Power Quality in Distribution Systems with Renewable Energy Resources

Workshop: Desempeño de Sistemas Elctricos de Potencia

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Medellín, December the 4th of 2018

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Calidad de Potencia
Conjunto de característcas de las seales de tensión y corriente para satisfacer las necesidades de un cliente.

Confiabilidad
Probabilidad de que un sistema funcione apropiadamente.

Qué efectos tienen las fuentes renovables de energía en desempeño de un sistema eléctrico?

- Balance de energía: Estabilidad, confiabilidad
- Distorsión de forma de onda y desbalance
- Cambio en requerimientos de energía: Cambio de demanda, dinámica de la generación
- Formas de operación diferentes: cambio de paradigma d sistema eléctrico
- Efectos sobre activos del sistema: gestión de activos

e

Power Systems Stability

Micrograds and Power Systems - New paradigm, low inertia, different network topology and impedances (higher resistances) - How do electrical networks collapse?

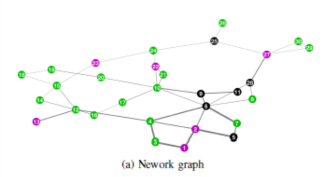

Figure 1: Graph theory applied to study collapse[1]

Long term voltage stability and Real time stability assessment

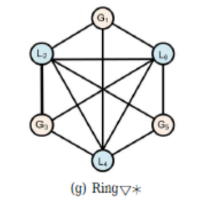

Figure 2: Topology effects on LT voltage stability [2]

Demand Side Management (DSM)

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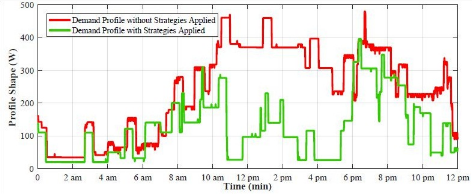

Figure 3: Demand profile with DSM strategies applied [3]

Analyze DSM strategies applied over customer patterns changes aggregated demand profile.

The different combined strategies DMS generate changes in aggregated demand profile, according to management actions, e.g. Peak clipping, Valley filling, Load shifting, and demand flexibility.

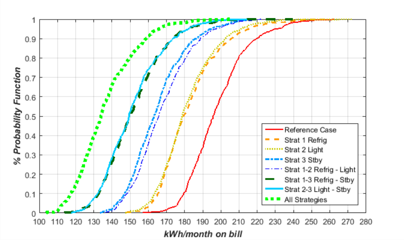

Figure 4: Different strategies applied to demand profile

Asset Management

Asset Management

Asset Management comprises a serie of techniques in order to apply different management actions over an asset in order to obtain an improvement in its performance but also keeping an optimal profit

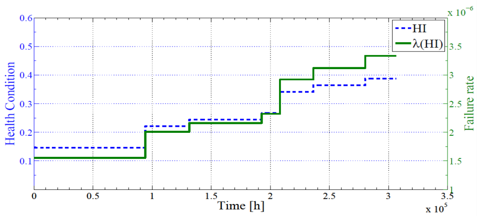

Figure 5: Simulation of Health Condition and Failure rate in a typical transformer.

In the electric system, the **power transformer** is a critical asset.

- Strategies: Health Condition, Maintenance Actions, Ageing evaluation and remnant life calculation, and Failure rate.

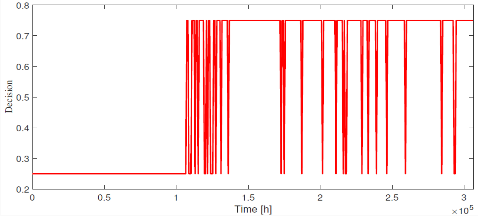

Figure 6: Determination of needing a maintenance action based on fuzzy logic and health condition model [4].

Microgrids

Effects of Distributed Generation on Distribution Networks Reliability

Protection schemes coordination is loss with a high penetration of DG, e.g. loss of protection coordination, directional false tripping, unwanted fuse blowing, and loss of sensitivity.

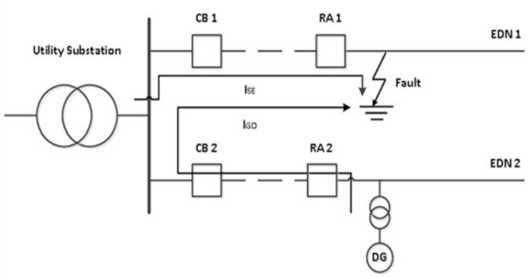

Figure 7: Typical problem in protection schemes.

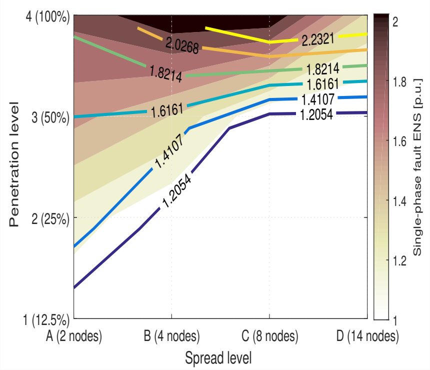

Figure 8: Protection coordination [5]

Generalized methodologies are developed to make changes in the schemes depending on penetration level of generation.

Responsibilities and Causality

Location of Power Quality Stationary Disturbances Sources in Low Voltage Power Grids

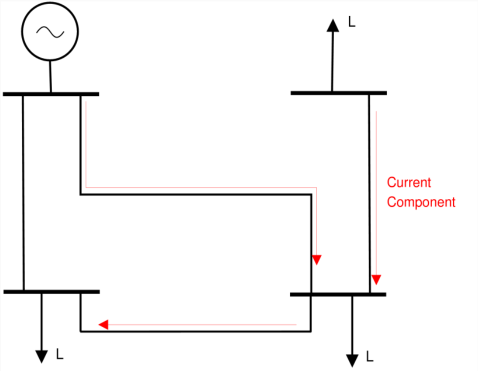

Figure 9: Multi-point system [6]

To develop a causality assessment method for power quality stationary disturbances, that allows to characterize the magnitude and direction of the contribution of all nodes belonging to a multi-point system.

Applications:

- Electrical vehicles
- Renewables
- PLC, efficient lighting devices
- **JWG CIGRE C4.42**

Causal probabilistic models for harmonic analysis

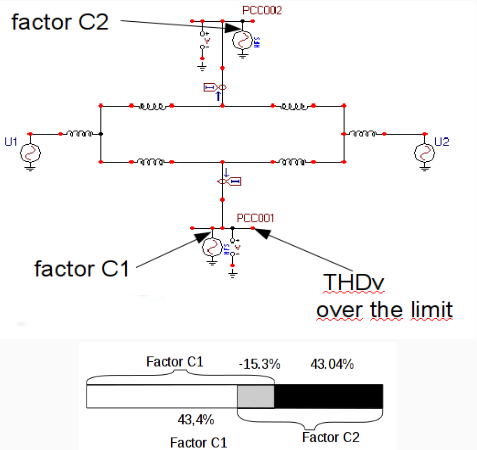

Figure 10: Causes of critic levels of THDv

Use of causal probabilistic models to analyze the impact and interaction of non-linear loads on harmonic distortion in distribution networks.

Supraharmonics

Assessment of Supraharmonic Emissions

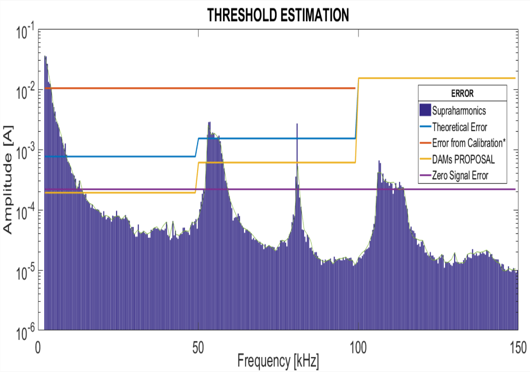

Figure 11: Threshold estimation for emissions between 2-150 kHz [7]

- Measurement and Metrology aspects
- Emissions under single operation [8]
- Interaction of disturbances between 2-150 kHz

Bibliography

C.Caro-Ruiz,J.Ma,D.J.Hill,A.Pavas, and E.Mojica-Nava,, *Cascading Collapse of Power Flow Networks Under Minimum Cut Set-based Attacks,* IEEE Trans on Smart Grids, (accepted for publication) 2019 (T&D-LA)

R.Rincon,A.Pavas, and E.Mojica-Nava,, *Long-term voltage stability analysis and network topology in power systems,* 2016 IEEE PES Innovative Smart Grid Technologies Conference Europe (ISGT-Europe), Ljubljana, 2016, pp. 1-6.

M. A. Cortés and O. A. González and E. M. Soto and C. A. Cusgen and E. Mojica-Nava and A. Pavas, *Opinion Dynamics and Social Incentives Applied to Demand Response Programs*,2018 IEEE PES Transmission Distribution Conference and Exhibition - Latin America (T&D-LA), 2018, Pages 1-5.

L. Rosero-Z, A. Pavas and I. C. Durn, *Analysis of Maintenance in Transformers Based on a Fuzzy Logic Method,* 2018 IEEE PES Transmission & Distribution Conference and Exhibition - Latin America (T&D-LA), Lima, Peru, 2018, pp. 1-5.

J.Valbuena and A.Pavas, *Loss of protection coordination in distribution grids due to renewable energy penetration*, PowerTech 2019, Milan, Italy.

- D. Agudelo-Martnez, C. Garzón and A. Pavas, "Interaction of power quality disturbances within 2150 kHz (supraharmonics): Analytical framework," 2018 18th International Conference on Harmonics and Quality of Power (ICHQP), Ljubljana, 2018, pp. 1-7.
- D.Agudelo, A.Pavas, A.M.Blanco and J.Meyer, *Influence of Measurement Setup on the waveform distortion between 2-150 kHz*, PowerTech 2019, Milan, Italy
- S. K. Rnnberg, M. Bollen, H. Amaris, G. W. Chang, I.Y.H. Gu, L. H. Kocewiak, J. Meyer, M. Olofsson, P. F. Ribeiro, J. Desmet, *On waveform distortion in the frequency range of 2kHz150kHzReview and research challenges*, Electric Power Systems Research, Volume 150, 2017, Pages 1-10.

Thanks for your attention
Questions and comments?

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