Impact of Load Factor on Distinct Feeders of 132/11 kV Grid Station in Distribution Network

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***Abstract*— The poor Load Factor (LF) causes the tripping of transformers, heating of conducting material, failure of insulation and increase of the reactive power. Improving LF is an important issue to stabilize the power system. To investigate the power loss caused by the poor LF, the calculated peak and minimum load data loss at variable loads for times is analyzed. The low LF is calculated through collected data of minimum and maximum loads. The analysis of 7 feeders at 132/11kV grid station is carried out for this research purpose. The distribution system and analysis of load on different feeders are estimated through an investigation of site techniques. The major findings are discussed in the result and discussion section of this study.**

***Index Terms*— Energy Loss Minimization, Network Losses, Energy Consumption, Tariff, Peak Load.**

I. INTRODUCTION

Recently the energy crises are the key issues all over the world. Energy crises are becoming hurdles in economic growth and also has an environment cost because mostly fossil fuels are used and there is a need for renewable energy resources [1]. So this issue will become a challenge for developing countries and their increasing population [2]. In this scenario i.e., for increasing the efficiency of an electric system, the aim of the research is to analyze the potential of distributed resources although they do not decrease the efficiency of the system [3], [4].

The system should have an abundant capacity to certain the supply of fluctuating demand for electricity i.e., 100% of all the times with the minimum amount of equipment and energy input. Having the maximum efficiency may not be desirable but only if the system efficiency is reduced as a result of any issue [5], [6].

Following, there is a transmission which distributes electricity at high voltage from the huge generators to the rest of the system. For the electric load or demand, the quantity of electricity required by the consumer should be known in advance [7], [8].

The paper is distributed into 7 sections. In **Section I**, the energy and load factor has been discussed. In **Section II** and **Section III**, the research background has been described. In addition to this, the detailed distribution system has been discussed. In **Section IV**, the loss reduction techniques device specifications, and energy losses based on the usage model have been discussed. The impact of Load Factor (LF) on distribution has been discussed in **Section V**. The detailed analysis of 132/11 kV feeders has been presented in **Section VI**. Conclusion and future work have been presented in **Section VII** and **Section VIII** respectively.

II. TECHNICAL LOSSES

The technical losses are due to the inherent electrical properties of system components [9]. These losses can occur in the system because of the Corona Effect. The transformer iron, eddy current, conductor and Ohmic losses are part of the electrical losses in the system. Transformer losses are divided into two parts: Discharge Loss and Pressure Loss [10]. The discharge loss is generated by the energy required to keep the core flowing constantly and as the load of the transformer changes, depending on the load, the resistance loss of the coil conductor will produce a voltage drop [11].

III. NON-TECHINCAL LOSSES

These are occurred due errors caused by humans, improper installation and handling of the meter and unauthorized meter users (especially theft). It is a great dilemma for our declining generation of electricity as the administration's concerns are with the office while consumers are involved in unfair means. In some cases, when a large system has a total power loss, it is clear that part of the non-technical loss is serious, from 3% to 6% [12]; depending on the length, service life, system line voltage level and other factors [13]. It is estimated that in some third world countries the power of theft is astonishingly high i.e., 10% to 40%, while in developed countries it is more than 3% [14].

IV. TECHNIQUES OF LOSSES REDUCTION

The most effective technologies for reducing the loss of power distribution systems are feeder repair [15], power distribution or Distributed Generation (DG) up-gradation, reactive power compensation analysis [16] and reduction/control of non-technical damage to smart metering devices.

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Reducing losses and maximizing balance is the main step to re-configure the network. Re-configuring the feeder distribution system to reduce feeders, reduce load balance and improve system security is a very important task [17], [18].

The feeder may change the switching speed, returning from the feeder to the open and closed state of another feeder. The best re-structuring of the network depends on automatic circuit breakers that respond to network topology changes [19].

Applying small quantities of Distributed Generation (DG) can reduce power consumption until it reaches the lowest level. After reaching this lowest level, the level of infiltration increases and then the losses begin to increase somewhat [20]. Increasing the level of DG penetration will increase the loss. Controllable capacitors can also be used to reduce active power and increase voltage [21], [22].

V. IMPACT OF LOAD FACTOR ON DISTRIBUTION LOSSES

Consumer electricity consumption varies throughout the day and the season. Residential users usually draw the highest electricity demand in the evening. The same commercial customer load usually peaks in the afternoon. Because the current level is the main cause of distributed power loss, maintaining a high power consumption level throughout the day will reduce peak power loss and overall power loss [23]. No need to enter LFs for the sale of public tube wells and traction in medium/large industries power. The power and electricity consumption of this survey can be explored in two industries [8-10]. Most demand readings are directly related to industry and demand meter tube-wells [24].

VI. RESULT AND DISCUSSION

The LF is calculated in percentage, which plays an important role in the efficiency and reliability of the electrical system. Good energy consumption per kilowatt-hour (kWh) depends on a good LF in terms of energy consumption. Increase the LF and reduce the cost of electricity consumption, while the electric charge component plays an important role in the efficiency of the electrical system using electrical load components; By improving the LF, the power system increases the reliability, safety and stability of the system from power generation customers. This is because the average load increases with decreasing peak load and the load on the system are running regularly, no reactive force is generated and the electrical equipment also works with confidence and reliability. In general, improving the LF is a necessary concept of a power system.

The maximum, minimum and average, load of different feeders for the years 2016-2018 are shown in Table I. The LF calculations of all feeders for the years 2016-2018 are laid out in Table II.

Table I: Maximum, Minimum and Average Loads of Distinct Feeders for the Years 2016-2018

S. No.	Feeder's Name	2016			2017			2018		
		Max. Load (kW)	Min. Load (kW)	Avg. Load (kW)	Max. Load (kW)	Min. Load (kW)	Avg. Load (kW)	Max. Load (kW)	Min. Load (kW)	Avg. Load (kW)
1	Tube Well	475	120	297.5	450	110	280	500	130	315
2	New Petaro	130	40	85	120	30	75	125	32	78.5
3	LMC	250	58	154	255	60	157.5	248	56	152
4	OCF-I	75	25	50	80	30	55	70	20	45
5	OCF-II	140	48	94	120	28	74	130	30	80
6	Old Petaro	100	25	62.5	110	35	72.5	98	20	59
7	Allama I.I. Qazi	300	65	182.5	305	60	182.5	298	60	179

Furthermore, it has been observed through Fig. 1, that the maximum load was higher on Tube-Well and Allama I. I. Qazi feeders, which were 315 and 300 in 2018, as compared rest of the feeders.

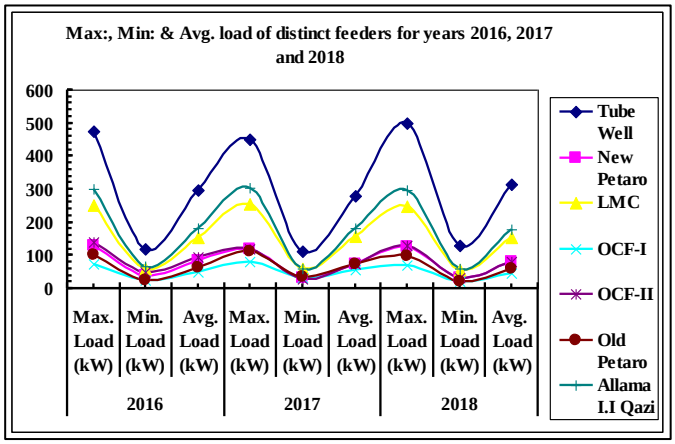

Fig. 1: Illustration of Maximum, Minimum and Average Loads of Distinct Feeders for the Years 2016-2018

Table II: Calculations of Load Factor of Distinct Feeders for the Years 2016-2018

S. No.	Feeder's Name	Load Factor		
		2016	2017	2018
1	Tube Well	62.63	62.22	63
2	New Petaro	65.38	62.5	62.8
3	LMC	61.6	61.76	61.29
4	OCF-I	66.67	68.75	64.28
5	OCF-II	67.14	61.66	61.53
6	Old Petaro	62.5	65.9	60.2
7	Allama I.I Qazi	60.83	59.83	60.06

The graphical illustration of calculations based on LF of distinct feeders for the years 2016-2018 are shown in Fig. 2.

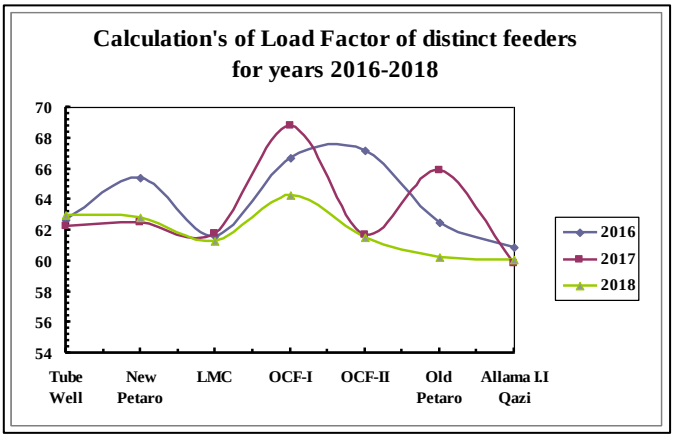

Fig. 2: Calculations of Load Factor of Distinct Feeders for the Years 2016-2018

Comparing of minimum and maximum load and their calculations in terms of saving of different feeders of 132/11 kV Gird Station Jamshoro for 2018 are presented in Table III. The length of different feeders such as the Tube well feeder is about 15 km.

Table III: Comparison of Minimum and Maximum Loads and the Resultant Annual Savings of Tube-Well Feeder for the Year 2018

Month's	Voltage	p. f	Peak Position Load (Amp.)	Declined Peak Position Load (Amp.)	Peak Position Load (Units)	Declined Peak Position Load (Units)	Save Units	Peak Position Load (Cost)	Cost of Declined Load	Save Rupees
January	220	0.8	150	100	19008	12672	6336	180576	102769.92	77806.1
February	220	0.8	147	102	18627.8	12925.44	5702.4	176964.4	104825.31	72139.1
March	220	0.83	158	90	20772.6	11832.48	8940.09	197339.4	95961.41	101378
April	220	0.82	170	110	22081	14287.68	7793.2	209769.1	115873.08	93896
May	220	0.83	200	115	26294.4	15119.28	11175.1	249796.8	122617.36	127179
June	220	0.84	350	160	46569.6	21288.96	25280.6	442411.2	172653.46	269758
July	220	0.8	475	290	60192	36748.8	23443.2	571824	298032.76	273791
August	220	0.78	470	300	58069.4	37065.6	21003.8	551659.6	300602.01	251058
September	220	0.8	465	305	58924.8	38649.6	20275.2	559785.6	313448.25	246337
October	220	0.8	380	200	48153.6	25344	22809.6	457459.2	205539.84	251919
November	220	0.75	200	130	23760	15444	8316	225720	125250.84	100469
December	220	0.8	160	125	20275.2	12672	7603.2	192614.4	102769.92	89844.5
Total Annual Saving Rupees								**Rs 1955575.54**		

It is clear from Fig. 3 that high and low load units occurred in July and January for the year 2018 respectively.

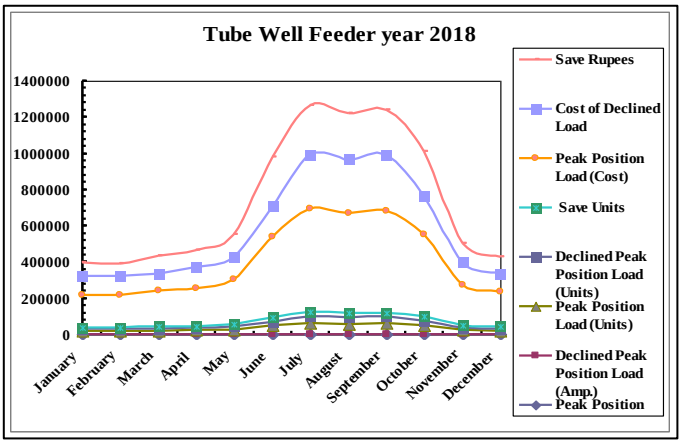

Fig. 3: Illustration of Load and Annual Savings of Tube Well Feeder for the Year 2018

The Table IV presents different categories of units for the year 2018, from which maximum units saved in rupees was in the month of June by New Petaro feeder is shown. It is important to mention that 20 km is the length of New Petaro feeder. Graphical results are presented in Fig. 4 and the maximum demand for units has been observed in June.

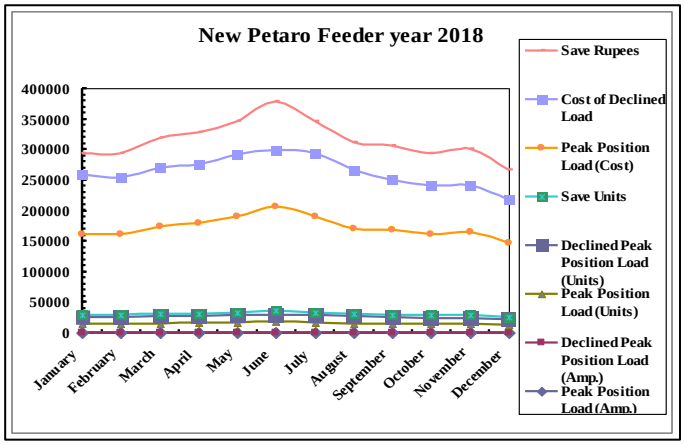

Fig. 4: Illustration of Load and Annual Savings of New Petaro Feeder for the Year 2018

Table IV: Comparison of Minimum and Maximum Loads and the Resultant Annual Savings of New Petaro Feeder for the Year 2018

Month's	Voltage	p. f	Peak Position Load (Amp.)	Declined Peak Position Load (Amp.)	Peak Position Load (Units)	Declined Peak Position Load (Units)	Save Units	Peak Position Load (Cost)	Cost of Declined Load	Save Rupees
January	220	0.8	110	95	13939.2	12038.4	1900.8	132422.4	97631.4	34791
February	220	0.8	110	90	13939.2	11404.8	2534.4	132422.4	92492.9	39929.5
March	220	0.83	115	90	15119.3	11832.48	3286.8	143633.2	95961.4	47671.8
April	220	0.82	120	90	15586.6	11689.92	3896.64	148072.3	94805.2	53267.1
May	220	0.83	125	95	16434	12489.84	3944.16	156123	101292.6	54830.4
June	220	0.84	135	85	17962.6	11309.76	6652.8	170644.3	91722.15	78922.2
July	220	0.8	130	100	16473.6	12672	3801.6	156499.2	102769.9	53729.3
August	220	0.78	120	95	14826.2	11737.44	3088.8	140849.2	95190.6	45658.6
September	220	0.8	115	80	14572.8	10137.6	4435.2	138441.6	82215.9	56225.7
October	220	0.8	110	78	13939.2	9884.16	4055.04	132422.4	80160.5	52261.9
November	220	0.75	120	80	14256	9504	4752	135432	77077.4	58354.6
December	220	0.8	100	70	12672	8870.4	3801.6	120384	71938.9	48445.1
Total Annual Saving Rupees								**Rs 624087.13**		

Throughout the year 2018, it has been analyzed that the cost of peak load is higher for the month of July than other months, in Liaquat Medical College (LMC) feeder. This is presented in Table V. The length of LMC feeder is 6 km; its results are graphically shown in Fig. 5.

Table V: Comparison of Minimum and Maximum Loads and the Resultant Annual Savings of LMC Feeder for the Year 2018

Month's	Voltage	p. f	Peak Position Load (Amp.)	Declined Peak Position Load (Amp.)	Peak Position Load (Units)	Declined Peak Position Load (Units)	Save Units	Peak Position Load (Cost)	Cost of Declined Load	Save Rupees
January	220	0.8	180	140	22809.6	17740.8	5068.8	216691.2	143877.8	72813.4
February	220	0.8	190	150	24076.8	19008	5068.8	228729.6	154154.8	74574.8
March	220	0.83	200	160	26294.4	21035.52	5258.8	249796.8	170598.06	79198.7
April	220	0.82	210	175	27276.5	22730.4	4546.08	259126.5	184343.5	74783
May	220	0.83	220	185	28923.8	24322.32	4601.52	274776.4	197254.01	77522.4
June	220	0.84	240	190	31933.4	25280.64	6652.8	303367.7	205025.99	98341.7
July	220	0.8	250	210	31680	26611.2	5068.8	300960	215816.83	85143.2
August	220	0.78	230	190	28416.7	23474.88	4941.81	269961.1	190381.27	79579.9
September	220	0.8	210	180	26611.2	22809.6	3801.6	252806.4	184985.85	67820.6
October	220	0.8	200	170	25344	21542.4	3801.6	240768	174708.86	66059.1
November	220	0.75	180	150	21384	17820	3564	203148	144520.2	58627.8
December	220	0.8	170	130	21542.4	16473.6	5068.8	204652.8	133600.8	71052
Total Annual Saving Rupees								**Rs. 905516.53**		

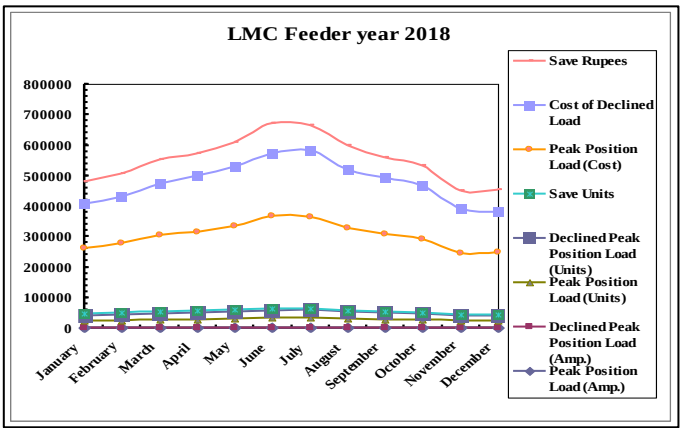

Fig. 5: Illustration of Load and Annual Savings of LMC Feeder for the Year 2018

The comparison of savings of all the feeders of 132/11kV Gird Station Jamshoro is depicted below by analyzing minimum and maximum load, for the year 2018 are presented in Tables i.e., Table VI, Table VII, Table VIII and Table IX and its graphical representation response has been shown in below Figures i.e., Fig. 6, Fig.7, Fig. 8 and Fig. 9 respectively.

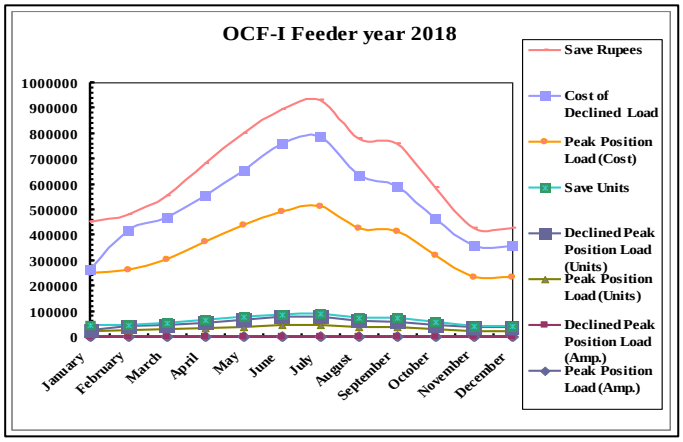

Fig. 6: Illustration of Load and Annual Savings of OCF-I Feeder for the Year 2018

Table VI: Comparison of Minimum and Maximum Loads and the Resultant Annual Savings of OCF-I Feeder for the Year 2018

Month's	Voltage	p. f	Peak Position Load (Amp.)	Declined Peak Position Load (Amp.)	Peak Position Load (Units)	Declined Peak Position Load (Units)	Save Units	Peak Position Load (Cost)	Cost of Declined Load	Save Rupees
January	220	0.8	170	130	21542.4	1647.6	19894.8	204652.8	13362.02	191291
February	220	0.8	180	150	22809.6	19008	3801.6	216691.2	154154.88	62536.3
March	220	0.83	200	155	26294.4	20378.16	5916.2	249796.8	165266.87	84529.9
April	220	0.82	250	170	32472	22080.96	10391	308484	179076.58	129407
May	220	0.83	290	200	38126.3	26294.4	11832.4	362205.3	213247.58	148958
June	220	0.84	320	250	42577.9	33264	9313.9	404490.2	269771.04	134719
July	220	0.8	350	270	44352	34214.4	10137.6	421344	277478.78	143865
August	220	0.78	300	210	37065.6	25945.92	11119.7	352123.2	210421.41	141702
September	220	0.8	285	170	36115.2	21542.4	14572.8	343094.4	174708.86	168386
October	220	0.8	220	140	27878.4	17740.8	10137.6	264844.8	143877.88	120967
November	220	0.75	170	130	20196	15444	4752	191862	125250.84	66609.2
December	220	0.8	160	120	20275.2	15206.4	5068.8	192614.4	123322.9	69291.5
Total Annual Saving Rupees								**Rs. 1462261.45**		

Table VII: Comparison of Minimum and Maximum Loads and the Resultant Annual Savings of OCF-II Feeder for the Year 2018

Month's	Voltage	p. f	Peak Position Load (Amp.)	Declined Peak Position Load (Amp.)	Peak Position Load (Units)	Declined Peak Position Load (Units)	Save Units	Peak Position Load (Cost)	Cost of Declined Load	Save Rupees
January	220	0.8	95	70	12038.4	8870.4	3168	114364.8	71938.9	42425.9
February	220	0.8	110	80	13939.2	10137.6	3801.6	132422.4	82215.9	50206.5
March	220	0.83	115	85	15119.3	11175.12	3944.16	143633.1	90630.22	53002.9
April	220	0.82	110	80	14287.7	10391.04	3896.64	135732.9	84271.33	51461.6
May	220	0.83	120	90	15776.6	11832.48	3944.16	149878.1	95961.41	53916.7
June	220	0.84	130	95	17297.3	12640.32	4656.96	164324.1	102512.99	61811.1
July	220	0.8	140	100	17740.8	12672	5068.8	168537.6	102769.92	65767.7
August	220	0.78	120	90	14826.2	11119.68	3706.56	140849.2	90180.6	50668.6
September	220	0.8	115	85	14572.8	10771.2	3801.6	138441.6	87354.43	51087.2
October	220	0.8	110	80	13939.2	10137.6	3801.6	132422.4	82215.93	50206.5
November	220	0.75	100	70	11888	8316	3572	112936	67442.76	45493.2
December	220	0.8	90	60	11404.8	7603.2	3801.6	108345.6	61661.95	46683.7
Total Annual Saving Rupees								**Rs 622731.44**		

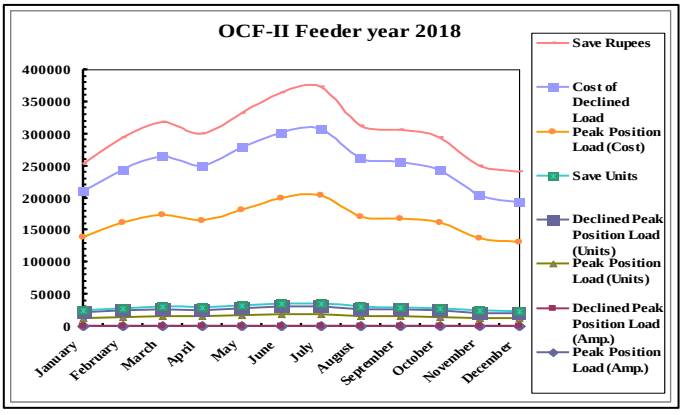

Fig. 7: Illustration of Load and Annual Savings of OCF-II Feeder for the Year 2018

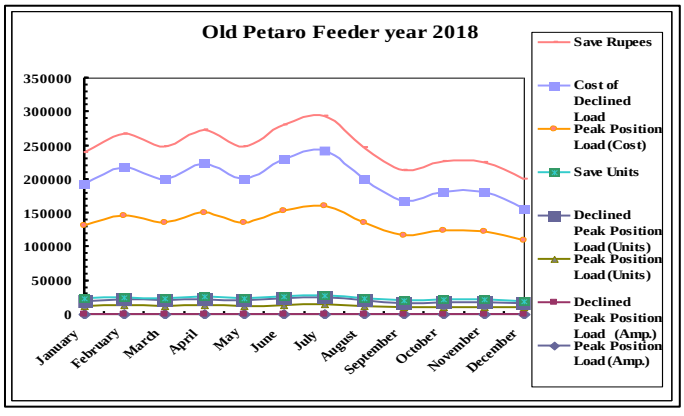

Fig. 8: Illustration of Load and Annual Savings of Old Petaro Feeder for the Year 2018

Table VIII: Comparison of Minimum and Maximum Loads and the Resultant Annual Savings of Old Petaro Feeder for the Year 2018

Month's	Voltage	p. f	Peak Position Load (Amp.)	Declined Peak Position Load (Amp.)	Peak Position Load (Units)	Declined Peak Position Load (Units)	Save Units	Peak Position Load (Cost)	Cost of Declined Load	Save Rupees
January	220	0.8	90	60	11404.8	7603.2	3801.6	108345.6	61661.95	46683.7
February	220	0.8	100	70	12672	8870.4	3801.6	120384	71938.94	48445.1
March	220	0.83	90	60	11832.5	7888.32	3944.16	112408.6	63974.27	48434.3
April	220	0.82	100	70	12988.8	9092.16	3896.64	123393.6	73737.41	49656.2
May	220	0.83	90	60	11832.5	7888.32	3944.16	112408.6	63974.27	48434.3
June	220	0.84	100	70	13305.6	9313.92	3991.68	126403.2	75535.89	50867.3
July	220	0.8	110	80	13939.2	10137.6	3801.6	132422.4	82215.93	50206.5
August	220	0.78	95	65	11737.4	8030.88	3706.56	111505.7	65130.43	46375.3
September	220	0.8	80	50	10137.6	6336	3801.6	96307.2	51384.96	44922.2
October	220	0.8	85	55	10771.2	6969.6	3801.6	102326.4	56523.45	45803
November	220	0.75	90	60	10692	7128	3564	101574	57808.08	43765.9
December	220	0.8	75	45	9504	5702.4	3801.6	90288	46246.46	44041.5
Total Annual Saving Rupees								**Rs 567635.19**		

Table IX: Comparison of Minimum and Maximum Loads and the Resultant Annual Savings of Allama I. I Qazi Feeder for the Year 2018

Month's	Voltage	p. f	Peak Position Load (Amp.)	Declined Peak Position Load (Amp.)	Peak Position Load (Units)	Declined Peak Position Load (Units)	Save Units	Peak Position Load (Cost)	Cost of Declined Load	Save Rupees
January	220	0.8	210	165	26611.2	20908.8	5702.4	252806.4	169570.36	83236
February	220	0.8	230	150	2945.6	19008	10137.6	276883.2	154154.8	122728
March	220	0.83	240	180	31553.3	23664.96	7888.3	299756.1	191922.8	107833
April	220	0.82	260	190	33770.9	24678.72	9092.1	320823.3	200144.4	120679
May	220	0.83	280	210	36812.2	27609.12	9203.04	349715.5	223909.9	125806
June	220	0.84	290	220	38586.2	29272.32	9313.9	366569.2	237398.5	129171
July	220	0.8	300	225	38016	28512	9504	361152	231232.3	129920
August	220	0.78	230	180	28417	22239.36	6177.6	269961.1	180361.2	89599.9
September	220	0.8	200	140	25344	17740.8	7603.2	240768	143877.8	96890.2
October	220	0.8	180	120	22809.6	15206.4	7603.2	216691.2	123323.9	93367.3
November	220	0.75	160	90	19008	10692	8316	180576	86712.1	93863.9
December	220	0.8	150	70	19008	8870.4	10137.6	180576	71938.9	108637
Total Annual Saving Rupees								**Rs. 1301731.04**		

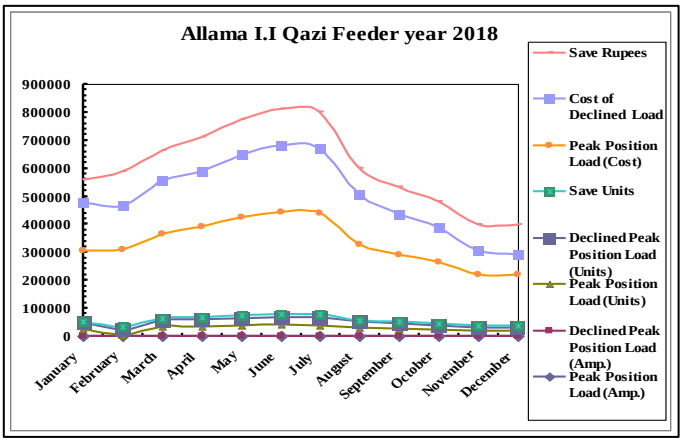

Fig. 9: Illustration of Load and Annual Savings of Allama I. I Qazi Feeder for the Year 2018

VII. CONCLUSION

The Load Factor (LF) enhancements that is needed for the preferred results is the need of the hour because it gives essential data to Hyderabad Electric Supply Company (HESCO) i.e., the LF is low and it must be enhanced as per the requirements.

The improved LF protects from typical faults such as technical losses, Load shedding, and power demand.

It is suggested that instead of repairing the old equipment, they must be replaced by new equipment to fulfill energy demands on time.

This study is useful for Distribution Companies (DISCOs) and the customers. It is also beneficial for a secure and continuous supply of electricity.

From this research study, it is concluded that the load shedding can be reduced to an extent which is tolerable by the customers which is a major problem nowadays in our country.

VIII. FUTURE WORK

It is recommended that HESCO should present seminars/programs/webinars publically to inspire all type of customer to help them manage their maximum loads according to HESCO's mentioned policy/instructions on electricity bill. The policy must be followed at all times which are only possible with customers support.

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