European Association for the Development of Renewable Energies, Environment and Power Quality (EA4EPQ)

International Conference on Renewable Energies and Power Quality (ICREPQ'10)
Granada (Spain), 23th to 25th March, 2010

Maximum power injection acceptance in a residential area

C. Debruyne[1,2], J. Desmet[1,2], J. Vanalme[1,2], B. Verhelst[1,2], G. Vanalme[1,2], L. Vandevelde[2]

[1] HOWEST, Department GKG
Graaf Karel de Goedelaan 5, B-8500 Kortrijk (Belgium)
Phone:+ 32 56 24 12 35, e-mail: colin.debruyne@howest.be, jan.desmet@howest.be, johan.vanalme@howest.be, bart.verhelst@howest.be, greet.vanalme@howest.be

[2] Ghent University, Department EESA
Sint-Pietersnieuwstraat 41, B-9000 Ghent (Belgium)
Phone: +32 9 264 34 22, e-mail: lieven.vandevelde@ugent.be

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_{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

ALLOWED VOLTAGE	ELECTRIC MOMENTUM
$U_{max} = U_{110\%} = 253{,}0$ V	$P.l = 6690$ kWm
$U_{max} = U_{108\%} = 248{,}4$ V	$P.l = 4056$ kWm
$U_{max} = U_{106\%} = 243{,}8$ V	$P.l = 1506$ kWm

All power injections along a feeder can be converted to 1 equivalent power injection at the end of the feeder (1).

$$P_e = \frac{\sum P_i . l_i}{L} \qquad (1)$$

where P_e 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)

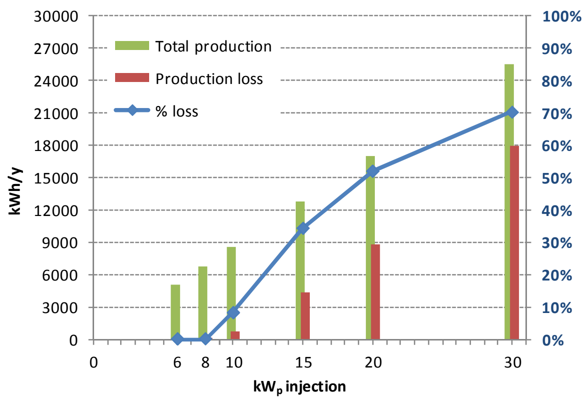

Fig. 1. Yearly production and loss due to overvoltage vs. PV peak power

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.