Controllable low voltage transformers and low voltage grids with high photovoltaic contingent

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Introduction

Both the resources of conventional energy are soon ending and their pollution make it necessary to reduce and stop their consumption. Therefore photovoltaic and wind energy are used to replace coal and nuclear power stations. But the grids are designed for the big power plant and the loads far away from them. Especially rural grids are not designed to transport energy which is mostly produced in these areas and transported via the high voltage grid towards the industrial centers. Because of the inverse and fluctuating load flow these grids are overloaded and must be improved. This is very expensive.

Theory

In high voltage grids there are tap controllers in use to control the load flow. With these tap controllers used in low voltage grids excess voltages can be avoided and the girds didn't need to be improved. In load situations (when the load flows from the building connection lines towards the transformer) the voltage at the transformer is reduced. Therefore there is no excess voltage at the end of the grid. If there is less photovoltaic input the voltage at the transformer rises and avoids low voltage at the critical point of the grid.

Methods

Some typical and some extreme grids were defined. Load profiles were generated by a load simulator, photovoltaic profiles were measured and scaled to some reference power plants (bigger ones are located at farms). Few tap controllers (different number of steps and switching range) were used. The simulation was done with DigSiLent.

Results

The typical grids are never really critical and can be controlled with every tap controller both in the spring and the summer simulation. The extreme grids are problematic. They need a wide step range and a medium pitch. If the difference of the taps is too small, there are many switching acts necessary. This reduces the life time of the tap controller. If the pitch is too high, there are problems with flicker. Small and long grids are much more problematic than bigger and interconnected grids.

Conclusion

Tap controllers are a good and cheap method to improve grids, especially rural ones with high photovoltaic input. But if the tap controller works without communication (voltage measurement at some critical points) and there is a high photovoltaic input the tap controller has to be chosen properly. It is always a trade-off between the durability of the tap controller and the fluctuation of the voltage.
Some real tap controllers are installed in few grids to validate these results. The industry wants to improve the number of switching operations to improve the voltage stabilization being able to use a smaller pitch.