











The Future of Energy Challenges and Opportunities

IEF Seminar

20/02/2020

ACWA POWER

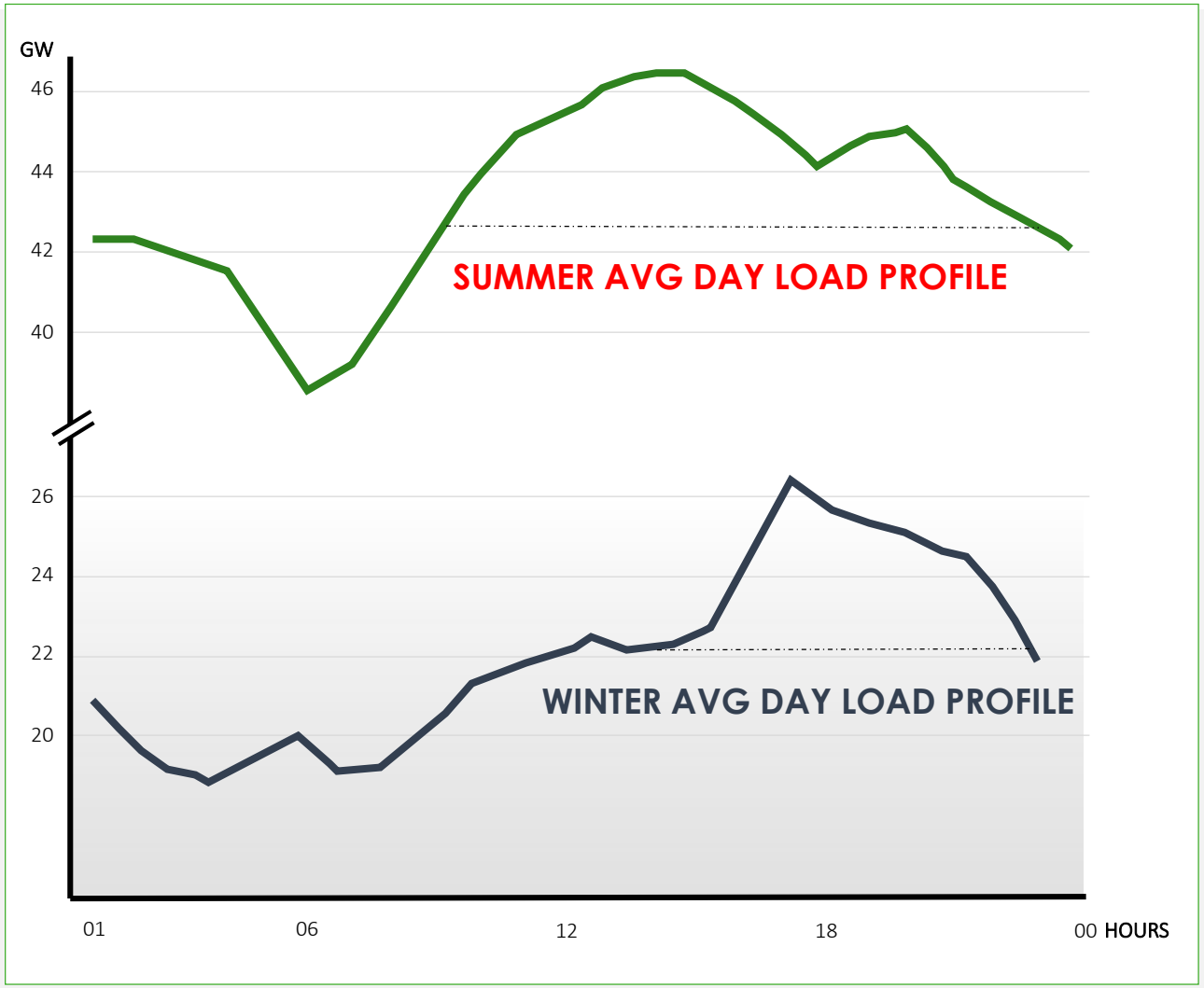
Contents

1. Renewable and Gas ; wholly embraced in KSA?
2. Renewable Energy, a cost competitive value proposition
3. Gas and LNG Competitiveness.
4. Where is this transition headed?
5. Fossil Fuels – What is the Future?
6. Why we at ACWA Power are convinced?

1. Clean Energy in KSA fully embraced

- Clear Target to deploy 58.7GW of Renewable Energy by 2030, in a system which by then is expected to have a capacity of 125GW
- Decommission Oil fired power plants (currently 45% of the energy mix in power generation) by 2030
- First two utility scale plants in construction. 300MW PV + 400MW wind
- 2000MW PV due to go into construction in the next month
- 2500 +MW of capacity in tender
- Kingdom is intent of capturing industrialization opportunities on the back of this scale of RE procurement

2.1 Load Profile in KSA on a Typical Summer & a Winter Day

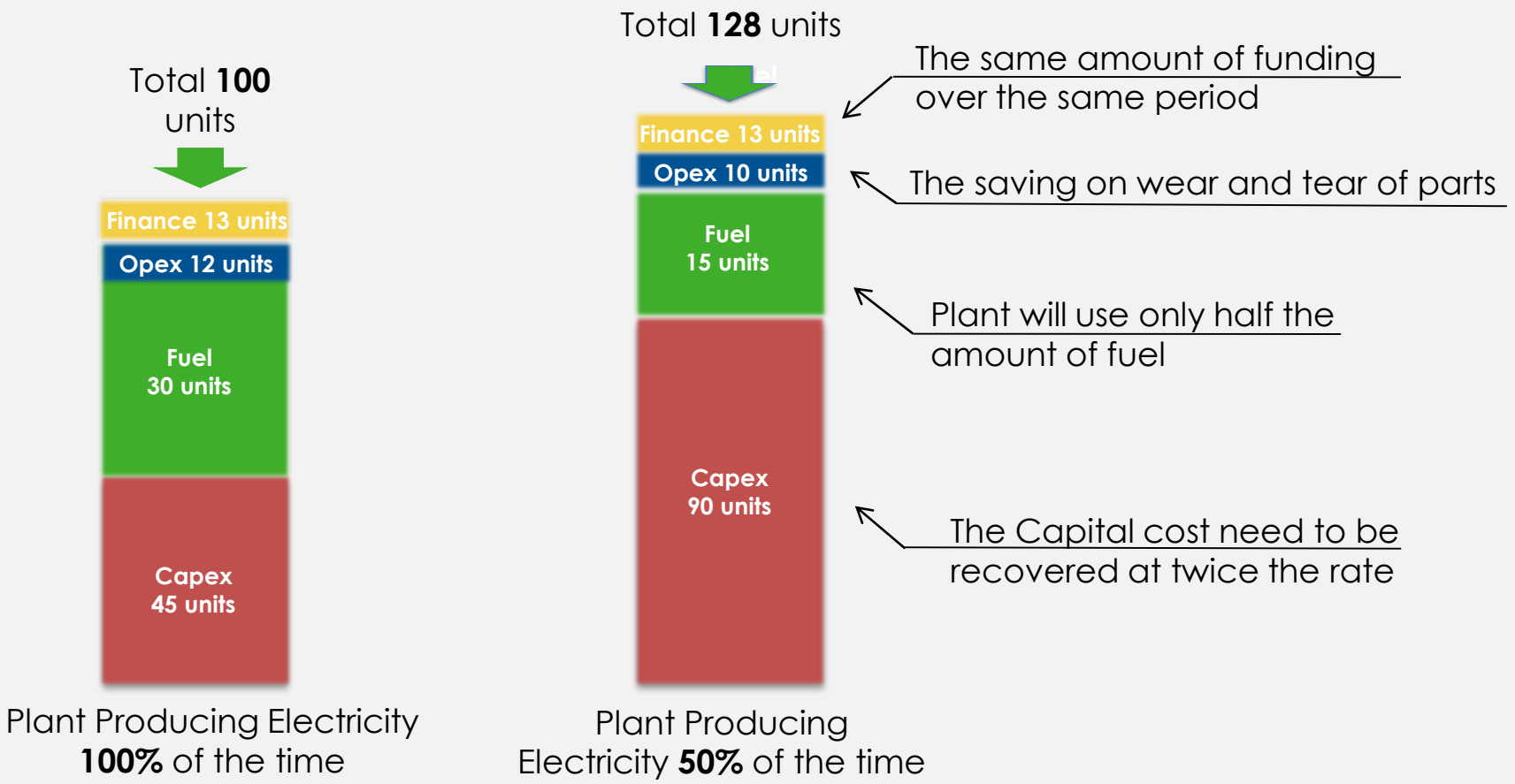


- For this segment of load, during a summer day or winter day, one needs to keep a power plant and run it only for these few hours.

Source: ECRA annual report 2013

2.2 Cost of Electricity will Depend on Duration of Dispatch

Plant Capacity Factor



2.3 Levelized Cost of Electricity (LCOE) from Renewables today

< 3.5 $¢/kWh

< 8 $¢/kWh

CAPACITY FACTOR

20% | 30% | 40% | 50% | 60% | 70% | 80% | **BASE LOAD**

3.5 $¢/kWh

3.0 $¢/kWh

2.5 $¢/kWh

2.0 $¢/kWh

10* $¢/kWh

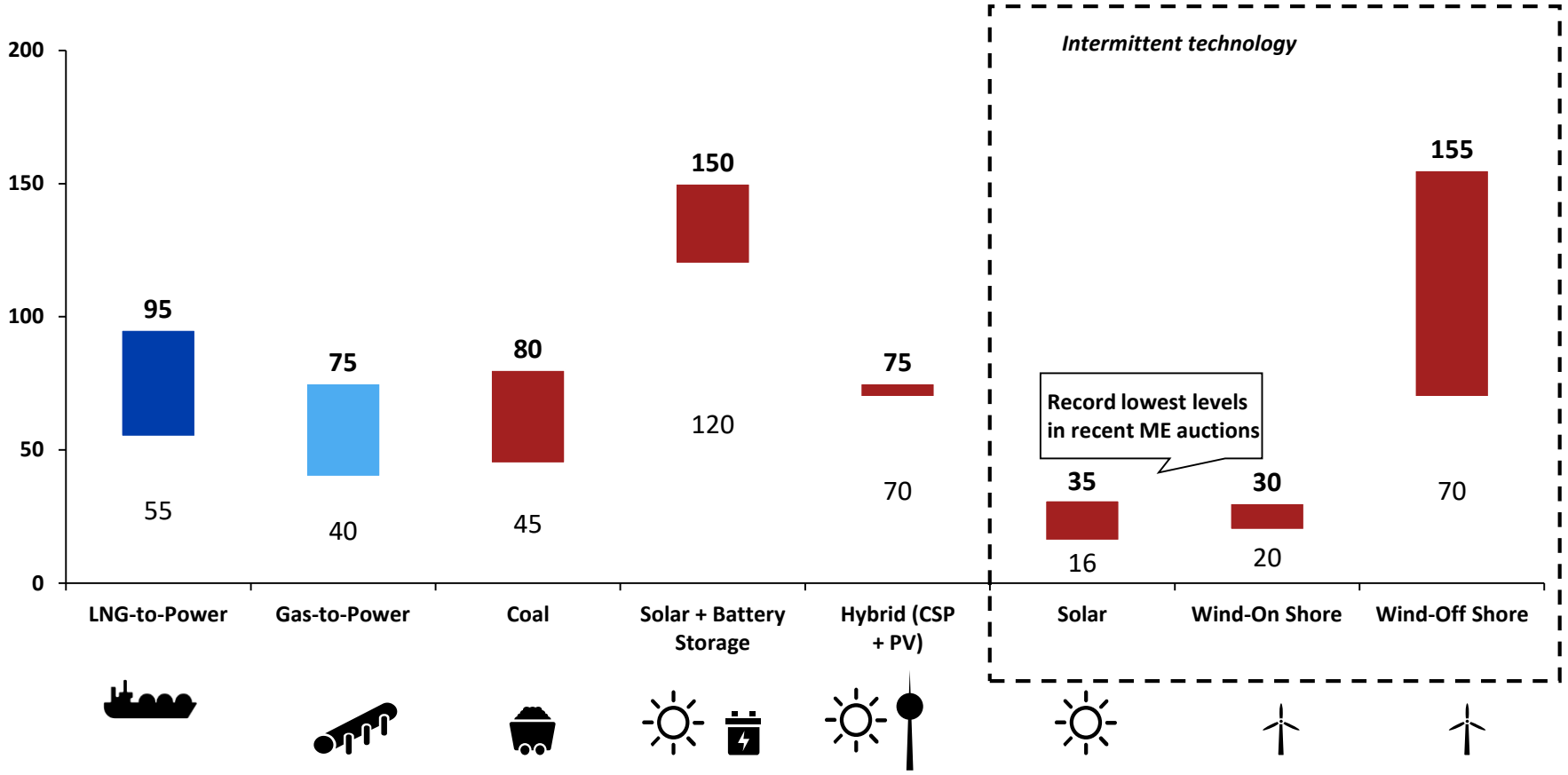
* Assumed 30$ tipping fee per metric Ton

2.4 Renewable Energy; Cost Competitive

Real numbers from recent contracts in the MENA region

- Jordan Wind Power – US$ Cents 2.41/kWh
- Dubai CSP 750MW CSP 24 hours per day; 7 days a week – US$ Cents 7.3/kWh
- Egypt PV – US$ Cents 2.75/kWh
- Ethiopia – US$ Cents 2.54/kWh
- KSA (PV – US$ Cents 2.34/kWh and Wind US$ Cents 1.99/kWh
- DUBAI PV 900 MW – US$ Cents 1.69/kWh

3.1 Competitiveness of LNG/Gas LCOE vs. alternatives



- Sources: Lazard; IRENA, ACWA Power, Strategy& analysis

- LCOE for renewables is becoming more attractive and as a consequence LNG/Gas prices have to be competitive
- In particular, gas companies have to adjust their operations and profit margins expectations accordingly to be able to compete against other source of energy

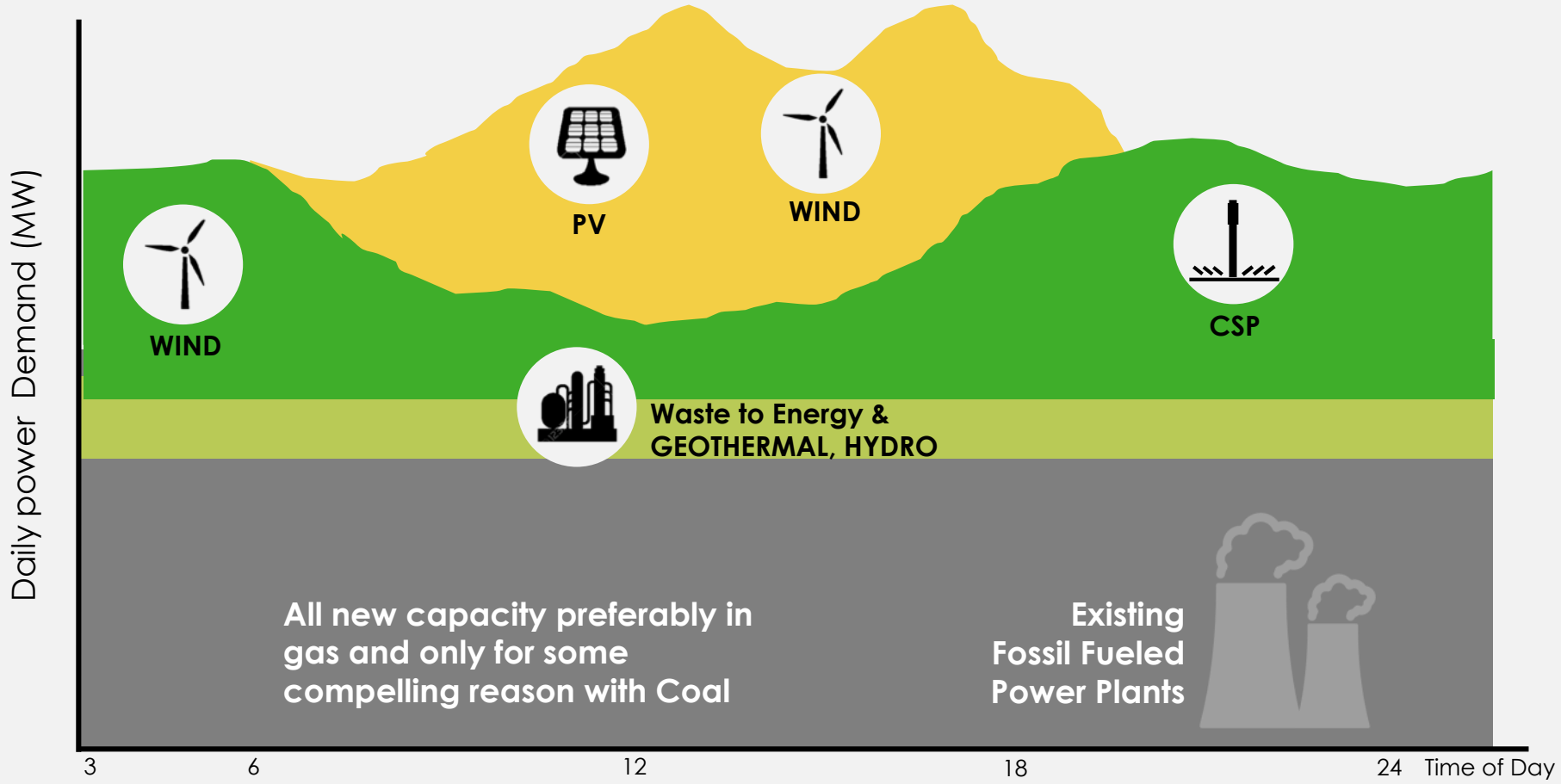
3.2 Gas Vs Coal

Parameter	Advanced Gas based CCGT	Ultra-Supercritical Bituminous Coal based Power Plant.
Thermal Efficiency	65 % CCGT	44 %
EPC cost (On gross MW basis)	0.5 to 0.6 Million USD/MW	1 to 1.5 Million USD/MW
Estimated CO2 Emission from 3.6 GW power plant Annually @ 94 % Availability.	9.48 Million Tons	25 Million tons.
Maintenance Requirement	Boiler require less maintenance compared to Coal based	More maintenance will be required.
Auxiliary consumption.	The Auxiliary consumption of CCGT plant is around 2.5 %	The Auxiliary consumption of Coal based Power plant range between 7 to 9 %.
Land required	Less land required based on per MW basis. Around 100 Hector Land will be required to put a 3.6 GW CCGT plant.	More Land required in Coal fired Power plant. Around 160 Hector Land will required to put a 3.6 GW Supercritical Coal based Power plant.
Transmission line cost.	Gas Plant can be build close to demand center	It is difficult to build coal plant to demand center.
Carbon Tax	As Emission of Carbon dioxide is 3 time less than that Coal fired Power plant so future risk of carbon Tax will have less impact.	As Emission of Carbon dioxide is 3 times more than CCGT plant so future risk of Carbon tax is there, which ultimately raised the tariff.
Cost of lending	World Banks and international Banks still supporting CCGT high efficient Technology of Power Generation.	World Bank and international banks are not willing or less inclined to support Coal based Power generation.
Calorific Value	Gas has very high Calorific value compared to Coal. The Calorific value of Gas is around 46 MJ/Kg.	Coal of good quality (Bituminous) has calorific value in the range of 20 MJ/Kg.

3.3 Gas vs Coal

Parameter	Advanced Gas based CCGT	Ultra-Supercritical Bituminous Coal based Power Plant.
Thermal Pollution to Sea or River	Less water requirement to condense the steam in the condenser, hence less thermal pollution to the sea which result in to comparatively better marine life. Around 120,000 m3/h of Sea water will be required for 3.6 GW	Huge amount of Sea water is required for steam condensation in the condenser which will ultimately increase the sea water temperature when out fall water mixed in the Sea. Around 360,000 m3/h of Sea water will be required FOR 3.6 GW.
Sulphur dioxide emission.	Due to very low or negligible Sulphur in gas and high efficiency of Power Cycle Emission of Sulphur dioxide is very low	The emission of Sulphur dioxide in environment is high even with the use of high efficient FGD..
Emission of NOX in the environment	Very low NOX emission in environment	High emission of NOX in the environment even with the use of SCR or SNCR.
Particulate Emission	The gas contain negligible amount of dust so there is almost no particulate emission from CCGT plant	Coal contain high amount of dust so emission of particulate are very high. Even after use of Electrostatic precipitator the dust in the environment remains with higher % compare to Gas. Particulate emission contribute to lungs problems in human being of nearby locality.

4.1 What Does this Mean for Power Generation NOW?



Source: pres. KACARE 2012 & ACWA Power analysis of cost

4.2 Where is this Transition Headed (2050 Horizon)?

1. Roof Top Generation both in Rural and urban setting with small batteries reducing levels of central generation

2. Central Generation with increasing levels of renewable energy and Gas in the mix

3. Long Distance HVDC improving efficiency of asset utilization

4. Smart Grids integrating multiple sources of generation and storage including household level generation + batteries including EV batteries + demand management with time of use adjustments

5.

4.3 Where is the transition Headed?

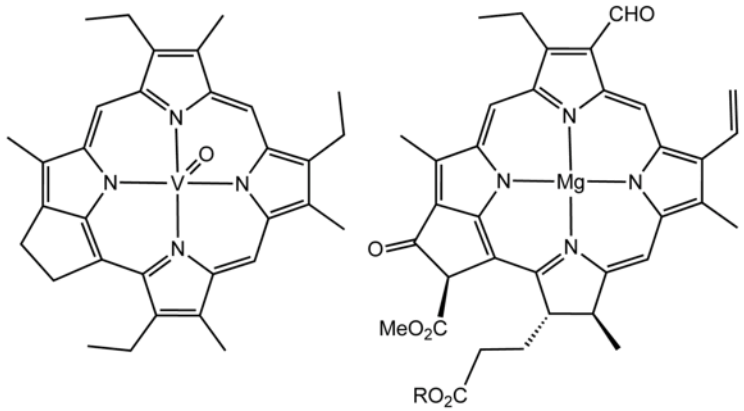
- Increasing use of electricity which in turn will be utilized more efficiently also optimizing time of use.
- Grater use of renewables; reducing carbon content in power generation
- Cost of electricity will come down due to increasing content of the lower cost renewable energy in the mix
- More of the cost of that electricity getting fixed; reduction in cost volatility due to reduction in fossil fuel content in the “fuel” mix

4.4 Example of Cost Reduction due to RE in the mix - Jordan

- 2012 Negligible RE; average cost of generated electricity – US Cents 23/kWh
- 2018 16% RE in the mix; average cost of generated electricity – US Cents 15.6/kWh

5. Fossil Fuels – What is the Future?

- Gas will be the transitionary fuel for base load power generation for many decades to come
- At least as far as SAUDI ARAMCO is concerned "Chemicals is the fastest growing crude oil demand sector. It is also the fastest growing segment of our business. So we are working hard to develop new, more efficient ways to convert crude oil into chemicals" from ARAMCO Website
- The target is to convert 70% to 80% of each barrel of Crude Oil to Chemicals
- All major oil companies are committed to reducing carbon emission in their own operations and to find ways to reduce carbon emissions in the use of their products.
- Considerable faith is being placed on carbon capture and sequestration. Still to be convinced.



At A Glance

We are a leading global developer, investor and operator of a portfolio of power generation and desalinated water production plants

ACWA Power **reliably delivers electricity and desalinated water** at a **low cost**, contributing to the **social and economic development** of the communities and countries it invests in and serves

54 Assets*

30 GW Power*

5.3 Mm^3 per day Desalinated Water*

13 Countries

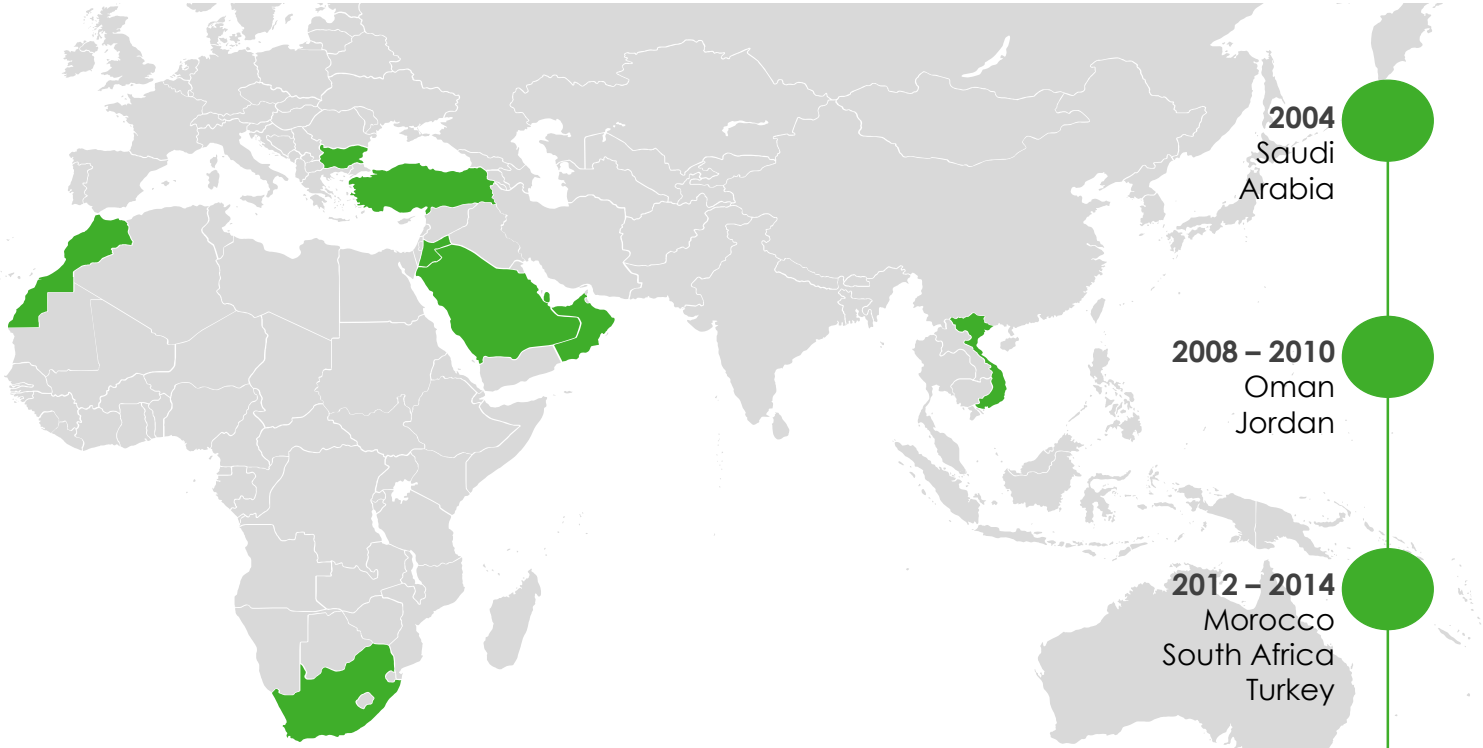
$45+bn USD of Assets*

23% Portfolio in Renewable Energy based on Share of project cost

3,500+ Employees

30+ Nationalities

~60% Local Employment in projects



2004
Saudi Arabia

2008 – 2010
Oman
Jordan

2012 – 2014
Morocco
South Africa
Turkey

2015 –
UAE
Egypt
Vietnam
Bahrain

* Figures inclusive of advanced development projects

DEVELOP

We win bids as lead developer, by partnering with the best and focusing on cost leadership.

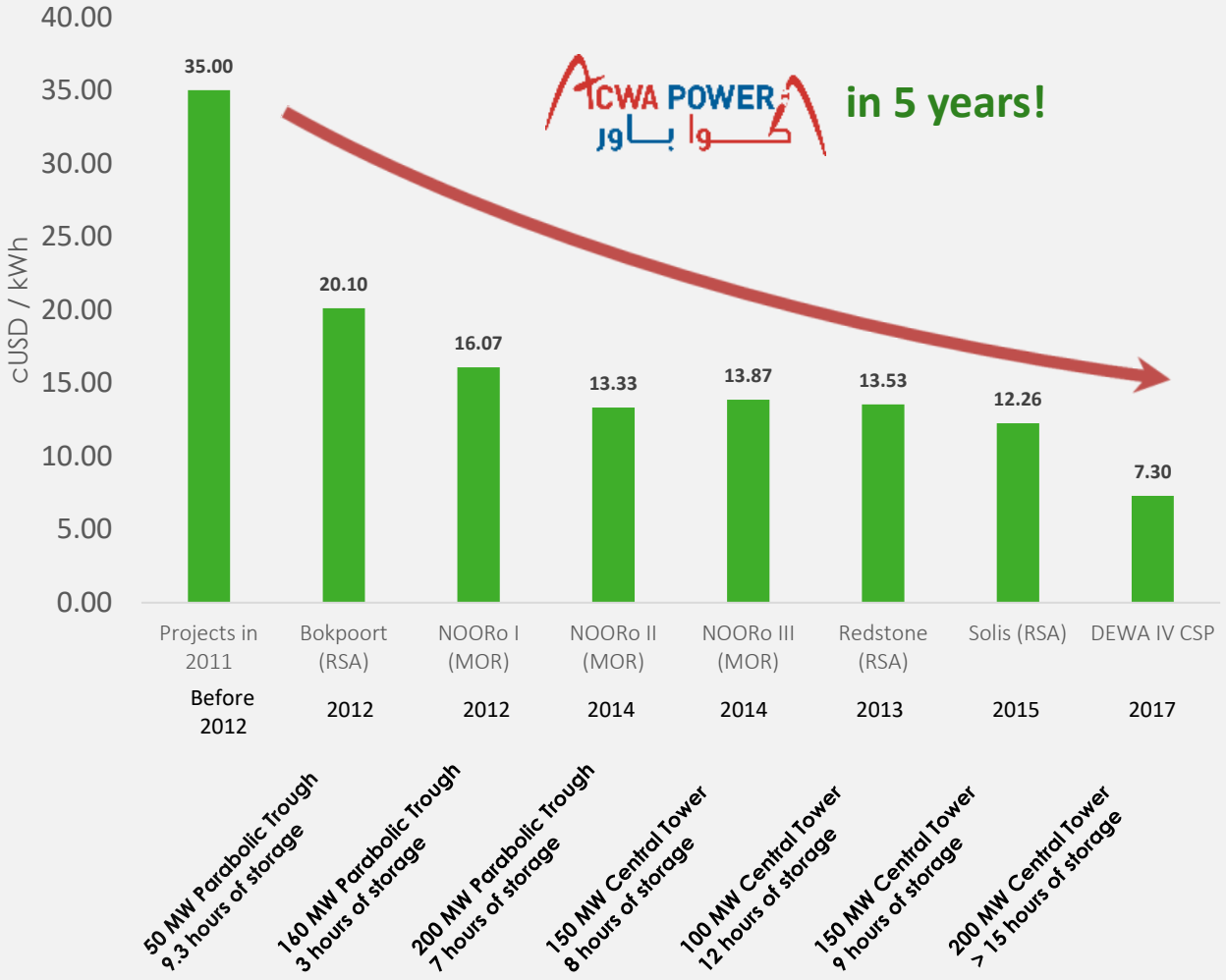
INVEST

While taking significant, long-term stakes in all our plants

OPERATE

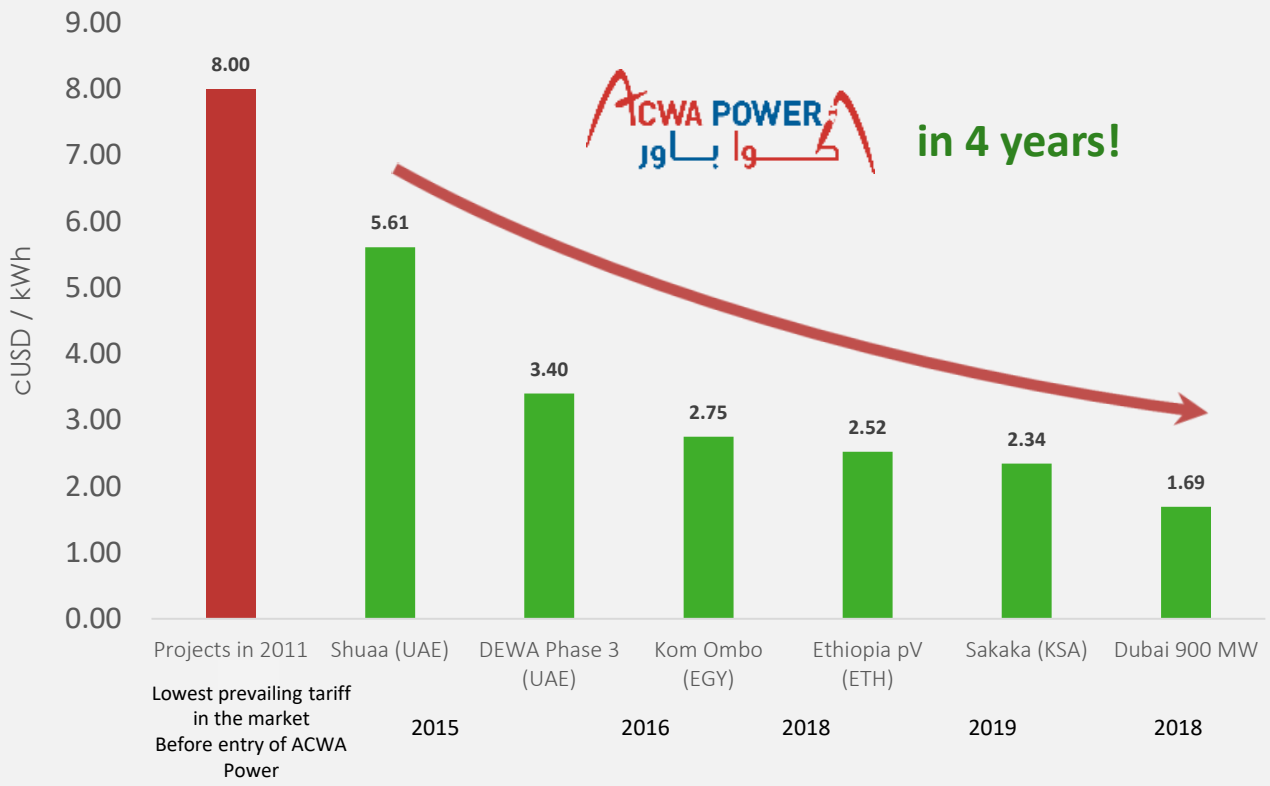
We operate and maintain our plants to the highest global standards

By leading CSP Tariff Reduction, ACWA Power has made this versatile solution viable; to in turn accelerate the Energy Transition

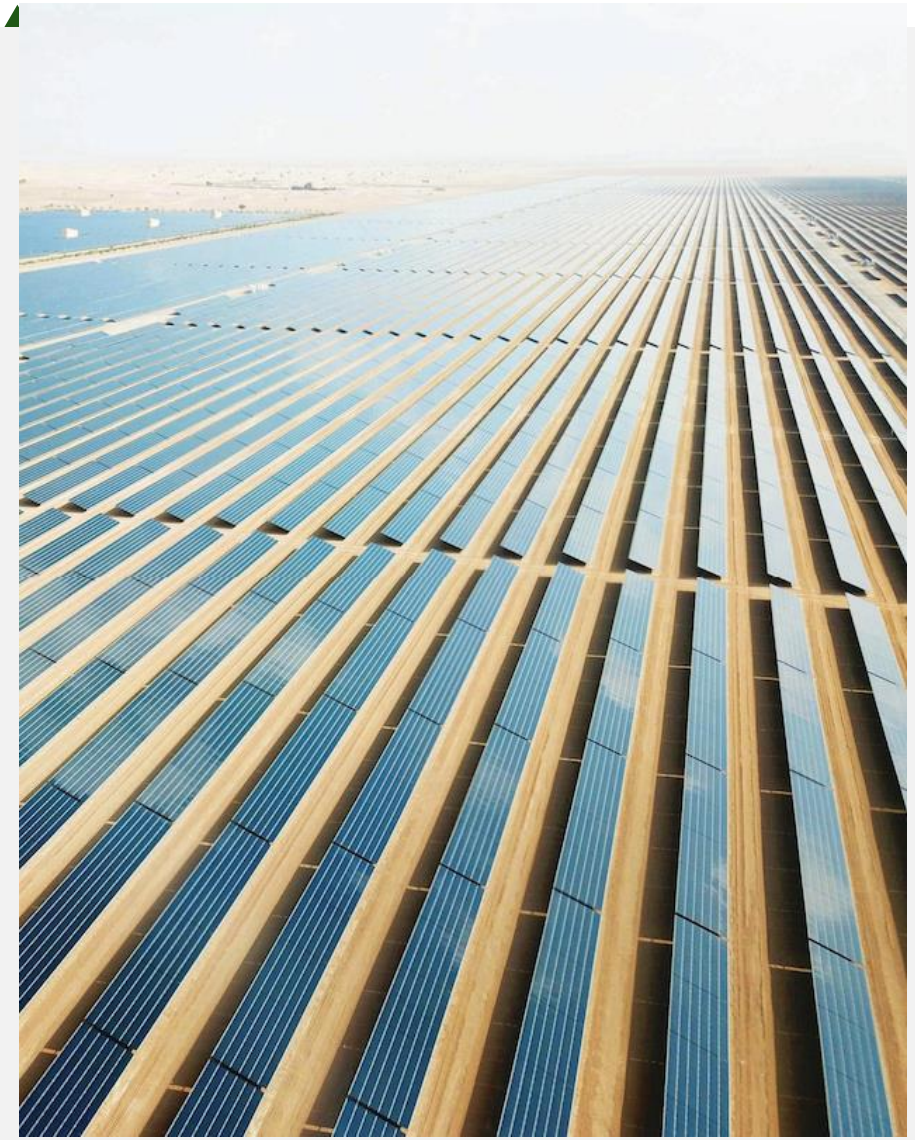


Please note that methods of calculation of tariffs compared differs, as some tariffs are year 1 not escalated and others are LCOE basis. However, it indicates a trends of reductions. Pleas note that DEWA CSP is indicated on LCOE basis.

By leading PV Tariff Reduction, ACWA Power is accelerating the Energy Transition

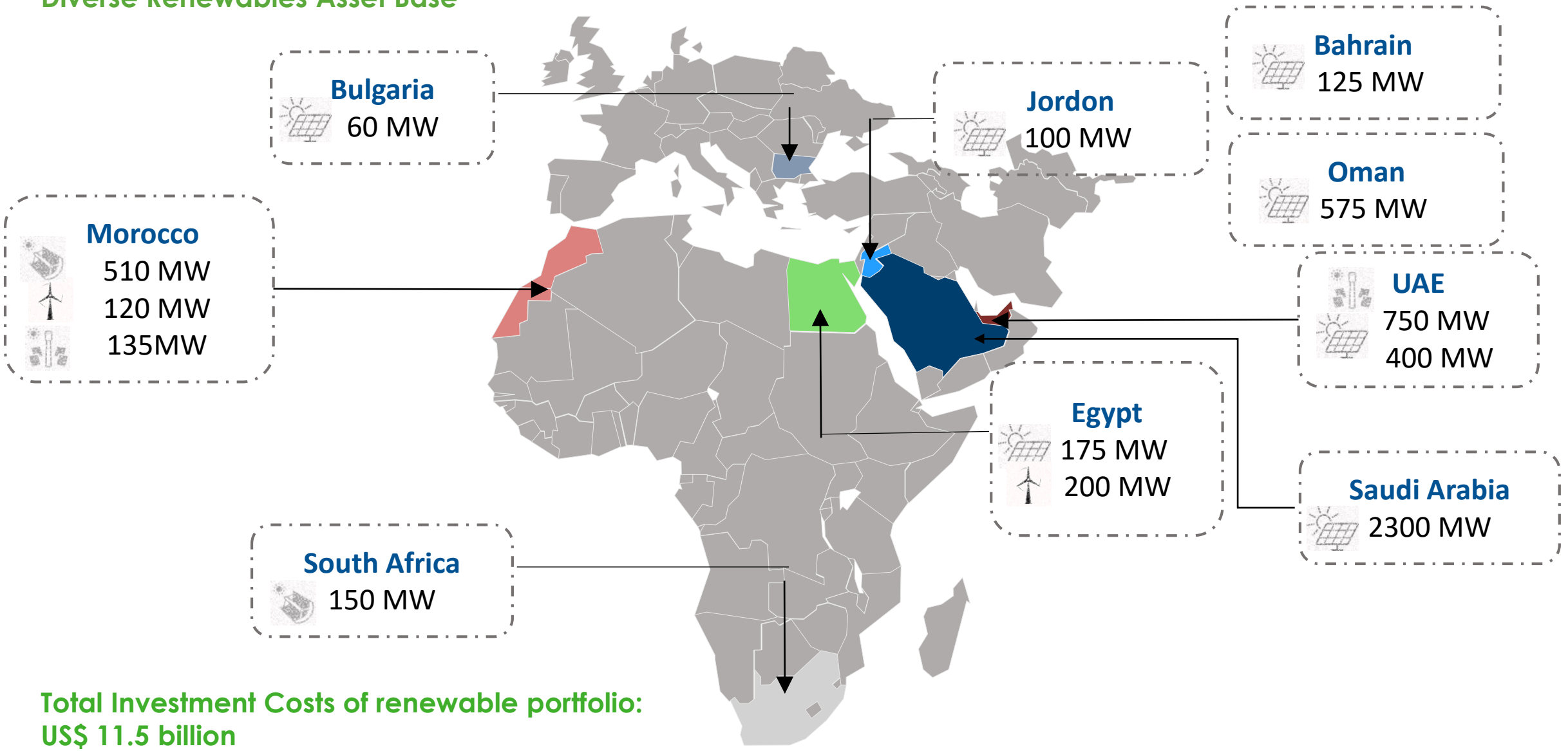


Please note that methods of calculation of tariffs compared differs, as some tariffs are year 1 not escalated and others are LCOE basis.



ACWA Power in Renewable Energy Today - 5000 MW in Construction & Operation

Diverse Renewables Asset Base



Total Investment Costs of renewable portfolio:
US$ 11.5 billion

ACWA POWER
أكوا باور

Je vous remercie Danke obrigado

mihi koe ραĸмет сізге

Teşekkürler شكرا

நன்றி

謝謝

Asante

Дякую

cảm ơn bạn

감사합니다

አመሰግናለሁ

ありがとうございました

Спасибо

धन्यवाद

Thank you

Terima kasih

Ngiyabonga

Tak

www.ACWAPower.com
Comms@acwapower.com

Saudi Arabia

Building 1,
Ground Floor,
Business Gate
Office Complex,
Airport Road
P.O. Box 22616
Riyadh 11416
T: +966 1 2835555
F: +966 1 2835500

China

2101 Tower B,
Ping An International
Financial Center,
No. 1-3,
Xin Yuan Nan Lu,
Chao Yang District,
P.O. Box 10027,
Beijing
T: +86 10 8438 1078
F: +86 10 8438 1075

Jordan

Amman-Khelda,
Al Khalideen Suburb,
Al Hakam Bin
Amro Street -
Bldg No. 22
P.O. Box: 2564
Amman 11953
T: +962 6 534 0008
F: +962 6 535 7210

South Africa

7th Floor,
90 Grayston Drive,
Sandton,
Johanesburg,
2196
T: +27 117224100
F: +27 117224113

Saudi Arabia

King Abdulaziz
Branch Rd,
Ash Shati,
Jeddah,
23613
T: +966 12 618 9000

Egypt

Plot 176,
Second Sector,
City Center Giza
Systems Building,
New Cairo,
Cairo
T: +202 23 225 500

Morocco

65 Avenue
Mehdi Ben Barka,
Souissi,
Rabat 10100
T: +212537287878
F: +212537714165

Vietnam

11th floor,
BIDV Tower 194,
Tran Quang Khai St.,
Hoan Kiem District,
Hanoi
T: +84 43 935 2966
F: +84 43 935 2969

UAE

The One Tower, 41st
Floor, Barsha Heights,
Sheikh Zayed Road,
P.O. Box 30582
Dubai
T: +971 4 2480800
F: +971 4 3859625

Indonesia

MidPlaza 2 Building,
16th floor, Jl. Jend.
Sudirman Kav. 10-11,
Jakarta 10220
Tel: +62 21 570 7744
Fax: +62 21 570 6180

Oman

South Lobby Roof
Top,
Grand Mall,
P.O.Box: 163,
PC: 136,
Al Khwair,
Muscat
T: +968 22065 752
F: +968 22063 753

Turkey

Barbaros Plaza,
Emirhan Caddessi,
No.113 Kat.19,
Dikilitas,
Besiktas
Istanbul
T: +90 212 259 3396
F: +90 212 259 3397