Annals of DAAAM for 2010 & Proceedings of the 21st International DAAAM Symposium, Volume 21, No. 1, ISSN 1726-9679
ISBN 978-3-901509-73-5, Editor B. Katalinic, Published by DAAAM International, Vienna, Austria, EU, 2010
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Annals of DAAAM International

OPERATIONAL METHOD TO INCREASE THE SERVICE QUALITY OF SUPPLY WITH ELECTRIC ENERGY BY SECTIONING THE ELECTRIC NETWORKS

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Abstract: *The paper has three parts. In the first part is justified the concern, the principle of the method and the criterions that substantiate their applying. In the second part is given the mode of operational method within an entity of distribution of electric energy and the obtained results, as in the last part is given the conclusions of the analyze.*

Key words: *electric networks, quality of service, supplying with electric energy, sectioning*

1. INTRODUCTION

The sectioning of electric networks (EN) is made by reclosers (RA) or remote controlled separators (ST) (Haghifam et al., 2003, Pregalj et al., 2006).

To allot RA / ST in EN of MV can be approached as a combinatorial optimization problem that includes the variables to optimize, technical and economical restriction and the chosen optimization criterion (Albut-Dana, 2010).

In this case, the variables of optimization have a binary nature represented by de mounting position of RA / ST of the scheme. The value that may be taken is 1 (if RA / ST are allotted to that position) or 0 (if RA /ST aren't allotted to that position).

Generally, the problem is addressed without mathematical restrictions, however there are technical restrictions related to coordination of protection, accessibility, and presence of the remote control signal.

The sectioning is made to enhance the quality of electricity supply (EE) to the consumers, reflected by the values of the quality indicators:

- SAIFI – Average system interruption frequency index;
- SAIDI – System average interruption duration index;
- MAIFI – Momentary average interruption frequency index;
- ASIFI – System average interruption frequency index.

The authors of the paper were concerned about application of this method about EN of MV in zone of Oradea – Romania, offering optimization solutions, which were the subject of published works (Felea et al., 2009). The syntheses of some obtained results are the object of this paper.

2. APPLICABLE OPTIMIZING MODELS

The literature uses a wide range of criteria, that are based on the minimizing of the number or on the interrupted power (minimizing SAIFI or ASIFI), to criteria that define a composed criteria based on the cost of interruption and the cost of acquisition of RA / ST.

A model implemented relatively quickly is based on minimization of SAIFI or ASIFI indicator by imposing restrictions on the acquisition cost of RA / ST (Haghifam et al., 2003, Ciugudeanu et al., 2002):

$$\mathrm{Min(SAIFI)} = \mathrm{Min}\left(\frac{\sum_{s=1}^{n} N_s}{N_T}\right) \quad \text{or} \quad \mathrm{Min(ASIFI)} = \mathrm{Min}\left(\frac{\sum_{s=1}^{n} S_s}{S_T}\right) \qquad (1)$$

where:

- N_S/N_T – the number of interrupted customers, above 3 seconds, in *s* interruption / total deserved consumers;
- S_S/S_T – is the interrupted power at *s* interruption / total operational power (installed);

A more complete model (Pregalj et al., 2006, Felea, 1996), takes into account both the number of interruptions lasting (by SAIFI) and short duration (by MAIFI), duration of interruptions (by SAIDI) as a composite index (IC) given by relationship:

$$\mathrm{Min(IC)} = \mathrm{Min}\left(C1\frac{\mathrm{SAIFI}-\mathrm{SAIFI_{imp}}}{\mathrm{SAIFI_{imp}}} + C2\frac{\mathrm{SAIDI}-\mathrm{SAIDI_{imp}}}{\mathrm{SAIDI_{imp}}} + C1\frac{\mathrm{MAIFI}-\mathrm{MAIFI_{imp}}}{\mathrm{MAIFI_{imp}}} \right) \qquad (2)$$

C1, C2, C3 is the largest of the design factors;

$SAIFI_{imp}$, $MAIFI_{imp}$, $SAIDI_{imp}$ - required values (target) of indicators AIFI, MAIFI, respectively SAIDI;

The most complete models are basing on the minimizing costs. In (Pregalj et al., 2006) is given a model based on in costs of investments (I), the cost of maintains (C_M) and of undelivered energy cost to consumers due to the failures in the network (C_W).

$$\mathrm{Min(Cost)} = \mathrm{Min}\left(I + C_M + C_W\right) \qquad (3)$$

An optimization model (Haghifam et al., 2003) preferred by many authors refers on investment cost (CI) minimize, RA/ST and interruption of consumer cost (C_C), given by relationship:

$$\mathrm{Min(Cost)} = \mathrm{Min}\left(I + C_C\right) = \mathrm{Min}\left(I + \sum_{i=1}^{n}\sum_{j=1}^{m} \lambda_i \cdot C_{ij} \cdot P_{ij} \right) \qquad (4)$$

where:

λ_i - is the fault intensity of a section i of the whole analyzed network;

P_j - step *"j"* of total power in section i;

C_{ij} – the cost of interruption of the load (Felea, 1996).

Solving the optimization model evoked by relations (1 ÷ 4), is realized by classical methods specific to optimization problems with integers or later, using evolutionary methods of calculation (such as genetic algorithms, immune algorithms, hybrid algorithms, etc.)

3. APPLYING THE METHOD IN ORADEA SDEE

In this paper, the problem of RA / ST allot in electric networks is made by using an optimization model, expressed by equation (1), model that is the base of the computing program RECLOS_1 (Ciugudeanu et al., 2002), and applicable valuing reliability database regarding operational reliability of EN managed by Oradea SDEE.

Applying the program RECLOS_1, implies steps be taken:

1. Reduction single core scheme analyzed network, thereby achieving "Computer Optimization Single core Schemes location RA/ST;
2. Collecting input data necessary to optimize and setting the maximum number of RA/ST or reclosers which are intended to be mounted;
3. Entering data input in the program;
4. Identification of optimal variant by minimizing ASIFI indicator.

In the paper are presented the obtained results for a number of 29 electric lines of 20 kV, located in Oradea municipality.

The results are briefly given in table 1 and in fig.1, 2, with electric lines (LES) and the elements of characterization (EC).

EC / LES 20KV	ASI [Year^{-1}] / S_1 [kVA]		ASIFI [Year^{-1}] / S_2 [kVA]		NR RA mounted	DR [year]
BARSEI	6247.318	1.243	3370.094	0.67	3	4.44
CENTRU CIVIC	3642.282	1.233	1421.124	0.254	3	5.92
CRISTAL	7663.189	1.382	2380.941	0.429	4	3.40
SANEPID	7662.13	1.33	3:75.161	0.521	4	3.82
SC 2B NORD	4689.58	1.763	3002.369	1	3	5.01
SEMTETS	7775.964	2.124	3971.185	0.879	5	3.13
PTA 1 DECEM	3430.223	0.996	2346.533	0.39	4	13.04
PA 1 NUFARU	6402.381	1.997	4020.83	1.254	2	2.10
MATERNO-IN	7449.47	1.61	1817.353	0.389	6	4.33
INDUSTRIEI	5549.711	0.996	1760.731	0.213	3	4.74
DRUM NOU	2649.15	0.87	647.815	0.212	4	15.05
PT 14 NUFARU	7302.96	1.556	4318.272	0.9792	3	3.42
PA SPITAL A	14616.601	2.086	2872.347	0.378	8	2.21
PA SPITAL B	6203.749	1.418	6203.749	0.348	6	7.37
VULCAN	31342.151	3.005	17831.11	1.362	12	1.40
LUKOIL	3324.272	1.072	2354.31	0.759	3	13.77
LILIACULUI	3776.575	0.997	2674.014	0.702	4	17.27
WAGNER	1601.208	1.059	823.305	0.544	3	19.60
CT-A IOSIA	2058.321	1.262	1789.634	1.097	2	25.71
NATIONAL TV	10006.878	1.414	2:82.231	0.291	4	2.41
POLIGRAFIE	14929.068	2.354	9611.056	1.515	4	1.58
HOREA	6079.736	1.378	2433.104	0.521	6	6.88

Tab. 1. Elements to characterize (EC) of analyzed LES

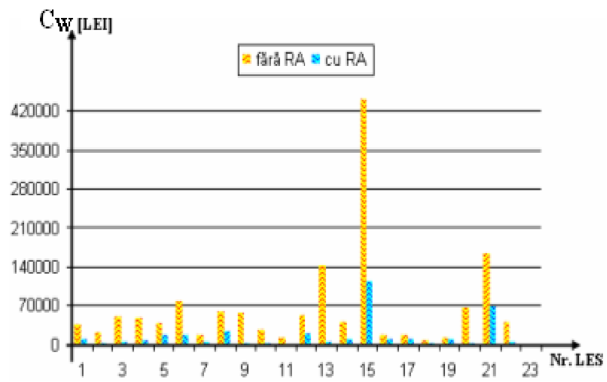

Fig. 1.Variation of the undelivered energy cost (C_W)

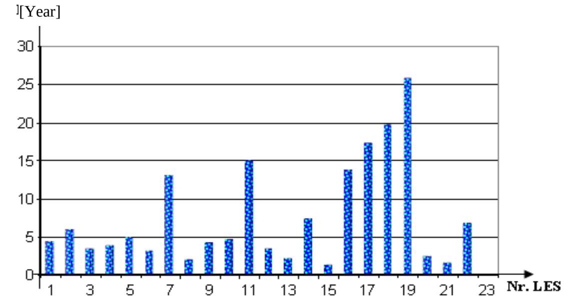

Fig. 2. Length of payback (DR)

4. CONCLUSION

Automating distribution of EN aims to improve quality indicators of electricity supply service connected to consumers. To ensure distribution automation will be used, preferably, ST, RA will make use only where strictly necessary. It is necessary as the remote control separators and reclosers to be equipped properly to a telecontrol system.

For earning desire of "minimal cost of reliability" is necessary to apply optimization methods to location ST and RA based on indicators of quality in supplying the consumers, indicators that cover the system as a whole, as indicator ASIFI.

From the results obtained on the 29 LES review finds the existence of three categories:

- LES I: DR = [6; 25] years → feasible
- LES II: DR = [25; 50] years → feasible
- LES III: DR > 50 years → feasible

Location of ST will be operational to LES from I category (LES I) in increasing order of DR indicator.

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