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Guidelines for the hosting capacity evaluation of distribution networks for distributed energy resources

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GUIDELINES FOR THE HOSTING CAPACITY EVALUATION OF DISTRIBUTION NETWORKS FOR DISTRIBUTED ENERGY RESOURCES

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Draft	Report on voting
8B/212/DTS	8B/225/RVDTS

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The language used for the development of this Technical Specification is English.

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GUIDELINES FOR THE HOSTING CAPACITY EVALUATION OF DISTRIBUTION NETWORKS FOR DISTRIBUTED ENERGY RESOURCES

1 Scope

This document specifies methods for the evaluation of the maximum export capacity of distributed energy resources (DER) that distribution networks can accommodate. It provides guidance on the technical constraints that should be considered in evaluating hosting capacity, information required to be collected to undertake a hosting capacity evaluation, and evaluation methods.

This document is applicable to AC distribution networks operating at a nominal frequency of 50 Hz or 60 Hz.

This document does not specify allowable values of system parameters that can be impacted by the addition of DER on a distribution network, such as maximum or minimum voltage, maximum current, etc. These values are to be determined by the user, from international or national standards, local regulations or the like, and used as an input to the evaluation methods described in this document.

Options for increasing the hosting capacity of distribution networks are not specifically considered, although the identification of constraints to the hosting capacity will assist users in developing methods for increasing the overall hosting capacity.

This document is mainly used by distribution system operators (DSO) and other organizations with corresponding qualifications and capabilities. The evaluation results can serve the DER investors, DSO, energy sector regulators and other stakeholders as a decision-making basis.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60255 (all parts), *Measuring relays and protection equipment*

IEC 60364 (all parts), *Low-voltage electrical installations*

IEC 60834-1, *Teleprotection equipment of power systems – Performance and testing – Part 1: Command systems*

IEC 60909-0, *Short-circuit currents in three-phase a.c. systems – Part 0: Calculation of currents*

IEC 61000 (all parts), *Electromagnetic compatibility (EMC)*

IEC 61400-27-1, *Wind energy generation systems – Part 27-1: Electrical simulation models – Generic models*

IEC 61936-1, *Power installations exceeding 1 kV AC and 1,5 kV DC – Part 1: AC*

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IEC TS 62749, *Assessment of power quality – Characteristics of electricity supplied by public networks*

IEC TS 62786-1, *Distributed energy resources connection with the grid – Part 1: General requirements*

IEEE 1547.4, *Guide for Design, Operation, and Integration of Distributed Resource Island Systems with Electric Power Systems*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

For the purposes of this document, the following terms and definitions apply.

3.1
distributed energy resources
DER
generators (with their auxiliaries, protection and connection equipment), including loads having a generating mode (such as electrical energy storage systems), connected to a low-voltage or a medium-voltage network

[SOURCE: IEC 60050-617:2017, 617-04-20, modified – "pl" was deleted from the term and abbreviated term.]

3.2
hosting capacity
maximum export capacity of DER that the distribution network can accommodate, under the condition that the distribution network operates safely and reliably

3.3
distribution network
electric power network for the distribution of electric power from and to network users for which a distribution system operator (DSO) is responsible

[SOURCE: IEC TS 62786:2017, 3.4]

3.4
distribution system operator
DSO
party operating a distribution network

[SOURCE: IEC 60050-617:2009, 617-02-10, modified – "distribution network operator" and "distributor" were deleted from the equivalent terms.]

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3.5
reverse load rate
ratio of reverse active power through a transformer, line, cable, etc. to its actual maximum operating capacity

Note 1 to entry: Reverse direction of power flow is from downstream to upstream.

Note 2 to entry: The actual maximum operating capacity of a transformer, line, cable, etc. is affected by aging and climate.

3.6
thermal rating
ability of electrical equipment to bear the thermal effect of current in long-time operation

3.7
short-circuit current
electric current in a given short-circuit

[SOURCE: IEC 60050-614:2016, 614-02-03]

3.8
voltage deviation
difference between the supply voltage at a given instant and the declared supply voltage

[SOURCE: IEC 60050-614:2016, 614-01-04]

3.9
harmonic voltage
sinusoidal voltage with a frequency equal to an integer multiple of the fundamental frequency of the voltage

[SOURCE: IEC 60050-614:2016, 614-01-14]

3.10
voltage unbalance
in a polyphase system, a condition in which the RMS values of the phase voltages or the phase angles between consecutive phases are not all equal

[SOURCE: IEC 60050-161:1990, 161-08-09, modified – "voltage imbalance" was deleted for the equivalent terms.]

4 Basic requirements of the evaluation

4.1 Evaluation principle

The evaluation is to guide the development of DER to match the current situation and future development of distribution network. Therefore, the evaluation should be carried out to identify the hosting capacity of a distribution network while ensuring the safe and reliable operation of distribution network. The objective is to provide a reference for the planning, designing, reconstructing and operating of DER and distribution network.

The hosting capacity of a certain voltage level should not exceed that of the corresponding upper level. Therefore, the evaluation should be based on the principle of "hierarchical evaluation zone by zone", i.e. it should be carried out from the whole to the segment and from higher-voltage level to lower-voltage level according to the power supply area and voltage level.

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The evaluation should be carried out periodically in synchronization with the analysis of distribution network operation mode and distribution network planning. The evaluation period should be appropriately adjusted according to the changes of distribution network structure, electrical load and power generation, which can be shortened in the distribution network of low hosting capacity.

4.2 Evaluation scope and objects

The evaluation scope could be the whole distribution network or a part of it, for example, a control area of DSO or a supply zone of a transformer, etc.

The evaluation objects should include corresponding electrical equipment, including transformers, lines, cables, switching equipment, corresponding relay protection equipment, etc.

4.3 Impact factors

4.3.1 Structure of distribution network

The hosting capacity is directly related to the structure and equipment capacity of the distribution network. If the structure of distribution network is strong and the equipment capacity of distribution network is large, the corresponding hosting capacity of distribution network is relatively large.

4.3.2 Composition of existing power generation

The equipment capacity in a distribution network is generally fixed. Other power generation transmitted through the same channel as DER in the distribution network can cause congestion in certain parts or sections of infrastructures of determined areas. Therefore, it is necessary to consider the composition of the existing power generation when planning additional DER installations.

4.3.3 DER under construction or approved

Different nodes in a distribution network have different thermal rating margins, voltage deviations, and short-circuit capacities. As a result, different nodes can support different capacities of DER. The additional DER should consider the DER under construction and approved at the specific connection node.

4.3.4 Load characteristics

Consumption including local consumption and delivery of DER should be analysed with the load distribution and its operation curve. The higher the load density of the distribution network or the more similar the shape of the load curve to the DER output curve is, the higher the hosting capacity is.

5 Evaluation contents

5.1 Thermal rating

The evaluation objects should include transformers, lines, cables, etc. within the evaluation scope. The reverse load rate λ should be used as the evaluation index for thermal rating evaluation.

The reverse load rate λ should be calculated according to factors such as the distribution network operation mode, transformers, lines and cables limits, load characteristics, and output characteristics of DER and other power generations.

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