solis seminars

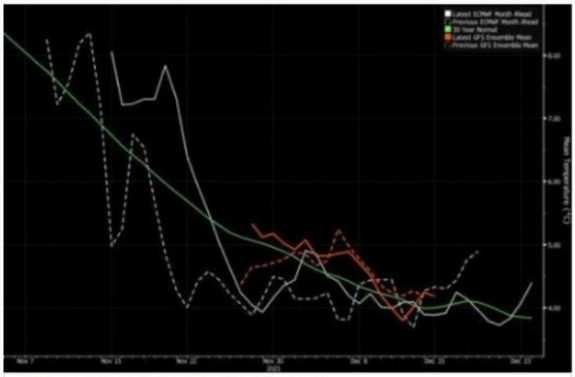
Episode 36

The influence of winter on Solar PV system operation and related O&M considerations

Background

Winter is well and truly on its way for the northern hemisphere with temperatures beginning to fall and already reaching freezing point in some regions. According to forecasts there will be prolonged periods of icy and snowy weather in Europe on its way. So, what are the specific effects of winter on the operation of a solar PV system, and how should we carry out effective operation and maintenance (O&M) of the PV plant in cold weather?

This Solis seminar will look into the effects of cold weather and share suggestions for keeping your solar plants running effectively through winter.



Northwest European month-ahead forecast

The main impact of winter on PV plants

On the whole, the overall solar radiation intensity in winter is relatively low. Looking at the power generation of a PV plant in one year, summer is the peak period of power generation, and winter is the low period of power generation.

In addition, the main influences on the operation of solar power plants in winter are the following factors:

1) Low temperature

In cold weather, the ambient temperature in some areas often drops below freezing point (0°C), and in some severe cold areas may drop below -10°C;

Low temperature affects the operation of system equipment

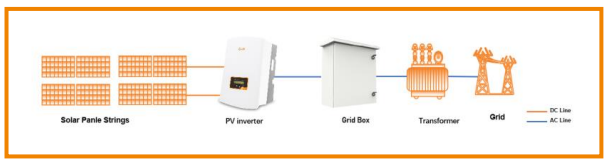
Since the equipment in a solar PV system, such as solar panels, inverters, data collectors, batteries,

etc., have a certain operating temperature range, when the temperature is lower than the allowable temperature of the equipment, it may affect normal operation. This should be considered when choosing the installation site and design of the system.

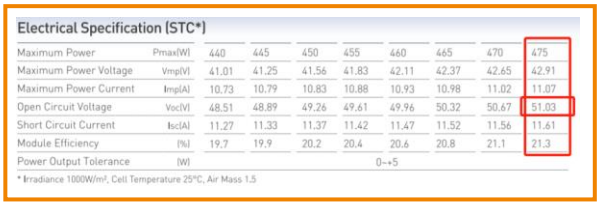
Recommendation: Equipment should be sited in areas that have temperatures within the working limits of the equipment. Items such as energy storage batteries, household PV inverters, data collectors, etc., could be installed indoors or in a cold-proof environment.

Low temperature affects the Voc voltage of the PV system

Low temperature will cause the open circuit voltage(Voc) of PV strings to increase. If the initial design of the system does not fully consider the influence of temperature, during the later operation of the system, the string Voc under low temperature conditions can exceed the maximum allowable input voltage of the inverter, which will likely cause damage.



Taking a 20kW (maximum DC input voltage of 1100V) grid-tied PV system as an example, 52 475W PV panels are used. Assuming that the lowest temperature in the area during the day is -15°C, the string open circuit voltage (Voc) The following table:



Electrical Specification (STC*)

Maximum Power	Pmax(W)	440	445	450	455	460	465	470	475
Maximum Power Voltage	Vmp(V)	41.01	41.25	41.56	41.83	42.11	42.37	42.65	42.91
Maximum Power Current	Imp(A)	10.73	10.79	10.83	10.88	10.93	10.98	11.02	11.07
Open Circuit Voltage	Voc(V)	48.51	48.89	49.26	49.61	49.96	50.32	50.67	51.03
Short Circuit Current	Isc(A)	11.27	11.33	11.37	11.42	11.47	11.52	11.56	11.61
Module Efficiency	(%)	19.7	19.9	20.2	20.4	20.6	20.8	21.1	21.3
Power Output Tolerance	(W)	0~+5							

* Irradiance 1000W/m², Cell Temperature 25°C, Air Mass 1.5

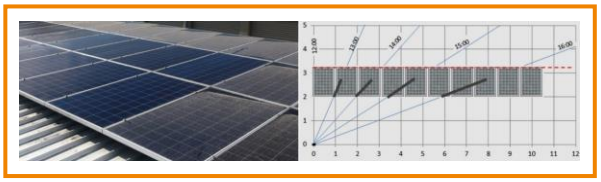
Note: The open circuit voltage temperature coefficient of this PV panel is -0.28%/**℃**, The value of this coefficient is different for different brands of PV panels;

	Inverter1				Inverter2			
	MPPT1		MPPT2		MPPT1		MPPT2	
PV panel quantity/string	16	16	20	0	17	17	18	0
Voc of PV string(at 25℃)	820	820	1025	0	871	871	923	0
Voc of PV string(at -15℃)	928	928	1160	0	969	969	1025	0
Remark	Voc is normal		Voc over 1100V		Voc is normal		Voc is normal	

Recommendation: In the preliminary design of a PV plant, it is necessary to fully consider the Voc of the PV string in extreme low temperature. Reserve sufficient margin to prevent the DC overvoltage in the winter from causing damage to the inverter. If the system has a "OV-DC" alarm, it is necessary to immediately turn off the DC switch of the inverter and reduce the number of solar panels of the PV string.

2) Shading

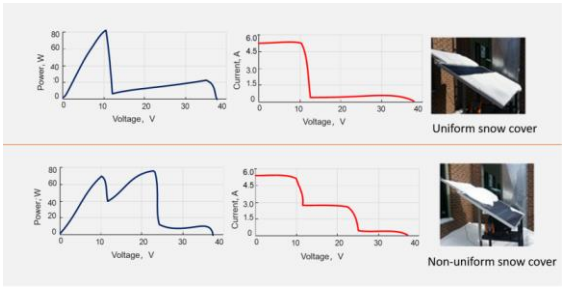
In winter, the angle of sunlight is narrower and shadows are longer. Therefore, the PV array is more prone to shadow occlusion, which has a great influence on the power generation of the PV system.



Recommendation: In winter, the cleaning of the solar panel surface is advised to avoid dirt accumulation. It is also recommended to keep overhanging trees well cut back to prevent the formation of shadows as well as removing furniture causing shadow if possible.

3) Snow cover

Another major problem facing PV plant operation in winter is snow accumulation. Snow covering the solar panel will reduce the solar radiation received by the solar panel and directly reduce the power generation. Moreover, the long-term uneven irradiation of the components may also cause greater hidden dangers due to the hot spot effect.



In addition, snow cover is also a major test for the structural design of the entire PV system due to its weight. Severe snow accumulation can even cause the PV array to collapse, causing equipment damage and personal injury and property losses.

Recommendation:

1)Clear snow from panels in good time

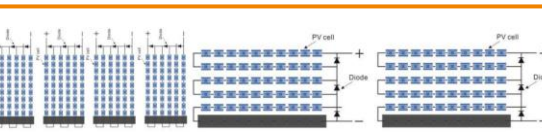
When a PV plant accumulates snow, it needs to be cleaned off in good time to prevent excessive snow accumulation forming into ice, making it heavy and difficult to clean. Please use soft objects for cleaning, do not scratch the glass, and do not step on the PV panel.

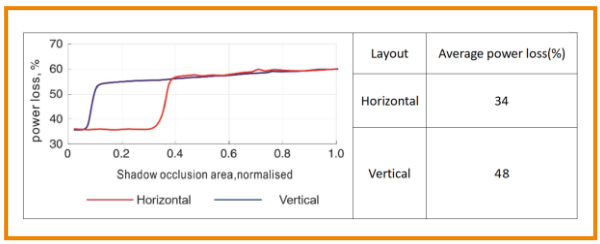
Snow removal includes not only solar panels, but also equipment such as inverters and power distribution cabinets. For example, timely clean-up of snow from the cooling air outlet of the inverter, will prevent the surface of the inverter and the external cooling fan from icing.

2)Adapt design and installation to local conditions

For areas with frequent snowfall, we need to increase the inclination angle of the solar panel within the optimal inclination range. Keeping within the limits of effective power generation, it is also convenient for snow on the surface of the solar panel to slide down on its own.

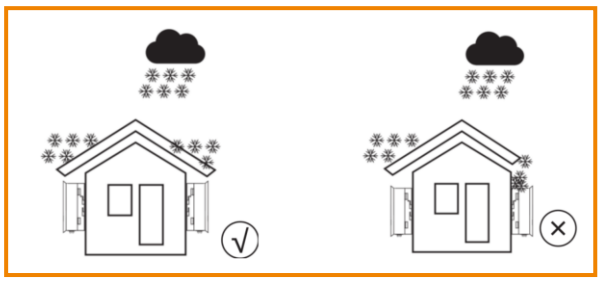
When installing, keep a certain distance between the bottom of the solar panel and the ground to prevent snow from accumulating on the bottom. In addition, it is recommended that solar panels be installed horizontally in areas where it snows frequently. Compared with vertical installations, this solution can ensure that there is enough space between the bottom of the solar panel and the ground to avoid snow stacking. Due to the structural characteristics of a solar panel, adopting horizontal installation is conducive to reducing the loss of power generation.





Layout	Average power loss(%)
Horizontal	34
Vertical	48

It is also recommended to install the inverter in a place where snow can be avoided, such as under the solar panel array bracket, indoors, etc. If the inverter is installed in an open area, it is recommended to add a baffle to prevent excessive snow from blocking the cooling air duct of the inverter or adding extra weight to cause the inverter to fall and be damaged.



3)Online operation and maintenance

The severe cold, wind and snow in winter can cause great difficulties in the maintenance of a PV plant. Therefore, in addition to the operation and maintenance activities such as snow removal and equipment replacement, most of the PV plant inspection and operation and maintenance work is recommended to be remotely implemented through the Solis intelligent monitoring platform, SolisCloud.

Summary

Winter is coming! In addition to the adequate protection of warm and cold protection measures, you also need to maintain your own photovoltaic power station, keeping the panels clean and clear of shadowing. If snow falls, clear it swiftly to avoid potential damage and loss of power. Ensuring local conditions and weather patterns are taken into consideration when designing a new solar PV system will ensure that power is maintained during harsh winters.