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IMPACTS OF DISTRIBUTED GENERATION AND ENERGY STORAGE ON POWER QUALITY

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Abstract: The Distributed Generation (DG) from unconventional renewable sources, has been getting more and more space in the distribution system (DS). In Brazil, this DG dissemination is predominantly photovoltaic solar energy (PV) due to the characteristics and high levels of solar radiation. This type of generation can insert electromagnetic disturbances in the electrical systems due to the intermittency of the generation and the equipment needed to connect the distributed generation to the grid. Due to the possible problems that DG can cause in DS, this paper presents an analysis of the impact on power quality (PQ) of a DS, considering different allocations, penetration levels, and system load.

1 Introduction:

The increase in the use of PV is mainly justified by the availability of the generation source, but there are some problems, where the main is the intermittence. This issue cause voltage and frequency fluctuation [1]. In order to minimize the effect of voltage fluctuation, energy storage systems (ESS) have been used in conjunction with PV. According to [2] the most suitable ESS for this application are the batteries.

However, with the high DG and ESS penetration in DS, have up insertion of electromagnetic disturbances. The main disorders inserted are: (i) voltage imbalance, caused by to single-phase generation connection; (ii) harmonic distortion, caused bay the use of frequency converters; and (iii) voltage variation [3] and [4].

Considering the increased use of DG and ESS, this paper seeks to analyze the impacts od distributed photovoltaic generation and batteries on the distribution system. Different scenarios of loading, penetration and allocation of DG were analyzed.

2 Power Quality Overview:

For the energy to have the voltage and current wave form as sinusoidal as possible, thus avoiding damage to the electrical system and consumers, standards have been established to regulate the insertion of disturbances that affect the power quality. The main international standards are IEC 61000, IEEE 1159 and IEEE 519.

In the Brazilian scenario, the standard regarding distribution systems are found in PRODIST (Distribution Procedures). Power Quality standardization is in module 8, where the limits for electromagnetic disturbances are established. The limits for steady state voltage and harmonic distortion are presented in the figure 1. For voltage imbalance the limit is 2% [5].

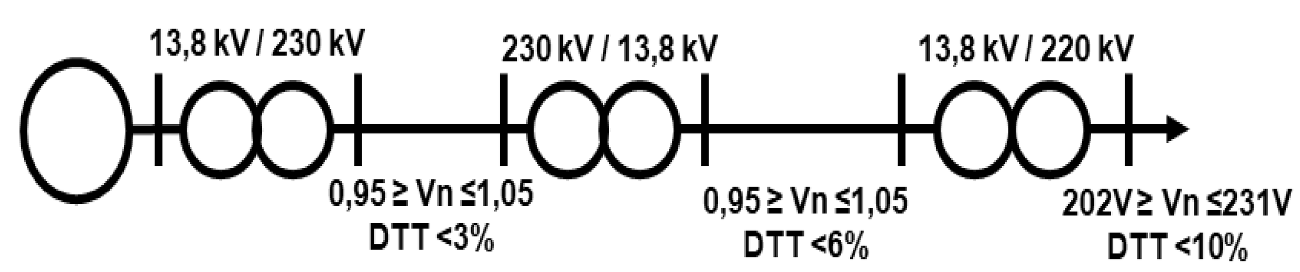

Fig 1: Voltage Range and Harmonic Distortion Limits

3 Methodology:

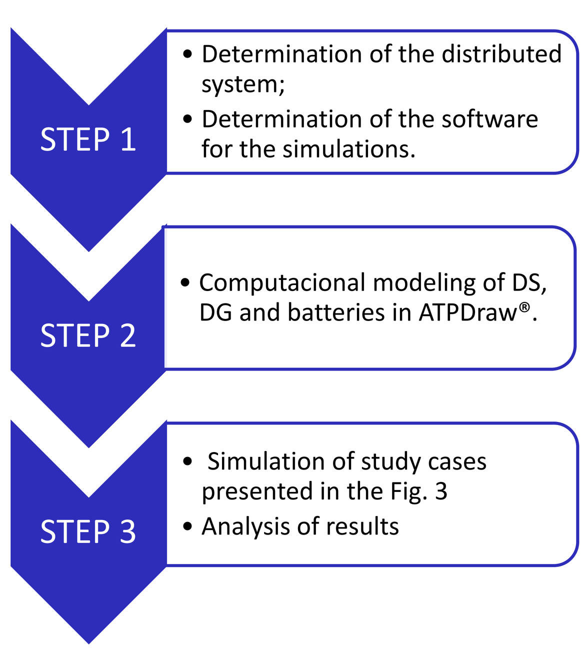

Fig 2: Research Steps

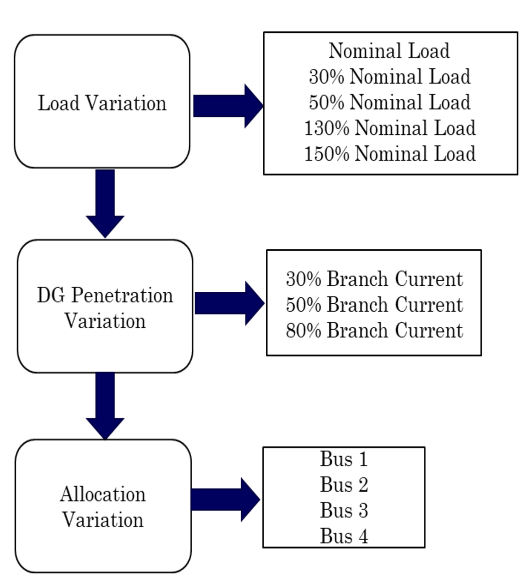

Fig 3: Simulated Cases

4 Results and Discussion:

Load Variation: In the Fig 4, Fig 5 and Fig 6 are presented the results for the electromagnetic disturbances analyzed considering load variation.

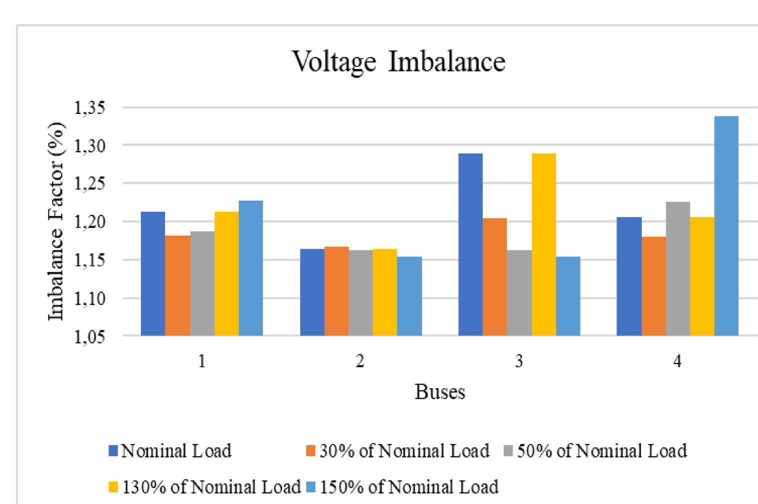

Fig 4: Voltage Imbalance for Load Variation

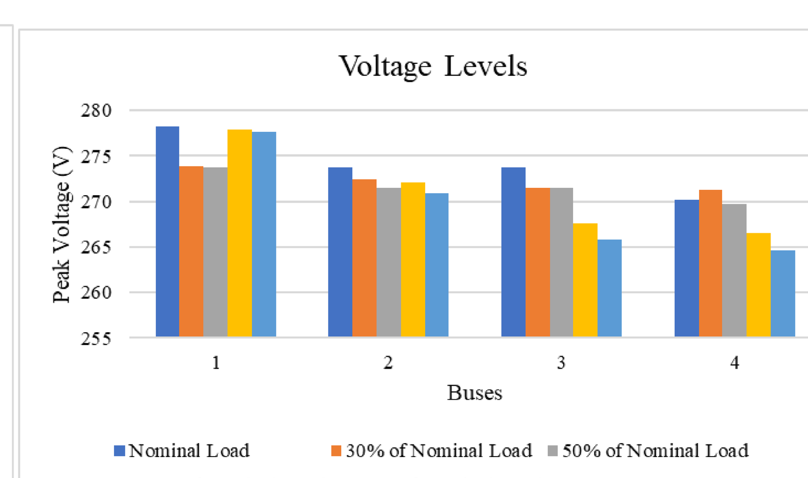

Fig 5: Voltage Level for Load Variation

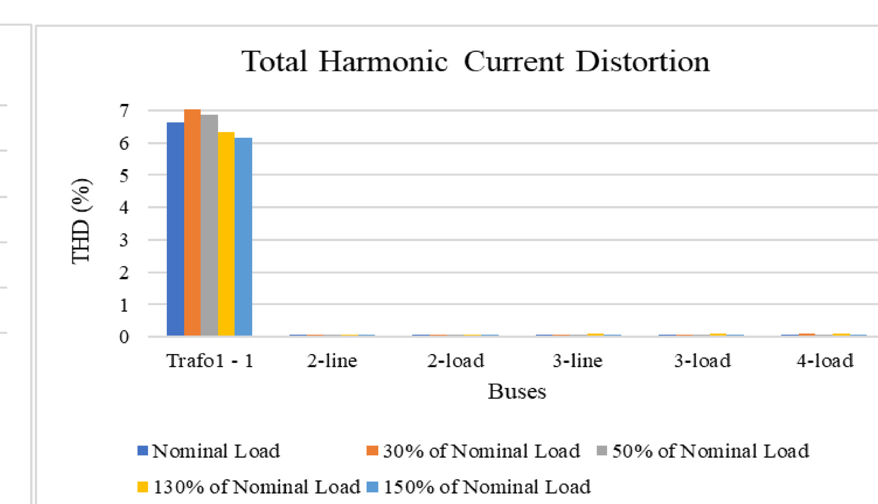

Fig 6: THD for Load Variation

DG Penetration Variation: In the Fig 7, Fig 8 and Fig 9 are presented the results for the electromagnetic disturbances analyzed considering DG penetration variation.

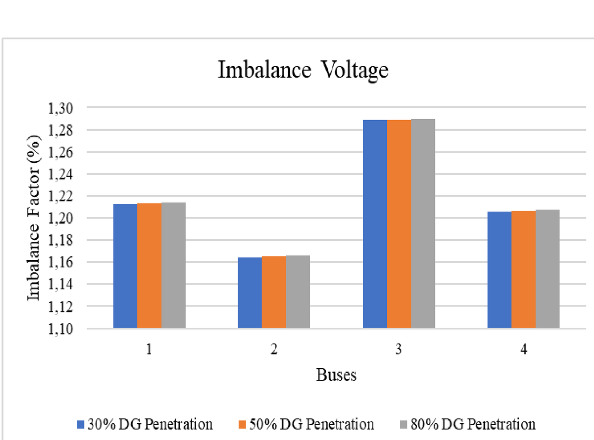

Fig 7: Voltage Imbalance for DG Penetration Variation

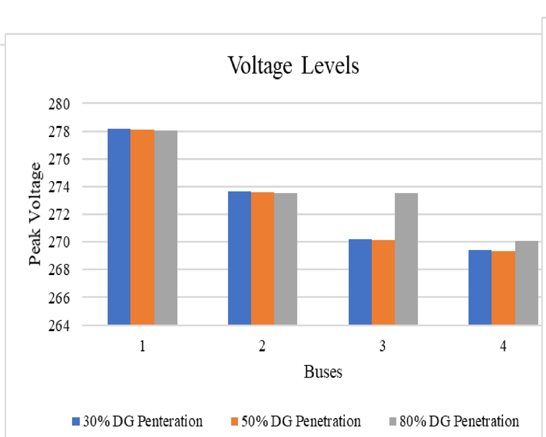

Fig 8: Voltage Level for DG Penetration Variation

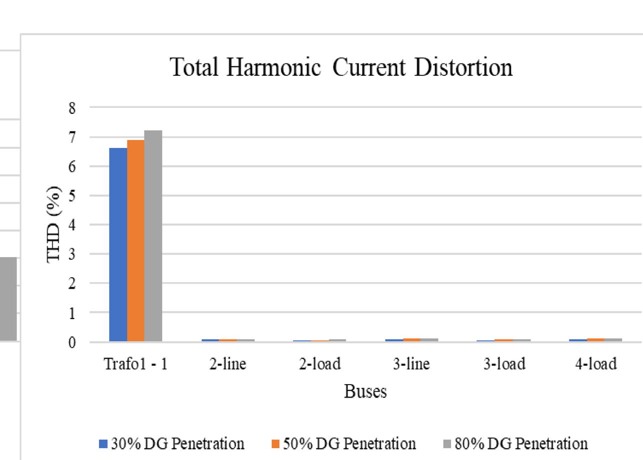

Fig 9: THD for DG Penetration Variation

Allocation Variation: In the Fig 10, Fig 11 and Fig 12 are presented the results for the electromagnetic disturbances analyzed considering allocation variation.

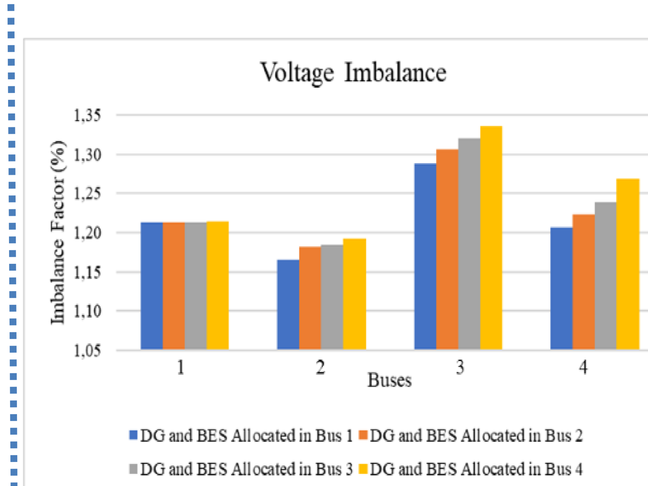

Fig 10: Voltage Imbalance for Allocation Variation

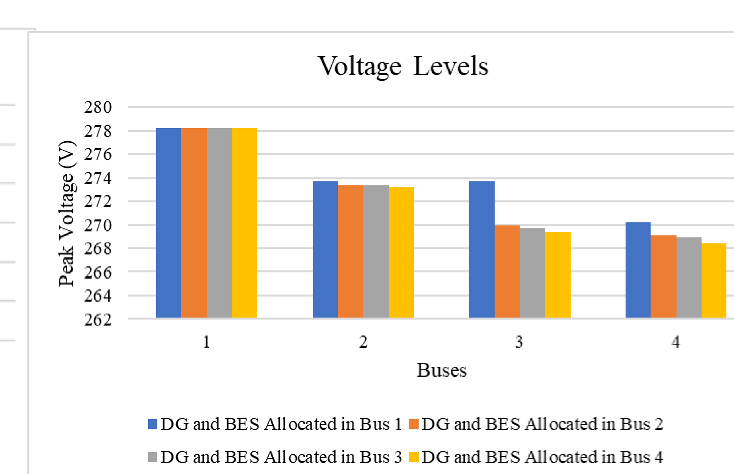

Fig 11: Voltage Level for Allocation Variation

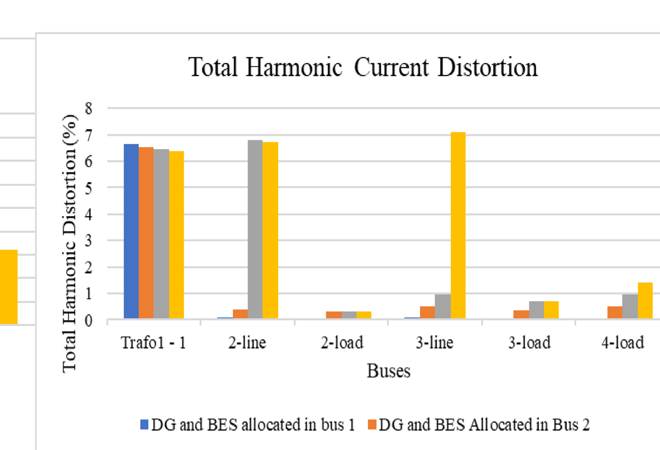

Fig 12: THD for Allocation Variation

5 Conclusion:

I. The insertion of distributed generation and storage of energy present advantages for the electrical system.
II. There are disadvantages, such as the insertion of harmonics or overvoltage.
III. The allocation of DG and batteries can mitigate the disturbances caused by them.
IV. For the cases analyzed the best allocation is when the DG and batteries are closer to the distribution transformer.

References:

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