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Application of meteorological data for state estimation of an electrical low voltage grid with a high amount of photovoltaic systems

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The successful implementation of a feed in tariff in Germany and many other countries has led to a growing number of small photovoltaic (PV) systems with less than 10 kWp, in private households, increasing rapidly. More than 98 % of these systems are connected to the low voltage grid.
The distribution system operators (DSO) had planned their distribution grids historically only in view of the demand of their customers and have to adapt their planning and operation rules to an increasing influence of decentralized generators with a volatile feed-in characteristic as well as high load and high feed in times.
There exist two options to collect information about the grid state. On the one hand it is possible to install measurements into the grid but depending to load situations and control actions the grid structure changes and finding the proper position of a measurement becomes difficult. Furthermore installed measurement devices produce annual costs for communication.
This publication shows approaches for using meteorological remote sensing technologies especially satellite images for estimate the grid state in a low voltage distribution grid from the DSO point of view. Until now the results of the approaches allows calculating the electrical load flow over a low voltage distribution grid transformer by using solar irradiance delivered by the MSG weather satellite, parameters of installed PV systems (position, tilt and angle) and typical load profiles of the connected households. Furthermore it is possible to determine the voltage drop over the transformer which is necessary to calculate the voltage inside the grid structures without addition measurement equipment as well as investigate the influence of clouds to the voltage.
An additional benefit of the described approach is the possibility to use the satellite images for nowcasting the meteorological parameters and thereby the grid state. This is a very new approach for distribution gird operators and become more important with the increase of decentralized renewable energy sources with a weather depending volatile characteristic e.g. Photovoltaic.