Optimal integration of photovoltaic systems in the grid

More and more photovoltaic systems feed electricity into the distribution grid. If the electricity generated locally is not used locally by consumers, this can increase the voltage in the grid. In the PV-Integrated research project, scientists are developing inverter control systems which help stabilise the grid. The new models are currently being evaluated in field tests.

The more photovoltaic systems (PV systems) feed electricity into the grid, the more important it is that reactive power is provided at various grid feed-in points to comply with the permitted voltage range in the grid.

Inverters play an important role in this. They ensure the reactive power required is generated by the PV systems and fed into the grid at the connection point. Inductive and capacitive reactive power affects the voltage. The voltage quality can be improved, for example, by countering the voltage increases via active power feed-in from the PV systems. Intelligent regulation can reduce the voltage and relieve the strain on the grids. "Cost-benefit analyses show that active involvement of PV inverters in voltage maintenance reduces expansion costs by up to 80 per cent compared with conventional grid expansion," explains scientific project manager, Dr Christian Töbermann, from the Fraunhofer Institute for Wind Energy and Energy System Technology IWES in Kassel. He adds "this is because the ability of the distribution grid to absorb photovoltaic power increases. It also helps avoid throttling for the system operators."

Expanded regulation options for inverters

In the "Integration of Significant Levels of Photovoltaic Energy in the Supply of Electricity" (PV-Integrated) project, the scientists and industrial partners are developing alternative regulation options for PV inverters. As part of this, they are combining regulation of reactive power Q(U) with regulation of active power P(U). Reactive power regulation initially ensures that the inverters provide inductive reactive power depending on their local grid voltage, and thus maintain the voltage. When the inverter reaches its maximum reactive power provision from a certain grid voltage, its reactive power output remains constant. If the grid voltage continues to rise, the PV inverter then reduces its active power output. Advantages of this regulation method: The ability of low-voltage grids to absorb more PV power increases overall. It also prevents triggering of the overvoltage protection and disconnection of the system from the grid.
Testing new inverters
Grid operators Bayernwerk and inverter manufacturer SMA Solar Technology are currently testing the theoretical research results in practice. They are carrying out tests at Franz Xaver Denk, a medium-sized company located in Niederalteich, Lower Bavaria. Its PV system covers roughly 70 per cent of its annual electricity consumption. All consumers and the PV system are connected to Bayernwerk’s medium-voltage grid via a shared grid connection point. "The field test proved that PV systems are a very attractive solution, technically and economically, for local reactive power compensation and flexible provision of reactive power for efficient grid operation," explains Daniel Premm from SMA. The inverters used are three-phase units from the newest generation. As standard, they support grid-side functions for provision of active and reactive power and grid-supporting properties in the event of faults. Overall, multiple field tests are being carried out throughout Germany as part of this research project.

The German Federal Ministry for Economic Affairs and Energy funds the PV-Integrated project, which is to run for a total of four years. The results of this research project will also contribute to the "Task 14: High Penetration of PV Systems in Electricity Grids" project by the International Energy Agency (IEA). Task 14 is implemented as part of the IEA’s "Photovoltaic Power Systems" technology initiative.

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