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Power Transmission and Distribution Losses - A Modal Based on Available Empirical Data and Future Trends for All Countries Globally

M.Tech. Scholar Sadre Alam, Prof. Lokesh Shukla
Department of Electrical Engineering,
SORT People's University,
Bhopal, MP

Abstract- Distribution system operating environments are changing rapidly due to the integration of the intermittent renewable in to the power grid at the distribution side of the power system. Therefore, with increasing number of wind based distributed generators (DFIGs) being installed within distribution systems, the traditional methods for distribution system modeling, DFIG placement & sizing, network reconfiguration needs to be reviewed and better practical ones developed to cater for the intermittent renewable power. The combined participation factors, realized by the Newton Raphson method, capture network parameters, load distributions and DFIG capacities (sizes) and locations have been formulated considering real and reactive power. A distributed slack bus model taking into consideration network sensitivity is proposed in the research as compared to the distributed slack bus models based on the DFIG capacity, DFIG domains and the single slack bus model. DFIG placement and sizing using a particle swarm optimization method (PSO) and a hybrid of GA and PSO (HGAPSO) and by load flow method are compared. With simulated results, the optimal location of the DFIG is the primary distribution system, with the HGAPSO giving improved results as compared to the ordinary PSO and the load flow. The active distribution network reconfiguration problem with an objective function of reducing real and reactive power losses in the presence of DFIG and uncertain loads proves the practicability of such a method in reducing power losses and in improvement of the voltage profile .Here an hybrid method of bacterial foraging and differential evolution (HBFDE)is applied. The proposed methods, as applied to the IEEE 33 Bus Radial distribution system, are found to be effective in the power loss reduction in the power system wind based distributed generation.

Keywords- distribution Transformers, HVDS, LVDS, Losses, Load Flow Technique, Radial Distribution System, Real Power Flow, Reactive Power Flow.

I. INTRODUCTION

In the present scenario of energy crisis, saving of the power has become a major issue. Studies have indicated that as much as 13% of total power generated is wasted in the form of losses at the distribution level [1]. Loss reduction is more economical than increasing generation. The main function of a power system is to feed industrial and consumer loads as economically as possible and with a reasonable level of reliability and quality. Distribution system provides the final link between the high voltage transmission system and the consumer. Radial distribution systems are popular because of their simple design and low cost. Radial distribution feeders are typically spread over large urban and rural areas and are becoming large and complex. This stressed the need for an efficient and effective distribution network.

The important requirement of a distribution system is that it should maintain a good power factor and the voltage variations at the consumer's terminals should be as low as possible. Low and high voltages result in loss of revenue and may cause permanent damage to the equipments. Therefore, a good distribution system should ensure that the voltage variations at consumer's terminals should be within permissible limits. The statutory limit of voltage is plus minus 5% of rated voltage at the consumers terminals. The reactive power compensation using shunt capacitors results in reduction of losses, improvement in voltage profile and power factor [2].

The installation of shunt capacitors on radial distribution system is also essential for the improvement of system stability and KVA capacity of the distribution equipments. The energy demand is increasing rapidly on distribution system due to growth of new customers and industrial establishment. Due to this the distributions systems are operating mostly under heavily loaded conditions and result in major power loss. It is very much necessary to give good quality of power to the consumer. The electrical energy is transferred from the generating station to consumer through transmission and distribution networks are accompanied by losses.

The major power loss is occurs in the distribution system. It is estimated that almost 10-13 % of the total power generated is consumed as I^2R loss at the distribution level (Ng et al., 2000). It is very essential to reduce the I^2R loss in the distribution system so as to improve the overall efficiency of the power transmission in the distribution system. The main reason behind the major power loss and voltage dip is due to insufficient reactive power. It is necessary to meet the energy demand with existing generating capacities.

Establishing new power generation requires huge capital costs and lands etc. In order to avoid these issues, it is planned to utilize the existing power optimally. It is necessary to optimize the distribution system operation by improving power loss reduction and voltage profile enhancement. In order to overcome the power quality issues, it is very much essential to use the compensating devices in the distribution system such as Capacitor placement, Distributed generation placement and DSTATCOM placement.

Improper placement of compensating devices leads to reduce the benefits of the distribution system and even endanger to the entire system operation. Therefore, it is necessary to determine the optimal location and size of these compensating devices to achieve the maximum benefit of the system. This thesis work presents a new approach to minimize the total power loss and voltage profile enhancement. It is planned to place capacitor, distributed generation and DSTATCOM placement in radial distribution system to overcome the power quality issues.

1. Grey Wolf Optimizer:

Grey wolf optimization method is a meta-heurist technique inspired by the hunting behavior and leadership hierarchy of Grey wolves [84]. Grey wolves prefer to live in a pack of size 5 to 12 and have a very dominant social hierarchy as shown in fig 4.1. The leaders are a male and female, called alphas. The alpha is mostly responsible for making decisions about hunting, sleeping place, time to wake, and so on.

The alpha's decisions are dictated to the pack. However, some kind of democratic behavior has also been observed, in which an alpha follows the other wolves in the pack. In gatherings, the entire pack acknowledges the alpha by holding their tails down. The alpha wolf is also called the dominant wolf since his/her orders should be followed by the pack. The alpha wolves are only allowed to mate in the pack. Interestingly, the alpha is not necessarily the strongest member of the pack but the best in terms of managing the pack.

This shows that the organization and discipline of a pack is much more important than its strength. The second level in the hierarchy of grey wolves is beta. The betas are subordinate wolves that help the alpha in decision-making or other pack activities. The beta wolf can be either male or female, and he/she is probably the best candidate to be the alpha in case one of the alpha wolves passes away or becomes very old. The beta wolf should respect the alpha, but commands the other lower-level wolves as well.

It plays the role of an advisor to the alpha and discipliner for the pack. The beta reinforces the alpha's commands throughout the pack and gives feedback to the alpha. The lowest ranking grey wolf is omega. The omega plays the role of scapegoat. Omega wolves always have to submit to all the other dominant wolves. They are the last wolves that are allowed to eat. It may seem the omega is not an important individual in the pack, but it has been observed that the whole pack face internal fighting and problems in case of losing the omega. This is due to the venting of violence and frustration of all wolves by the omega(s).

This assists satisfying the entire pack and maintaining the dominance structure. In some cases the omega is also the babysitters in the pack. If a wolf is not an alpha, beta, or omega, he/she is called subordinate (or delta in some references). Delta wolves have to submit to alphas and betas, but they dominate the omega.

Scouts, sentinels, elders, hunters, and caretakers belong to this category. Scouts are responsible for watching the boundaries of the territory and warning the pack in case of any danger. Sentinels protect and guarantee the safety of the pack. Elders are the experienced wolves who used to be alpha or beta. Hunters help the alphas and betas when hunting prey and providing food for the pack. Finally, the caretakers are responsible for caring for the weak, ill, and wounded wolves in the pack notwithstanding the societal pecking order of pack of wolves; bunch searching for prey is added fascinating societal conduct of the pack of grey wolves.

2. Mathematical model of GWO:

The above social behavior of Grey wolves is mathematically modelled and then optimization algorithm is developed.

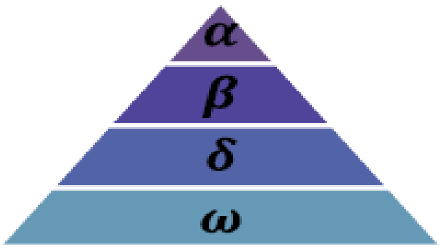

Fig 1. Social Hierarchy of Grey Wolf Optimization.

2.1 Social Hierarchy:

The best solution is accounted as the alpha wolf (α), the second and third finest solutions are treated as beta wolf (β) and delta wolf (δ) respectively.
The remaining solutions are assumed to be omega wolf (ω). The social hierarchy of wolves is shown in Figure 4.2. Further striking of prey, or optimization is directed by positions of α, β and δ and ω wolves track these three wolves.

2.2 Encircling Prey:

The Grey wolves encircle a prey throughout the searching for prey. Following equations are proposed to represent the behavior of the wolves in the form of a mathematical model:

2.3 Crossover:

The original GWO is modified by incorporating the operator crossover which is obtained from the Genetic Algorithm. The ability of global search is improved in the HGWO by incorporating crossover operator. All the members of the pack gain an opportunity to share their data amongst them which aids in getting closer to the optimum solution. The obligatory procedures of the exploration and exploitation among the wolves are maintained. Hence, it takes the edge of the problem of assortment and evades premature convergence. The probability of crossover PC can be 0 to 1.

According to this probability 100XPC % of strings of total population is selected for crossover. While 100X (1-PC) % of the population remains as it is. Crossover is the first operator applied on population of Grey wolves in hybrid grey wolf optimizer. The crossover probability is defined first for selection of pair of population. From the population of grey wolves, according to probability crossover is executed. The cross site is selected randomly from size of population matrix and the values after cross site is interchanged. The process is repeated for each population pair.

2.4 Mutation:

Mutation operator is used to further improve string/array after crossover. Mutation operator can be used to compliment. The mutation probability Pm is decided first. In this algorithm Pm is set to 1%. Mutation is the second operator applied here on grey wolf matrix. A mutation matrix of zeros and ones is generated according to mutation probability and is multiplied with grey wolf matrix element to element thereby changing some of the values.

The observational examination uncovers the fact that there may be the issue of immature convergence in the GWO because of absence of diversity in the search space.

Further, it has been observed that sharing of information takes place only with three best solutions. During convergence, as the iterations converge, the GWO begins losing its diversity. In this manner, in the event of multimodal issues (where numerous nearby optima are available), it very well may be caught into an imperfect point, weakens it decent variety, and untimely crossover happened.

The Hybrid GWO (HGWO) can reduce the neighborhood ideal stagnation and resolve the decent variety issue. In this modification, the operator of GA is incorporated with the GWO. The combining of evolutionary strategies into GWO, improves the pursuit capacity as each part can impart its data to other pack mates. Thus, HGWO makes appropriate balance between exploitation and exploration.

II. RELATED WORK

This section presents a brief discussion regarding the power loss minimization techniques adopted to the radial distribution system such as capacitor placement, Distributed Generation placement and DSTATCOM placement and analyzing the current scenario in this field.

Sirojiddin R. Chorshanbiev et.al (2019) this paper presents the results of a structural study of power losses in the Dushanbe (6-10 / 0.4 kV) distribution network in the Republic of Tajikistan. Data were given on the number of converters and the capacity installed in Dushanbe (6-10 / 0.4 kV) and the length of the distribution network (0.4-6-10 kV). A power loss structure dividing the power level and the type of loss is presented. The cost of electricity on the distribution network that Dushanbe studied is compared to the average loss value on the Russian electricity grid. In the 6-10 / 0.4 kV distributions network of Dushanbe and Russia, there was a significant discrepancy between the load rate and the conditional constant loss rate [6].

Dai Wan et al. (2019) as the load increases each year, the number of distribution converters also increases. Meanwhile, the impact of coordination interventions on the power system has become even greater in recent years. In order to study the effect of the alignment in hot weather the spread of the fuel pipe, based on the calculation of the load loss, the effect of the uneven distribution of the current loss density on the heat. 'The warm place of the entire seat examined. Adjust the model to be under the logical period set in the previous study.

The results show that the horizontal wave will cause an additional temperature rise in the converter. When the harmonic distortion rate is 40%, the temperature rise in the hot zone reaches 102.7 K which exceeds the limit of 78 K in the hot spot distortion. When the harmonic conversion rate is 60%, the maximum temperature of the heat transfer at the top of the converter is more than 60K. At present, the high oil temperature reaches 112.2 ° C, which is close to the flash of mineral insulate oil, which has a significant impact on the safe operation of the material [7].

Ying DING et.al (2018) Disruption of power supply and energy causes problems with power supply and demand problems. Direct power exchange between the provinces can make full use of the power lines in the region to alleviate this problem. However, the members of the market involved in direct power exchange between the provinces are very different from the region; therefore, the transmission losses caused by the differences cannot be ignored. Not found. When we negotiated direct power exchanges in the provinces, we did not consider the impact of losses on transmission, which resulted in unfair exchanges in the market. Based on consideration of the safety issues and losses of transmission, this paper sets out a model of direct power negotiation in the province.

This model considers the various methods of power lines, offers a way to measure and quantify transmission losses, and examines the queue rules for direct power exchange between regions. The law considers the impact of transfer losses under priority on cost and energy protection and environmental protection. This model promotes the improvement of trading methods and maintains fairness in electronic market transactions. The results are relatively stable and can be used as empirical data for practical applications. This model provides support for decision-making on the relationship between supply and demand in the power market and the optimum distribution of large-scale resources [8].

III. PROPOSED SYSTEM

The computational procedure required to determine the steady state operating conditions of a power system network is termed as load flow. Load flow calculation is an important tool in the area of transmission and distribution system. It is required for automated distribution systems for operation and control, planning and optimization etc, this load flow technique is computationally efficient and is fast in convergence.

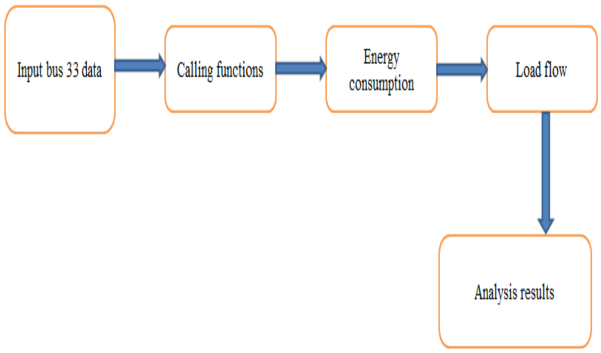

Fig 2. Proposed flow diagram.

The load flow techniques are used for solving radial distribution system. A simple and efficient load flow technique has been used for solving the both Low Voltage Distribution System (LVDS) and High Voltage Distribution System (HVDS).

The effectiveness of the proposed method is tested with practical radial distribution system. A. Assumptions It is assumed that the 3-phase radial distribution network are balanced and represented by their single line representation.

Table 1. Line data of 33 Node Radial Distribution Test System data.

No line data	Branch Sn	Rc.	Line	Line
1	Nd	Nd	Resistance	Reactance
	1	2	0.0922	0.0470
2	2	3	0.4930	0.2511
3	3	4	0.3660	0.1864
4	4	5	0.3811	0.1941
4	5	6	0.8190	0.7070
6	6	7	0.1872	0.6188
7	7	8	0.7114	0.2351
8	8	9	1.0300	0.7400
9	9	10	1.0440	0.7400
10	10	11	0.1966	0.0650
11	11	12	0.3744	0.1238
12	12	13	1.4680	1.1550
13	13	14	0.5416	0.7129
14	14	15	0.5910	0.5260
15	15	16	0.7463	0.5450
16	16	17	1.2890	1.7210
17	17	18	0.7320	0.5740
18	2	19	0.1640	0.1565
19	19	20	1.5042	1.3554
20	20	21	0.4095	0.4784
21	21	22	0.7089	0.9373
22	3	23	0.4512	0.3083
23	23	24	0.8980	0.7091
24	24	25	0.8960	0.7011
25	6	26	0.2030	0.1034
26	26	27	0.2842	0.1447
27	27	28	1.0590	0.9337
28	28	29	0.8042	0.7006
29	29	30	0.5075	0.2585
30	30	31	0.9744	0.9630
31	31	32	0.3105	0.3619
32	32	33	0.3410	0.5302];

Table 2. Line data of 33 Node Radial Distribution Test System data.

Load data of 69 Node Radial Distribution Test System			
Load data	%No. (kW)	(kVAr)	Injected
1	0	0	0
2	100	60	0
3	90	40	0
4	120	80	0
5	60	30	0
6	60	20	0
7	200	100	0
8	200	100	0
9	60	20	0
10	60	20	0
11	45	30	0
12	60	35	0
13	60	35	0
14	120	80	0
15	60	10	0
16	60	20	0
17	60	20	0
18	90	40	0
19	90	40	0
20	90	40	0
21	90	40	0
22	90	40	0
23	90	50	0

24	420	200	0
25	420	200	0
26	60	25	0
27	60	25	0
28	60	20	0
29	120	70	0
30	200	600	0
31	150	70	0
32	210	100	0
33	60	40	0

IV. SIMULATION AND RESULT DISCUSSION

Load Flow Method for Radial Network- The computational procedure required to determine the steady state operating conditions of a power system network is termed as load flow. Load flow calculation is an important tool in the area of transmission and distribution system. It is required for automated distribution systems for operation and control, planning and optimization etc.

Radial Distribution Load Flow Solution

Bus No.	Voltage Mag.	Angle Degree	Load kW	Load kVAr	Substation kW	Substation kVAr	Injected kvar
1	1.0000	0.0000	0.0000	0.0000	2662.7191	2419.6307	0.0000
2	0.9971	0.0009	90.0000	60.0000	0.0000	0.0000	0.0000
3	0.9837	0.0057	90.0000	40.0000	0.0000	0.0000	0.0000
4	0.9757	0.0084	90.0000	80.0000	0.0000	0.0000	0.0000
5	0.9679	0.0111	60.0000	30.0000	0.0000	0.0000	0.0000
6	0.9475	0.0131	60.0000	20.0000	0.0000	0.0000	0.0000
7	0.9433	0.0092	90.0000	100.0000	0.0000	0.0000	0.0000
8	0.9377	0.0105	90.0000	100.0000	0.0000	0.0000	0.0000
9	0.9296	0.0091	60.0000	20.0000	0.0000	0.0000	0.0000
10	0.9220	0.0079	60.0000	20.0000	0.0000	0.0000	0.0000
11	0.9209	0.0081	45.0000	30.0000	0.0000	0.0000	0.0000
12	0.9190	0.0084	60.0000	35.0000	0.0000	0.0000	0.0000
13	0.9112	0.0067	60.0000	35.0000	0.0000	0.0000	0.0000
14	0.9083	0.0051	90.0000	80.0000	0.0000	0.0000	0.0000
15	0.9064	0.0042	60.0000	10.0000	0.0000	0.0000	0.0000
16	0.9046	0.0036	60.0000	20.0000	0.0000	0.0000	0.0000
17	0.9019	0.0018	60.0000	20.0000	0.0000	0.0000	0.0000
18	0.9011	0.0016	90.0000	40.0000	0.0000	0.0000	0.0000
19	0.9964	0.0006	90.0000	40.0000	0.0000	0.0000	0.0000
20	0.9916	-0.0009	90.0000	40.0000	0.0000	0.0000	0.0000
21	0.9907	-0.0014	90.0000	40.0000	0.0000	0.0000	0.0000
22	0.9898	-0.0019	90.0000	40.0000	0.0000	0.0000	0.0000
23	0.9814	0.0067	90.0000	50.0000	0.0000	0.0000	0.0000
24	0.9776	0.0087	100.0000	200.0000	0.0000	0.0000	0.0000
25	0.9756	0.0096	100.0000	200.0000	0.0000	0.0000	0.0000
26	0.9456	0.0144	60.0000	25.0000	0.0000	0.0000	0.0000
27	0.9430	0.0163	60.0000	25.0000	0.0000	0.0000	0.0000
28	0.9309	0.0216	60.0000	20.0000	0.0000	0.0000	0.0000
29	0.9224	0.0259	90.0000	70.0000	0.0000	0.0000	0.0000
30	0.9191	0.0293	100.0000	600.0000	0.0000	0.0000	0.0000
31	0.9150	0.0292	90.0000	70.0000	0.0000	0.0000	0.0000
32	0.9141	0.0291	100.0000	100.0000	0.0000	0.0000	0.0000
33	0.9137	0.0289	60.0000	40.0000	0.0000	0.0000	0.0000
Total			2485.0000	2300.0000	2662.7191	2419.6307	0.0000

Fig 3. Load flow solution for LV System.

This load flow technique is computationally efficient and is fast in convergence. The load flow techniques [9-10]]are used for solving radial distribution system. A simple and efficient load flow technique has been used for solving the both Low Voltage Distribution System (LVDS) and High Voltage Distribution System (HVDS). The effectiveness of the proposed method is tested with practical radial distribution system.

Radial Distribution Load Flow Solution

Bus No.	Voltage Mag.	Angle Degree	Load kW	Load kVAr	Substation kW	Substation kVAr	Injected kvar
1	1.0000	0.0000	0.0000	0.0000	3715.2816	2300.1880	0.0000
2	0.9960	0.0004	100.0000	60.0000	0.0000	0.0000	0.0000
3	0.9770	0.0024	90.0000	40.0000	0.0000	0.0000	0.0000
4	0.9668	0.0040	120.0000	80.0000	0.0000	0.0000	0.0000
5	0.9568	0.0057	60.0000	30.0000	0.0000	0.0000	0.0000
6	0.9318	0.0036	60.0000	20.0000	0.0000	0.0000	0.0000
7	0.9271	-0.0020	200.0000	100.0000	0.0000	0.0000	0.0000
8	0.9205	-0.0012	200.0000	100.0000	0.0000	0.0000	0.0000
9	0.9119	-0.0032	60.0000	20.0000	0.0000	0.0000	0.0000
10	0.9040	-0.0048	60.0000	20.0000	0.0000	0.0000	0.0000
11	0.9028	-0.0047	45.0000	30.0000	0.0000	0.0000	0.0000
12	0.9008	-0.0044	60.0000	35.0000	0.0000	0.0000	0.0000
13	0.8924	-0.0068	60.0000	35.0000	0.0000	0.0000	0.0000
14	0.8894	-0.0089	120.0000	80.0000	0.0000	0.0000	0.0000
15	0.8874	-0.0098	60.0000	10.0000	0.0000	0.0000	0.0000
16	0.8856	-0.0105	60.0000	20.0000	0.0000	0.0000	0.0000
17	0.8828	-0.0125	60.0000	20.0000	0.0000	0.0000	0.0000
18	0.8820	-0.0127	90.0000	40.0000	0.0000	0.0000	0.0000
19	0.9953	0.0001	90.0000	40.0000	0.0000	0.0000	0.0000
20	0.9906	-0.0015	90.0000	40.0000	0.0000	0.0000	0.0000
21	0.9896	-0.0019	90.0000	40.0000	0.0000	0.0000	0.0000
22	0.9888	-0.0024	90.0000	40.0000	0.0000	0.0000	0.0000
23	0.9722	0.0016	90.0000	50.0000	0.0000	0.0000	0.0000
24	0.9632	-0.0005	420.0000	200.0000	0.0000	0.0000	0.0000
25	0.9588	-0.0015	420.0000	200.0000	0.0000	0.0000	0.0000
26	0.9292	0.0046	60.0000	25.0000	0.0000	0.0000	0.0000
27	0.9257	0.0061	60.0000	25.0000	0.0000	0.0000	0.0000
28	0.9101	0.0085	60.0000	20.0000	0.0000	0.0000	0.0000
29	0.8989	0.0107	120.0000	70.0000	0.0000	0.0000	0.0000
30	0.8941	0.0134	200.0000	600.0000	0.0000	0.0000	0.0000
31	0.8884	0.0114	150.0000	70.0000	0.0000	0.0000	0.0000
32	0.8871	0.0109	210.0000	100.0000	0.0000	0.0000	0.0000
33	0.8867	0.0107	60.0000	40.0000	0.0000	0.0000	0.0000
Total			3715.0000	2300.0000	3715.2816	2300.1880	0.0000

Fig 4. Load flow solution for HV System.

Figure 1: POWERLOSS

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	Real power(KW)	Reactive power(KVAR)
HVDC	0.2816	0.1880
LVDC	177.7191	119.6307

Fig 5. Power losses in HVDC and LVDC.

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The end user, either in the HVDS or in the LVDS operates his equipment at LT voltage only. Hence by comparison it can be observed that an losses In HVDC System is lower than LVDC System.

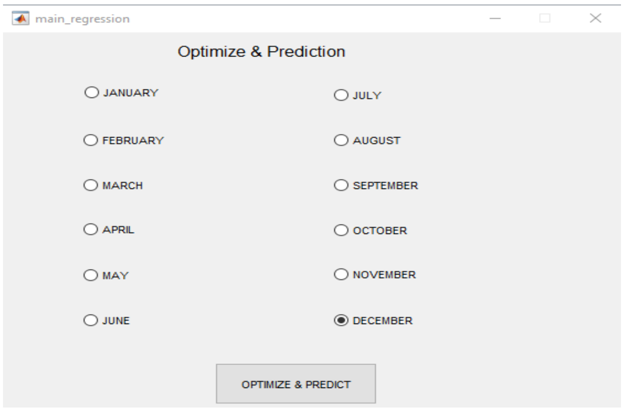

Fig 6. GUI window.

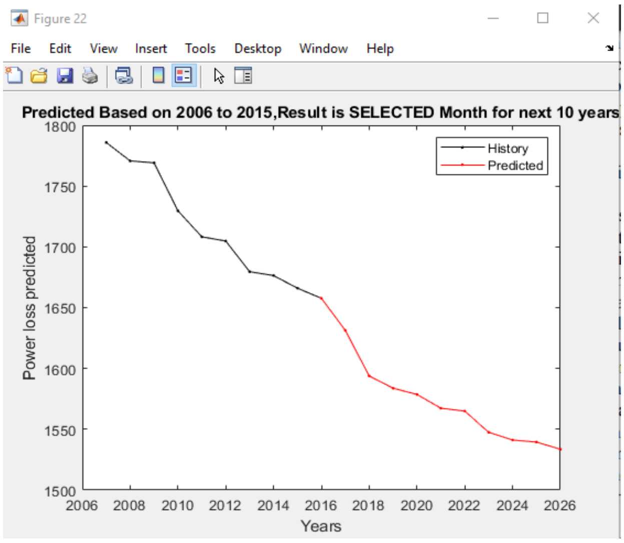

Fig 7. Power loss prediction.

	Hours	thermal 1	thermal 2	thermal 3	hydro 1	hydro 2	hydro 3	hydro 4	wind	solar	Battery Power	loss	load
1	1	53.5972	86.0310	118.4647	97.8326	102.9363	103.8626	97.3317	2.5968	0	95.8357	8.4885	750
2	2	39.8558	73.6548	107.4538	112.0493	116.3839	116.8470	112.5761	12.8624	3.9072	92.0920	7.6823	780
3	3	37.3636	68.8760	100.3883	97.6803	101.6804	101.9892	99.1419	11.3292	7.8143	83.7618	10.0250	700
4	4	34.4500	45.8198	57.1895	98.9808	102.8137	103.0453	100.9098	20.9020	11.7215	85.9505	11.7830	650
5	5	28.2279	56.4558	84.6837	99.3270	103.0595	103.2448	101.3599	40.3992	15.6287	48.6559	11.0424	670
6	6	41.6280	83.2560	124.8840	113.1788	116.8444	116.9988	115.3709	12.3902	19.5359	63.1647	7.2517	800
7	7	53.9598	115.0601	176.1604	161.9477	165.5656	165.6979	164.3025	4.0816	23.4430	-74.6487	5.5701	950
8	8	64.1527	145.3405	226.5284	157.9436	161.5256	161.6414	160.4205	5.7863	27.3502	-95.2573	5.4319	1010
9	9	55.6139	143.9492	232.2845	162.4587	166.0128	166.1158	164.9991	49.4827	31.2574	-75.5050	6.6691	1090
10	10	66.3541	166.5631	266.7722	153.5241	157.0560	157.1486	155.9606	6.0116	35.1645	-78.1705	6.3844	1080
11	11	63.4532	153.9906	244.5280	171.0309	174.5445	174.6287	173.5487	11.3157	39.0717	-99.0917	7.0201	1100
12	12	59.3402	143.9024	228.4645	169.3223	172.8207	172.8979	171.9079	39.6838	42.9789	-94.2983	7.0201	1100
13	13	58.1578	152.4134	246.6689	168.1821	171.6676	171.7388	170.8250	10.6763	46.8860	-79.8097	7.4063	1110
14	14	61.3541	140.5177	219.6812	157.4304	160.9049	160.9710	159.9132	5.0877	50.7932	-81.1163	5.5372	1030
15	15	50.9815	138.2344	225.4873	153.4030	156.8679	156.9297	155.8635	22.3203	54.7004	-99.3561	5.4319	1010
16	16	62.5525	131.9801	201.4077	171.0949	174.5514	174.6093	173.6097	2.6340	58.6075	-85.1201	5.9271	1060
17	17	43.4859	116.8077	190.1294	166.8398	170.2890	170.3435	169.4027	59.0298	62.5147	-93.0915	5.7510	1050
18	18	57.2087	145.8439	234.4790	162.7845	166.2332	166.2847	165.2955	35.5351	66.4219	-72.2635	7.8229	1120
19	19	51.7703	142.4143	233.0584	148.6489	152.1472	152.1959	150.9955	56.2090	70.3290	-81.6304	6.1382	1070
20	20	41.5129	116.7568	192.0007	169.2298	172.7197	172.7661	171.6246	18.0612	74.2362	-73.1570	5.7510	1050
21	21	47.8950	118.4604	189.0257	118.3857	121.8680	121.9122	120.8251	71.8416	78.1434	-72.5421	5.8149	910
22	22	43.1838	86.3677	129.5515	132.6582	136.1336	136.1757	135.1286	70.3810	82.0505	-85.3264	6.3042	860
23	23	42.7707	85.5414	128.3121	136.8758	140.4882	140.5284	139.2019	12.6252	85.9576	-55.8882	6.4132	850
24	24	38.7245	80.8578	122.9911	118.0834	121.7122	121.7508	120.3675	69.7481	89.8648	-76.8483	7.2517	800

Fig 8. DATASET.

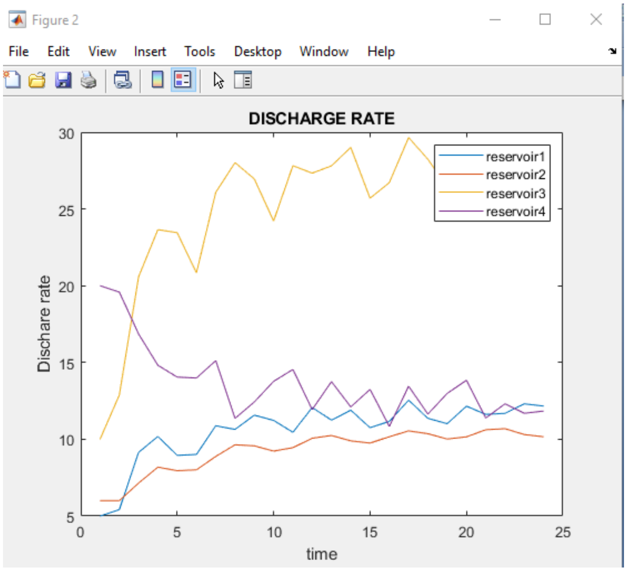

Fig 9. Discharge Rate.

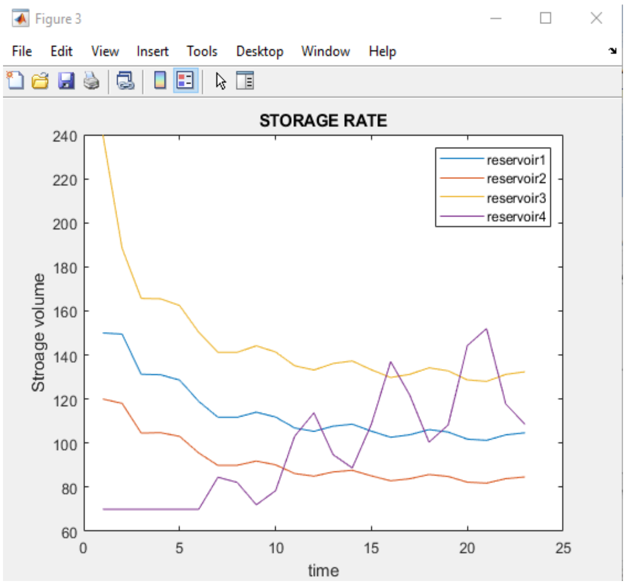

Fig 10. Storage rate.

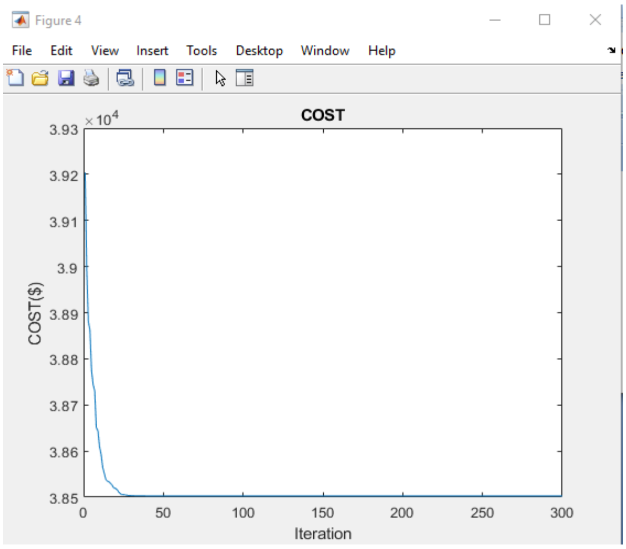

Fig 11. Cost graph.

V. CONCLUSIONS

In this work, the optimal switching criterion based minimization of power loss for the distribution systems is proposed. It can efficiently relieve the system contingency such as overloading of the main transformers or the occurrence of faults in the distribution systems.

The optimal switching criterion can increase the operational efficiency of the distribution systems by minimizing the power loss. The load profile of the distribution feeders and the load patterns of each type of load customers are used to evaluate the loading condition at each moment of variation and the feeder load behavior is represented more accurately.

It is much easier to use a training algorithm of the neural network even when the number of neurons is larger than the conventional one. However, the neural network has much better online application with a small number of neurons. This means it will respond correctly to the closely related pattern other than the one used for training. In the present research, the proposed Network is less dependent on the weighting factors and is more generic than the other Neural Network based capacitor placement methods.

Also, the use of forward-only algorithm simplifies the computation process in the second order training that can handle arbitrarily connected neural networks and has the benefit of speed for networks with multiple outputs.

This application capability has wireless connectivity to identify the capacitor location from the sub-stations. Any sub-station (Distribution System), needs to continuously measure and monitor parameter (voltage, 154 frequency, power factor) and associated equipments. A system to monitor the electrical parameters and instantly convey to the decision loops for quick action using WAP is proposed in this research. Percentage reduction in the line loss and voltage regulation is achieved. It can be extended for a more complex distribution system and expansion planning.

The techniques developed in the present research for planning, designing and management of distribution systems are very effective and offers a good scope for optimum planning and designing of distribution systems with an emphasis on reduction of energy losses. The thesis proposes a new physical representation of the RDS, and the development of an expert system based RDS optimization tool to ensure maximum electrical energy utilization, minimum distribution feeder losses and enhanced energy utilization efficiency. The simulation results obtained by using Genetic Algorithm, Neural Network and WAP system on a sample feeder are found to be very encouraging. Hence, the heuristic rules are validating.

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