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Technological Innovation for Resilient Systems

The Use of Cooperative NZEB Communities to Improve the Grid Resilience

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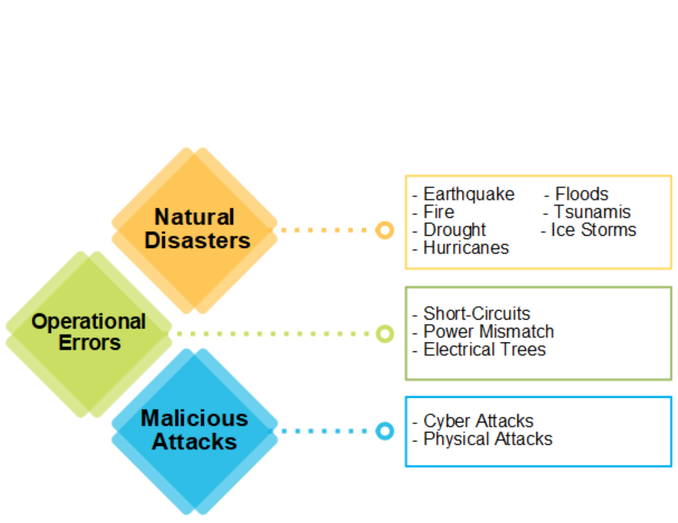
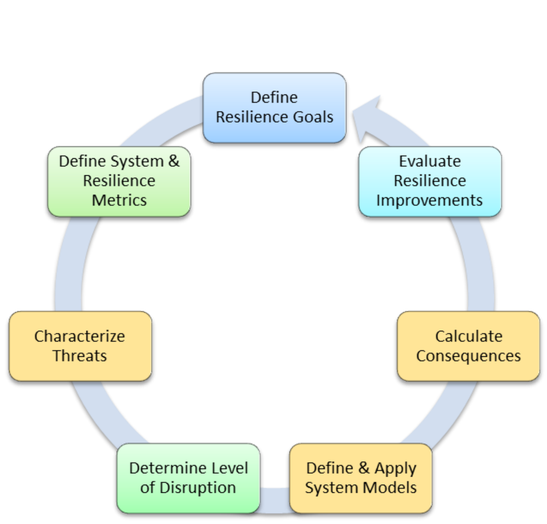
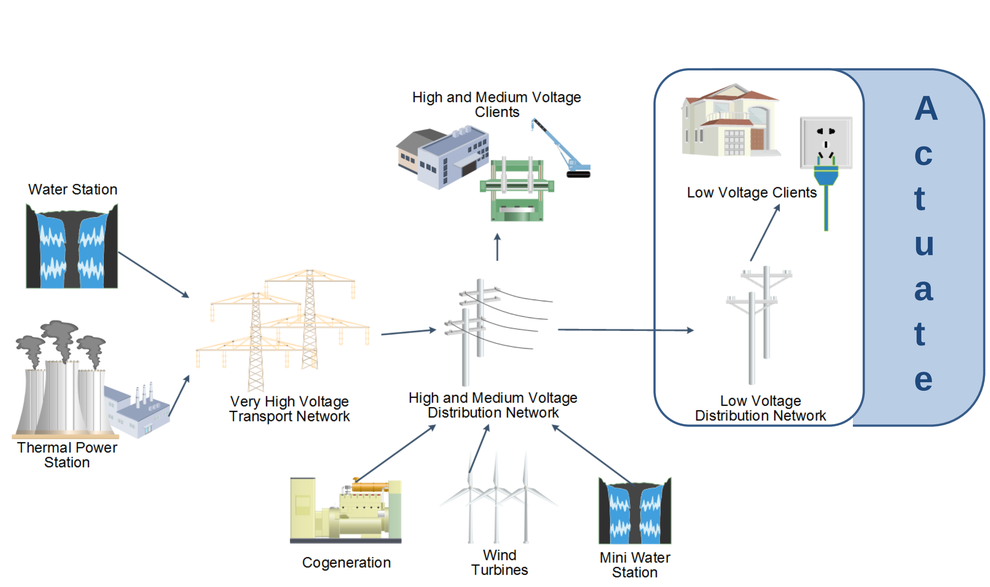
Motivation

The electrical grid has been designed and implemented with the purpose of operate under normal conditions during a long time. However, faults caused by extreme weather events or human failures can lead to grid destruction and consequently abnormal operation. With the evolution of the grid and the introduction of smart grids, it is expected that power systems become more and more resilient to work under high-impact low-probability events like storms, hurricanes or fires, taking into account natural disasters, [1]-[2]. On the other hand, cyber attacks became more usual, with the introduction of smart techniques, and can be a big problem to the electrical grid system because of its unexpectedness [3].







Problem addressed

- Different problems can cause different types of failures like **Blackout, brownout or frequency mismatch** that normally cause the total loss of energy.
- The NZEB concept is based on the fact that a building produces the same amount of consumed energy during a certain time period (usually one year) [4]. If we consider a NZEB community, integrated in the grid, when an outage occurs, the segment of the grid where the NZEB community is inserted will be able to have energy enough to survive by itself during a certain period of time, which can be maximized considering load flexibility. In this way will be possible to know where is more important to actuate and the resilience of the grid will be improved.

Research Question

- What would be a suitable combination of tools and techniques to improve the resilience of the electrical grid using cooperative NZEB communities?

Hypothesis

- **H1:** Combining load matching techniques, data and optimization algorithms within cooperative NZEB communities, the resilience of the electrical grid will be improved when a failure occurs.

Planned Approach

- Study possible causes of failure and the consequences. Develop a database with information about it integrated in a system. The system will correlate the information with the NZEBs to prevent the total loss of energy considering the load flexibility.
- In this way the system will predict the type of failure, when possible, and actuate in order to prevent the failure or to minimize the outage. When it isn't possible to predict, the knowledge about the failure will allow to actuate in a more effective way.
- Validation will be done through simulation of several scenarios with real data and different optimization algorithms.

Relation with conference theme

- The 9th DoCEIS' 2018 reflects the growing need for development and integration of resilience into technological systems, due to increased rate of disruptive events around the globe. Such events are due to a variety of causes and challenge the way systems are designed, implemented, and managed.
- Regarding the increase of natural disasters, it is aimed to improve the resilience of the electrical grid, in low voltage distribution systems, in order to avoid the total loss of energy for the customers.

References

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[2] - Zhu, Y., Yan, J., Tang, Y., Sun, Y., & He, H. (2014). Resilience analysis of power grids under the sequential attack. *IEEE Transactions on Information Forensics and Security*, *9*(12), 2340–2354

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[4] - Sartori, I., Napolitano, A., & Voss, K. (2012). Net zero energy buildings: A consistent definition framework. *Energy and Buildings*, *48*, 220–232. https://doi.org/10.1016/j.enbuild.2012.01.032