

CAUSES OF A BLACKOUT: THE GRID OPERATION AND THE ENVIRONMENT

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Despite huge advancements in different power system components, operations, and protection technologies, today's power systems are more vulnerable to blackouts than ever before. Deregulation, market competition, and increasing demands, in addition to less investment in transmission assets, all contribute to the critical state power systems operate at. Two main characteristics of the power system are always being put under the scope of study, reliability and security.

This paper takes a subjective thorough look at the previous numerous blackout events, surveyed by the authors, that have been encountered by different power systems around the globe and classifies them into different types and levels. Blackout incident surveys and comparisons, starting from 1965 to now, are presented. A timeline of the major events is presented showing the frequency of these events over periods of time. Also a classification according to location is made. Common reasons and developing mechanisms are contrasted between the different incidents, and presented into two main categories of interest.

The first group is reasons associated with the grid itself, due to system conditions, states, and components. The second being reasons related to the environment. Thus, in this paper a full-size picture of the blackout is attempted to be drawn, and speculation concerning the environmental roles at different stages of the reported incidents takes place.

At the end, learnt lessons and common measures for possible future prevention and/or mitigation of blackout causes are stated, as an effort to stress the introduction of improvements and support for increasing both system's reliability and security. Furthermore, a proposed vision and a roadmap are presented to minimize and/or mitigate the risk of inadvertent disturbances by mitigating, as far as possible, the root causes of system disturbances through the following three steps:

Step-I: Analyses and audits.

Step-II: Preventive and corrective actions.

Step-III: Public policy, transmission, and future investments.

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