

Cable constraints due to background harmonic amplifications

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The use of long EHVAC cables is today a tendency of grid development, expected to be even stronger in the years to come, for connecting new clients in a short delay as well as for grid developments.

When inserting long EHVAC cables in its grid, RTE is used to study reactive energy compensation for voltage stability issues taking into account zero-miss effect. Transient overvoltages are also phenomena watched during studies because of resonance. Indeed, EHVAC insulated cables are capacitive elements and as RTE's grid is rather inductive, their association creates series or parallel resonances depending where they are seen from.

These resonances are today also investigated by RTE for harmonic distortions assessment. RTE has observed in its recent studies these phenomena are responsible for background harmonic amplifications when harmonics match a resonance in terms of frequency. Amplifications increase with the length of cables to be installed reaching several tens of times the initial harmonic amplitude mostly on the first odd harmonics. This issue is especially expected with the use of cables to connect the future first French offshore wind farms.

For offshore wind farm connection projects, RTE observed that harmonic voltages applied on the connection cables can be up to 20 times the harmonic voltages prior to the wind farm connections for harmonics #3 to #7 taken into account various grid scenarios including grid contingencies, load variations, and wind farm projects uncertainties. The issue was observed stronger offshore than onshore.

The method used by RTE for investigating background harmonics is composed of field measurements and simulations with the EMTP-RV simulation tool. Measured harmonics are concentrated on the 3rd, the 5th, and the 7th rank on the 225kV grid with amplitudes lower than 2%. However, with amplifications up to 20, even a reasonable content of background harmonics could be sufficiently amplified. Studies presented in this paper showed that the 5th and the 7th harmonics can easily exceed the grid code limits up to 600% in the case of offshore wind farm connections for instance. This significant excess of grid code limits can be the source of power quality disturbances and could stress HV equipment including cables.