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Challenges to establish an application protocol for harmonic sharing responsibility methods

With the increase of non-linear loads in electrical systems at their different voltage levels, involving generation, transmission, and distribution systems, the issues associated with harmonic distortions present themselves as important challenges in scientific and applied engineering contexts. In addition, there is an exponential growth in the number of generation plants connected to the electricity grid via electronic converters, such as wind parks and photovoltaic farms. In fact, once violations of the recommended limits for harmonic distortions are found, it becomes imperative to apply mitigating procedures. In this context, it is a fact that many power system busbars in several countries, such as Brazil, already have levels of harmonic distortions close to (or above) the normative limits. Furthermore, such mitigating solutions are in general financially expensive. Thus, they require criteria and procedures aimed at sharing the technical and economic responsibilities for the problem solution.

In order to obtain procedures to solve the problem of harmonic sharing of responsibilities, the literature reports different methodologies for determining harmonic contributions between the parties. Among the procedures with feasibility for field applications, the following stand out: Dominant Impedance Method [1], Harmonic Current Injection Method [2], Capacitor Switching Method [3], Active Filter Method [4], and IEC Method [5].

Despite the recognition of important scientific advances in the laboratory and in the field, there are still gaps regarding regulatory propositions when considering issues associated with the establishment of protocols for the execution of work on responsibility sharing. Certainly, this situation presents itself as a challenge at a global level, as there is a complete absence of discussion of protocols that can provide subsidies for the implementation of processes of sharing harmonic responsibility in the field.

Thus, this contribution to the Special Reports of the 2022 CIGRE Session aims to conduct a discussion regarding the previously mentioned challenges. The premises that should guide the establishment of a protocol for applying methodologies in the field will be pointed out, offering consistent bases for defining the responsibility percentages.

At first, the protocol should consider a minimum measurement time interval, which must be consistent with the requirements of each sharing responsibility methodology. As an example, processes based on state changes will require repetitive operations of devices throughout the recording period. This characteristic imposes an expressive difference in the measurements when compared to power quality assessments. In fact, the well-known 10-minute intervals used for many applications [6] would not be appropriate for imposing state changes in the network. Some methods may require shorter intervals to perform state changes and, consequently, share responsibility.

In addition, there is still the question of the total monitoring time over which harmonic distortion responsibilities will be determined. Naturally, a possibility that is consistent with some standards would be the use of a minimum period of 7-day consecutive. Bearing in mind that, in this interval, eventual purges would also be considered due to different transient occurrences in the electrical system. A minimum power consumption/generation from the parties can also be defined.

Complementary aspects cannot be disregarded in the discussions to be carried out concerning to sharing responsibility in a real system, such as temporal aggregation interval; aggregation among different phases; weightings depending on the power or energy demanded; application of statistical tools for data processing like the percentile 95 or the use of analysis in quartiles; establishment of responsibility-sharing ranges; etc.

Finally, it is worth mentioning that establishing the harmonic responsibility sharing protocol is a discussion that goes beyond the simple harmonic measurement activity, as it has to deal with the particularities of the different responsibility sharing methodologies. Therefore, the convergence of the processes related to harmonic sharing responsibility is an important challenge in evolving electric power systems.

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[3] A. C. dos Santos, I. N. Santos, and J. C. de Oliveira, "Capacitor switching methodology for responsibility sharing of harmonic voltage distortions," International Transactions on Electrical Energy Systems, vol. 29, no. 12, p. e12135:1-16, 2019, doi: 10.1002/2050-7038.12135.

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