How to stop shading impacting solar performance

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Over the past 10 years, solar PV has become one of the most popular sources of renewable energy generation across many global markets. Figures from the International Energy Agency (IEA) showed an 18-fold increase in the amount of installed solar PV capacity between 2010 and 2020, and IEA executive director Fatih Birol recently stated that 'I see solar becoming the new king of the world's electricity markets'.

Picture courtesy of Maxeon Solar Technologies

With this growth has come innovation across all applications, from residential through to commercial & industrial and utility-scale. Exciting installations, including bifacial modules, floating solar parks, and integration with other low-carbon technologies such as electric vehicles, mean that solar is becoming a key tool for many governments keen to meet ambitious decarbonization targets.

That said, using the infinite resources the sun provides does offer its own set of challenges. Often referred to as 'intermittent', meaning that energy output is reduced when the sun does not shine, solar technology companies such as FIMER have been focussed on developing solutions to help optimize the performance of solar even when the panels do not always receive constant irradiation.

One example is shading, it is almost impossible to avoid instances of shading, which can be caused by temporary factors such as clouds, snow or falling leaves or nearby permanent structures such as other buildings, trees or chimneys. These can impact the output of the panels, for example, scientists in the Netherlands are conducting a new study to assess how hybrid wind-solar projects may be impacted by the shade produced by the wind tower and wind turbine blades on the PV facility.

Clearly, shading is not something new, and while the best solution is to avoid it completely, in reality this is often just not possible. While some elements, to a certain degree, can be controlled at the outset of a project, such as ensuring the array is not placed in direct sight of a fixed object like another building, chimney or structure, some more temporary elements, including clouds, snow and air pollution, are out of the installer's control.

Using MPPT

Up until now, using an inverter with Maximum Power Point Tracking (MPPT) capability has helped to mitigate some of the challenges when it comes to maintaining an optimal power output.

MPPT is now often fitted as standard in the latest inverters and increases energy yield as well maximizing optimization, as energy within the solar array constantly modulates and changes. Optimization is dependent on several factors, including shading, as well as solar radiation levels, ambient temperatures, PV plants that are built with varying degrees of topology and/or strings exposed to different angles of irradiation, right through to the condition of the PV module itself.

Tackling the shading issue

However, even MPPT has some limitations. In normal operating conditions, with no shading effect, a standard MPPT is easily able to detect and convert the maximum amount of power.

However, in shaded conditions, when some panels do not receive the same irradiation as the others, the power curve changes and a standard inverter could continue to track the previous power point, meaning that it is not providing the maximum power point. As a result, the energy yield from the panel is reduced.

In order to mitigate the negative impact of shading, one option that is often considered is installing additional devices, such as DC optimizers, at module level to enhance the energy production of that specific PV module when it is shaded.

However, this approach requires several additional components to be installed underneath the panels, increasing the installation cost. These can also be exposed to humidity and temperature changes, increasing the possibility of failure.

A new algorithm to maximize output in shaded conditions

In response to these challenges, FIMER has developed a smart scanning algorithm, FIMER

PowerGain that periodically checks if the PV system is able to produce more energy. The FIMER PowerGain function is built in as standard to all FIMER's string inverter portfolio, including its recently launched PVS 10/33 series, meaning that no additional cost is incurred as no extra components, such as optimizers, are required.

As a result, it is able to provide the same mitigation of the shading condition as panel optimizer solutions without the need for additional mechanisms. Importantly, this also reduces the risk of possible failure due to changes in temperature or other conditions.

So, how does FIMER PowerGain work?

The smart algorithm means that the inverter rapidly scans the input voltage and, within milliseconds, is able to identify the absolute maximum power point. This means it can avoid chasing relative maximum power points, i.e. lower peaks in the curve, which would result in less power being produced.

As a result, the working point is moved on the curve, allowing the system to handle the maximum available power even in shading conditions.

It is also possible to schedule the interval between scans, allowing up to 60 scans an hour, based on the project requirements. Therefore, the solution is able to meet the requirements of any project, from residential to commercial & industrial that may be impacted by shading.

The benefits of an in-built solution over optimizers

As well as the need for no additional components, FIMER also wanted to fully assess the performance benefits of FIMER PowerGain in a comparative study. This monitored power production using our inverters with the in-built solution, versus both standard inverters installed in PV systems without DC optimizers at module level and PV systems with DC optimizers.

The results were compelling. They showed that the FIMER PowerGain solution allowed up to 10 percent higher yields when compared to PV systems using traditional inverters, and it performed significantly better than optimizers in both unshaded and slightly shaded conditions.

In addition, over a longer time period, which included several days of varying degrees of shaded conditions, FIMER PowerGain performed better than the traditional optimizers.

And, while the study showed that optimizers performed slightly better than FIMER PowerGain in a temporary and moderate shaded environment, such as clouds, the additional risk factors when installing optimizers outweigh the marginal performance gains in a few shading conditions.

These included an increased likelihood of failure due to the additional components required, as well as the exposure to moisture and thermal cycling as a result of where the optimizers are installed (in tight enclosures underneath the PV modules). Extra components also mean additional cost, complexity and greater ongoing maintenance, all of which can be avoided with a smart in-built algorithm.

Another potential risk with an optimizer is fire hazard. In a study into fire hazard related to PV systems carried out by the international safety certification body TÜV Rheinland, in cooperation with the research institute Fraunhofer Institute for Solar Energy Systems, which was published by the U.S. Department of Energy: 'Assessing Fire Risks in Photovoltaic Systems and Developing Safety Concepts for Risk Minimization', each additional component involves a higher risk of causing faults and, potentially, a higher risk of fire.

For each optimizer which is added to a PV system, four connectors are also added, exponentially increasing the numbers of elements such as cables and contacts which can cause faults and even fire emergencies.

Conclusion

As the rise of solar continues, in its World Energy Outlook report at the end of 2020, the International Energy Agency (IEA) said solar PV, driven by continued cost reductions, will become the main driver of renewables growth, setting new records for deployment in each year from 2022 until 2040 – the requirement for more innovative solutions in a variety of conditions will also grow.

While PV systems are generally designed and placed to guarantee a constant sun irradiation, it is not possible to completely avoid shading situations. The inverter – which is often referred to as 'the brain' of the PV system - is central to ensuring the installation performs in the most optimal way, even where shading is a regular feature. With clear benefits over other technologies, such as optimizers and standard MPPT, a smart, in-built scanning algorithm will help increase energy yield and return on investment, and in turn, help support the future growth of solar.

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Bio

Florian Chan is Managing Director, Residential Business Line at FIMER. He has a wide international solar sector experience, and has held different roles throughout his career including Business Development Executive and Director of Distribution Europe, achieving impressive results in terms of Business and Team growth, with a particular specialism in the residential segment.