LOSS ANALYSIS OF DISTRIBUTION SYSTEM AND POWER FACTOR IMPROVEMENT (A CASE STUDY)

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ABSTRACT:*Water and Sanitation Agency, Faisalabad is one of the largest consumer of FESCO and near about 60 million rupees pays as an electricity bill per month. In WASA Faisalabad, the electrical installations are increasing with the passage of time without any long term and technical future planning and load growing demands are also increasing rapidly. In WASA Faisalabad electrical installations, currently low power factor and there is no technical management for installing power capacitor banks. Feeders coming from WAPDA /FESCO Grid station to WASA Faisalabad have also a low power factor. Due to the expansion of power demand and low power factor, the power losses have reached the level of over to 05% to 42.05%. Existing FESCO-WASA Distribution system being developed un-planned is now becoming heavily over-loaded and frequent and un-expected load-shedding causes large financial losses in term of technical and non-technical losses. There is very strong need of identifying the technical and non-technical losses separately. After thoroughly studying of different methods for reducing energy loss, including area planned, reconductoring and finally we will apply capacitor installation..*

Key words:FESCO-WASA, Loss analysis, Power factor, was a distribution system.

I. INTRODUCTION

The first preference of the world organizations is to achieve maximum financial output and also provide durable, continuous and satisfactory services to their consumers from their existing system[1]. The performance and the quality of service are measured in term of service reliability and continuity[2]. Like world made energy producing organization and WAPDA distribution system, FESCO-WASA Distribution system is now facing the technical and non-technical power losses [3,4]. Technical losses in power distribution system arise due to poor design (over/under size conductors of transmissions and distribution lines) of electrical equipment and low power factor. While non-technical losses are due to manpower store co-ordination and theft of electrical energy[5,6,7].

In FESCO-WASA Distribution System, for calculating technical, non-technical losses and to increase the existing power factor, new modern and sophisticated techniques are required. The first basic purpose of this research thesis is to demonstrate out the main cause of these heavy losses and low power factor[5,6]. The second basic reason is to propose the methods and techniques for reducing power line losses in FESCO-WASA Distribution system by suggesting the countermeasures and improving the existing power factor.

According to one latest field survey report of FESCO-WASA Distribution System, line losses have reached over to 42.05%. These losses are due to frequent WAPDA load-shedding and fluctuation in line voltages[8]. Like the WAPDA System, FESCO-WASA Distribution System is divided into two main sections.

1. High Tension(HT)side 11Kv.
2. Low Tension(LT)side 400Volts.

II. STATEMENT OF THE PROBLEM

The Increasing cost of energy has brought the critically important for energy generation, energy conservation, energy management and elimination of energy waste. For developing organization, it has become very important to reduce the power loss and improve the power factor[2]. In this regard, the technical design of a power system distribution has a great bearing on voltage regulation, monitoring, controlling and deep insight for energy loss and capacitors installment for the area of distribution system having low power factor[8]. In FESCO-WASA distribution system, the energy loss is due to following reasons.

1. Capital investments are too low to sustain exceptionally high growth rate.
2. Heating effect (I^2Rt).

III. OBJECTIVES

The objectives of this report is to present energy audit findings with a focus on condition and capacity of facilities, energy use at each facility and identification of areas where through appropriate measures energy consumption and energy losses can be reduced[9].

The objectives of this report are listed below;

1. Energy/loss analysis of all assets for implementing energy saving and low-cost effective solutions.
2. Increasing of recovery by reducing energy consumption, operational costs and maintenance costs.
3. Assessment of assets with a focus on condition, capacity and service delivery..
4. Identify energy conservation opportunities without compromising the output of assets.
5. Improve the current condition to enhance the life of machinery.

IV. SCOPE/APPLICATIONs

This project on energy management captures energy utilization and saving opportunities for WASAs Faisalabad through energy utilization assessment of existing machinery and facilities with focus on condition and service delivery capacity. The facilities of WASA's that are included in the audit are operational service delivery components of water supplies, sewerage and waste water treatment plants such as motor, pumps, tube wells and disposal stations etc.

The contour of scope operationalization is translated into the following board steps or activities conducted through consultation with WASA[5].

1. Train WASAs official through Training Workshop on Energy management and hands-on training of instrumentation in field.
2. Thw design of the asset condition survey, energy management forms and other Tech Proforma for WASA Faisalabad.
3. Identifying parameters to adopt the strategy of adjusting and optimizing energy requirements per unit of output.
4. Encourage WASAs in data collection, data entry, data analysis and in decision-making.
5. Recommendation for modification and repair/replacement of specific components.
6. Energy investment strategy plan with analysis, recommendations and implementation.

Phase-1

During Phase-1 energy cost of WASA was assessed by analyzing historic energy bills for the year 2013-2014 and a site survey termed as 'Condition Survey' of existing assets and facilities. The condition survey identified areas of improvement and low-cost measures to improve energy efficiency. This was done by assessing nine areas including two areas of processes and procedures recommended by WASA staff and ranked each assessment in terms of its asset condition.

An energy management strategic plan was developed and recommended as result of findings and analysis to reduce energy costs and consequently enhance revenue. Training session was carried out for effective implementation of the energy management.

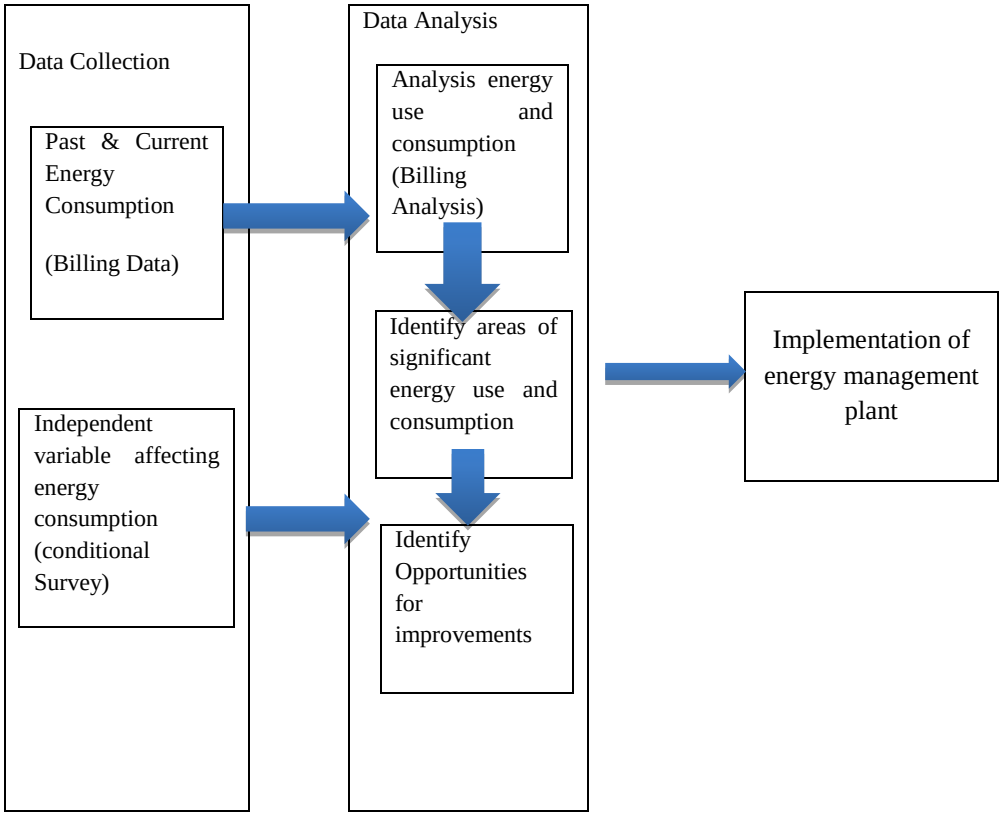


Fig 1: Enegry management process diagram Phase-1

Phase – 2

In phase-2 actual measurements and implementation of recommended options was carried out according to terms of reference defined as under.

Training & Capacity Enhancement	• Establish audit scope & mandate. • Design and Develop data collection tools & perfomas. • Hand on training on management methods and techniques.
Survey & Data Collection	• Conditional survey. • Collect billing data energy analysis
Finding and analysis	• Analysis consumption against variables effecting. • Identify recommended energy efficient options. • Identify opportunities for improvements.
Energy Management Plan	• Action plan and Targets(Phase-1)
Implementation of Action Plan	• Implementing the recommended and proposed action in the form of actual measurements(Phase-2).

Fig 2: Energy Audit Activities in Phase-I and Phase-II

V. CONDITION SURVEY ANALYSIS

Tube wells of WASA-Faisalabad were in better condition as the disposal station. 59% Tube wells were in excellent condition and only 2% were in poor conditions whereas 42% disposal stations(fig.3) were in poor condition and rehabilitation cost of both TS and DS is Rs.3.79 million. BOQ for WASA Faisalabad, is given in Table 1.

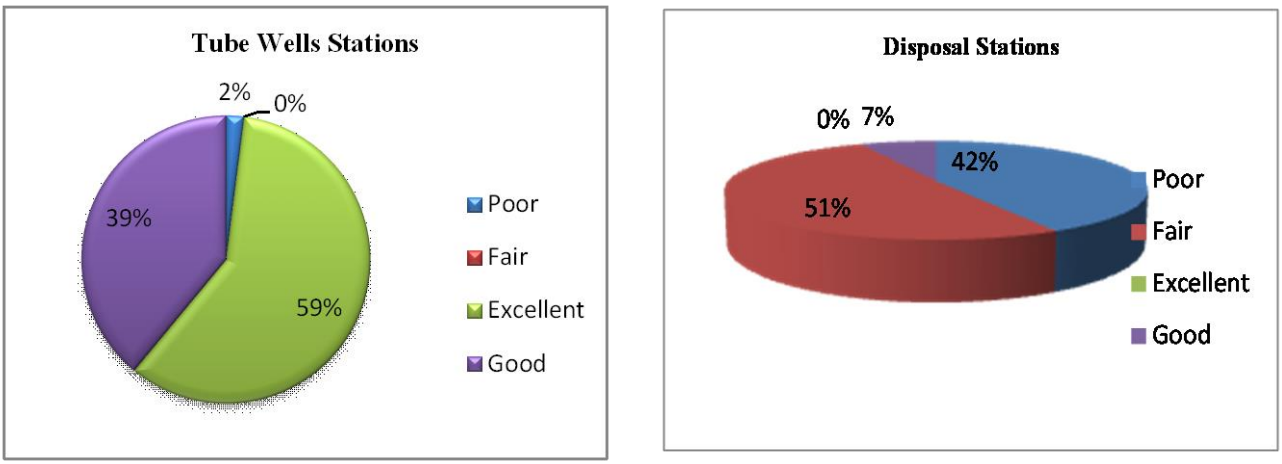


Fig -3:Condition Survey

Table-1: BOQ for WASA Faisalabad

Sr. No	Description	No. of Tube wells Effected	Scale	Tentative Price (PKR)
1	PVC 4 Core 370/0.083 Cable 120mm Copper Material	2	20 ft	155,903
2	30 KW MCU with Three Phase Soft Starter (Star Delta Type)	7	7 Units	350000
3	Pressure Gauge 0-10 Kg/cm2	9	9 Units	
4	Three Phase Automatic power factor Correction Relay up to 40 KVARs Compensation	29	29 Units	1595000
5	Non-Return Valve i) 12" pipe Size ii) 6" pipe Size	32	 i)29Units ii)03 Units	4888000
6	Bearings	1		4000
7	Cooling Fan Covers.	1		500
8	Energy Efficient 24" Exhaust Fan with Frame than 75 watts	1	1	8000
9	Fire Fighting Equipment, Safely Helmet with Head Torch Ear Muffs, Safely Gloves with Protector	54	54 Sets	81000
10	Chlorine Injector Pump	54	54 Units	324000
11	Lubricant Seals/Seal Gland Packing of Shaft Size	4	i)1 Unit 45mm Shaft ii)3 Unit for 30mm Shaft	2800
12	Thread Seals	6	6 Units for 30mm Shaft	3000
13	Operator Log Book	6	6	900
	Total:-			3,787,103

The summary of results of condition along with rehabilitation cost for WASA Faisalabad is summarized below in the Table 2

Table-2: Condition of Tube-well and Disposal Station of WASA Faisalabad and Rehabilitation Cost.

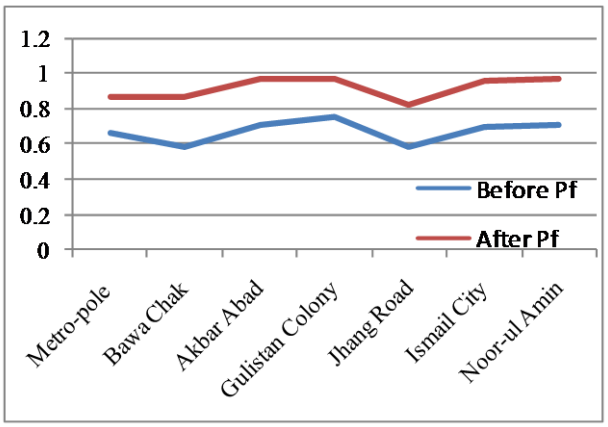
Condition Category	Tube well Station Condition (%)	Disposal Station Condition (%)	Rehabilitation Cost Million PKR
Excellent	59%	0%	3.8
Good	39%	7%	
Fair	0%	51%	
Poor	2%	42%	

VI. DISPOSAL STATION, WASA FAISALABAD

Table-3: List of Disposal Station with beofore and after Capacitor installations

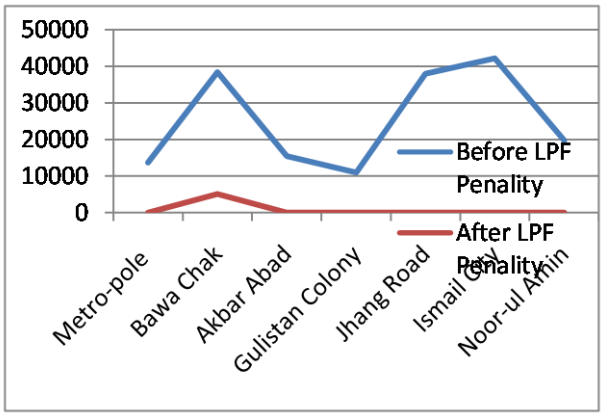
Sr. #	Disposal Station	Ref #	KVAR	Before Penalty (Rs)	After penalty (Rs)	Before P.F	After P.F	Load (KW)
1.	Gulistan Colony	24-13124-5401116	150	10,920	Nil	0.75	0.97	139 KW
2.	Metropole	24-13224-5403400	150	13632	Nil	0.66	0.87	135 KW
3.	PS-30 Bawa Chak	24-13124-5304300	112.5	38,400	5040	0.58	0.87	272 KW
4.	Jhang Road	24-13214-5404100	150	37,939	Nil	0.58	0.82	504 KW
5.	Ismail City	24-13123-5309580	225	42,166	Nil	0.69	0.96	454.31 KW
6.	Akbra Abad	24-13123-5313200	150	15,360	Nil	0.701	0.96	145 KW
7.	Noor Pur	24-13127-5704810	125	19,720	Nil	0.71	0.97	280 kw

VII. GRAPH OF POWER FACTOR AT DISPOSAL STATION BEFORE AND AFTER CAPCITOR INSTALLATION



Graph -1: Before and after capacitor installation

VIII. GRAPH OF LPF PENALITY AT DISPOSAL STRATIONS BEFORE AND AFTER CAPCITOR



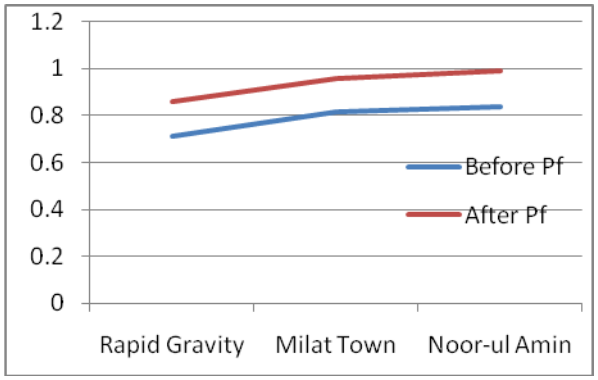
Graph -2: LPF Penality before and after capacitor installation

IX. WATER STATION, WASA FAISALABAD

Table-4: List of Tubewells with beofore and after Capacitor installations

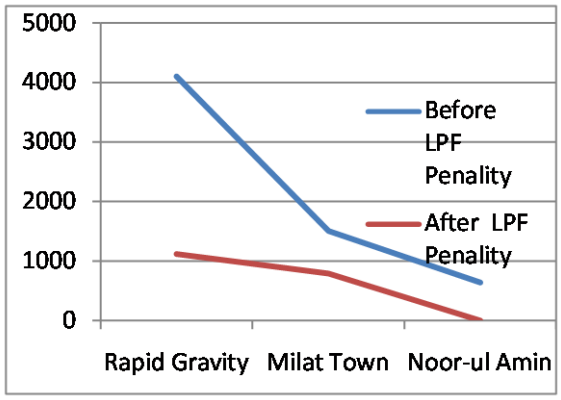
Sr. #	Water Station	Ref #	KVAR	Before Penalty (Rs)	After penalty (Rs)	Before P.F	After P.F	Load (KW)
1.	Rapid Gravity Ws#02	24-13132-5201250	100	4,104	1120	0.71	0.86	279.99 KW
2.	Millat Town Ws#05	24-13127-5702100	50	1,504	791	0.82	0.85	46 KW
3.	Noor-ul-Amin Ws#04	24-13127-6736300	25	640	Nil	0.84	0.99	23 Kw

X. GRAPH OF POWER FACTOR AT WATER STATION BEFORE AND AFTER CAPCITOR INSTALLATION



Graph -3: Before and after capacitor installation

XI. Graph of LPF Penality at Water Stations Before and AfterCapcitor Installation



Graph -4: LPF Penality before and after capacitor installation

X. FINDINGS AND ANALYSIS

The outcome of a Condition Survey assisted to analyze the conditions of the facility, possible energy losses of the assets make adjustments in order to reduce energy consumption and costs. In order to improve the condition of the asset, the following findings have been made for WASA Faisalabad.

1. Replacement of under-sized and damaged electric cable,
2. Replacement of Motor Control Unit with soft starter of appropriate size,
3. Installation of pressure Gauges on the delivery & suction pipe line. Installation of non- returning valves.
4. Replacement of noisy motor or provision of upper & lower bearing to avoid the intense vibrations in noisy motor
5. Installation of cooling fan on the motor to avoid the motor heating and burn out incidents.
6. Installation or repair of chlorine injector pumps to the water supply station based on water quality test.
7. Replacement of water thread seals to prevent the water leakage and rusting of the pipes.
8. Repair & maintenance of screening chamber of the waste water collection well.
9. Operator should have a log book (with standard operating procedures of pumps) to note down the specific parameters like discharge, pressure head, Kilowatts, power factor and pumping hours and timing.
10. De-silting of wastewater collection well.

XI. CONCLUSION & RECOMMENDATIONS

1. WASA Faisalabad is providing its service by using PKR 400 Million for FESCO bills with installed daily capacity of 11.03MW electricity.
2. It is recommended that in order to remove the power factor penalty either Static Capacitor or Automatic power factor relay can be used according to specific needs. The energy audit phase-I has gathered key information and carried out analysis to not only improve the service delivery but also enhance the condition of assets and power factor with significant cost saving of approximately 6-9 percent.
3. Energy audit findings revealed that the expected saving potential of PKR 60 Million (15 percent of total annual billing) in WASA Faisalabad from FESCO bills with institutionalizing of training, energy efficiency measures and appropriate operation and maintenance.
4. It is recommended that under PCGIP, this cost and intervention is including for approval in the procurement plans of WASA Faisalabad along with institutionalization of training efficiency measure and measurement by an energy efficiency unit in WASA Faisalabad.

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