Under the patronage of **H.E. Dr. Abdullah Belhaif Al Nuaimi -** Minister of Infrastructure Development

CONFERENCE
OMAINTEC
2019
EXHIBITION

17th Edition

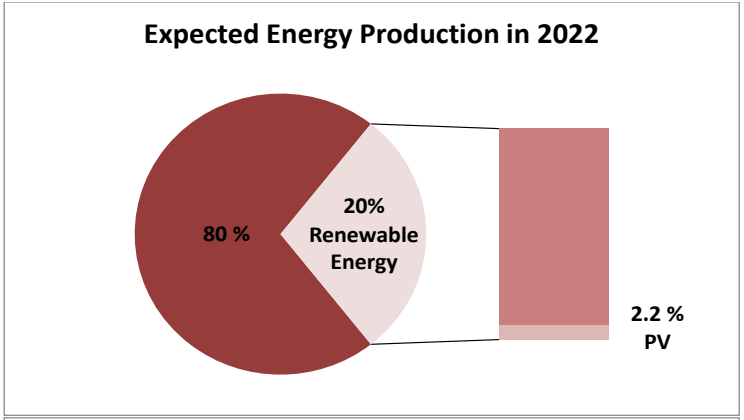
International Operations & Maintenance Conference in the Arab Countries

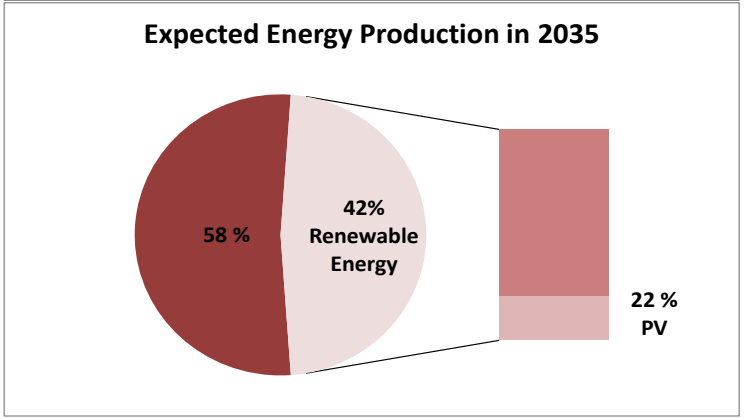
19, 20, 21 NOV 2019
Le Meridien Dubai Hotel
& Conference Centre
United Arab Emirates

Under the Theme:
Enhancing Maintenance
Through Big Data Management

CURRENT AND SUGGESTED PHOTOVOLTAIC MAINTENANCE IN EGYPT

INTRODUCTION





Renewable energy in Egypt expected to reach 20% by 2022 and the photovoltaic will be 2.2%. By 2035 the renewable energy is planned to be 42% and the PV will be 22%.

PV installation lifetimes are expected to be 25 years or more, so safe and proper maintenance is an integral part of successful and reliable operation.

INTRODUCTION

FACTORS EFFECT PV OPERATION

- Partial and/or full shadowing due to dust accumulation
- Hot spot generation (due to cell mismatch or shading)
- Bypass diode thermal failure (due to overheating or under sizing of diodes)
- Mismatching

THE CURRENT STATUS OF PV IN EGYPT

2013	Government Initiative to install photovoltaic systems on 1000 governmental buildings.
2014	Feed-In Tariff (FIT) low first round
2016	Feed-In Tariff (FIT) low second round
2017	Net-Metering scheme up to 20 MW

THE CURRENT STATUS OF PV IN EGYPT

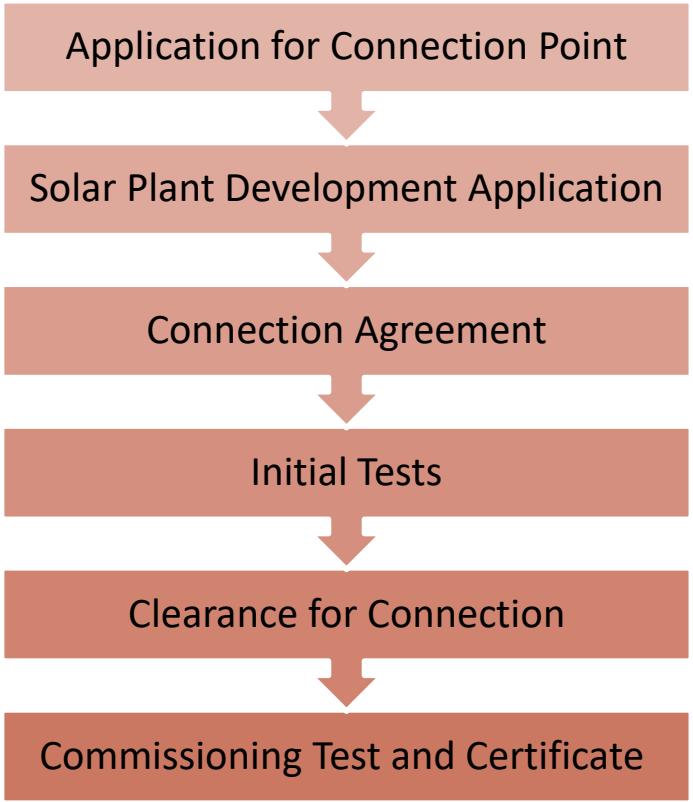
- Total ssPV and MSPV capacity reached 23.5 MW.

EEHC and affiliated companies have adopted a project to install solar PV systems on the roof of buildings with total connected capacities (116 plants totaling 2.5 MW)

By Subscribers: Feed-in-Tariff Scheme 73 plants totaling 13.2 MW and Net-Metering Scheme 143 Plants totaling 7.7 MW)

- The first PV solar plant in Benban, Aswan, was connected to the national grid in January 2018 within the first phase of FIT scheme with a capacity of 50 MW, and commercially operated in February 2018.

THE CURRENT STATUS OF PV IN EGYPT



STEPS FOR CONNECTING PV TO GRID

- According to the PV capacity the grid operator applies the codes to ensure the PV is comply with the requirements of the code (small scale PV code up to 500 kW and Solar Energy Plants Grid Connection Code from 500 kW up to 20 MW)
- ssPV code does not mention the steps for connecting PV but EGYPTERA published regulation for connecting ssPV but for FIT scheme
- Solar Energy Plants Grid Connection Code has determined the steps which shall fulfill for solar plant application

THE CURRENT STATUS OF PV IN EGYPT

OPERATING AND MAITENANCE

- Grid operator ensures the PV operation is safe when connecting to the grid without concern the efficient operation for the PV
- Owner does not have the experience of the efficient PV maintenance. His only knowledge is about cleaning the panel once a week and few owners care about monitoring to judge the produced accumulated energy with the excepted energy or not

There are many procedures for maintenance to prevent sudden power outage and inefficient operation

SUGGESTED MAINTENANCE PROCEDURE

1) PV Coding

Voltage	Geographical zone	Qualified company number	owner	Number of PV connected in the system	Transmission or distribution company
(1) For low voltage (2) For medium voltage (3) For high voltage	This is sited as distribution companies' codes	As per New and Renewable Energy Authority (NREA) numbering	(1) The customer owns the PV station (2) The customer has a suppling contract with qualified company	PV number as company's numbering	Two letters from the company's name.

SUGGESTED MAINTENANCE PROCEDURE

2) PV Monitoring

Provide enough information to accomplish an “energy balance” accounting for the amount of solar resource available, and the losses in each energy conversion process up to delivery at the point of interconnection

Types of collected data:

- Irradiance measurements
- Module temperature measurements
- String measurements
- Inverter measurements
- Energy meter
- Control settings
- Alarms
- AC circuit / Protection relay

SUGGESTED MAINTENANCE PROCEDURE

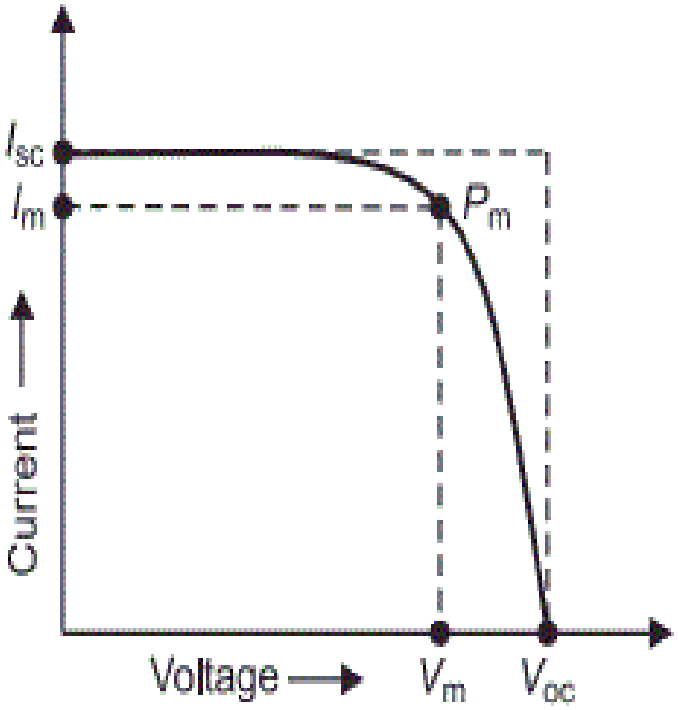
3) I-V CURVE PREDICTION

Monitoring data as temperature measurements and irradiance measurements will help in I-V curve prediction.

A. Compare this prediction curve with the actual I-V curve

B. This comparison will indicate potential cases for the PV as following

SUGGESTED MAINTENANCE PROCEDURE



3) I-V CURVE PREDICTION

I. Higher or Lower Voc Value than Predicted:

- PV cell temperature is different than the modeled temperature
- One or more cells or modules are completely shaded
- One or more bypass diodes is conducting or shorted
- One or more PV modules were not included in the circuit as-built

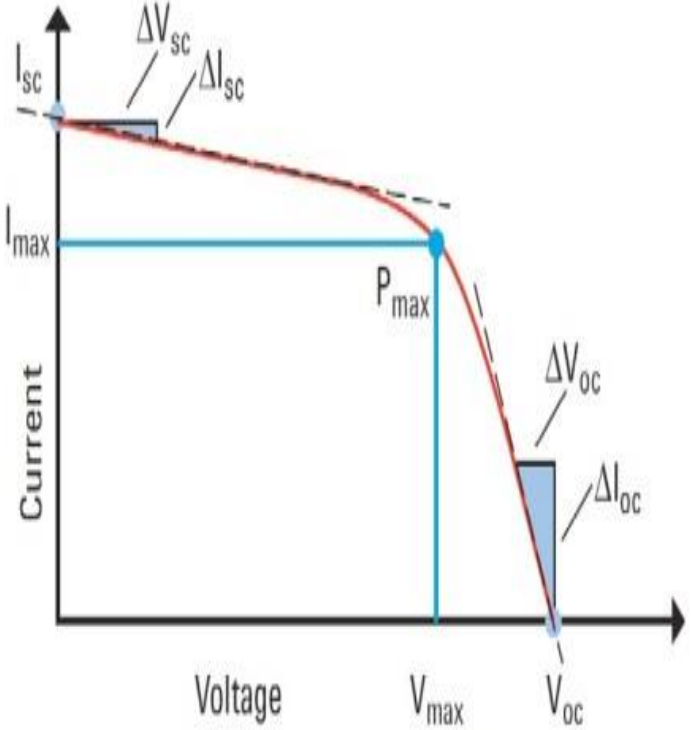
II. Lower Current than Predicted:

- PV array is soiled (especially uniformly) and PV modules are degraded

III. Higher Current than Predicted:

- Irradiance sensor is oriented incorrectly
- Irradiance sensor calibration factor is entered incorrectly Reflections contribute additional irradiance
- The sun is too close to the horizon

SUGGESTED MAINTENANCE PROCEDURE



3) I-V CURVE PREDICTION

IV. The slope of the I-V curve between maximum voltage (Vmp) and open circuit (Voc) is reduced the steepness of the slope:

- PV wiring has excess resistance
- insufficiently sized
- Electrical interconnections in the array are resistive
- Series resistance of PV modules has increased

V. The Slope of the Curve near short circuit current (Isc) Does Not Match the Prediction:

- Shunt paths exist in PV cells
- Shunt paths exist in the PV cell interconnects
- Module Isc mismatch

VI. The I-V curve has notches or steps:

- Array is partially shaded
- PV cells are damaged
- Bypass diode is short-circuited

SUGGESTED MAINTENANCE PROCEDURE

4) MAINTENANCE CHECKLIST

PV Panels

Inverter

Cables

Switchboards

Lighting / grounding system

Item	Check
PV Panels	
Check the front side of the panel for scratches and discolorations	
Check the back side of the panel (connection box, cable insulation, tedlar surface)	
Check the stability clamps	
Check the aluminum frame bending	
Check the aluminum profile surfaces	
Power Cables	
Visual cable check	
Check connections	
Underground Power Cables	
Check thorough cable for malfunctions	
Check for excessive voltage stress	
Inverters	
Check for external damage	
Screen check for abnormal displays	
Cable check for wear and connection loosening	
Vent filter inspection and replace it if necessary	
Varistor check for delays and replace it if necessary	
Check switch and regulator for damage or abnormal function	
Check safety markings	
Check grounding continuity	
Fuses' metal surface lubrication	
Switchboards	
Check external damage (scratches, corrosion, bending)	
Check internal damage (electric arc markings)	
Water-mold check	
Check connection (incoming and outgoing cables)	
Check fuses	
Fuses' metal surface lubrication	
Check automatic switches for delays	
Varistor check for delays and replace it if necessary	
Check markings on the measuring device	
Check safety markings	
Individual measuring of every string maximum voltage and maximum current during operation	
Insulation resistance measurement of each string	
Check measuring equipment	
Lighting / grounding system	
Check surface elements for damage or corrosion	
Check grounding conductors	
Grounding resistance measurement	
Check grounding rods	

SUGGESTED MAINTENANCE PROCEDURE

5) KEY PERFORMANCE INDICATORS (KPIs)

- Energy Availability
- Energy Performance Index (EPI)
- All-in Energy Performance Index
- Energy Delivery
- Specific Performance
- Capacity Test
- System Efficiency
- Solar Fraction
- Capacity Factor
- Performance Ratio
- PV System Yield

THANK YOU
FOR
YOUR ATTENTION