The successfully performed and result oriented task of

ENERGY AUDIT

----A CASE STUDY
DHAROI RURAL REGIONAL WATER SUPPLY SCHEME

PROJECT HISTORY

As mitigating efforts to the excessive fluoride problem in North Gujarat GWSSB has implemented Dharoi Regional Water Supply Scheme covering 779 Villages/6 Towns of Mehsana and Patan districts based on Dharoi Reservoir on Sabarmati River as a sustainable surface source of potable water.

In the reservoir near dyke No. (4) works of Intake well, Pump house, Approach bridge (100mts) Electric Panel room, & vertical turbine pump set having discharge Capacity 2000 m^3/Hr & 78.50 mt. Head-6 Nos. (4+2 stand bye) has been constructed. From Intake well, Raw water is being pumped through two M.S. Rising mains having dia 1100mm up to 0.0 to 670mts chain age & afterwards it convey into 1422 & 850mm from chain age 671 to 6700 mts. Which terminates in the Distribution Chamber @ Main Head works Vav.

At main head works Vav there are two Rapid sand conventional Water Treatment Plants having Capacity of 2000m^3/Hr & 4000 m^3/Hr. with 20% Overloading Capacity i.e. Project is designed for 20 Hours For Storage of treated water there are three under ground sumps having capacity of 45 Lacs Lit-2.00 Nos. & 30 Lacs Lit-1.00 No. From underground sump the clear water is pumped to E.S.R. constructed @ same head works site having Capacity of 27.50 Lacs Lit-20.00 mts. height & 15.00 Lacs Lit1-18.00mt. height. For Pumping of Clear Water there is a clear water pumping station in two phase.

In Phase-I there are 5 (3+2 stand bye) horizontal centrifugal pump set having discharging capacity 1000$m^{3/}$Hrs. & 52.00mts. head. This Pump set Pumped the clear water towards 15.00 Lacs Lit ESR which is for (1) Dharoi (2) Kheralu (3) Vadnagar & @ Visnagar groups of the Project covering 212 Villages/3 towns ((1) Kheralu (2) Vadnagar & @ Visnagar).

In Phase-II there are also 5 (3+2 Stand bye) horizontal centrifugal pump set having discharging capacity 1000$m^{3/}$Hrs. & 52.00mts. head. This Pump set pumped the clear water towards 27.5 Lacs Lit

ESR which is for (1) Sidhpur (2) Unjha (3) Der-Balisana & @ Mudvada groups of the Project covering 166 Villages/2 towns (Sidhpur & Unjha).

From ESR constructed @ Vav Headwork site the clear water filled the sub head works ESR through Express M.S.Gravity main 2.00 Nos. of Diff. Diameter One for Kheralu,Vadnagar & Visnagar group & other one for sidhpur,Unjha Der-Balisana & Mudwada group. (Approx Length of bothline-160 Kms) & From Sub head work ESR clear water reach up to village level Sump through distribution network of A.C./PVC/M.S. Pipeline (Approx. Length 1050.00mts.)

While for Banaskantha District potable water supplied from 30.00 lac Lit Sump of Vav Headwork site up to Mumanvas/ Kothasana Sub Head Work site by gravity line & Than after supplied by pumping towards villages & Palanpur City.

The Project was completed & commissioned since June-2001 for Mehsana & Patan District while Part Project of Banaskantha District are completed & other are under commissioning.

The constructional features of DRRWSS are as under:

Intake at Dharoi Dam:

PUMP

Pump type	Vertical turbine pump
Make	Voltas
Number of pump	6
Number of normal working pumps	4
Design capacity	556 LPS,(2000 m3/hr)
Total head at Design capacity	78.2
Mtrs.Total duration of operation	continuous
Speed	959 RPM at 48.5 Hz.
Submergence require minimum	1.5 Mtr from bell mouth edge

Motor

Motor type	vertically mounted
Make	BHEL
Rating	600 kW
Voltage	6600
Full load Amp. Of stator	67

Starters

FCMA type Neutral soft starter-or 6.6KV, 600 KW motors-6 no

Transformers:

3000 KVA	11000/6.6KV	2 no
350 KVA	11000/415 volts	1 no

Clear water pumping station

PUMP

Pump type	HSCF Pump
Make	Voltas
Number of pump 5 in each phase	(10 pumps)
Number of normal working pumps	3 in each phase (6 pumps)
Design capacity	278 LPS, (1000 m3/hr)
Total head at Design capacity	58 Mtrs.
Total duration of operation	continuous
Speed	1440 RPM at 48.5 Hz.
NPSH	4 meters available

Motor

Motor type	TEFC SQ Cage induction horizontally mounted
Make	BHEL
Rating	220 kW
Voltage	600
Full load Amp. Of stator	24

Starters

FCMA type Neutral soft starter for 6.6KV, 220 KW motors-6 no **Transformers**:

3000 KVA	11000/6.6KV	2 no
250 KVA	11000/415 volts	1 no

PROCES HISTORY:

The process of energy audit in board is started in 2001.Though **it is a mandatory requisite of the connected load equal and above 200 K.W**.board has understand its vitality and started for energy audit in its bulk and major distribution network very early. The first task has been carried out in Dharoi Rural Regional Water Supply Scheme. Rates were invited among the authorized energy auditors and the lowest bidder **M/S SAKET PROJECTS** limited was awarded the job. The task to be performed were specified for the following components alongwith the remedial measures:

1. Performance evaluation of existing pumping machineries on intake well as well as CWPS Ph-I & Ph-II
2. Measurement of existing electrical distribution net work study on intake well as well as CWPS Ph-I & Ph-II
3. Water flow measurements in distribution system at key location for identifying the leakage in the water distribution network. CWPS Ph-I & Ph-II

Methodology:

The Energy Audit Study of the above mentioned areas should be carried out with the following methodology.

A) Electrical system study:

i. Individual Motors/Load Centers for various Electrical parameters like **V, A, Hz, P.F., KWH, KVARH, KVA, KVAR** etc. to evaluate the performance of motor. Also, ratings and locations of major capacitors shall be reviewed to suggest Power Factor Improvement Schemes, if required.

ii. Load study of all the major motors shall also be carried out for identification of under loaded/overloaded motors.

iii. Illumination study shall also be made by measurement of Lux level and lighting power, operating voltage etc.

iv. Electrical campaigns at L.T. main feeder for longer duration of 24 hours shall be carried out to establish **Demand Profile** and also rationalization of transformers, capacitors etc

As per the requirement, power analyzers for both balanced and unbalanced load Measurements shall be deployed.

B) Water Pumping System:

(i) Evaluation of pump performance has been done by simultaneous measurements of head, flow and power.

Flow measurements have been done using Ultrasonic Flow Computer. Power measurement has been done using microprocessor based power analyzer. Digital pressure indicator shall do measurement of head.

(ii)Study of pumping systems as a whole been done to understand the system requirement and identify the possibilities for optimization through retrofits/ replacement of pumps and installation of energy saving control devices.

2)Pressure/Head Measurement:

Having experienced realized the need for the accurate head measurements, we have acquired pressure transducers of high turn-down ratio and inbuilt dampening feature which allows us to have an accuracy of ± .075% as against ± 3-5% and more in pressure gauges.

3)For evaluation of pump performance power have been measured using

The Water Pumping System mainly comprises of

(i) Single pump operation
(ii) Parallel pump operations of multiple pump sets - even with different ratings
(iii) Single rising mains

(iv) Multiple rising mains
(v) Static head predominant
(vi) Frictional head predominant.

Energy audit of Water Pumping Systems essentially starts with the accurate measurements of head, flow and power. The analysis based on these measurements includes the preparation of operating characteristic curve and comparing it with the manufacture's rated curve for determination of the extent of derating and shift of the duty point. Besides pinpointing the pump inefficiency, the overall system inefficiency, should be identified.

The broad **measure**s generally considered for improvement **in pumping system** includes but not limited to

(i) Impeller Trimming
(ii) Installation of variable speed drive
(iii) Piping modification to reduce the system losses
(iv) Optimum selection of pump
(v) Refurbishment and/or coating of pump internals etc.

The **measures** generally considered for improvement in **electrical systems** includes

(i) Elimination of idle running by suitable automation
(ii) Installation of Energy Savers
(iii) Capacitor installation/relocation to reduce the cable losses
(iv) Transformer rationalization
(v) Maximum demand control
(vi) Reduction in Contract demand etc.

Evaluation of various alternative measures and suggestion of tailor made system for energy saving requires in depth understanding and analysis of system characteristics. Therefore, wide experience of various pumps and systems study is essential for bringing out the best of the results. Saket Projects Limited has carried out energy audits of various pumping system including **Mega Water Supply Schemes** of GIDC. The suggested measures were implemented and Saket Projects Limited was appointed as a **"Third Party Inspector"** to ascertain the results.

FINDINGS

Raw water pumping station:

Measurement of actual head and ideal system head at various flow conditions has been observed .it has been seen that the measured head closely matches with system head requirements and hence there is no additional pressure drop in the rising main.

Pumps →	***5***	***2, 4 and 5***
Measured flow (m3/hr)	2200	6070
Measured head (meter)	78.10	78.31
Head as per system curve (meter)	73.65	74.84

The total system curve that theoretical total flow with four nos. of pumps running in parallel is 7200 m3/hr i.e. 158.4 MLD at 80.19m head.

Action taken report: Raw water pumping station
Conclusion:

No	Component	Observation	Recommendation	Corrective action taken
1	Pump performance	System performance at present is satisfactory	No suggestions	Does not require any change
2	Electrical system profile	Present contract demand matches with the present actual max. Demand	No suggestions	Does not require any change
3	Present load profile	System performance at present is satisfactory	No suggestions	Does not require any change
4	Study of electrical distribution net work	System performance at present is satisfactory	No suggestions	Does not require any change
5	Presence of harmonics	System performance at present is satisfactory	No suggestions	Does not require any change
6	Transformer rationalization	At present trans. Eff. is 99.18 %to 96.56 %	No suggestions	Does not require any change
7	Capacitor rationalization	The each capacitor bank of 165 KVAR is giving around 180 KVAR at present op. voltage level	Additional running of 4 nos. of capacitor bank which gives around 1.0 (unity) P.F.	At moment of measurements they were not working due to fuse and tripping coil problems. Now rectified and put in operation as suggested.
8	Motor load study	Measurement of load at each motor reveals that avg.load factor on motors are within acceptable ranges.	No suggestions	Does not require any change
9	Illumination	Electronic ballast has not been installed in tube light expected saving potential is 18000/-Rs. Per year	Electronic ballast is to be installed in tube light	We are in process to install electronic ballast

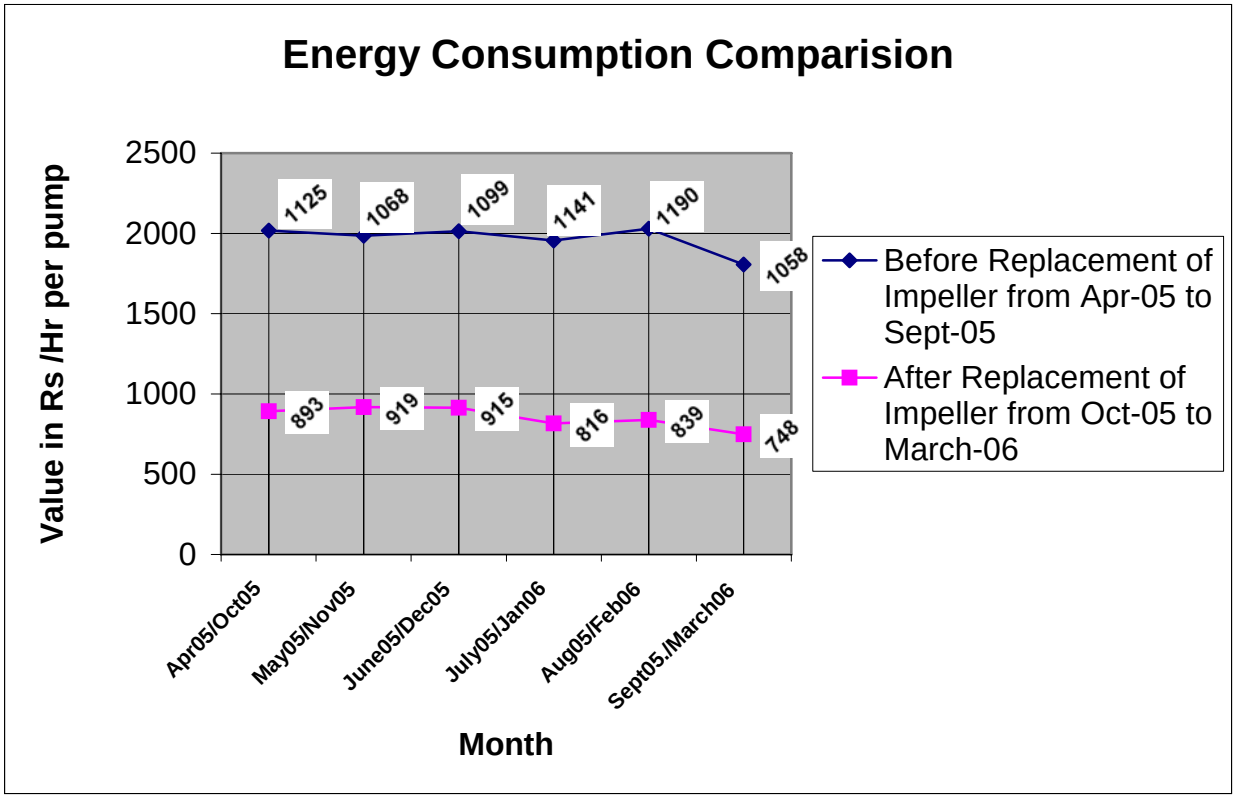
No energy saving scheme is suggested by auditor

Action taken report: Pump performance study

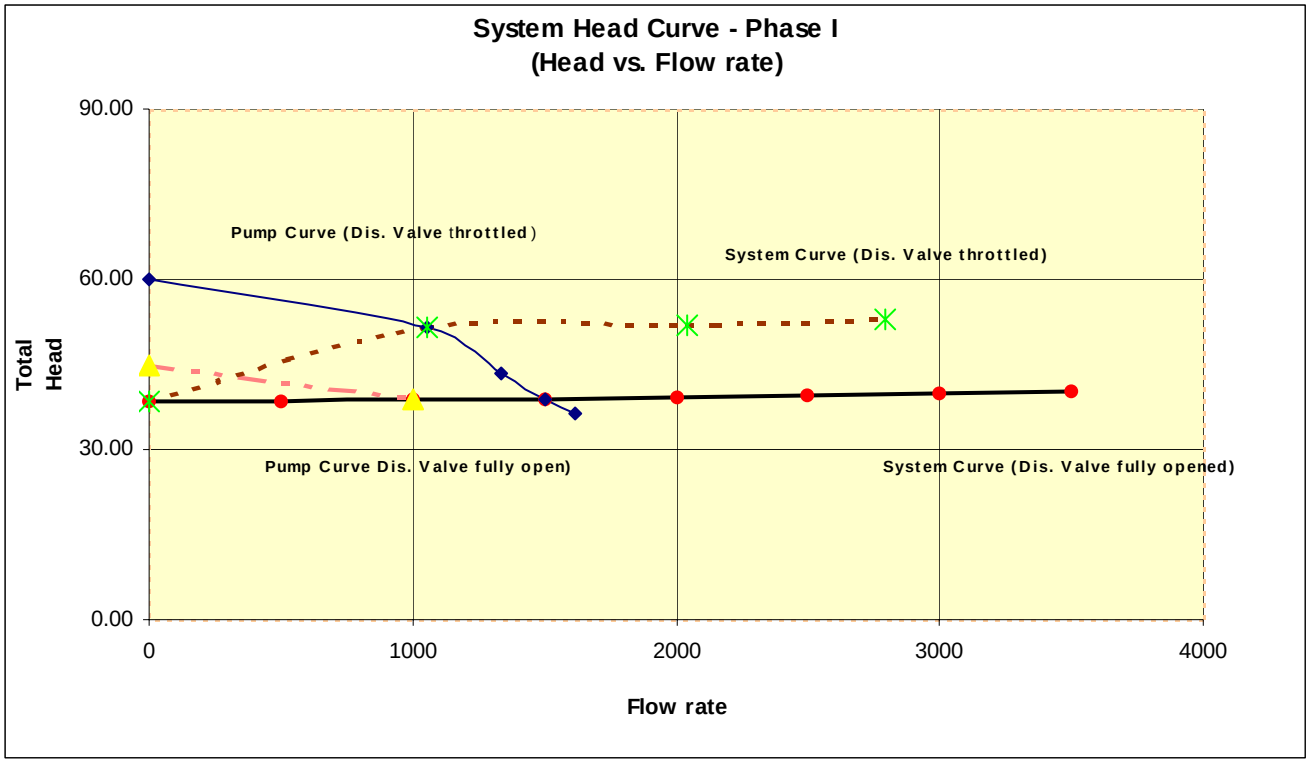
1	Operating flow of individual Pump 2000m3/hr matches with rated individual flow	No change require in impeller sizing
2	Present operating head is in the range of 75-79 m which matches with the rated head of 78.2 m.	
3	Pumps are running in good efficiency zone 75 % to 78 %	
4	The specific power consumption is between 0.03 to 0.34 kw/m3	

Clear water pumping station:

Observation	***Recommendation***	***Corrective action taken***
Study individual and parallel pump operation	Replacement of impeller, refurbishment with corro-coating in existing pumps with follow. Norms.	We have replaced impellers; in order to reduce cost, refurbishment corro-coating in existing pump is not done. Observed changes are mentioned as bellow.
Flow rate in individual pump is 1000-1025 m3/hr which matches with rated flow of 1000m3/hr.	Increase in flow at 1050 m3/hr.	1040 m3/hr., 1041 m3/hr., and 1019 m3/hr. observed after repl.
The measured pump pressure is in the range of 50-53 meter, with discharge valve throttled condition with two pumps running in parallel	Reduction of operating head 40 meter	Observed head after replacement of impeller 39.05 Mtr, 39.24 Mtr, 39.76 Mtr.etc.
Present measured system pressure is 39 meter in phase –I and 40 meter in phase-II, whereas the rated head of pump is 52 m. the head loss due to throttled is almost 13 meter		
The operating efficiency of pump is reduced 69 % to 76% in phase-I and 68 % to 78% in phase –II because pumps are running away from duty condition. Means energy loss.	Increase in pump operating eff.=84 %.	Pump efficiency has been increased 82.33 %, 81.98%, 81.86% etc.
Present power consumption=225 kw per pump	Power consumption will be=159 kw per pump	Powerconsumption BKW=134.29kw KW(m) =145
Specific power consumption is 0.22 kw/m3 in phase-I and 0.20 kw/m3 in phase –II	Sp. power consumption will be 0.1442 kw/m3	0.14 kw/m3 by calculation



***A static head predominant system, Friction head is 5% of Total head.**
***66 KW Power loss due to throttling of 13.25 mt.**


System Head Curve - Phase I
(Head vs. Flow rate)
90.00
60.00
30.00
0.00
Total Head
Pump Curve (Dis. Valve throttled)
System Curve (Dis. Valve throttled)
Pump Curve Dis. Valve fully open)
System Curve (Dis. Valve fully opened)
0
1000
2000
3000
4000
Flow rate