Influences of changed Grid Utilisation by Renewable Energies on the Ageing Behaviour of Medium Voltage Cables

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ABSTRACT

The DNOs asset management is facing more demanding challenges. Up to now it has been difficult to balance the (economic) efficient use of equipment with the supply security of the networks. This task is made even more difficult by the changed ageing conditions due to the increased use of renewable energies. Based on this, different ageing mechanism of power cables are described and aspects of today's utilisation are considered. An ageing model derived by the Montsinger rule and a corresponding simulation are presented which estimates the accelerated ageing of cables due to the increased utilisation caused by renewable energies.

KEYWORDS

Cable Life cycle; Asset Management; Medium Voltage Cable; Ageing; Ageing mechanism;

INTRODUCTION

The utilisation of the electrical grid in Germany, as in other countries worldwide, will change significantly in the next years and distribution network operators (DNOs) have to adapt to various new challenges. Besides trends like the future development of electro mobility (especially in cities), the expansion of renewables also represents a further issue that needs to be solved. Additionally, to the steadily generating base load plants powered for example by coal or nuclear power, more and more renewable energies are feeding-in the electrical grid in Germany (Figure 1).

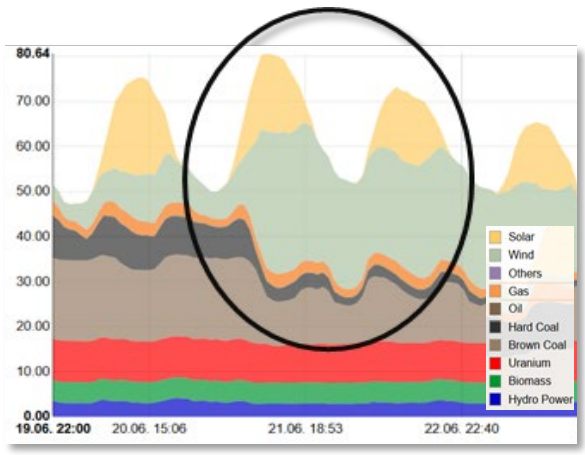

Figure 1: Electricity production in GW in Germany in June 2018 [1].

Due to this, the utilisation behaviour of the electrical distribution network is transforming and is getting more demanding. These changes also affect the ageing behaviour of the different components, which are necessary for the distribution grid. At the moment it is difficult to determine the ageing status of most components. There are some specific ageing models, e.g. the Montsinger rule for transformers or the Arrhenius law for different insulation systems. For medium voltage cables (in particular paper insulated leaded cables, PILC cables) there are less techniques to evaluate their ageing status and to determine their potential remaining lifetime. Due to the steadily and moderate utilisation, it has been less complex to estimate the remaining lifespan of the cables based on empirical values as well as by the expertise of the DNOs.

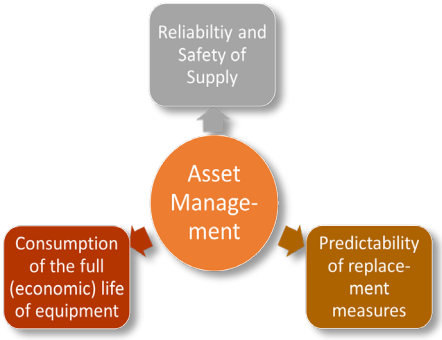

Figure 2: Trilemma of Asset Management

At the same time, however, the trilemma of the asset management (Figure 2) is gaining importance, which represents the contrary main aspects of the asset management. Asset managers often aim to operate as cost-effectively as possible, e.g. by using the entire (economic) lifespan of the equipment. On the other hand, the asset management has to assure the supply security of the electricity grid and thus also the (cost-) efficient maintenance of the system. A good example for this are medium voltage networks which have an extremely high importance for the urban or suburban supply reliability, represent highly important assets of the DNOs and failures provoke costly and time consuming replacement tasks in most cases. Sophisticated methods for the determination of the ageing status of electrical equipment as well as estimations about the expected remaining lifetime of the components within the entire quantity framework of a DNO (at defined utilisation levels) build an opportunity to assist the asset management in this trilemma.

Therefore, a project started to initiate a novel system, which is able to fulfil these requests [2]. Through this system the different ageing mechanisms are examined and empirical data will allow statistically based evaluation of the ageing and degeneration processes. For this purpose, different pre-aged cable samples of a specific type are thermally and electrically stressed in defined ageing sequences within a long lasting empirical laboratory study, resulting in forced