for PV solar and < 30 MW for wind), tender process applies. The launch of a 500 MW PV project resulted, in December 2019, in the allocation to three consortiums respectively of 300 MW, 100 MW and 100 MW. The lowest bid came at \$0.025 per kWh.

#### • Exportation regime:

Devised for electricity production for exportation purposes are entirely and exclusively with no capacity threshold or tender process and only royalties and fees to government, this regime has so far not been implemented.

Table 5 shows a summary of the different rounds and tenders for the local consumption regime.



Table 5: Local Consumption Regime in Tunisia

LOCAL CONSUMPTION REGIME			
AUTHORIZATION REGIME		CONCESSION REGIME	
SOLAR PV	WIND	SOLAR PV	WIND
Round 1 (Awarded) 6 x 10MW +4 x 1MW	Round 1 & 2 Combined (Awarded) 4x30MW	1 <sup>st</sup> 500 MW (2 x 50MW + 2 x 100MW + 1 x 200MW)	1 <sup>st</sup> Call for Tender (ongoing) 300MW (1x200 MW + 1x100 MW)
Round 2 (Awarded) 6 x 10MW + 10 x 1MW		Call for Tender (ongoing)	2 <sup>nd</sup> Call for Tender (ongoing) 200 MW (2 x 100 MW)
Round 2 (Awarded) 6 x 10MW + 10 x 1MW		Call for Tender (ongoing)	2 <sup>nd</sup> Call for Tender (ongoing) 200 MW (2 x 100 MW)

C&I SECTOR

The C&I segment in Tunisia is a very promising sector with the rise of initiatives within the self-consumption regime. However, the market is struggling with subsidized fuel prices. Incentives i.e. tax breaks, need to be given to the industry to invest in C&I.

CHALLENGES

Finance: international banks and finance institutions have so far played a key role in unlocking capital in the market while access to local finance was limited.

Grid: important investments had to be engaged to upgrade grid connections as well as distribution systems in order to allow integration of new renewable energy capacities.

Outlook:

With an annual 2-5% increase of the demand for renewable power for seen in the coming years, Tunisia’s government expects to attract \$2 billion of foreign investment for wind and solar power projects over the next three years. The Tunisian Ministry of Industry and Small and Medium Enterprises declared that the funding would be used to support an additional production capacity of 1,900 MW by 2022. The overall general context of the country should help raise Tunisia’s credit rating, reduce interest rates and financing costs and improve investor confidence.

K. UNITED ARAB EMIRATES

Current Situation:

UAE has been and is still a front runner in the energy transition in the GCC with the highest portfolio of renewables in the region. The UAE Vision 2021, UAE Green Growth Strategy, UAE Future Strategy and the UAE Centennial Plan (2071) as well as the UAE Climate Plan and UAE Energy Plan 2050 fix high targets for renewables. To raise the share of clean energy to 50% by 2050, 44 % would be supplied by renewables and 6% from nuclear power.

PROJECTS

Dubai

- Mohammad Bin Rashid Al Maktoum Solar Park, the largest single site solar park in the world will have a capacity of 5GW by 2030. The fifth phase totaling 900 MW, was allocated in November 2019, with a world record price of \$0.01693 per kWh.

- The current total production capacity of the solar park reaches 713 MW. The third to fifth stages of the project are still in process to be completed in the next years.
- The expected completion of the project is in 2030.

Table 6: Different phases of 5 GW Mohamad bin Rashid solar Park

Phase	Capacity	Technology	Status
Phase 1	13 MW	PV	Operational; 2013
Phase 2	200 MW	PV	Operational
Phase 3 - Stage 1	200 MW	PV	Operational; 2018
Phase 3 - Stage 2	300 MW		To be completed in 2020
Phase 3 – Stage 3	300 MW		
Phase 4	950 MW	PV (250MW) CSP ( 700 MW)	To be completed by 2030
Phase 5	900 MW	PV	To be commissioned starting Q2 2021

- Floating PV DEWA has issued an RFP appointing consultants to study, develop and construct floating solar PV plants in the Arabian Gulf. The utility is currently studying the installation of a floating solar PV system on the municipality’s deep tunnel rainwater drainage lakes – a project which is 50% complete. The floating solar station is expected to be placed on artificial lakes near Al Maktoum International Airport “so that the lakes receive rainwater and surface water from neighboring areas to be stored and then discharged to the deep tunnel” said Dawoud Al Hajiri, director general of Dubai Municipality.

Abu Dhabi

Abu Dhabi was home to the region’s first commercial scale CSP plant, which came online in 2013. Now the emirate is engaged in a new cycle of tenders to grow its solar energy capacity:

- The so far world’s biggest solar

park, Noor in Sweihan entered commercial operation in mid-2019 with a capacity of 1.78 GW.

- In early-2019, Abu Dhabi’s Emirates Water & Electricity Company called for an EOI to develop a 2 GW solar project in Al Dafrah. The 24 shortlisted local and international

companies submitted their proposals in November 2019. The project is expected to be completed in Q1 2022.

- A new tender of similar size is expected for early-2020 and Abu Dhabi could aim up to 6 GW of additional capacity by 2026.



## Northern Emirates

Up to 300 MW of solar are planned in the Northern Emirates. In early-2018, Ras Al Khaimah Municipality announced its new renewable energy and energy efficiency program, including a

target of 25-30% clean energy capacity by 2040. In January 2019, the Federal Electricity and Water Authority (FEWA) and the emirate of Umm Al-Quwain signed an agreement for the development of a 200 MW solar park. Bee'ah in the emirate of Sharjah is planning

for solar PV over its landfill, and Sharjah Investment and Development Authority (Shurooq) and Diamond Developers announced in March 2019 the construction of a sustainable city in Sharjah entirely powered by solar PV energy.

## NET METERING

Dubai's net metering policy, in particular, Shams Dubai, achieved a 125 MW of installed capacity in residential, commercial and industrial buildings in 2019. Similarly, Abu Dhabi's planned net metering establishment in 2017 incentivized the C&I sector to install rooftop solar systems. However, specific regulation is still expected to be released.

## Outlook:

UAE is faced with increased power coming online from renewables, nuclear and distributed solar energy which has created several challenges for the management of the grid. Storage is starting to be included in solar tenders as a key component for solving not only intermittency but managing daily and seasonal peaks.



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### Current Situation:

About 90% of the energy consumption of Iraq is based on fuel, the rest is supplied by natural gas. According to IEA, the electricity demand in Iraq, will increase with a 6% annual growth rate by 2030 and is expected to double to around 17.5 GW average per year.

With a high population growth and insufficient production and transmission capacities, the country is presently facing important issues of electricity shortages. This situation has fostered the use of diesel generators to fill the gap.

Iraq's engagement in renewables has been so far modest, with priority given to switch from oil to gas. However, as the country is now seeking to diversify its energy mix, the development of renewable energy power generation technologies of 21 GW of solar and 5 GW of wind by 2030 could improve the sustainability and reliability of electricity in the country. The share of renewables in the energy mix could possibly reach up to 30% by 2030.

Iraq's potentials of solar energy are important, with an average irradiation of 5.6 kWh/m<sup>2</sup>/day over 3,000 hours of bright sunshine per year. Combined generation of wind and storage development may, however, be required in parallel to face intermittency and stability issues.

The country's approach has not been very successful previously, including the feed-in-tariffs that was put in place in 2017. Iraq began taking a more decisive move in early 2019. UNDP supported the formulation of a solar policy aiming to deploy 5 GW of utility scale solar plants, as well as 5 MW of residential PV and 10% of the country's power demand with renewable energy by 2028.

In May 2019, the Ministry of Electricity has launched a first round of tender for a 755 MW of solar PV. The ministry invited companies to participate in the projects that will be located across the five provinces, Babel, Wasit, Karbala, Al-Muthanna and Diwaniyah. The capacities for each project:

• 50 MW and 30 MW Al-Muthanna (South)

• 2 x 50 MW Wasit (East)

• 225 MW Babel (Central)

• 300 MW Karbala (Central)

• 50 MW Diwaniyah (Central)

The projects will be developed on BOO basis. They were tendered in 2019 and are expected to be completed in 2020. As in other countries, the country is placing a focus on creating a local PV manufacturing sector.

Rooftop installations had increased significantly in Iraq over the past two years. The country shows a strong potential to implement off grid and distributed solar energy generation. Such solutions are providing a substitute for private diesel generators for additional need for energy. Solar capacities are installed in refugee camps with a plan for having a combination of PV and energy storage to be implemented in the Mam Rashan camp. A 5 MW solar project has also been supported by the UNDP to develop solar of households in Najaf, in central-south Iraq.

## 7. Conclusion

The trend in the MENA region has so far been towards the development of large utility scale projects. Combination of decreasing LCOE and latest technology have been enabled through competitive bidding. Solar PV is expected to remain the preferred option with growing contributions from CSP and storage projects.

Energy storage is set to emerge as a vital component for further renewable energy developments in the region. Large scale hybrid PV combined with CSP and storage projects may increasingly prove beneficial, as has been the case with projects developed in Morocco. A similar approach is also observed in the UAE. Cost of storage remains an issue, but with decreasing prices, adoption of battery storage is expected to grow for utilities, residential, commercial and industrial consumers.

Globally, the classic utility business models are undergoing profound changes. End use of solar energy is increasing steadily. There is a significant demand for distributed generation projects throughout the region, even more changes in regulatory policy to incentivize self-generation along with excess energy sale back to the utility grid are necessary for this market to take off. In the long run, it is a new distribution of role between utilities and decentralized production, between electricity producers and consumers that is coming up. Beyond self-consumption, interaction will increase on the grid to balance the system with tools like net metering systems, wheeling, etc. These trends will require more flexibility emphasizing the role of grid and demand side management and buffer storage capacity. They foster the development of innovative technologies such as Power to X. The industry is embracing these changes and is looking at a promising future for solar clean energy.

### Outlook:

The power shortage that is currently faced by the country is being partly addressed through diversification of the energy mix. An emphasis on gas exists, but renewable energy is increasingly on the map. The grid capacity will, however, also have to be developed. Investments in transmission and distribution networks could be the central priority for the country in the medium- and long-term strategy. In this context, a continuous growth of distributed solar energy and C&I by residential consumers and industry is expected.



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## 8. Glossary of Terms

<b>AEDB</b>	: Alternate Energy Development Board	<b>IEA</b>	: International Energy Agency
<b>BIPV</b>	: Building Integrated Photovoltaics	<b>IFC</b>	: International Finance Corporation
<b>BNEF</b>	: Bloomberg New Energy Finance	<b>IGCEP</b>	: Indicative Generation Capacity Expansion Plan
<b>BOO</b>	: Build Own and Operate	<b>IRENA</b>	: International Renewable Energy Agency
<b>BOOT</b>	: Build Own Operate and Transfer	<b>ISCC</b>	: Integrated Solar Combined-Cycle
<b>CCoE</b>	: Cabinet Committee on Energy	<b>ISES</b>	: Integrated Sustainable Energy Strategy
<b>CdTe</b>	: Cadmium Telluride	<b>JICA</b>	: Japan International Cooperation Agency
<b>CIGS</b>	: Copper Indium Gallium Selenide (CIGS)	<b>JREEEF</b>	: Jordan Renewable Energy & Energy Efficiency Fund
<b>CREG</b>	: Algerian Electricity and Gas Regulation Commission	<b>KAPP</b>	: Kuwait Authority for Partnership Projects
<b>CSP</b>	: Concentrated Solar Power Plan	<b>KAPSARC</b>	: King Abdullah Petroleum Studies and Research Center
<b>DEWA</b>	: Dubai Electricity and Water Authority	<b>KFSA</b>	: Kuwait Society for Science Advancement
<b>DFI</b>	: Development Finance Institution	<b>KfW</b>	: The German Development Bank
<b>ECRA</b>	: Electricity Co-generation Regulatory Authority	<b>KISR</b>	: Kuwait Institute for Scientific Research
<b>EETC</b>	: Egyptian Electricity Transmission Company	<b>KNPC</b>	: Kuwait National Petroleum Company
<b>EOI</b>	: Expression of Interest	<b>KOC</b>	: Kuwait Oil Company
<b>ERA</b>	: Electricity Regulatory Authority Plan	<b>KPC</b>	: Kuwait Petroleum Corporation
<b>ESMF</b>	: Environmental and Social Management Framework	<b>LCGPA</b>	: Local Content & Government Procurement Authority
<b>FEWA</b>	: Federal Electricity and Water Authority	<b>LCOE</b>	: Levelized Cost of Electricity
<b>GDP</b>	: Gross Domestic Product	<b>MASEN</b>	: Moroccan Agency for Sustainable Energy
<b>HTF</b>	: Heat Transfer Fluid	<b>MEW</b>	: Ministry of Electricity and Water



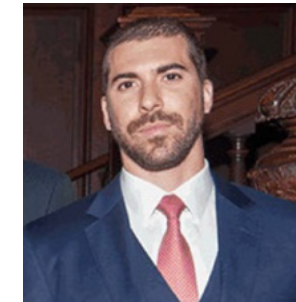


<b>MORSEEF</b> :	Morocco—Sustainable Energy Financing Facility	<b>PPP</b> :	Public-Private Partnership
<b>MoU</b> :	Memorandum of Understanding	<b>PV</b> :	Photovoltaics
<b>MPW</b> :	Ministry of Public Works	<b>RAECO</b> :	Rural Areas Electricity Company
<b>NEEAP</b> :	National Energy Efficiency Action Plan	<b>REFIT</b> :	Renewable Energy Feed in Tariff
<b>NEPRA</b> :	National Electric Power Regulatory Authority	<b>REN</b> :	Renewable Energy
<b>NPDRE</b> :	National Program for the Development of Renewable Energies	<b>REPDO</b> :	Renewable Energy Project Development Office
<b>NREA</b> :	New and Renewable Energy Authority	<b>RFP</b> :	Request For Proposals
<b>NREAP</b> :	National Renewable Energy Action Plan	<b>SEWA</b> :	Sharjah Electricity and Water Authority
<b>NREL</b> :	National Renewable Energy Laboratory	<b>SHS</b> :	Morocco Solar Home Systems
<b>NREP</b> :	National Renewable Energy Program	<b>Shurooq</b> :	Sharjah Investment and Development Authority
<b>NTDC</b> :	National Transmission and Despatch Company	<b>SIDF</b> :	Saudi Industrial Development Fund
<b>NTEC</b> :	National Technology Enterprise Company	<b>SSEP</b> :	Sindh Solar Energy Program
<b>OPWP</b> :	Oman Power and Water Procurement Company		
<b>PAI</b> :	Kuwait's Public Authority for Industry		
<b>PCRET</b> :	Pakistan Council of Renewable Energy Technologies		
<b>PDO</b> :	Petroleum Development Oman		
<b>PPA</b> :	Power Purchase Agreements		

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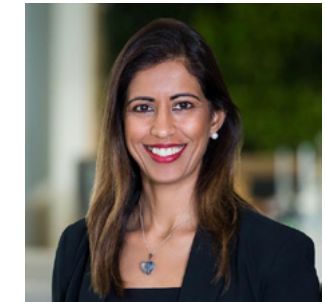
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