Greening Energy
Market and Finance

Sensitivity Matrix

Importance of the impact of climate change effects on a solar farm

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SENSITIVITY MATRIX

Object	Area	Air temperature increase	Rainfall change	Average wind speed change	Sea level rise	Storms	Flooding	Wild fire	Air quality
Solar instalation	Mechanical damage to installations								
	Energy production from installations								
	Access to the installation								

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SOLAR FARM

MK Electronics & Solar Solution

Year of Establishment: 2016
Legal Status of Firm: Sole Proprietorship (Individual)
Nature of Business: Manufacturer
Number of Employees: 11 to 25 People
IndiaMART Member Since Oct 2013

MK Electronics & Solar Solution is one of the leading manufacturer, wholesaler, trader and distributor of Solar Power Plant, Solar Street Light, Solar Panel System and Solar Inverter.

Solar Farm Technical Features

IV:	AC 270 V
Battery:	2v 1200 AH
Output Frequency:	50 - 60 Hz
System:	Off-grid

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1. AIR TEMPERATURE INCREASE

Area	Air Temperature Increase
Mechanical damage to installations	Overheating damages the panels
Energy production from installations	• Temperature Coefficient (tested by manufacturer) • Derating (computed indicator) • In sunny days the current supplied by the solar panel will rise marginally but the voltage drops somewhat faster so the power (voltage times current) is lower • So on a 35o day with bright sunshine (1000W.m-2), we see that a solar power plant could be expected to operate at 20% lower power, so 80% of its potential, due to the elevated solar module temperature • If they operate at higher temperatures the power delivered goes down, at lower temperatures it goes up
Access to the installation	The air temperature increase will not impact the access to the installation

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1. AIR TEMPERATURE INCREASE
De-rating

ENERGY PRODUCTION

Battery: 2v (nominal voltage) 1200 AH

Operation (recommended): [15°C;25°C]
Operation (maximum): [-40°C;50°C]

Factors that affect panel temperature

- Ambient Temperature:
  Solar panels are tested at room temperature (25 °C) so the power that is specified by the manufacturer corresponds to the unusual situation of the panel operating at room temperature while under strong sunlight. Ambient temperature varies with location (weather stations)
- Temperature Coefficient:
  The temperature coefficient represents the rate at which the panel will underperform at each increase in degree Celsius (°C));
- Type of Installation:
  if installed at the rooftop, they experience far greater temperatures than the current ambient temperature

Rack-type panel installation:

- panels fixed parallel to roof = 35°
- typical reck-type installation = 30°
- pole-mountain install = 25°

Temperature DERATING

$$\left[\begin{array}{c} Ambient\ Temperature \\ +rack\ type\ panel\ installation \\ -\ tested\ temperature \end{array}\right] * Temperature\ coefficient$$

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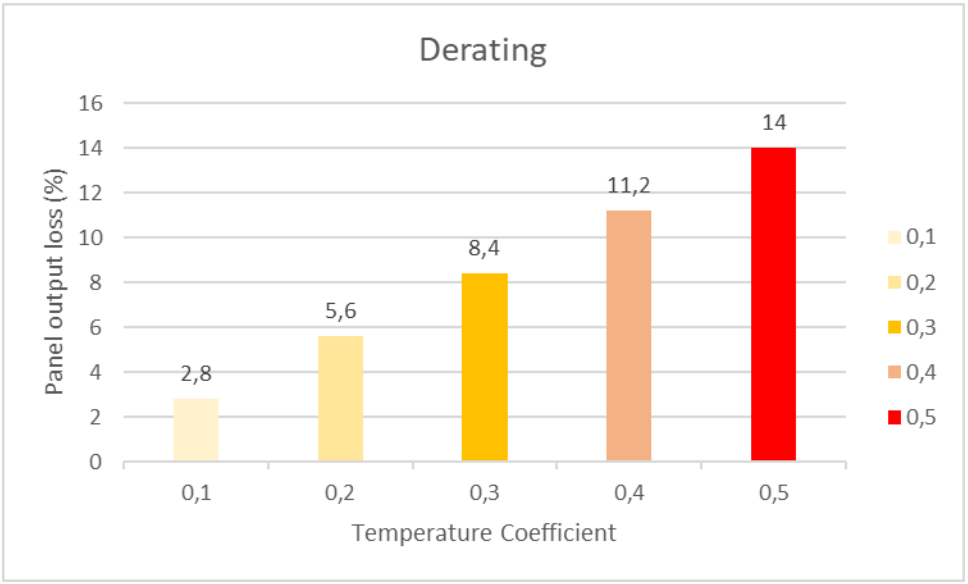
1. AIR TEMPERATURE INCREASE
Derating simulation 1

Ambient temperature: 23 °C
Tested temperature: 25 °C (benchmark)
Rack-type installation: 30 °C (typical)

Changing indicators: **Temperature Coefficient**

Typical conservative multi-crystalline module: -0,48%/ °C

ENERGY PRODUCTION



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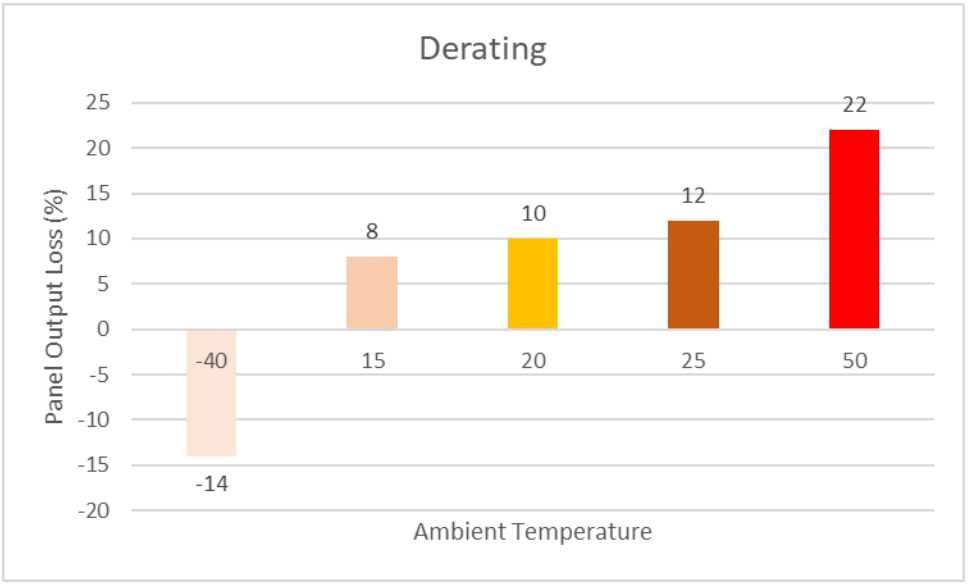
1. AIR TEMPERATURE INCREASE
Derating simulation 2

Temperature Coefficient: 0,4 (-%/°C)
Tested temperature: 25 °C (benchmark)
Rack-type installation: 30 °C (typical)

Changing indicators: **Ambient Temperature**

ENERGY PRODUCTION



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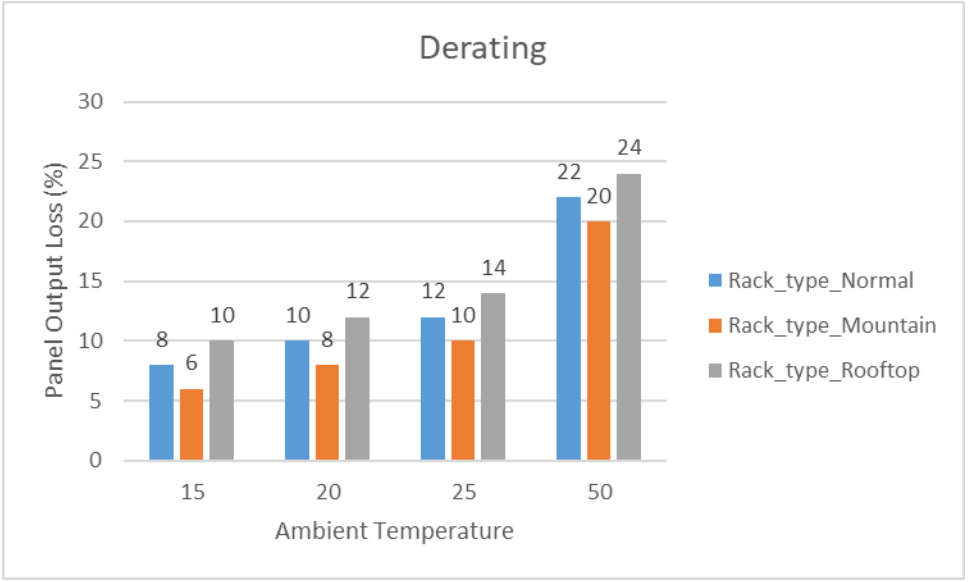
1. AIR TEMPERATURE INCREASE
Derating simulation 3

Temperature Coefficient: 0,4 (-%/°C)
Tested temperature: 25 °C (benchmark)

Changing indicators: **Ambient Temperature + Rack-type installation**

ENERGY PRODUCTION



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2. RAINFALL CHANGE

Area	Rainfall Change
Mechanical damage to installations	Solar panels are waterproof and can withstand large amounts of heavy rain without being damaged
Energy production from installations	Efficiency is reduced during rainy days (depending on how dark and heavy the rain and cloud coverage but the panels can produce anywhere between 10-25% of their optimal capacity) Occasional rain helps to clean the panels from dust, dirt or pollen
Access to the installation	An increase in rainfall will not impact the access to the installation

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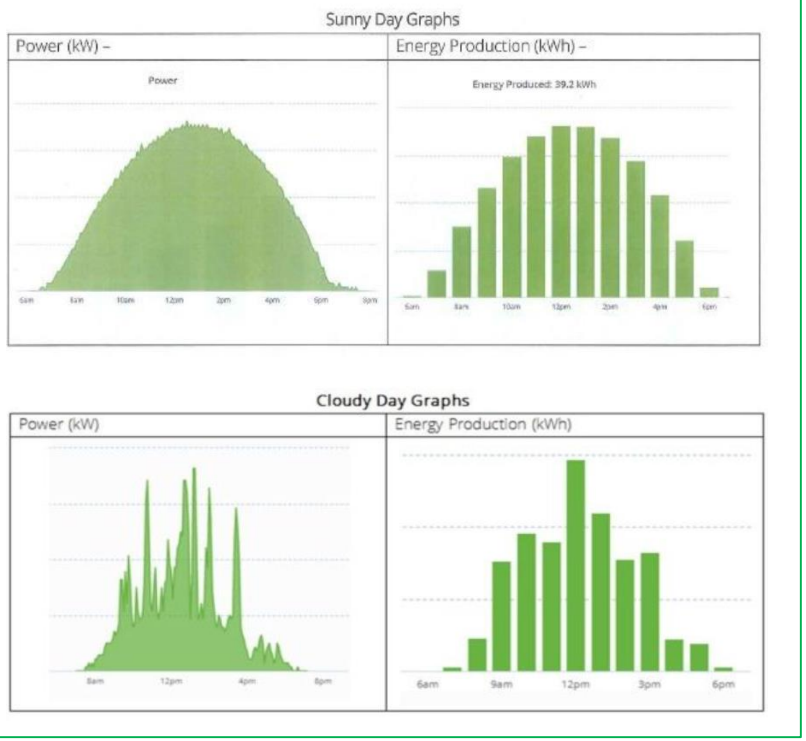
2. RAINFALL CHANGE

ENERGY PRODUCTION



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3. AVERAGE WIND SPEED CHANGE

Area	Average Wind Speed Change
Mechanical damage to installations	The average wind speed will not damage the panels Very low probability of panels being teared from their mounts, or the mounts from the roof or ground in case of intense wind. Racking equipment tested for those areas with frequent hurricanes or tornadoes (very unlike, for example, in Bologna)
Energy production from installations	Wind cools down the panels therefore increasing efficiency
Access to the installation	A change in the average wind will not impact the access to the installation

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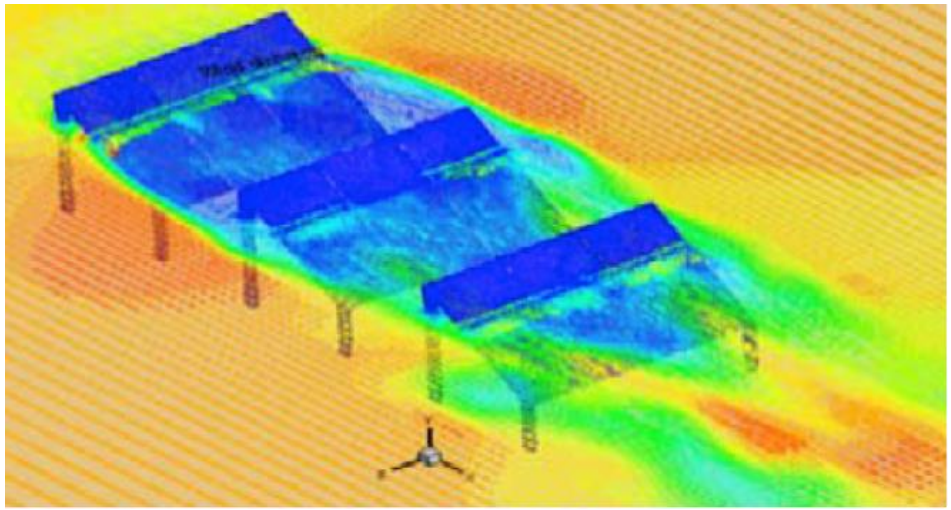
3. AVERAGE WIND SPEED CHANGE – WIND LOAD



Simulation from US, North Carolina

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4. SEA LEVEL RISE

Area	Sea Level Rise
Mechanical damage to installations	If the solar farm is not built in or near the sea, then it will not be impacted by the sea level rise
Energy production from installations	If the solar farm is not built in or near the sea, then it will not be impacted by the sea level rise *In the Netherlands, the largest solar panel island project to date is currently being developed. […] 15 floating solar islands, containing 73,500 panels, will be the first sun-tracking islands of this size in the world* [World Economic forum, December 2019, available Here]
Access to the installation	If the solar farm is not built in or near the sea, then it will not be impacted by the sea level rise

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5. STORMS

Area	Storms
Mechanical damage to installations	Strongs winds from storms can damage the PV infrastructure (e.g. flying debris, tree falling on the installation). Hailstorms can physically damage lower quality installations
Energy production from installations	Dust deposition on the panels results in reduced energy output
Access to the installation	Access to the installation can be difficult/impossible both during and after storms (e.g. if the storm causes floods, broken trees, exposes wires, etc..)

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6. FLOODING

Area	Flooding
Mechanical damage to installations	Panels can be ripped from the ground if they are flooded. Cables, the module junction box and the back sheet are situated at the bottom of the panel and can be damaged by continuous immersion in water
Energy production from installations	No energy production
Access to the installation	Access to the installation will be limited if the area is flooded

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7. WILDFIRE

Area	Wildfire
Mechanical damage to installations	Overheating will damage the panels and if the fire is on the installation the panels will be destroyed
Energy production from installations	No energy production if panels are severely damaged
Access to the installation	It may not be possible to access the panels during a wildfire

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8. AIR POLLUTION

Area	Air pollution
Mechanical damage to installations	Whilst pollution deposits may not damage the installation, frequent cleaning can lead to accidental damage to the panels
Energy production from installations	Substantial losses of energy output due to: - Dust, dirt and polluted atmospheric particles deposits on the solar panels the loss in efficiency is between 3.5% and 5% - A reduction of sunlight hitting the panels as the light may bounce around in the clouds or off the pollution. Studies show that in highly polluted cities the efficiency drop can high - 12%-17% in Delhi - 9%-13% In Beijing
Access to the installation	Air pollution can cause long-term health conditions to the people working on the solar farm

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