ASSESSMENT METHODOLOGY AND PERFORMANCE INDICATORS FOR HVDC GRID PROTECTION STRATEGIES

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Abstract

This paper presents an assessment methodology of protection strategies for meshed grids. It also proposes the computation of two performance indicators to evaluate protection strategies through a reliability and speed perspective. The Monte Carlo method is used to calculate the two indicators proposed. These two indexes can be used as criteria for comparison between protection strategies. Due to the increasing debate around the protection for HVDC grids, three proposals of protection of HVDC grids were chosen as application cases.

1 Introduction

High Voltage Direct Current (HVDC) grids are considered an interesting solution to integrate large amounts of renewable power and release congestion on existing AC power grids. However, the protection of HVDC grids remains one of the main challenges to overcome in order to ensure safe and reliable operation of such grids [1].

Several proposals have been made about how to perform the process of fault clearing in a HVDC grid. The choice and coordination of protection equipment is determined by the protection strategy. A few classifications for these protection strategies have been proposed in literature [3,4,7]. As proposed in [4], protection strategies can be classified in one of the following categories:

- Fully-selective fault clearing: the fault current is interrupted at the terminals of faulty line or bus.
- Non-selective fault clearing: the fault current contributors are suppressed in first place through the cooperation of several protection devices, then the faulty line or bus is disconnected and the system is re-energized.
- Partially-selective fault clearing: the DC grid is separated into zones by means of firewalls, confining the fault within a zone and isolating it from the healthy zones.

For each protection strategy there is a pre-defined sequence of actions to be performed by the protection equipment right after the fault occurrence, the primary sequence. In case of failure of the primary sequence, the fault clearing is performed by backup sequences. Several backup sequences can be defined depending on the type of failure during the primary sequence.

Usually, literature about protection strategies for HVDC grids contains only descriptions and simulations of the strategy. Probabilistic studies of protection strategies, such as reliability calculation or probabilistic distribution of the protection strategy duration, are less widely studied subjects. Likewise, comparison between protection strategies lacks criteria and indicators to support a reliable decision.

This paper presents both an assessment methodology and performance indicators that will facilitate the comparison between protection strategies.

The paper is organized as follows: Section 2, will present the protection strategies used as application case. For the sake of simplification, only non-selective strategies are compared in this work. The assessment methodology, inputs required, and the indicators proposed are presented in Section 3. The application of the methodology and indicators calculation is done in Section 4. Conclusions will highlight the main outcomes of the study. It will also indicate a few propositions on how to overcome the limitations of the presented methodology and indicators.

2 Non-selective protection strategies for HVDC grids

This study restricts the application cases exposed to non-selective strategies. Figure 1 shows a generic flowchart for a non-selective protection strategy. Three main steps can be identified: the AC grid contribution suppression, the faulty line isolation and the power flow restoration.

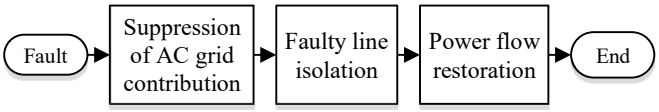

Figure 1: Generic flowchart for a non-selective fault clearing strategy.

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