THE NEED FOR SMART DIAGNOSTICS IN FUTURE SMART GRIDS – A PRACTICAL EXAMPLE FOR MV CABLES

Peter **VAN DER WIELEN**, KEMA, (The Netherlands), Peter.vanderWielen@kema.com
Fred **STEENNIS**, Eindhoven University of Technology and KEMA, (The Netherlands), Fred.Steennis@kema.com
Denny **HARMSEN**, Alliander, (The Netherlands), Denny.Harmsen@alliander.com
Danny **GELDTMEIJER**, Enexis, (The Netherlands), Danny.Geldtmeijer@enexis.nl

ABSTRACT

In future smart grids there is an increased need for smart diagnostics. Diagnostics are SMART if they are Specific, Meaningful, Actual, Reliable and Timely. These properties are explained in this paper, together with an explanation of the need for smart diagnostics in any grid, but particularly future smart grids. An example is given for a smart diagnostic for complete medium voltage power cable connections. This Smart Cable Guard monitors the condition of MV power cables continuously and also provides for continuous access to the associate risk levels. As this system is applicable in any grid, some examples are given.

KEYWORDS

Cable Insulation, Defect Location, Fault Diagnosis, Intelligent Networks, Intelligent Sensors, Intelligent Systems, Diagnostics, Partial Discharges, Power Cables, Power Cable Insulation, Power Cable Testing, Medium Voltage Cables, Smart Diagnostics, Smart Grids, Smart Cable Guard

INTRODUCTION

The majority of discussions around Smart Grids is about smart metering and application of smart control systems into the grid in order to e.g. increase the flexibility and optimal use of the grid. Increasing application of decentralized generation and storage possibilities (and needs) are often driving factors behind this need to smarten the grid. So measuring and controlling current flows and voltages in an intelligent way is an important part of the smart grid of the future. However, although the energy flows may not be unidirectional and from point to point anymore in the modern and future grids, the core purpose of a power grid remains transporting and distributing energy.

One of the methods to help ensuring this primary function will also hold in the (near or far) future is by applying diagnostics to assess the condition of the various components of the grid. In future smart grids, possibly also smarter diagnostics will be needed. Whether this is useful or needed, what is the value and whether their values, functions and methods of application will change in the future smarter grid is the main subject of this paper.

In the next section of this paper, a definition is proposed, that makes a smart diagnostic different from any diagnostic. After this section, the main message of this paper is explained: the need for smart diagnostics in future smart grids. This is followed by a section about an actual example of a smart diagnostic for medium voltage cables, together with some real life results. Finally, the paper gives a summary of the important conclusions.

DEFINITION OF SMART DIAGNOSTICS

In order to be able to discuss smart diagnostics and their need in the future grid, a clear understanding of the definition of a "smart diagnostic" is needed.

The word "diagnostic" is a well known term in the power engineering world. This word is about determining the condition of equipment in order to assess whether it will fail during some future period and/or how well it will perform. An important part of the definition of diagnostic is also related to the difference with "test". A diagnostic is intended to be non-destructive and is focused on measuring certain properties of the equipment in order to estimate the condition and/or remaining life. A test can be destructive and is intended to subject the equipment to specific conditions in order to determine whether the equipment's properties change during the test (usually: whether the equipment fails or not).

The less trivial part in the term "smart diagnostics" is the word "smart". The question is: what makes a diagnostic smart? Obviously, this answer is related to its application in the future *smart* grid: it should be able to be implemented in the grid itself. Furthermore, a smart diagnostic is usually using various IT related capabilities in order to perform its diagnosis. Many people will think in the direction of something like a smart solution to a property that is difficult to measure , or by using smart and new technologies. All is true, but the most important aspects according to the authors' opinions are more related to the diagnostic results, how they are obtained and how they are made available. These can be summarized as follows:

First of all, a smart diagnostic should be specific. This has to do with two elements. (1) It should be specific in its results in a sense that it should be clear whether the measured properties are properties of the component that is measured and not some adjacent component in the grid. (2) A smart diagnostic is optimally also specific in the location of deviating properties of the measured component.

The second characteristic of a smart diagnostic is that the outcome should be meaningful. Applying a diagnostic is measurement of a certain measurable property. This property, however, is usually not the required information (i.e. the condition) itself, but some property that can be directly or indirectly an indication of this condition. In other words, usually, the measured property still needs some interpretation. A smart diagnostic should have this translation as part of the diagnostic, either implemented in the diagnostic equipment itself or as a service associated with the diagnostic. The resulting outcome should usually be something like condition, failure risk or remaining life