# IEEE PES Transformers Committee
## Fall 2024 Meeting
## St. Louis, Missouri

# Application of Probabilistic Bayesian Networks on Transformer Condition Assessment

## — Technical Presentation —
**Thursday, October 31, 2024**

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## 1. Abstract

Traditional transformer assessment techniques are developed based on the available data extracted from the transformers. Albeit aiming to estimate the risk of failure of a transformer, most conventional approaches were developed essentially centered on combining results from online monitoring system and offline test results. Thus, they focus more on ranking the units based on the data. The common strategies include, among others, weighted averages, criticality indexes and traffic lights, focusing more on maintenance prioritization, interventions, and budgets allocation. The method currently applied by the company represented by some of the authors already incorporates the estimation of the probability of failure, based on proprietary knowledge and experience. The current method expands the approach, allowing users knowledge and experience, as well as user-specific statistics, to be incorporated in the analytical process, adding a probabilistic layer to the typical tree of failure modes. Rather than the test results itself, the input data to the model is the "belief" that the data indicates the component or system will fail or not. For instance, abnormal results in a DGA result may impact the risk of failure in different components of the event tree, which will further impact the associated risks of the transformer to fail. Based on the concept of conditional probabilities in Bayesian statistics, this method allows inferring the expected impact / criticality of each type of issue (evidence propagation) on the continuous operation of the transformer. The likelihood of each failure mode can be estimated either based on the statistics of international transformer reliability surveys or on the experience of each asset management group. The Bayesian network analysis allows the bi-directional assessment of the system, both for checking the impact of each root cause on the transformer operation (inference) and to investigate the likelihood of a given cause, should a situation be identified (diagnostics).

## 2. Learning Objectives

This technical presentation provides attendees with opportunities to learn about the following:

a) A probabilistic method to assess transformer condition
b) Combination of probabilistic techniques and failure modes effects analysis (FMEA)
c) Belief propagation networks

## 3. Learning Outcomes

By attending this technical presentation, attendees will gain an understanding of the following:

- A sound statistical technique to be used in support of transformer condition assessment
- Examples of application of such technique

## 4. <u>Presenters' Biographies</u>

**Dr. Luiz Cheim** (IEEE Sr. Member) has been with ABB/Hitachi Energy since 2009 working as a Senior Principal in the Global R&D organization, with an extensive list of publications and work carried out as a Senior Member of the IEEE Transformers Committee and a Distinguished Member of CIGRE since 2006. His major activities are on the development of power transformers condition assessment and performance models, with the application of sophisticated statistical tools, AI/Machine Learning algorithms, holding a PhD in Electrical Engineering and AI Certificate courses in the MIT and Stanford Universities. Luiz already holds more than 20 granted patents with several new applications in progress.

**Alan Sbravati** counts over 20 years of experience in the transformer industry, having spent most of this time in positions related to R&D on Power Transformers and insulation materials Alan is currently the R&D Principal Engineer and Innovations Program Manager for Power Transformers with Hitachi Energy. He is a member of the IEEE PES Transformer Committee, occupying positions of secretary of the Insulating Fluids Subcommittee (IFSC) and chair of working groups and task forces.

**Kumar Mani** is a Senior Member of IEEE. He has been working for the last 21 years with Duke Energy in various roles and is currently a Transformer Subject Matter Expert for Duke Energy's Renewable and Regulated Energy Generation. He is an active member of the IEEE PES Transformer Committee and is responsible for developing Asset Management strategies for the entire Duke Energy's generation transformer fleet