Getting more from the sun

Efficiently charging electric vehicles thanks to phase switch-off in the case of a reduced PV output

The sun is always shining. Nonetheless, depending on the time of day and year, weather and clouds and other factors, the amount of sunlight that actually reaches roofs with PV installations varies. Until now, technical limitations have meant that the amount of sun exposure was not always enough to produce enough electricity to charge electric vehicles.

With their new function, however, Bender charge controllers now enable electric vehicles to be charged using PV electricity even when solar radiation is low. The charging station achieves this by automatically switching between three-phase and single-phase charging and thus significantly improving the efficiency of the system.

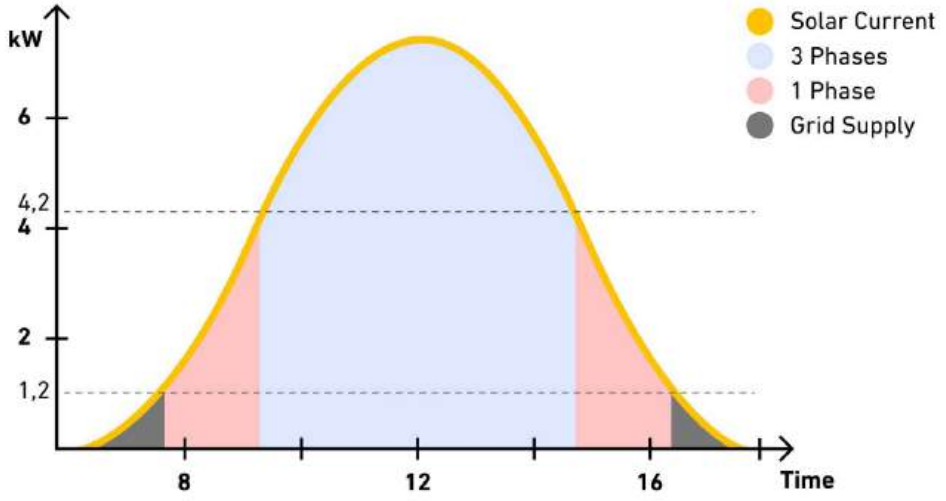
Excess charging without wasting any sunlight

Electric vehicles play an important role in helping to reduce CO_2 emissions in road traffic. To make them an even more sustainable solution, they should ideally be charged using electricity generated by PV installations. Excess PV charging supports this by solely using PV electricity to charge electric vehicles. There is, however, a limitation to this appliacation: If the amount of electricity generated by the PV installation falls below a certain value, the charging process stops. For example, at dusk, in the winter months or on cloudy days. The electricity produced is then fed into the grid, earning users a small feed-in bonus, and is no longer used for charging.

The challenge of excess PV charging

The technical background to this problem can be explained in just a few words: Most vehicle charging stations use three-phase charging, ideally with 16 A per phase. This enables them to achieve a charging capacity of 3 x 3.7 kW, equalling a total of approx. 11 kW. If solar radiation weakens so much that the PV output falls below 4.2 kW and less than 6 A is therefore available per phase, three-phase charging is no longer possible for technical reasons, despite the fact that solar power is still being generated to a relevant extent. This is because electric vehicles require at least 6 A per phase to charge. To enable excess PV charging to continue despite these circumstances and without using additional electricity from the grid, there is a simple solution close at hand, namely switching off, or 'shedding', two phases and switching to single-phase charging in periods of low solar radiation. With a reduced PV output, for example just 3.2 kW, such charging is possible with 14 A.

PV excess charging flexibly adapts the charging process to the available solar energy



Excess PV charging enables charging stations to switch flexibly between single-phase and three-phase charging and therefore to make optimal use of the solar energy available.

The control system for PV charging can be programmed to ensure that electricity from the grid is used additionally where needed to facilitate a charging process.

EN ISO 15118 expands communication

Improved communication between vehicles and charging stations in the medium term

According to standard IEC 61851-1, AC charging stations can only notify vehicles of the maximum amount of electricity they are permitted to use. This one-sided communication via the charging plug does not differentiate between individual phases, and the vehicle itself cannot communicate with the charging station.
The standard ISO 15118-20 can help to resolve this issue. It describes expanded communication between a charging station and a vehicle and enables a bidirectional data exchange. The power line communication (PLC) used for this exchange has already been available in Bender charge controllers for more than eight years.

In the medium term, it will be used to realise further functions that are essential for efficient energy management.

Although many of these functions have not yet been implemented in vehicles, they demonstrate the opportunities awaiting us in the future:

- Reporting the current charging status and requirements of vehicles to the charging station
- Sending information on the grid capacity and possible limitations from the charging station to the vehicle
- Efficient and grid-friendly charging thanks to charging time planning that factors in both the charging requirements and the grid capacity
- Use of the energy stored in the vehicle within the scope of vehicle-to-grid functions

Charge controllers for intelligent charging stations

Although this solution sounds simple, its technical implementation is slightly more complicated because the charging station needs to be able to independently switch phases on and off. To identify the correct operating point for making the switch, the station also needs to know how much PV energy is currently being generated and how much is available for charging purposes once all loads in the home grid have taken what they need. Charging products from Bender meet the necessary technical requirements thanks to their charge controllers, which determine the amount of power currently available by communicating with the PV installation and requesting the required data via SEMP or the SunSpec protocol. They achieve this by communicating with the inverter, the energy manager or an additional energy meter that is installed behind the house connection and integrated via Modbus TCP. This energy meter is connected to the Bender charge controller via Ethernet to record the net PV output available.

The benefits for charging station manufacturers

In terms of both hardware and software, many of Bender's charge controllers support several relays or contactors to switch phases on and off when managing the power supply between the charging station and the vehicle. Charging station manufacturers can choose to implement this function either discretely via contactors or using an integrated solution with a so-called power board. Manufacturers that already use Bender charge controllers can integrate PV charging via a software update and offer excess PV charging without phase shedding as a new function for existing products and charging stations. Furthermore, system and solution providers can expand their PV installations and energy solutions by exploring charging infrastructure options. They can use protocols such as EEBus, SEMP, OCPP and Modbus TCP to integrate the PV charging functions of charge controllers from Bender into their products. As a result, their solution will be simultaneously compatible with many charging stations produced by different manufacturers.

A modular solution with the ICC1324 charge controller

The charge controllers in the ICC1324 range enable manufacturers of charging stations to use Bender's IPM14x1 power boards to easily integrate phase shedding. Bender supplies the circuit logic for the power path. These additional boards known as power boards, for example the IPM1404, can be mounted directly below the controller and also offer a number of other sensible functions such as overvoltage protection, DC residual current monitoring and weld check. Alternatively, customers can also implement phase shedding with their own switch relay solutions or discretely via contractors. In this case, a switching output of the charge controller is used to control the process.

Comfortable control with the Bender app

Be it in a Bender charging station or a solution from another manufacturer, the PV charging function can be easily and conveniently controlled via the Smart Energy Control App. Manufacturers can simply use the Bender app, which is available for Apple and Android devices, as provided or adapt it to meet their own requirements. They can alternatively integrate their own app via a REST interface.

The Smart Energy Control App enables users to conveniently select their chosen charging mode via smartphone.

Three charging modes available

The Bender app enables manufacturers to choose between the charging modes of manual charging, PV charging and excess PV charging depending on their needs.

01 **In manual charging mode,** the vehicle is charged with the selected output or predefined amount of energy regardless of the PV output available. This is a sensible option when a vehicle needs to be charged as quickly as possible but an insufficient amount of solar energy is available.

02 **The PV charging mode** always favours the use of electricity from the PV installation. If the amount of electricity available falls below 4.2 kW, the system switches from three-phase to single-phase charging. If the charging capacity continues to decrease, for example to below 1.4 kW, the system can be programmed to automatically use electricity from the grid so that the charging process can continue and, where possible, no electricity is fed into the grid.

03 **Last but not least, excess PV charging** only uses electricity from the PV installation and pauses the charging process if the capacity falls below the set limit. Without phase shedding, this usually occurs when the charging capacity decreases to less than 4.2 kW.

All in all, the PV charging function plays an important role in helping to make the future of energy efficient and sustainable and to further reduce the carbon footprint of electric vehicles.