



CLEAN HORIZON

The Energy Storage Experts



Opportunities and potential of the energy storage Market in the Middle East

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Agenda



1. Executive summary: Energy storage opportunities by country



2. Middle East: Country overview

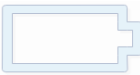


3. Questions





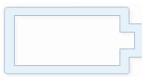
Executive summary: Battery energy storage opportunities per country



	Application	When will the opportunity arise?	Discharge duration
Saudi Arabia	Renewable integration	2020	2 to 4 hours
UAE	None	N/A	N/A
Jordan	<ul style="list-style-type: none">▪ Renewable integration▪ Frequency regulation	<ul style="list-style-type: none">▪ Now▪ 2020	<ul style="list-style-type: none">▪ 3 hours▪ 1 hour
Egypt	Renewable integration	Most likely 2020	Up to 6 hours
Lebanon	Renewable integration	Now	1 hour



Executive summary: Renewable status and targets per country



	Intermittent renewables today	Target year	Target energy share of renewables
Saudi Arabia	--	2030	58.7 GW
UAE	4%	2050	44%
Jordan	5.71 %	2020	25%
Egypt	8%	2030	35%
Lebanon	8.4%	2030	30%



Agenda



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2. Middle East: **Country overview**



3. Questions





Saudi Arabia: A country with remarkable untapped opportunities



Despite the huge potential, no clear intentions or regulatory frameworks concerning energy storage are available yet

- More than 5 GW of off-grid generation in the country.
- KACARE¹ will allocate 2.7 million USD for energy storage demonstration projects (Technology Localization & Commercialization (TLC) initiative)
- No regulatory or policy frameworks tackle the topics of renewables, energy storage or ancillary services
- Storage systems were expected by 2021 thanks to the \$200 billion / 200 GW project with the “largest utility-scale battery” as a key feature.
 - The revision of this project’s realization may affect the intentions to adopt such systems
- Why isn’t the KSA pushing for more storage?
 - Sensitive issue due to current high prices
 - Need to educate banks and investors on country-specific project funding
 - More information and education are needed, so storage adoption is awaited on the mid to long terms

Despite being a large country with ambitious objectives regarding the deployment of renewables, Saudi Arabia presents no clear opportunity for energy storage

1. KACARE: King Abdullah City for Atomic and Renewable Energy



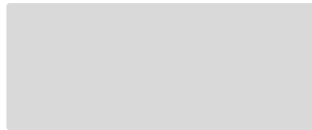
Legend



Concrete opportunity for storage



Partial opportunity for storage



No opportunity for storage



Country overview: Kingdom of Saudi Arabia



Nature of the opportunity / rationale for absence of opportunity

When will the opportunity arise?

Discharge duration

Generation

PV-plus-storage PPAs are the only opportunity for storage today in the country

End of 2020

2 to 4 hours

Grid

There is currently no market for ancillary services provision and electricity production relies heavily on fossil fuels

N/A

N/A

BTM

The electricity prices are reasonably low and the price structure does not encourage storage adoption

N/A

N/A



The United Arab Emirates: An early adopter that stalled on storage deployments



Once interested in energy storage solutions, the UAE doesn't express any need for battery energy storage in the near future

- Thermal and pumped hydro currently are the Emiratis' preferred methods of energy storage
 - Dubai showed real interest towards pumped-hydro storage:
 - 01/2018: MoU for a 400 MW/2500 MWh pumped hydro storage power station in the Arabian Gulf
 - 11/2018: MoU for a 250 MW pumped-storage power station near the Hatta Dam (Dubai Electricity and Water Authority, EDF)
- Power-to-Gas storage is witnessing a remarkable growth:
 - Siemens project at the Mohammed Bin Rashid Al Maktoum Solar Park
 - Collaboration between DEWA (Dubai Electricity and Water Authority), Toyota and Air Liquide for hydrogen-powered mobility

A noticeable interest in energy storage can be observed. However, no foreseeable interest in new battery energy storage projects



Country overview: United Arab Emirates



Nature of the opportunity / rationale for absence of opportunity

When will the opportunity arise?

Discharge duration

Generation

- Nothing has been done beyond the PV + storage project in Dubai (1.2MW/7.2MWh pilot project)
- Other storage alternatives are being considered (thermal, pumped-hydro, PtG)

N/A

N/A

Grid

- Nothing has been accomplished beyond the already available ADWEA BESS (108MW/648 MWh) but no further intentions
- No current market for ancillary services provision
- No regulatory framework for storage

N/A

N/A

BTM

Flat tiered tariffs and net-metering structurally don't allow storage investment recovery.

N/A

N/A

ABU DHABI WATER & ELECTRICITY AUTHORITY (ADWEA) NAS BESS

8 MW of NaS are being used to level electricity load curve in order to reduce the high cost of running peak load electrical generation. Such benefit is accomplished by storing excess available energy at night and injecting such energy back into the electrical grid during the day in Abu Dhabi. (Announcement date of project unknown - considered to be the same as commissioning date; the first 4 MW came online in January 2010 followed by an additional 4 MW in 2011 and finally 108 MW / 648 MWh online in 2017 according to sources at NGK.

Location

Island / Mainland:	Mainland
Continent:	Asia
Country:	United Arab Emirates
State / Region:	Abu Dhabi
City:	Abu Dhabi
Connection Point:	T&D

Storage Technology

Technology Category:	Electrochemical
Technology:	Sodium Sulfur Battery

Status

Status:	Operational
Announcement Date:	01/01/2010
Commissioning Date:	01/12/2017

Size

Nominal Power (MW):	108.00
Energy Capacity (MWh):	648.00
Duration Discharge (h):	6.00

Revenue(s)

Application(s)

Main application:	Electricity Bill Reduction
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Additional information

Actors

Energy Storage Technology Manufacturer:	NGK Insulators
System Integrator:	NGK Insulators
Developer / Owner:	Abu Dhabi Water & Electricity Authority

References

Hyperlink 1:	Link
Hyperlink 2:	Link
Last Updated:	12/09/2018

Source: *Clean Horizon Energy Storage Source (CHESS)*, Clean Horizon's own global energy storage project database

MOHAMMED BIN RASHID AL MAKTOUM SOLAR PARK BATTERY

The 1.2 MW / 7.2 MWh storage system will be used for solar smoothing, solar load-shifting, and to provide frequency regulation to the grid and is located alongside a 13 MW PV farm at the Mohammed bin Rashid Al Maktoum Solar Park.

Location

Island / Mainland:	Mainland
Continent:	Asia
Country:	United Arab Emirates
State / Region:	Dubai
City:	Dubai
Connection Point:	Generation

Storage Technology

Technology Category:	Electrochemical
Technology:	Sodium Sulfur Battery

Status

Status:	Operational
Announcement Date:	22/06/2018
Commissioning Date:	10/07/2018

Size

Nominal Power (MW):	1.20
Energy Capacity (MWh):	7.20
Duration Discharge (h):	6.00

Revenue(s)

Application(s)

Main application:	Renewable Energy Integration
Application 2:	Frequency Control

Additional information

Paired Grid Resource:	13 MW PV
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Actors

Energy Storage Technology	
Manufacturer:	NGK Insulators
Developer / Owner:	NGK Insulators

References

Hyperlink 1:	Link
Hyperlink 2:	Link
Last Updated:	20/07/2018

Source: *Clean Horizon Energy Storage Source (CHESS)*, Clean Horizon's own global energy storage project database



Jordan: An emerging market with a strong systemic need for storage



Jordan is the Middle-Eastern pioneer in energy storage adoption thanks to multiple grid-scale projects

- Since 2015 with the unlaunched 20 MW li-ion project of AES Energy storage .
- August 2017: 20-year PPA between Philadelphia Solar & the Irbid District Electricity Company (IDECO) for a 4MW/12 MWh battery storage plus 12 MWp solar PV.
- July 2017: request for expression of interest for the development of a two-phase energy storage program at the Ma'an Development area (MDA):
 - **Phase 1:** 30 MW/60 MWh battery system
 - **Remuneration mechanism:** 15-year capacity lease agreement
 - **Total cost:** \$40 million
 - **Estimated completion:** April 2019
 - **Uses:** spinning reserves and arbitrage.
 - **Phase 2:** yet to be determined (was expected by December 2018)
- A bidding round concerning the construction of a 200 MW renewable-plus-storage plant in Aqaba city has also been recently concluded (24/12/2018) - arbitrage and ramp control
- For a 4,025 MW estimated capacity of renewables in 2020, 161 MW (up) and 214 MW (down) of operating reserves will have to be installed. Energy storage systems are recommended for such a scenario. (USAID report, 2017)



Country overview: Jordan



Nature of the opportunity / rationale for absence of opportunity

When will the opportunity arise?

Discharge duration

Generation

- PV + storage is being recognized as a legitimate application by the government and two projects exist (one complete, one in bidding phase)
- High penetration of renewables expected (25% share of renewables by 2020)
- Market open to IPPs (BOO model)

Now

Probably 2-3 hours

Grid

- Ancillary service applications for storage are being studied
- No regulatory framework for storage

Most likely in 2020

1 hour

BTM

Flat tiered tariffs and net-metering structurally don't allow storage investment recovery.

N/A

N/A

PHILADELPHIA SOLAR IRBID DISTRICT ELECTRICITY COMPANY PV PLUS STORAGE

The lithium-ion large-scale battery will be the biggest in the Middle East once commissioned this year by Al Badiya (a subsidiary of Philadelphia Solar). A power purchase agreement (20-year PPA with the The Irbid District Electricity Company) was signed for the Middle East's largest solar-plus-storage project to date, 12 MW of PV with a 12 MWh lithium-ion battery, in a project being executed by Jordanian PV manufacturer and EPC Philadelphia Solar.

Location

Island / Mainland:	Mainland
Continent:	Asia
Country:	Jordan
State / Region:	Mafraq Governorate
City:	Mafraq
Connection Point:	Generation

Storage Technology

Technology Category:	Electrochemical
Technology:	Lithium-ion Battery

Status

Status:	Contracted
Annoucement Date:	11/08/2017

Size

Nominal Power (MW):	4.00
Energy Capacity (MWh):	12.00
Duration Discharge (h):	3.00

Revenue(s)

Main revenue:	PV + storage PPA
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Application(s)

Main application:	Load Shifting
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Additional information

Paired Grid Resource:	12 MW PV
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Actors

Developer / Owner:	Philadelphia Solar
Off-taker:	Irbid District Electricity Company (IDECO)

References

Hyperlink 1:	Link
Hyperlink 2:	Link
Last Updated:	29/05/2018

Source: *Clean Horizon Energy Storage Source (CHESS)*, Clean Horizon's own global energy storage project database

MA'AN DEVELOPMENT AREA PHASE 1

The government of Jordan is looking to sign a 15-year agreement with a developer to install a 30 MW / 60 MWh project in the Ma'an region to integrate the numerous PV power plants at this substation. Results of the tender are expected in Q3 2018, and the project cost is estimated at US \$40 million. The project should be completed in April 2019.

Location

Island/Mainland: Mainland
Continent: Asia
Country: Jordan
State/Region: Ma'an Governorate
City: Ma'an
Connection point: Distribution network

Storage technology

Technology Category: Electrochemical
Technology: Lithium ion Battery

Status

Status: Tendered
Announcement date: 22/02/2018

Size

Nominal Power (MW): 30.00
Energy Capacity (MWh): 60.00
Duration discharge (h): 2.00

Revenues

Main revenue: 15-year contract with utility

Applications

Main application: Frequency Regulation

Additional information

Paired grid resource: None

Actors

Developer/owner: Unknown yet
Off-taker: Jordan's National Electric Power Company (NEPCO)

References

Hyperlink 1: [Link](#)
Last updated: 15/10/2018

Source: Clean Horizon Energy Storage Source (CHESS), Clean Horizon's own global energy storage project database



Egypt: A huge potential with no concrete plans for the deployment of battery storage



Energy storage projects are limited and mostly oriented towards pumped-hydro solutions

- The Egyptian interest in storage systems is oriented towards pumped-hydro solutions to benefit from the existing hydropower stations. Upcoming projects:
 - 2.4 GW pumped storage hydropower station at the Ataqa mountain (2024)
 - Two pumped-storage hydropower plants in Luxor worth \$5 billion are being studied
- The current regulatory framework does not tackle electricity storage
- A 20 MWp solar plus 5MW/30MWh storage project at Hurghada city received funding in 2018 after a two-year halt but no progress has been made.

No serious interest has been shown or made towards new battery storage projects



Country overview: Egypt



Nature of the opportunity / rationale for absence of opportunity

When will the opportunity arise?

Discharge duration

Generation

- PV + storage is progressively being recognized as a legitimate application by the government.
- Electricity production relies heavily on fossil fuels

Most likely in 2020

Probably 5-6 hours

Grid

- Recent liberalization of the sector
- No current market for ancillary services provision
- No regulatory framework for storage

N/A

N/A

BTM

Flat tiered tariffs, ToU and net-metering schemes structurally don't allow storage investment recovery.

N/A

N/A



Lebanon: A dysfunctional power system trying to get back on its feet



Emerging solar-plus-storage projects give a glimpse of hope for the current electricity crisis

- The 2018 Capital Investment Plan prioritized the development of the electricity sector with more than 17 investment projects worth over \$5.59 billion over the 2018-2030 period
- A notice inviting Expressions of Interest for the development of grid-connected solar PV plus battery storage systems took place in April 2018.
 - Operations were expected by 2019.
 - Generation capacity is to be divided among three projects with a 70 MWp to 100 MWp PV generation and a minimally 70 MW/70 MWh rated BESS for each project
 - 20-year PPAs based on a Build-Own-Operate (BOO) scheme

With over 200 MW / 200 MWh to be deployed, the Lebanese program for energy storage is currently the largest opportunity for storage available in the Middle East



Country overview: Lebanon



	Nature of the opportunity / rationale for absence of opportunity	When will the opportunity arise?	Discharge duration
Generation	PV plus storage PPAs are the only opportunity for storage today in the country	Now	1 hour
Grid	There is currently no market for ancillary services provision and electricity production relies heavily on fossil fuels	N/A	N/A
BTM	The electricity prices are low and the price structure does not encourage storage adoption. Some minor private initiatives are however emerging.	N/A	N/A



Project financing policies

Saudi Arabia

Most of the services in the Saudi electrical systems are managed by the government-owned Saudi Electricity Company (SEC).

In most of the Arab rentier states such as Saudi Arabia and the UAE, the government aims to assert the public power to ensure the fairness and equality of services based on a governor-governed basis.

- Most of the major renewable projects are being financed by the Saudi Public Investment Fund (PIF, government-owned), backed by international financiers (Natixis, Société Générale, SoftBank, etc.) and the REPDO (Renewable Energy Project Development Office). 30% up the upcoming projects will be funded by the REPDO while the remaining 70% will be funded through a PIF-private investment scheme.
- BTM storage financing methods are unpredictable for the moment.

UAE

Investment opportunities are somewhat strict for power generation in the UAE:

- Abu Dhabi: Any IPP must have **60%** of its shares detained by ADWEA, the remaining **40 %** must be majority-owned by national private investors (51% minimum) and the remaining share can be owned by international ones.
- Dubai: The same principles as Abu Dhabi apply, there are only 3 IPPs for the moment. DEWA used to detain all generation assets.

All remaining T&D assets are owned by the electricity authorities (ADWEA, DEWA).

The existing storage projects have been financed through government funds and international financiers (BNP Paribas, SoftBank, etc).



The Middle-East, an emerging market with limited opportunities for energy storage

Overview of the opportunities for large-scale battery storage in the Middle-East

Country	Application	When will the opportunities arise?	Discharge duration
Lebanon	Renewable integration	Now	1 hour
Jordan	Renewable integration	Now	3 hours
Egypt	Perhaps renewable integration	Most likely 2020	Up to 6 hours
UAE	None	N/A	N/A
Saudi Arabia	Perhaps renewable integration	Perhaps 2020	2 to 4 hours

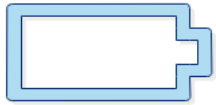
Variable interests towards energy storage reflect country-specific properties but also share common obstacles for energy storage

- None of the countries' regulatory frameworks consider energy storage solutions
- There's a need for long- and short-term storage but the prices are still limitative
- The highly subsidized electricity sector limits opportunities for behind-the-meter applications in all of the considered cases.
- Lebanon and Jordan are the only Arab states with ongoing energy storage projects with serious future adoption ambitions.
- What must change to allow development?:
 - Bankable PPAs with hourly tariffs allowing to offer tailored projects
 - Regulatory frameworks adapted to energy storage and fostering competition

- Currently, Lebanon and Jordan have the most favourable environments for energy storage
- The lack of specific regulations and electricity markets limits opportunities for such systems



Agenda



1. Executive summary: Energy storage opportunities by country



2. Middle East: Country overview



3. Questions



Thank you for your attention

Further details are available in our
Middle-East Market Analysis

<https://www.cleanhorizon.com/product/market-segment-watch-energy-storage-in-middle-east/>

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