Support decision making in Underground network Lifecyle management in variable operating regime

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ABSTRACT

Classical standard requires a minimal lifetime for the cable systems (based on accelerated ageing tests), all power links of a grid are not stressed at the same level. The estimation with a good accuracy of the real level of degradation stress, coupled with the cumulative damage approach, is a major step to support decision making on the replacement of the most stressed cable sections.

KEYWORDS

LifeCycle management, steady state vs dynamic operating regime, IEC 60287, thermal modelling, durability, renewable energy

INTRODUCTION

Growing penetration of variable energy resources together with increasing electricity demand are expecting to change the operating level and profile of the distribution grid. When it comes to underground network, higher load drives higher conductor temperature with potential consequences on aging. This phenomenon coupled with a context of aging grid infrastructure call for the question of the optimal time to replace the existing infrastructure. The increasing volume of cable to renew on an age based policy lead to the need to extend the diagnostic and analysis capability of underground cable behaviour over the whole lifecycle. This article intends to present a novel method coupling best engineering practices and material aging investigation. From a risk based approach, the described method aims at supporting essential decision making for both operating limit definition and lifetime extension strategy.

Decision making repose on 3 different steps:

1) Data collection of relevant historical or simulation load data, to assess the level of stress on the electricity network.
2) Calculation of the conductor temperature response from this load history in steady state (most conservative case) and in operating regime (more realistic case).
3) Risk of potential impact on the lifetime through the cumulative damage approach to quantify the impact of the temperature exposure in function of load levelling variation.

1ST STEP : DATA COLLECTION

Total electrical power produce by renewable energy have the particularity to be wheather dependant (in time & in intensity) with very high cyclic solicitation. Based on actual net power available (after converter), various scenarios has been created for wind & solar plant production over one year (sampling time: 1 hours). Two parameters will be investigate:

A) Cable crosssection (150 mm² vs 240 mm²). Even if the initial costing is more important, an increasing of the crosssection has the advatange to increase current rating capability & decrease losses by Joule effect (with the same load solicitation)
B) Increasing of the net power transmissited in an existed line due to the developpement of renewable resource either driven by the increase of installed capacity or different new built installed capacity options. Three scenarios have been simulated: "Basic case" (noted BC) represents actual net power available for wind (11 MW) & solar (12 MW) energy, +30% of net power available (noted High) represented 14 MW for wind & solar and +50% of net power available (noted High+) represented 16 MW. For the purpose of this study the houry operating profile has been computed based on French National available operating profile for Wind and Solar.

RES	Cable crosssection	Net power available	(partial) Curtailement hours at 90°C (h)
Wind	150 mm²	BC	0
Wind	150 mm²	High	123
Wind	150 mm²	High+	417
Wind	240 mm²	BC	0
Wind	240 mm²	High	0
Solar	150 mm²	BC	0
Solar	150 mm²	High	147
Solar	150 mm²	High+	447

Table 1: Description of all scenarios investigated in function of RES type, Cable crosssection, Net power available and number of curtailement hours at 90°C

Figure 1 shows the load percentage for a cable used in case of a solar production (orange line) vs a wind production (blue line) in the BC configuration.

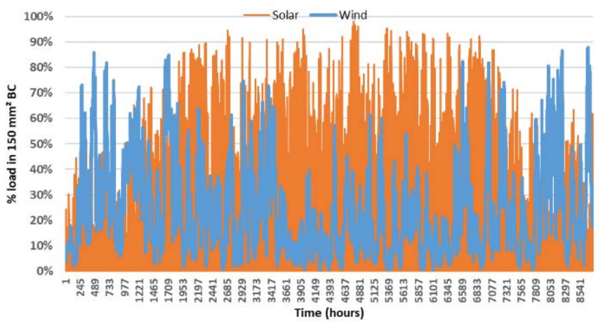

Figure 1: Evolution of load in 150 mm² for the case BC for solar farm (In orange) and Wind farm (in blue)