The impact of the technical condition of power transformers on the reliability of supply

Challenge and objective

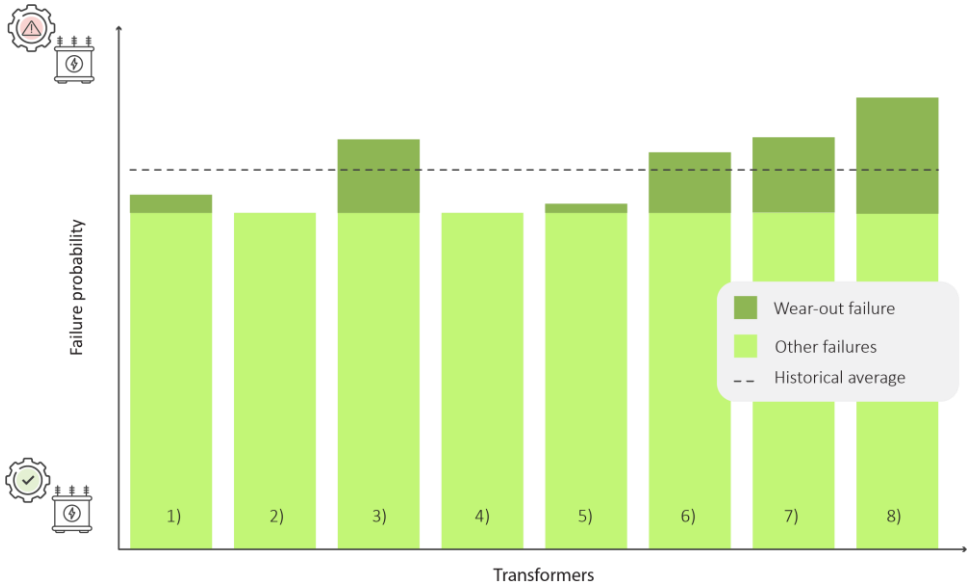
- Deteriorating technical condition will increase the probability of component failure, which in turn will weaken the reliability of supply.
- Power system reliability analysis traditionally does not consider that different components have different technical condition.
- The objective has been to develop methodologies for analysing reliability of supply that consider both the condition and location of power system components, focusing on power transformers

What have we learned?

- The correlation between component age and condition is not particularly strong.
- In power systems where components are in a good condition, it is not very important for the reliability of supply in the short term to account for their technical condition.
- The technical condition becomes important for the reliability of supply depending on the criticality of the component in the power system.
- It becomes much more important to account for the technical condition of each component in reliability of supply analyses, if the technical condition is allowed to deteriorate.
- SINTEF's transformer health index model gives higher failure rates than historical failure frequencies. This can to some extent be explained by preventive replacements causing statistical censoring of wear-out failures. Depending on the purpose of the reliability analysis, it is important to consider the difference between the uncensored failure rate and the censored failure frequency.

Implications and recommendations

- Component age should not be primary basis for asset management decisions
- Condition data should be collected in a common data base both for operational transformers (periodic oil test data) and scrapped transformers (age, degree of depolymerization), together with historic load and temperature data
- The development of technical condition of components and the consequent impact on the reliability of supply should be monitored over time
- Condition-dependent failure rate for individual transformers can be incorporated in both new and existing reliability analysis tools (e.g. Statnett's MONSTER tool).



[1] H. Toftaker, J. Foros, and I. B. Sperstad, 'Accounting for component condition and preventive retirement in power system reliability analyses', *IET Generation, Transmission & Distribution*, vol. 5, no. 1, 2023, doi: 10.1049/gtd2.12761.