Abstract. The number of installed distributed generation (DG) in residential areas rapidly increases, specifically in the form of photovoltaics (PV), causing some undesired side effects such as voltage rise. Overvoltage can damage critical loads, but is also disadvantageous for the owner because inverters switch off in case of overvoltage, resulting in output loss. Voltage limits are investigated through calculation and simulation of the voltage profile in a typical low voltage (LV) grid using load data. Insolation data is used for the particular case of PV. This paper presents practical guidelines for the maximum power acceptance in a residential distribution network and the estimation of PV production loss due to overvoltage.

1. Results

Voltage profiles along a feeder are simulated for different injection power and injection location. For a given maximum voltage $U_{\text{max}}$, the maximum power injection at a certain distance can be determined. Table I shows results for the considered Belgian residential area.

Table I. – Electric momentum for different allowed voltages

<table>
<thead>
<tr>
<th>ALLOWED VOLTAGE</th>
<th>ELECTRIC MOMENTUM</th>
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<tbody>
<tr>
<td>$U_{\text{max}} = U_{110%} = 253.0 \text{ V}$</td>
<td>$P.L = 6690 \text{ kWe}$</td>
</tr>
<tr>
<td>$U_{\text{max}} = U_{108%} = 248.4 \text{ V}$</td>
<td>$P.L = 4056 \text{ kWe}$</td>
</tr>
<tr>
<td>$U_{\text{max}} = U_{106%} = 243.8 \text{ V}$</td>
<td>$P.L = 1506 \text{ kWe}$</td>
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All power injections along a feeder can be converted to 1 equivalent power injection at the end of the feeder (1).

\[
P_e = \sum \frac{P_i l_i}{L}
\]  

(1)

where $P_i$ is the equivalent power injection, $i$ the location index, $P_i$ the power injection at location $i$, $l_i$ the distance between location $i$ and the transformer, $L$ the total feeder length.

In order to estimate the PV production losses due to overvoltage, network voltages are simulated during one year, taking into account time dependent load and PV production profiles. The percentage of overvoltage for an arbitrary loading (0-100% of houses is consuming power) lies between minimum and maximum values, which can be linearly approximated. In case of overvoltage, inverters must switch off. The switching will result in voltage oscillations and production losses. From the simulation results the yearly production loss in kWh can be evaluated (fig. 1)

2. Conclusions

This paper gives a general approach for the determination of the maximum power acceptance in residential areas. Using the equivalent power injection approach, the available power injection capacity or the possible violation of voltage limits can be quickly estimated. Guidelines are proposed to calculate PV production losses due to overvoltage. This guideline can be used to choose the peak power of a PV installation. Simulations and calculations are performed for a Belgian residential area. However, the methodology can be generally applied.