3.1 General questions

**What extreme scenarios must be analysed before deciding if the connection of DER is permissible?**

Testing according to DIN EN 50160: −

Maximum load & minimum generation at all voltage levels

Minimum load 1) & maximum generation at all voltage levels

1) Value for the load depends on the times, when maximum DER feed-in occurs (e.g. for PV between 10 am and 4 pm).

**What tap-changer position (set-point value for voltage regulation on MV side) should be assumed for the HV/MV transformer depending on the scenario?**

Maximum load & minimum generation at all voltage levels**, minimum tapping** (within control range) at HV / MV transformer

Minimum load 1) & maximum generation at all voltage levels, **maximum tapping** (within control range) at HV/MV transformer

**What is the maximum permissible voltage rise (in % of nominal voltage) for the MV and LV level during normal operation? How does this threshold change during n-1 contingency conditions?**

Testing according to technical connection rules during normal conditions: −

MV level (bdew): voltage change when all DER are connected (compared to the case without any DER)

LV level (VDE AR 4100 and 4105): voltage change when all DER are connected

During normal operation (continuous voltage fluctuation)

Maximum voltage deviation at PCC (Point of Common Coupling)

− LV: -5% to +10%

− MV: -5% to +5% Defined for 95% of the time, measured over one week

During fault conditions (n-1 case, single outage):

− LV: -8% to +10%

− MV: -10% to +10%

After reactive actions (e.g., stepping of on-load tap-changer):

− MV: -8% to +8%

**What is the maximum permissible line loading under normal conditions for the MV and LV level?**

Testing according to technical connection rules:

− Maximum load & minimum generation at all voltage levels, minimum tapping (within control range) at HV / MV transformer

− Minimum load 1) & maximum generation at all voltage levels In both cases, minimum tapping at HV / MV transformer

1) Value for the load depends on the times, when maximum DER feed-in occurs (e.g. for PV between 10 am and 4 pm).

For the current limits, the maximum steady-state loading is limited to 100 % of the long-term assets capacity. Some DSOs make exceptions, e.g., allowing a temporarily loading of 130 % of maximum steady-state loading for MV/LV stations.

**Time Series Analysis without DER:-**

Weekday in Summer: Residential Case (H0)

maximum, mean, and minimum voltage of the buses at MV voltage levelChart, line chart

Description automatically generated

maximum, mean, and minimum voltage of the buses at LV voltage level

Chart, line chart

Description automatically generated

Mean and maximum line loading over time

Chart, line chart

Description automatically generated

Sunday in fall/Spring: Residential Case (HO)

maximum, mean, and minimum voltage of the buses at MV voltage level

Chart, line chart

Description automatically generated

maximum, mean, and minimum voltage of the buses at LV voltage level

Chart, line chart

Description automatically generated

Mean and maximum line loading over time

Chart, line chart, histogram

Description automatically generated

Saturday in Winter: Residential Case (HO)

maximum, mean, and minimum voltage of the buses at MV voltage level

Chart, line chart

Description automatically generated

maximum, mean, and minimum voltage of the buses at LV voltage level

Chart, line chart

Description automatically generated

mean and maximum line loading over time

Chart, line chart, histogram

Description automatically generated

Weekday in Summer: Commercial Case (G0)

maximum, mean, and minimum voltage of the buses at MV voltage level

Chart, line chart

Description automatically generated

maximum, mean, and minimum voltage of the buses at LV voltage level

Chart, line chart

Description automatically generated

mean and maximum line loading over time

Chart, line chart, histogram

Description automatically generated

Sunday in Spring: Commercial Case (G0)

maximum, mean, and minimum voltage of the buses at MV voltage level

Chart, line chart

Description automatically generated

maximum, mean, and minimum voltage of the buses at LV voltage level

Chart, line chart

Description automatically generated

mean and maximum line loading over time

Chart, line chart

Description automatically generated

Saturday in Winter: Commercial Case (G0)

maximum, mean, and minimum voltage of the buses at MV voltage level

Chart, line chart

Description automatically generated

maximum, mean, and minimum voltage of the buses at LV voltage level

Chart, line chart

Description automatically generated

mean and maximum line loading over time

Chart, line chart, histogram

Description automatically generated

**Time Series Analysis with DER only active power:-**

Workday in Summer: Residential Case (H0)

maximum, mean, and minimum voltage of the buses at MV voltage level

Chart, line chart

Description automatically generated

maximum, mean, and minimum voltage of the buses at LV voltage level

Chart, line chart

Description automatically generated

the mean and maximum line loading over time

Chart, line chart, histogram

Description automatically generated

Workday in Summer: Commercial Case (G0)

maximum, mean, and minimum voltage of the buses at MV voltage level

Chart, line chart

Description automatically generated

maximum, mean, and minimum voltage of the buses at LV voltage level

Chart, line chart

Description automatically generated

the mean and maximum line loading over time

Chart, line chart

Description automatically generated

Sunday in Spring: Residential Case (H0)

maximum, mean, and minimum voltage of the buses at MV voltage level

Chart, line chart

Description automatically generated

maximum, mean, and minimum voltage of the buses at LV voltage level

Chart, line chart

Description automatically generated

the mean and maximum line loading over time

Chart, line chart, histogram

Description automatically generated

Sunday in Spring: Commercial Case (G0)

maximum, mean, and minimum voltage of the buses at MV voltage level

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maximum, mean, and minimum voltage of the buses at LV voltage level

Chart, line chart

Description automatically generated

the mean and maximum line loading over time

Chart, line chart

Description automatically generated

Saturday in Winter: Residential Case (H0)

maximum, mean, and minimum voltage of the buses at MV voltage level

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maximum, mean, and minimum voltage of the buses at LV voltage level

Chart, line chart

Description automatically generated

the mean and maximum line loading over time

Chart, line chart, histogram

Description automatically generated

Saturday in Winter: Commercial Case (G0)

maximum, mean, and minimum voltage of the buses at MV voltage level

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maximum, mean, and minimum voltage of the buses at LV voltage level

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the mean and maximum line loading over time

Chart, line chart, histogram

Description automatically generated