
The impact of self-consumption in mitigating the distribution network issues

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Lately, new policies were introduced to limit the global warming and to promote carbon neutrality both at the global and European levels. Those policies have conducted to a growth in renewable energy sources. The integration of renewable energy sources has led to a modification in the structure of the network. It has also created the need to find new ways to manage the network in order to provide security and to supply the demand.

The first part of the thesis lays the foundations of the present context to better understand the impacts of renewable energy sources on the network and, the solutions envisaged nowadays to better integrate them. Among the different issues occurring on the electrical grid, the over-voltages faced by a Belgian distribution system operator at the low voltage level are specifically outlined. Ways to alleviate those voltage issues with the use of residential battery energy system storages are studied. Self-consumption is particularly the adopted solution.

Firstly, self-consumption simulations are conducted. They aim at determining what is the optimal battery capacity to use for a residential self-consumption application. The results based upon eight real prosumers show that increasing the battery capacity does not lead to significant improvements in reducing the energy exchanges with the grid. Moreover, as the batteries are still expensive and the current Walloon electricity tariff does not promote the deployment of battery energy storage systems, a 4.4 kWh battery capacity combined with a 1.8 kW converter turn out to be the optimal system to conduct self-consumption.

Secondly, the impact of self-consumption in mitigating the over-voltages on the network is assessed by simulating a feeder designed with twenty customers. The control strategies applied use self-consumption and then, associate self-consumption with reactive power. It turns out that self-consumption is not sufficient to efficiently attenuate over-voltages because of the limit on the battery capacity. However, adding the reactive power control seems to be a good approach to help both the distribution system operator to face over-voltages issues and the consumer in achieving a more renewable consumption.

Finally, this paper presents the tests performed on a practical system carrying out self-consumption.