# DHYBRID MIPT WHITEPAPER

## Maximum Inverter Power Tracking (MIPT) Technology

## Summary

Microgrids with decentralized solar power plants can reduce diesel consumption significantly. However, they rarely work to their full potential because conventional energy management systems are unable to separately control the output of individual system parts.

With its patented Maximum Inverter Power Tracking (MIPT) technology, DHYBRID has developed a solution for dynamically optimizing the performance of solar plants in a microgrid. This reduces costs and increases the proportion of solar power in the energy supply without the need to invest in additional hardware.

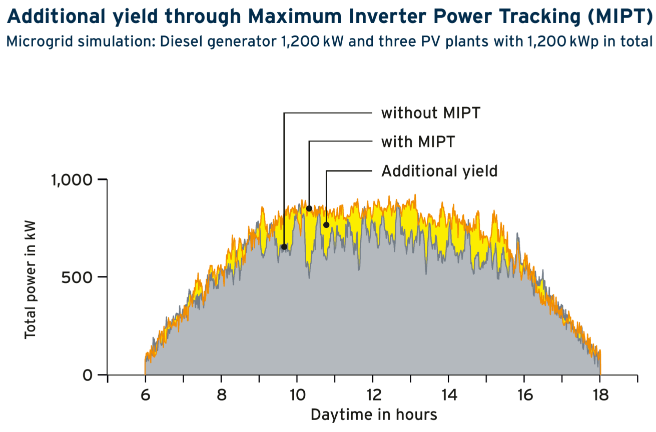


*Figure 1: MIPT functionality*

## The Challenge

Instead of controlling inverters individually, conventional microgrid energy management systems assign the same feed-in power to all devices.

For instance, all the inverters in a system may only be permitted to feed in a certain percentage of their nominal capacity. In such cases, PV plants within the microgrid which are generating high yields at a given time are treated the same as those that are not performing as well. The resulting power output losses are entirely avoidable and can have significant effects for microgrids in particular. This is because microgrids often include several PV plants that are all connected but may experience different degrees of shading, for instance.

This inflexible control system is particularly detrimental to performance if individual inverters fail. Defective inverters continue to have the same feed-in power assigned to them as all the other devices – despite the fact that they are no longer generating any energy. At the same time, fully operational plants that could compensate for this shortfall do not achieve their potential. MIPT, in contrast, detects outages automatically and can immediately offset them by engaging functioning plants.

## MIPT in practice

Since October 2020, nine decentralized photovoltaic plants have been reducing fuel consumption and $CO_2$ emissions at The Residence Falhumaafushi resort in the Maldives. DHYBRID planned and installed the solar energy supply system, which has a total output of 400 kWp.

*Figure 2: The Residence Falhumaafushi*

Using MIPT technology, The Residence Falhumaafushi has increased the proportion of solar power in the grid by 7 percent and lowered its fuel consumption and $CO_2$ emissions. The diesel generators can also steadily feed in power, improving their efficiency and service life.

**MIPT technology**

The patented Maximum Inverter Power Tracking (MIPT) technology is an integral part of DHYBRID's Universal Power Platform (UPP). UPP users do not need to invest in any additional hardware.

Using the MIPT software, the UPP controls each inverter individually by collecting data on consumption, feed-in power and other grid parameters several times per second so that it can identify the optimum settings.

The dynamic MIPT algorithm then distributes the maximum PV feed-in power across the connected inverters several times per second. This makes it easier to unlock the potential of plants that are functioning well, increasing the proportion of solar power in the microgrid.

## Smart Grid Control Platform

- In this sample microgrid, half of the plants are in the shade. They only generate 20 percent of their maximum output, while the plants which are not shaded generate 100 percent.

- The conventional energy management system provides all the inverters in the microgrid with the same set point, meaning that they are each permitted to feed in 40 percent of their rated output.

- The non-shaded plants feed in the permissible 40 percent of their rated output, while those in the shade continue to feed in just 20 percent. Taken together, the plants achieve 30 percent of their rated output.

- The MIPT energy management system, in contrast, ensures that the non-shaded plants can feed in 60 percent of their rated output, resulting in 40 percent as opposed to just 30 percent of the total rated output being supplied.

## Simulation

### MIPT optimization in a grid with three PV plants

This simulation compares the feed-in power of three decentralized PV plants in a microgrid:

- Plant 1: 350 kWp
- Plant 2: 350 kWp
- Plant 3: 700 kWp

Due to parameters such as the minimal feed-in power of the diesel generator, the plants' global set point is dynamically fixed at a percentage of the total output.

### Without MIPT

The feed-in rate of each PV plant in the microgrid is limited to the master set point. The following feed-in data is recorded. The yellow curve indicates the maximum possible feed-in power of the given plant, while the orange curve shows the actual power output as stipulated by the set point.

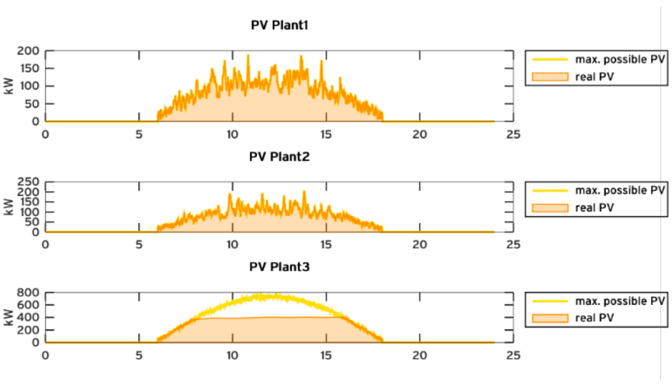


*Figure 3: Limited feed-in rates without MIPT*

In plant 3 in particular, a significant proportion of the potential solar power is not being used. This untapped potential is shown by the white area visible between the orange and yellow curves.

Over a 24-hour period, solar power accounts for **24 percent** of all the power generated.

### With MIPT

The set points are continuously optimized to allow plant 3 – the highest performing plant – to be used to its full potential. The yellow curve indicating the maximum possible feed-in rate is identical to the orange curve showing the actual rate.

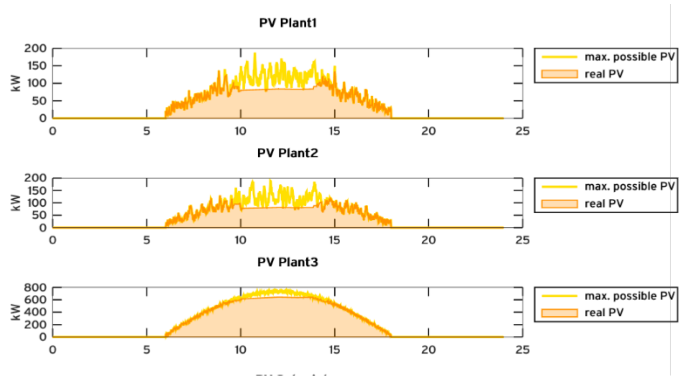


*Figure 4: Optimization with MIPT*

The proportion of solar power generated over a 24-hour period increases by 10 percent and now accounts for **27 percent** of all the power generated.

**Diesel consumption and $CO_2$ emissions have fallen by 3 percent without the need for any additional investments.**

**In the example at hand, this corresponds to additional annual savings of 67,000 US dollars – all made possible by DHYBRID's MIPT.**

## Simulation

### Inverter failure in one of the three PV plants

This simulation examines what would happen if one of the inverters failed. Again, three decentralized PV plants are feeding power into a microgrid:

- Plant 1: 350 kWp
- Plant 2: 350 kWp
- Plant 3: 700 kWp

A uniform set point establishes the maximum feed-in power for each of the plants.

In this example, however, the inverter in plant 2 has failed.

### Without MIPT

Again, the yellow curve indicates the maximum possible feed-in power of the given plant, while the orange curve shows the actual power output as stipulated by the set point. Plant 2 is not supplying any power.

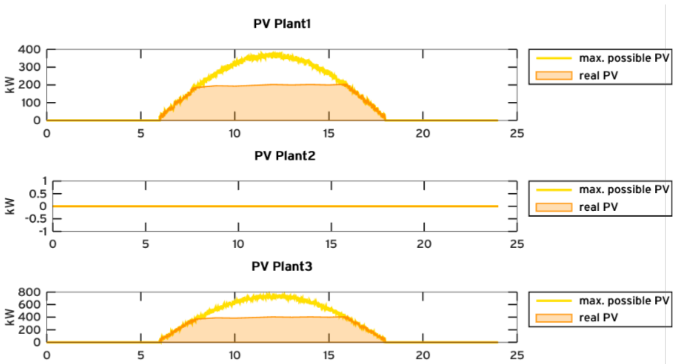


*Figure 5: Inverter failure without MIPT*

Due to the failure of plant 2, plants 1 and 3 could feed in more power without exceeding the permissible total output. However, the energy management system reduces their output, resulting in an avoidable loss of up to 350 kW.

### With MIPT

The MIPT algorithm assigns a higher maximum possible feed-in power to plants 1 and 3. This allows them to automatically compensate for part of the output lost.

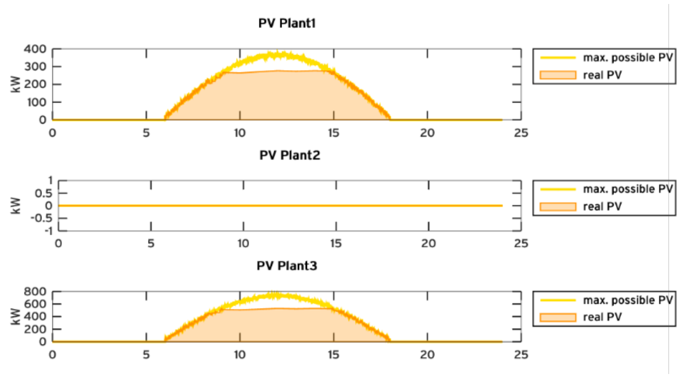


*Figure 6: Inverter failure with MIPT*

This means that the proportion of solar power generated over a 24-hour period increases **from 23 percent to 27 percent** of all the power generated.

Please contact us for further information, system design support and quotes. We will be happily assisting you with your requirements.

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