WINNER OF THE watt d'or 2024

SMART SOLUTION FOR OPTIMISATION ISSUES IN THE POWER GRID

ENERGY TECHNOLOGIES CATEGORY. The power grid is an energy infrastructure that is currently benefiting greatly from the excellent research being conducted at Swiss universities. Using mathematical methods and digitalisation, researchers are working on the power grid of the future – a grid that is coming under increasing pressure as electricity production becomes more decentralised, e.g. on the roofs and facades of buildings. This is a problem for the distribution network operators, who have to transmit this electricity; the existing grids have finite physical capacity, and to expand them is costly and time-consuming. Our universities are coming up with solutions to this problem. For example, ETH Zurich is working on a pilot project at AEW Energie AG, a distribution network operator in Aargau. Thanks to an optimisation algorithm developed on the basis of basic mathematical research conducted at ETH Zurich, the AEW network can be boosted by 10% – virtually, i.e. without the need for physical expansion. This is achieved by means of permanent real-time measurements and control commands that optimise reactive power and voltage in the grid.

Specifically, the network operators' dilemma is an optimisation problem: the more electronic components or decentralised systems with irregular grid feed-in are connected to a

Alessandro Scozzafava, team leader in Grid Development and Maintenance at AEW Energie AG, and Lukas Ortmann, professor for Control Systems at OST Rapperswil (from left to right)

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Federal Office of Energy SFOE

Date: December 2023

+ FIND OUT MORE

AEW, 5001 Aarau
↗ **WWW.AEW.CH**

AUTOMATIC CONTROL LABORATORY ETH ZURICH
↗ **WWW.CONTROL.EE.ETHZ.CH**

section of the grid, the more reactive power flows occur. This reactive power is caused by phase shifts in current and voltage in the AC grid and, in contrast to active power, it cannot be utilised. It does, however, cause load on the power line. The ETH Zurich algorithm, which is based on a mathematical method developed at the Institute of Automation at ETH Zurich and the NCCR Automation with the support of the Swiss Federal Office of Energy, continuously evaluates the voltage and reactive power in the grid using real-time measurements (online feedback optimisation), with the aim of optimising reactive power flows. "The project regulates the reactive power at an installation, which also has a positive local effect on the voltage. This results in a higher active power flow, even though the cross-section of the line remains the same," explains Alessandro Scozzafava, team leader in Grid Development and Maintenance at AEW Energie AG. If there is too much capacitive reactive power in the network, the voltage can rise so much that it exceeds the limit values. Axpo, which operates the upstream grid, remunerates compliant (inductive) reactive energy and charges for non-compliant (capacitive) reactive energy. If less non-compliant reactive energy is exchanged at the grid supply point to Axpo, this reduces the costs for AEW's network usage tariff for reactive energy, which in turn results in more favourable network usage tariffs for AEW customers.

The ETH Zurich algorithm ensures that AEW can itself optimise the reactive power problem in its medium-voltage network. If the real-time measurements indicate a problem, control commands are sent to the inverters of a large 865kWp photovoltaic system operated by AEW in Tägerig, Aargau. The inverters then produce inductive (voltage-reducing) or capacitive (voltage-increasing) reactive power, which is used to optimise the reactive power available in the grid.

The pilot project has now been successfully completed. "Without really trying it out, you can't say whether it will fail because of some minor detail. And here we were able to show that it really works in practice in the grid," says Lukas Ortmann, looking back. He was in charge of the project at ETH Zurich and is now professor of Control Engineering at OST Rapperswil. The pilot project involved only one PV system controlled for reactive power production in the medium-voltage grid. However, the ETH software solution could open up much greater potential if it were also to be used decentrally in systems with inverters (PV systems, charging stations, heat pumps) in the distribution grids downstream of AEW, Ortmann explains. This way, solar energy could be made more grid-friendly and grids could be operated more efficiently, securely and cost-effectively thanks to the continuous feedback data.

"Power grids are critical infrastructures, and so it is no surprise that network operators are cautious about implementing new solutions. At first we were afraid that we wouldn't find a partner for the pilot project," says Ortmann. But AEW Energie AG was very keen to work with ETH. "As the person responsible for network development, one of my tasks is to look to the future. That's why we immediately agreed to work with ETH," says Alessandro Scozzafava. And AEW seems to have no regrets: the ETH software is still operative in its network.

WATT D'OR VIDEOS

Since more than ten years, the Swiss Federal Office of Energy rewards best performances in the energy sector with the Watt d'Or. The aim of the Watt d'Or is to increase awareness of these achievements and thus motivate companies, politics and the general public to discover the advantages of innovative energy technologies for themselves. www.wattdor.ch

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Federal Office of Energy SFOE